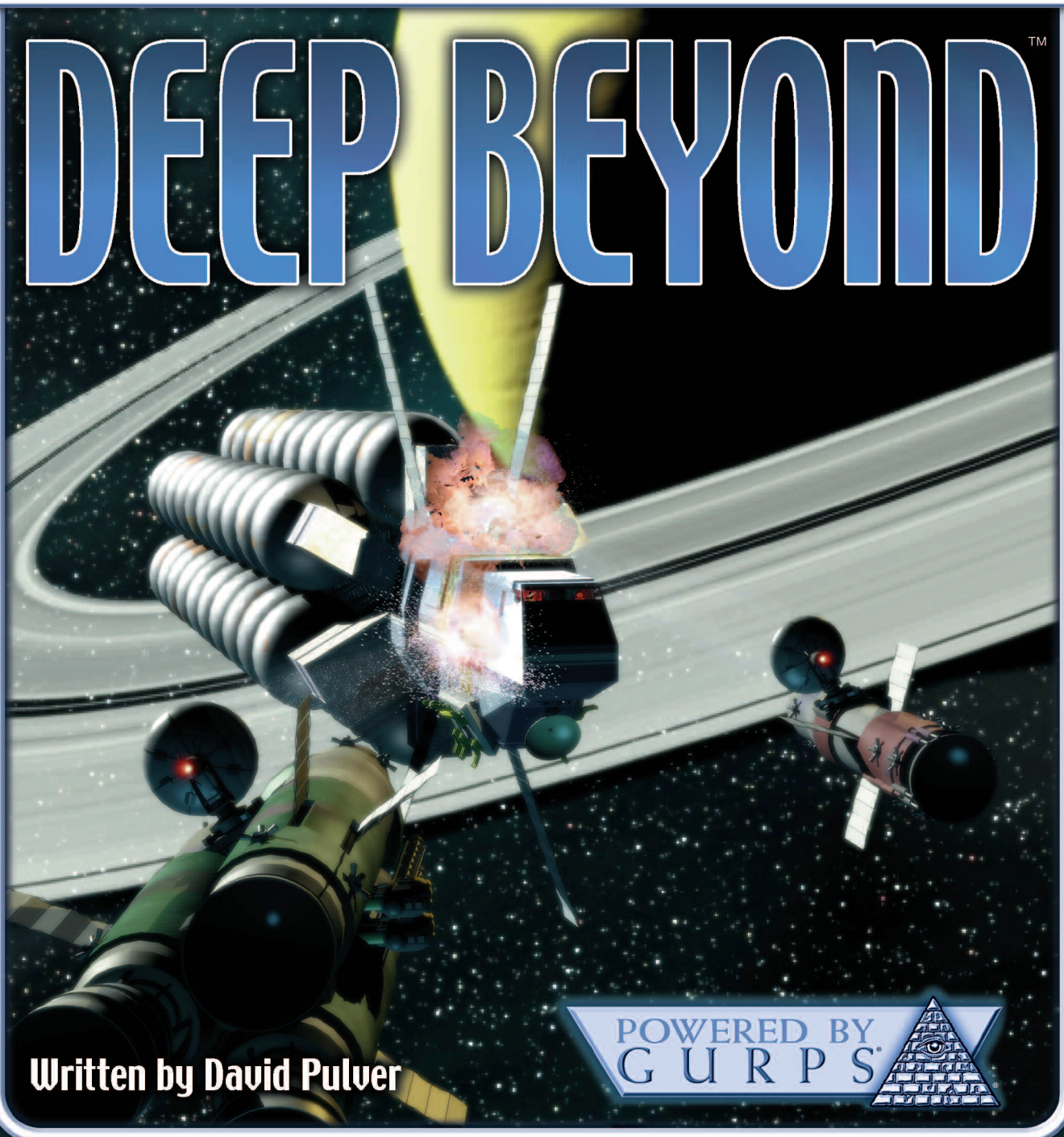
TransHuman Space

Deep Beyond



Written by David Pulver

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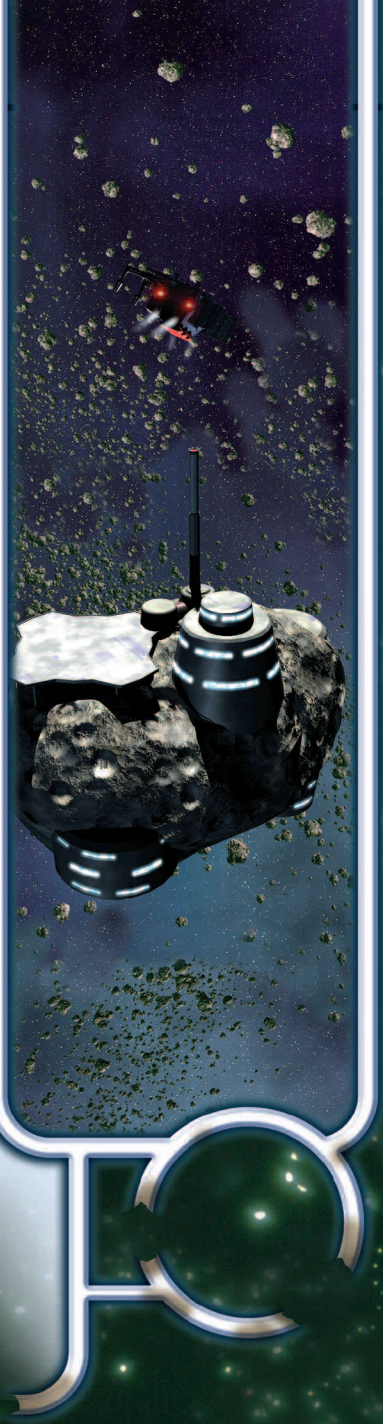
The Edge of Nowhere

The Deep Beyond is the solar system's final frontier. A vast zone stretching from the asteroid belt to the edge of interstellar space, its siren call has drawn researchers, pioneers, visionaries – and outlaws. ***Deep Beyond*** includes:

- Expanded descriptions of the asteroids, gas giants, moons, and comets of the outer system. Visit the gas mines of Saturn and Europa's icy oceans!
- What it's like to grow up in the Deep Beyond . . . as a Duncanite parahuman, a sapient AI, or even an enslaved bioroid.
- Dozens of organizations, from the rebel ghosts of Axon to the cyber-soldiers of the 82nd Spaceborne.
- New character types, from judges-for-hire to Jump RATS and Swarmdozers.
- New vehicles and technologies: ice-hulled Gypsy Angel spacecraft, portable lasers, prospector swarms – even the black hole power plant.



Transhuman Space is required to use this supplement. ***GURPS Basic Set***, *Third Edition Revised*, ***Compendium I***, and ***Transhuman Space: In The Well*** are also recommended.

Written by David Pulver
Edited by Steve Jackson and Scott Haring
Cover by Jesse DeGraff
Transhuman Space **designed by David Pulver**

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TransHuman Space

DEEP BEYOND™

By David Pulver • Cover by Jesse DeGraff

Edited by Steve Jackson • Illustrated by Attila Adorjany, Andy Clarkson, Jesse DeGraff, Dennis Detwiller, Thomas Floyd, Steve Hartley, Jeremy McHugh, Torstein Nordstrand, Klaus Scherwinski
Map design contributions: Nelson Cunnington • Additional editing by Scott Haring

***GURPS* System Design ■ Steve Jackson**
Managing Editor ■ Andrew Hackard
***GURPS* Line Editor ■ Sean Punch**
***Transhuman Space* Line Editor ■ David Pulver**
Project Administrator ■ Monique Chapman
Art Director ■ Philip Reed
Production Artist ■ Justin De Witt
Print Buyer ■ Monica Stephens
Errata Coordinator ■ Andy Vetromile
Sales Manager ■ Ross Jepson

Lead Playtester: Kenneth Peters
Playtesters: John Buston, Frederick Brackin, John Freiler, Juergen Hubert, Anthony Jackson, MA Lloyd, Phil Masters, David Morgan-Mar, Nana Yaw Ofori, Robert Prior, Jeff Raglin, Dalton Spence, Constantine Thomas

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STEVE JACKSON GAMES

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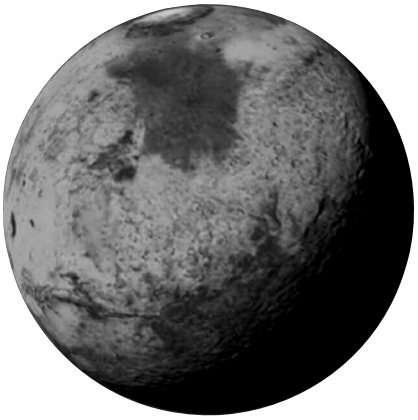

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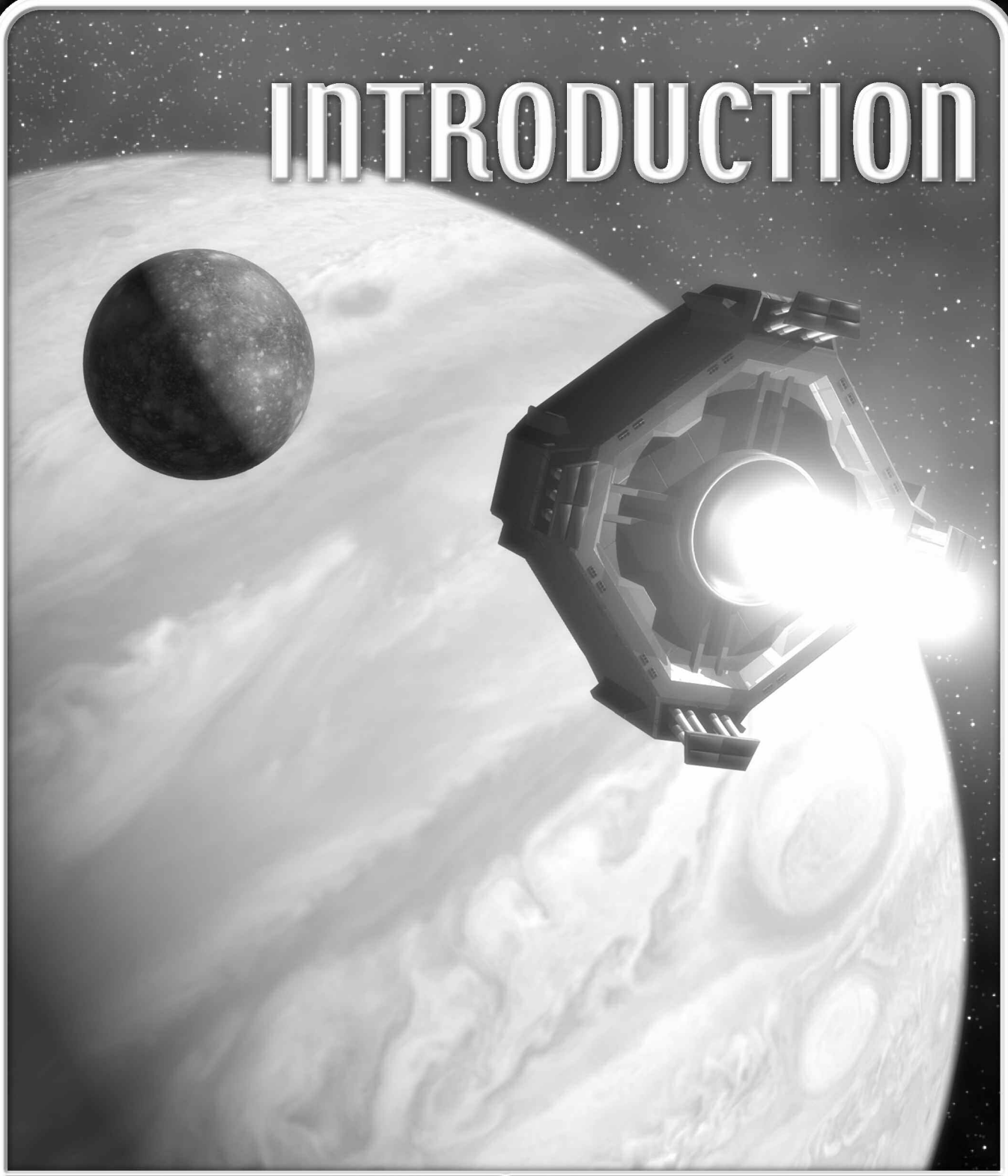
INTRODUCTION



The Deep Beyond is the solar system's last frontier. It is the region of space outside the orbit of Mars, encompassing the countless asteroids of the Main Belt; the four giant planets Jupiter, Saturn, Uranus, and Neptune, and their many moons; the two clusters of Trojan asteroids; and the icy realm of the Centaurs and Kuiper Belt. Its nebulous boundary is the vast Oort Cloud, where Sol system merges with interstellar space.

The isolation of the Deep Beyond is a fertile womb for outlaw subcultures, nonhuman life, and exotic technologies, but it's also a source of valuable resources and scientific innovation vital to the interests of powerful nations and transnationals. This clash of ways and memes breeds conflict, from crime and terrorism to the threat of interplanetary war.

About Transhuman Space

The ***Transhuman Space*** series presents a unique hard-science and high-biotech universe for roleplaying. Set in the Solar System in the year 2100, it is a setting rich in adventure, mystery, and ideological conflict. The core book is ***Transhuman Space,*** which presents an overview of the setting. Other books available include ***Fifth Wave*** (focusing on Earth), ***In the Well*** (Mars and the inner system) ***Orbital Decay*** (terror in Earth orbit), ***Spacecraft of the Solar System*** (a compendium of spacecraft), and ***Personnel Files*** (a collection of detailed, ready-made characters), with more to follow.

About the Author

David Pulver has been a science fiction fan since before he learned to read and a gamer since 1978. The creator and editor of the ***Transhuman Space*** line, he lives in Victoria, British Columbia. David has authored or co-authored over 50 roleplaying games and sourcebooks.

About GURPS

Steve Jackson Games is committed to full support of the ***GURPS*** system. Our address is SJ Games, Box 18957, Austin, TX 78760. Please include a self-addressed, stamped envelope (SASE) any time you write us! Resources include:

Pyramid (**www.sjgames.com/pyramid/**). Our online magazine includes new ***GURPS*** rules and articles. It also covers ***Dungeons and Dragons, Traveller, World of Darkness, Call of Cthulhu,*** and many more top games – and other Steve Jackson Games releases like ***In Nomine, Illuminati, Car Wars, Toon, Ogre Miniatures,*** and more. *Pyramid* subscribers also have access to playtest files online!

New supplements and adventures. ***GURPS*** continues to grow, and we'll be happy to let you know what's new. For a current catalog, send us a legal-sized or 9"×12" SASE – please use two stamps! – or just visit **www.warehouse23.com**.

Errata. Everyone makes mistakes, including us – but we do our best to fix our errors. Up-to-date errata sheets for all ***GURPS*** releases, including this book, are available on our website – see below.

Gamer input. We value your comments, for new products as well as updated printings of existing titles!

Internet. Visit us on the World Wide Web at **www.sjgames.com** for errata, updates, Q&A, and much more. ***GURPS*** has its own Usenet group, too: rec.games.frp.gurps.

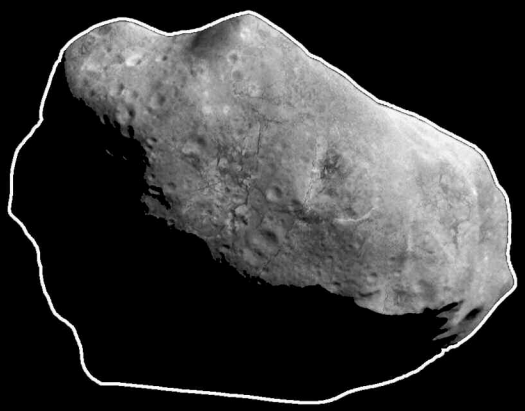
GURPSnet. This e-mail list hosts much of the online discussion of ***GURPS.*** To join, send e-mail to majordomo@io.com with "subscribe GURPSnet-L" in the body, or point your web browser to **gurpsnet.sjgames.com**.

The ***Transhuman Space: Deep Beyond*** web page is at **www.sjgames.com/transhuman/deepbeyond/**.

Page References

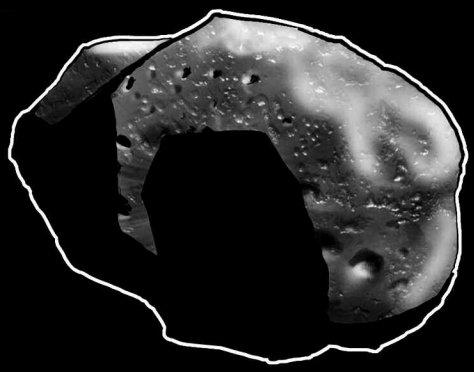
Rules and statistics in this book are specifically for the ***GURPS Basic Set,*** *Third Edition.* Any page reference that begins with a B refers to the ***GURPS Basic Set*** – e.g., p. B102 means p. 102 of the ***GURPS Basic Set,*** *Third Edition.* Page references that begin with CI indicate ***GURPS Compendium I.*** References to ***Transhuman Space*** books are are FW for ***Fifth Wave,*** ITW for ***In The Well,*** SSS for ***Spacecraft of the Solar System,*** and TS for ***Transhuman Space*** itself. The abbreviation for *this* book is DB. For a full list of abbreviations, see p. CI181 or the updated web list at **www.sjgames.com/gurps/abbrevs.html**.

1 THE ASTEROIDS



Stony Asteroid

Metallic Asteroid



Carbonaceous Asteroid

The Department of State cautions U.S. citizens visiting the Deep Beyond to exercise precautions when traveling to certain Main Belt and Trojan asteroids. In addition to the continuing slight risk of AKVs (Autonomous Kill Vehicles) left over from the Pacific War, new violence has flared up in recent months.

Most incidents have involved clashes between Chinese nationals and stateless individuals, primarily Duncanites. However, 87 U.S. citizens were victimized in the Main Belt and Trojans in 2099, three times as many as in 2098. British, Chinese, and private security patrols have kept the space around Aletheia, Ceres, Hygeia, and Pallas reasonably secure, but risks are greater when traveling elsewhere, and the danger of large-scale terrorist incidents or attacks on homesteaders cannot be ruled out.

The majority of violent incidents last year were connected to ongoing conflict between Red Duncanite "blackjacker" militias and the People's Liberation Army Navy Space Force (PLAN-SF). There has also been an increase in softjacking by Digital Creationist radicals. Recent police actions undertaken by EDI, Royal Navy, and South African forces in the Main Belt against rogue infomorphs and Martian Triad crime cells have contributed to the hostilities. The U.S. government's ability to assist kidnapped, softjacked, or xoxnapped American or foreign citizens in the Belt and Trojans is limited, but individuals in distress should contact the U.S. consulate office at Aletheia.

For further information regarding the Main Belt and Trojan asteroids, travelers should consult the Department of State's latest Consular Information Sheet for the Deep Beyond.

This replaces the April 6, 2099 Travel Advisory for the Main Belt and Trojan Asteroids.

– U.S. State Department Travel Advisory, December, 2099

The Main Belt and Trojan Asteroids include more than a million tiny worlds, home to over 100,000 sapient beings. Anarchists, fascists, Christians and Buddhists, decelerationists and scientists and transhumanists . . . it's not surprising they don't get along.

Discovering the Asteroids

"Let the distance from the Sun to Saturn be taken as 100, then Mercury is separated by 4 such parts from the Sun. Venus is 4+3=7. The Earth 4+6=10. Mars 4+12=16. Now comes a gap in this so orderly progression. After Mars there follows a space of 4+24=28 parts, in which no planet has yet been seen. Can one believe that the Founder of the universe had left this space empty? Certainly not. From here we come to the distance of Jupiter by 4+48=52 parts, and finally to that of Saturn by 4+96=100 parts."

– Johann Elert Bode,
Anleitung zur Kenntnis des Gestirnten Himmels

In 1772, a German astronomer named Johann Bode, working from the earlier theories of Johann Titius, realized that the orbital spacing of the planets followed a specific mathematical pattern. From this he formulated Bode's Law, which predicted the presence of a planet between Mars and Jupiter, where no such planet had been seen. A few years later, the newly discovered seventh planet, Uranus, found beyond the orbit of Saturn, also conformed to Bode's relationship. Thus encouraged, Europe's best astronomers began a concerted hunt for the "missing planet" that was believed to orbit between Mars and Jupiter.

On the first day of the 19th century, the astronomer Giuseppe Piazzi discovered an object that he initially believed was a new comet. After its orbit was better determined, it was obviously something else. It resembled a tiny planet, much smaller than Earth's moon, and was exactly where Bode had predicted it should be. Piazzi named this minor planet Ceres, after the Roman goddess of grain. Little more than a year later, another small body, Pallas, was discovered, sharing a similar orbit. The astronomer William Herschel declared that since these bodies were so tiny compared to the planets, they should be called asteroids ("small stars") rather than planets.

The two asteroids were not unique. Countless more asteroids would be discovered, making up an "asteroid belt" of millions of discrete objects circling the sun.

The Earth should be regarded as the womb of life – but one cannot remain in the womb forever.
– Frank Tipler

Asteroids

An asteroid is any rocky or metallic body that isn't one of the major planets, their moons, or one of the comet-like ice dwarfs of the Kuiper Belt and Oort Cloud.

Asteroids are leftover detritus from the birth of our solar system, prevented by Jupiter's strong gravity from forming an actual planet. Instead, they coalesced into many smaller bodies. That was 4.6 billion years ago. Since then, most of these original "parent body" asteroids have been further fragmented by high-velocity collisions, resulting in the countless smaller asteroids that exist today.

The vast majority of the asteroids exist within the Main Belt or "asteroid belt," circling the sun between the orbits of Mars and Jupiter. The asteroid belt is a roughly disk-shaped region about 2 to 4 AU distant from the sun and 0.2 AU deep. It straddles the point (2.8 AU from the sun) where Bode's Law had predicted a planet would be found.

Most Main Belt asteroids follow elliptical but stable orbital paths around the sun. They travel in the same direction as the Earth, but take three to six years to complete an orbit. Asteroid orbits are not uniformly distributed over the Main Belt. Due to the gravitational influences of Mars and Jupiter there are some relatively empty orbital paths, called Kirkwood Gaps, where fewer asteroids exist. Groups of asteroids also exist that have relatively similar orbital characteristics – see *Asteroid Families*.

Asteroid Families

An asteroid family is a group of Main Belt asteroids that follow very similar orbital paths. Families are named after the lowest-numbered (first-discovered) asteroid belonging to them. They include the Cybeles, Eos, Floras, Hildas, Hungarias, Koronis, Phocaea, and Themis families. About 45% of asteroids belong to identifiable families.

Asteroid families were formed when a sizable asteroid suffered a major collision with another large body, breaking one or both of them into fragments, some of which followed the same orbit. Family members are usually similar in composition. Asteroid families *do not* represent tight clusters of asteroids in physical proximity – two asteroids may have nearly identical orbits, on opposite sides of the sun.

Asteroid Characteristics

The Main Belt includes 16 huge asteroids that are 150 miles or more in diameter (the biggest is Ceres, 527 miles across). There are also thousands of mid-size asteroids 10 miles or more in diameter, a few million asteroids a half-mile or more in diameter, and billions of meteoroids ranging in size from large boulders to tiny pebbles. Even so, the combined mass of all the asteroids in the Main Belt is unimpressive compared to the planets – if gathered together, they'd only form a sphere about half the size of Luna.

On average, the separation between asteroids that are a mile or more in diameter is about a million miles (roughly 0.01 AU). However, the asteroid belt is not quite as empty as this – there's usually a chunk of rock a couple of hundred feet across (big enough to mine or hide behind) every 100,000 miles, and a boulder several feet across every 10,000 or so miles.

Asteroids can be even closer together – many asteroids are orbited by other asteroids, the result of collisions that ejected debris into a stable orbit. A typical asteroid moonlet orbits its primary at a distance of about 3-6 times the larger asteroid's diameter. Most asteroid moons are less than one-tenth the size of their primaries, but a few are larger. Some are "doubles," with two roughly equal bodies orbiting a common center of mass.

Minor Asteroid Populations

Most of the asteroids are in the Main Belt. The other populations include;

Near-Earth Asteroids: A much smaller group of asteroids (see p. TS40) that lies inside the orbit of Mars (and some of which also cross Earth's orbit). Few NEAs are more than a couple of miles in diameter.

Trojan Asteroids: Two large clusters of asteroids are found at Jupiter's Trojan Points. See p. 29.

Centaur Asteroids: These are located in the outer system (p. 70); many are former comets.

Eccentric Asteroids: A few asteroids have highly eccentric orbits and don't fit into any of these classifications.

Most asteroids in these groups were originally Main Belt asteroids (or comets, in the case of the Centaurs) whose orbits were perturbed into different paths as a result of external influences, such as Jupiter's gravity or collisions with other bodies.

Asteroid Taxonomy

There are many different types of asteroids, but the majority are classed as metallic, stony, carbonaceous, or frozen volatile. In the Main Belt, metallic and stony asteroids predominate in the "inner Main Belt," closer to the sun, while carbonaceous and frozen volatile asteroids are concentrated further away from the sun, in the "outer Main Belt."

Metallic Asteroids

Metallic asteroids resemble dirty, pock-marked metal boulders. They are the least common of all asteroid types, representing about 5% of the total population. Most are found in the inner Main Belt, just past the orbit of Mars.

When the solar system formed, the original "parent body" asteroids in the inner Main Belt contained mostly ordinary rock, iron, and other heavy metals, but also a salting of unstable radioactive isotopes such as aluminum-26. As these decayed, they generated intense heat, causing the asteroids to melt. Under the influence of gravity, the molten asteroids became differentiated – iron and other heavy metals sank deep into their cores, while lighter rock and a coating of solidified lava formed their crusts and mantles. Once they cooled, these large primeval asteroids had an interior structure similar to that of the planets.

Few of these primeval differentiated asteroids survived intact – most were shattered by billions of years of inter-asteroid collisions. Today's metallic asteroids are the fragments of the primeval metal cores: large chunks of nickel-iron laced with "impurities" that include platinum, iridium, uranium, gold, and other valuable ores. This makes a metallic asteroid a potential treasure trove of precious and industrial metals.

Stony Asteroids

Stony asteroids are a dirty nickel color, a bit darker and more heavily cratered than the metallic asteroids. There are various kinds of stony asteroids, which can be further subcategorized as either *silicate* (mostly rock) or *stony-iron* (rock and metal). About 15% of all asteroids are this type.

Silicate asteroids usually have the same origin as the metallic asteroids, but instead of being fragments of primeval asteroid cores, they're chips of the rocky outer crust and mantle. Silicate asteroids are mainly found in the inner region of the Main Belt.

Stony-irons are often fragments of smaller primeval asteroids that never underwent differentiation, due to their lower gravity or lack of radioisotopes. Also known as "ordinary chondrites" (named after a class of meteorites), these undifferentiated asteroids contain grains of metallic iron mixed with iron and magnesium silicates and other minerals. Like the metallic asteroids, the stony-irons can contain valuable quantities of metals such as platinum

and gold, but as they are undifferentiated, the metals are in the form of grains rather than specific veins. Stony-irons are usually found in the central Main Belt.

Carbonaceous Asteroids

A carbonaceous asteroid has a charcoal-colored surface pitted with craters and crevasses. Areas exposed to sunlight may vent small plumes of gas, as volatiles sublime into space. Similarly, frost may form on the asteroid at night.

Carbonaceous asteroids are the most common type, making up 75% of the total Main Belt population. They are concentrated in the outer Main Belt. The asteroids that formed there were comparatively short of heavy metals and radioisotopes, and did not undergo the process of differentiation that created the metallic asteroids. Carbonaceous asteroids are a mix of silicate material, carbon, water ice, and a small amount of metals, as well as frozen gases such as nitrogen, hydrogen, and oxygen.

Most primeval carbonaceous asteroids were shattered by collisions into many smaller bodies, but a few big ones (such as Ceres) have survived largely intact since the formation of the solar system. Carbonaceous asteroids contain a larger fraction of volatiles (substances that are gaseous at terrestrial temperatures) than do ordinary terrestrial rocks. Hence, they have a somewhat lower density.

Carbonaceous-Volatile Asteroids and Frozen Volatile Asteroids

These asteroid classes are found farther away from the sun, in the outermost part of the Main Belt and the outer solar system beyond. it. They represent about 10% of all Main Belt asteroids, as well as almost all of the Trojan and Centaur asteroid population.

They are similar in composition to the carbonaceous asteroids, but have a higher ratio of volatiles to silicate rock. They are hard-frozen hydrocarbon sludge, mixed with rocky chunks, water-soluble salts, ice, magnetite, clay, and some metals. Many of these asteroids, especially the dark, reddish-spectrum "D-type" asteroids that predominate in the Trojans and outer system, are rich in primitive organic material and carbon polymers.

Many of the smaller moons of the gas giants are similar to large frozen volatile asteroids.

Other Asteroid Types

There are other rarer asteroid types, such as Vesta and Pallas (surviving primeval differentiated bodies with a structure similar to Luna's) or the Vesta-type asteroids (basalt chunks of molten rock that were knocked off Vesta by collisions).

Main Belt Astrography

1.9-2.3 AU: The Inner Main Belt, dominated by stony silicate and metallic asteroids.

2.4-3.2 AU: The Central Main Belt, dominated by stony-iron asteroids.

3.3-4 AU: The Outer Main Belt, dominated by carbonaceous asteroids.

4-5 AU: The Outermost Main Belt, dominated by carbonaceous-volatile asteroids.

Asteroid Structure

The largest asteroids, such as Ceres, Pallas, Vesta, and Hygeia, have been pulled into roughly spherical shapes by their own gravitational attraction. Most other asteroids are fragments of larger bodies that have undergone repeated collisions – they are irregular chunks. Some are "contact binaries" where two or more bodies collided and mashed together, forming odd shapes like dog bones or barbells.

Rubble Piles

Some asteroids are solid, homogenous bodies, but many others, particularly stony and carbonaceous asteroids 5-50 miles in diameter, are rubble piles. These are asteroids that were completely shattered by a massive collision with another asteroid, but whose debris cloud had enough gravitational attraction to reaccumulate into a single mass.

A rubble pile consists of multiple rocks and chunks of gravel weakly bound by gravity. The component elements may vary in size. For example, a 10-mile-diameter rubble pile may have several solid hill-sized chunks a few miles across, many smaller boulders, plus numerous interior cavities. Rubble piles can be easy to mine, but aren't suitable for use as Cole or shell habitats (see *Habitats,* p. 132). They are impractical to move via mass driver, since any linear acceleration greater than the gravitational attraction that holds the rubble pile together will cause it to fly apart.

The conclusions are staggering: the materials available in the Asteroid Belt would suffice to maintain indefinitely a human population of at least 10 million billion people – about one million times the maximum carrying capacity of Earth.

– John S. Lewis

Asteroid Rotation

All asteroids are spinning, unless their rotation was stopped through deliberate engineering. Rotational periods (the asteroid's "day") vary from 2 hours to 50 days. The average is dependent on the asteroid's size. Very large asteroids (100 miles or more in diameter) usually rotate fairly quickly (taking an average of 5-8 hours), while most others complete one rotation in about 9-12 hours. This is because larger asteroids are less affected by collisions, which tend to rob an asteroid of angular momentum and slow its rotation.

Rotational period can be a good guide to an asteroid's composition – a rubble pile can't rotate as fast as a homogenous body. Rubble piles accrete due to gravitational attraction. As rocks collide, those with too much angular momentum bounce away again. Those with little angular momentum, or those whose momentum is canceled by the collision, will join the rubble pile. And any later strike that would have imparted angular momentum to a solid body will just scatter a part of the rubble pile instead. Thus, rubble piles start with little rotation and have no way to gain any.

Very slow rotations are also common in asteroids that have their own moons.

The Asteroid Environment

"Katsumi Latisha Payne is the winner in the 17th annual Ceres pogo-stick race, having finished the 5-km course in record time without falling or achieving escape velocity. She defeated last year's champion Thomas Bakunin Chang (second place), whose unfortunate detour into a dust pool cost him visibility and crucial seconds in the final half-mile. When the dust settled, Payne was in the lead, and held her first-place position until she crossed the finish line. Special thanks to all our volunteers for ensuring that this year's Ceres Pogo 5000 was run without any fatalities . . ."

Asteroids are airless environments with almost negligible gravity. An average small asteroid, about 100 yards in diameter, would have a surface gravity about 0.000015 G and an escape velocity of a mere 0.2 mph. This makes even an ordinary walking pace impossible – a bounce would send a person flying off into space. Hopping, flying, or crawling is much easier than walking, and running is out of the question.

Gravity will be a bit higher on larger asteroids, but not significantly so . . . each doubling of asteroid diameter gives an eight-fold increase in mass, but only doubles surface gravity. Even Ceres, the largest asteroid, has a surface gravity of only 0.038 G.

It's easy for humans or human-sized cybershells to move large object, since their weight is negligible. Large, light structures can be built, as gravity isn't a factor. However, heavy work (such as mining) can be tricky to perform without pushing oneself off into space. On the dusty, uneven surface of an asteroid, magnetic boots or sticky footwear are impractical. People and machines will often be secured by cables or anchors bolted onto the asteroid or wrapped around massive boulders. Some cybershells are designed with multiple clawed arms and legs to allow them to attach themselves to the asteroid. Use the *Microgravity* (p. TS54) and *Vacuum* (p. TS57) rules for action on an asteroid's surface. Microgravity also applies inside any asteroid habitat lacking artificial gravity.

As with most vacuum environments, surface temperatures depend on whether a location is in sunlight or shadow. Objects exposed to sunlight are warmer (depending on how far the asteroid is from the sun), while those in shadow gradually become very cold. Temperatures in the Main Belt can range from about 150º to -260º F.

Asteroid Landscapes

An asteroid's overall color depends on its type: metallic gray for metal asteroids, a "potato" shade of brownish-gray for most stony bodies, and a dark reddish-brown to coal black for carbonaceous bodies. Asteroids are heavily cratered, with a great many loose rocks scattered about on the surface, ranging from pebbles to house-sized boulders. The asteroid's surface is covered with regolith, a mixture of dust and small rocks formed by billions of years of meteoritic bombardment.

The Horizon

The curvature of a planet, moon, or small body can limit line-of-sight visibility, and weapon and sensor ranges. The horizon can be very significant on a small body such as an asteroid or an outer moon of a gas giant. On an irregularly shaped, rapidly spinning asteroid, things may appear even stranger! A rough formula for determining how far away someone can be spotted before they vanish behind the horizon:

Horizon (yards) = square root of [(D × 1,760 × H) + (H^2)]

D is the diameter of the body in miles, while *H* is your eye height above the local base level plus the height of the object you are observing, in yards.

For the actual distance to the horizon, just use eye height.

Example: Two people standing on Ceres (527 miles in diameter), each about 2 yards high, can see one another at up to about 1,900 yards.

Note that for small bodies, like asteroids, this formula is a *very* rough rule of thumb, as many are elongated or otherwise oddly shaped rather than spherical.

Dealing with Dust

A dust cloud can be produced by a surface explosion, drilling and mining, a reaction engine operating within a few yards of the surface, or anything else the GM thinks is likely to raise one. A vehicle or large cybershell (one big enough to have Inconvenient Size) can also stir up a dust cloud, as will powered takeoffs or landings.

A cloud may persist from several seconds to many hours after a disturbance. This depends on surface gravity – dust settles in about 10 seconds on a large asteroid like Ceres or Vesta, but would takes several hours on an asteroid only 100 yards across. A dust cloud can interfere with vision (and visually aimed attacks), as well as anything else that requires proper vision, such as Piloting or Free Fall rolls; assume a default penalty of -2, but the penalty could be increased to -3, -4, or even -5 for a very thick cloud of dust as might be produced by an ongoing mining operation.

Electrostatically charged dust from a dust pool may stick to surfaces until carefully cleaned, even after the cloud itself has dispersed. A dust cloud may coat a visual sensor, faceplate, or laser lens. It takes at least 2 seconds per sensor to partially clean dust off (half penalty) or 4 seconds to totally clean it (negates penalty); people can roll vs. Vacc Suit skill to clean it off in half the time. Cybershells and suits designed for dusty environments may use radar, or have dust covers, buzzwear coatings (p. TS146), and mechanical or electrostatic wipers (use the Nictating Membrane advantage).

Dust will be kicked up when anyone moves, and a cloud may take minutes or even hours to settle, coating sensors and faceplates that aren't properly protected. Some asteroids even have flat "ponds" of bluish dust. These dust ponds are created when sunlight charges particles of regolith, causing them to repel each other. They rise above the surface of the asteroid, then settle, flowing like liquid to fill any depressions. The electrostatic dust's composition resembles dry cement. Well-lit areas exposed to sunlight may have hundreds of dust ponds, many of them dozens of yards wide and several yards deep.

Settling the Belt

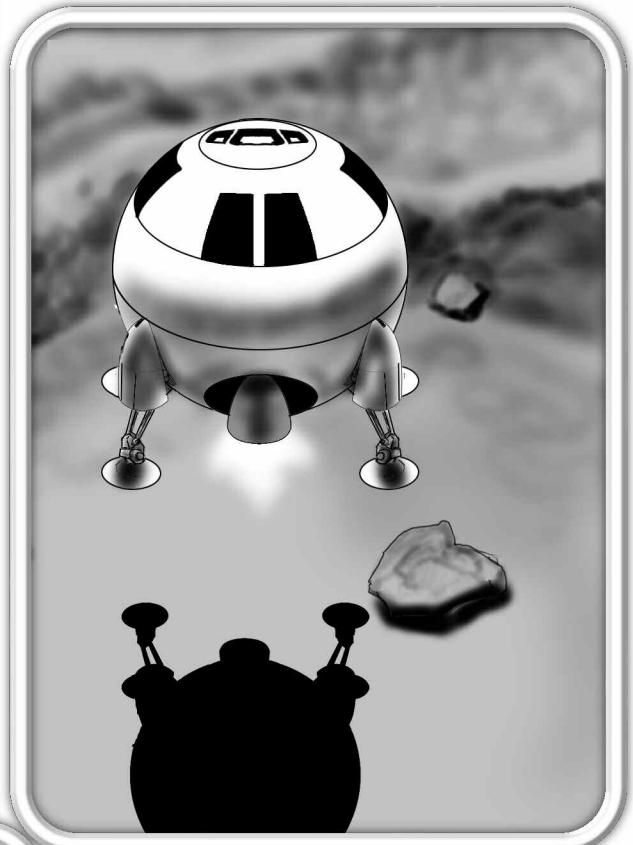
"Some have asked us the question: Why did we let them get away? How were Payne and her Ares Crew permitted to abscond to Ceres with half a billion dollars worth of gear?

"It was expediency, pure and simple. Violence between pro- and anti-terraforming factions threatened to turn the Red Planet into a war zone. The Ares Conspiracy had a lot of support back home, both in America and Japan. With the death of Kaneda, some of them were starting to look like martyrs. There were heated disagreements between the Chinese, the Japanese, and our own officials over how to handle it, and Beijing was on the verge of ordering troops to Mars to restore order . . . that would have been a disaster.

"So the exodus was a safety valve. It got rid of the hard-core anarchists like Payne, and the ones who stayed behind had no clear leaders, no organization. After the conspirators returned the ***Collins*** *in '44, we showed good faith and let the second batch of sympathizers join them. There was still violence, especially in '48, but it reduced things to a manageable problem. We called it exile, and the public accepted it.*

"Did Captain Fox act under sealed orders? I'm not aware of any. Certainly she was court-martialed in absentia, but it just wasn't feasible to go and arrest her. Other than that, no, there was no special consideration. The presidential pardon in '52 was simply part of the general amnesty extended to all American citizens who were involved."

– J. Godwin Merendino, retired U.S. Secretary of State and visiting professor of international politics, University of Mars (interview, 2067)



Main Belt Demographics

There are no exact figures for the Main Belt's population, as many people living there are not interested in reporting to census-takers. The best estimates place the population of the Main Belt at 105,000 sapient beings: about 55,000 biological sapients and roughly 50,000 sapient infomorphs. This breaks down as follows:

Sapient animals: 2,000 (400 Astropus and 1,600 others, mostly pets).

Ghosts: 7,000 (3,000 in bioshells, 4,000 in cybershells).

Humans: 12,000 (2,000 baseline, 3,000 floater, 3,000 genefixed, 4,000 gene-enhanced).

Parahumans: 18,000 (10,000 Tennin subtypes, 8,000 others).

Bioroids: 21,000 (mostly space-adapted types like the ZR-4).

SAIs and sapient shadows: 43,000 (2,000 in bioshells, 41,000 in cybershells).

However, that's not the whole story. In Fifth Wave nations on Earth, the proportion of low-sapient artificial intelligences to biosapients is about 1:1 . . . but in the Main Belt, the LAI ratio is more like 10:1. The high proportion of LAIs to the overall population results in a much higher productivity than that of terrestrial regions of comparable population.

The Ares Conspiracy was a group of scientists, engineers and visionaries who began the illicit terraforming of Mars. When their identities were uncovered, they faced two alternatives: arrest and deportation by China and the United States, or murder by preservationist vigilantes – a fate that had already befallen their leader, Fujihiko Kaneda. Instead, they found a third path. With the connivance of USAF captain Latisha Fox, 57 of them boarded a NASA deep space operations vessel, the *Michael Collins,* and headed into exile on a new world – the asteroid Ceres in the Main Belt. They were helped by the contents of *Michael Collins'* holds, which were packed with supplies originally destined for station-building on Deimos. The exiles used them to transform an abandoned Tenzan Heavy Industries survey base on Ceres into a new home: Silas Duncan Station, the first permanent community in the Main Belt.

The exiles included most of the leading Ares Conspiracy leaders and genetic engineers; chief among them was the charismatic Maya Payne, who had taken over the conspiracy's leadership after Kaneda's death. Many, including Payne, were anarchocapitalists and libertarians. For them, the Ares Plague had not only been about Mars, but was also an attempt to show what free people could achieve outside the tightly regulated confines of government-run science. Their vision of Mars was a new world where individuals could thrive, free of what they saw as a flawed and outdated concept of the nation-state. They'd failed on Mars – but they were determined to succeed on Ceres.

The key decision that the exiles made was to replace terraforming with pantropy, the reshaping of humans and animals into new species better adapted to their environments. One of their number, the brilliant Shiori Katsuki, had developed a "calcium hack" gene sequence that allowed humans to adapt to microgravity. The exiles – many of whom were genetic engineers – chose to modify their unborn children. It was a gamble, but it paid off. Over the next 50 years, exo-wombs, biogenesis technology, and immigration by like-minded individuals swelled the original handful of settlers to several thousand people, scattered across more than 40 asteroid settlements.

Nor were all the settlers Duncanites. The infrastructure that the Ceres exiles established and the processes they developed to facilitate microgravity life – the Tennin biomods – blazed a trail for other asteroid colonists, ranging from corporations to freedom-loving homesteaders. Most of them came to the Belt for the same reason the Duncanites did: freedom and isolation, whether from taxes and regulation, from the law, or from the mores of mainstream society. Nor is the Main Belt likely to become overcrowded. While it is spoken of as a single place, its worlds are separated by millions of miles. Unlike L4 and L5, a Belt station needn't worry about close neighbors.

Today, the Main Belt boasts some 140 inhabited asteroid stations and 300 automated bases. The stations range in size from the original community at Silas Duncan Station on Ceres (with over 16,000 biological sapients) to tiny "gas stations" operated by a half-dozen humans or infomorphs. In addition to these permanent stations, the Belt is also home to several thousand nomadic spacecraft – most of them tiny prospector swarms (p. 134), but some as large as mobile planetoids.

Main Belt Stations

This section describes some typical and not-so-typical inhabited stations in the Main Belt, and provides an overview of the major categories of stations found there and in the Trojans. As there are millions of asteroids and hundreds of stations, feel free to create additional asteroid bases to suit the needs of adventures.

1 Ceres – "Silas Duncan Station"

"Roy Joseph Clement, I find the evidence presented to me shows your criminal negligence was clearly responsible for the death of your co-worker Ariel Ling, and there wasn't much in the way of mitigating circumstance.

"As Ling has no surviving family or loved ones, and is represented here only by her insurance broker, Ceres Mutual, and her security company, Kinetic Logic, here's my judgment: Since you've committed a capital crime, your body is now the property of Ceres Mutual, acting as heirs for Ariel Ling. Your legal insurance is paying my fee."

"Judge – you can't do that!"

"Clement, just shut up. You may be an Elf, but you agreed to this court's jurisdiction when you made your own security contract with MAD. Since your own enforcers have pledged to abide by the judgment of this court as per your prior contract with them, and my judgment was just publicly registered, I sort of doubt any other legit security company is going to be picking up your case. You belong to Ceres Mutual."

"You punked-out glitch!"

"Uh-huh. I'm sure that would mean something if I was an Elf, but I'm going to let it ride. There's not a big demand for organs here, but I bet you'll make a good bioshell, as there isn't much to lobotomize. Dave, Akari – he's yours, now. Take him away."

Ceres is the largest Main Belt asteroid, a carbonaceous body with a diameter of 527 miles. It's shaped like a slightly flattened sphere, with a rotational period of 9.08 hours. Ceres circles the sun at an average distance of 2.77 AU, taking 4.6 years to make one orbit. Ceres is rich in resources: there's an exploitable surface layer of water ice permafrost, clay-like hydrated silicates, carbon-rich compounds, and substantial metal deposits.

Silas Duncan Station is the original Duncanite settlement, a beehive habitat with a population of 16,600 living in an anarchocapitalist society. It is the headquarters of Avatar Klusterkorp and the home of the Green Duncanites. Much of the station is owned by the original settlers, but it's a big asteroid, and plenty of territory has been carved out by later immigrants.

The station was founded by genetic engineers and terraformers, and its economy is dominated by biotechnology and asteroid real-estate development. The largest company is Avatar Klusterkorp (p. 89), but not everyone works for it. Many Ceres Duncanites are freelance bioengineers or consultants, doing R&D work for non-Duncanite companies elsewhere in the system. Others work for smaller local corporations, providing goods and support services at Ceres and other Main Belt stations. Ceres offers outfitting, resupply, maintenance, hospital, educational, judicial, and cultural services for Duncanites and other Main Belt residents.

Green Duncanite Stations

The Green Duncanites are humans, parahumans, or bioroids who are part of the original Duncanite colony on Ceres, or any of its daughter colonies. These are all anarchocapitalist and libertarian communities.

A society can be broadly defined by its dominant memes. The prevailing memes of the Green Duncanites are biochauvinism, colonialism, green system, libertarianism and anarchocapitalism, morphological freedom, nanarchy, and pantropy.

Green Duncanite stations in the Main Belt include Silas Duncan Station and Kaneda Station on Ceres, plus dozens of smaller habitats, many of them "freeholds" run by only a couple of families. There are roughly 20,000 Green Duncanites. About a third are Tennin parahumans, a third humans or other parahumans, and a third bioroids.

Momji Station: A typical freehold asteroid owned by the Kanzaki family (old Ares Crew), run by 90-year-old Momji Kanzaki, a few family members, and household bioroids. It's a Cole habitat with a large fish pharm. CR 2, with orbit similar to Vesta.

Major imports are advanced cybershells and software, especially AIs, although Duncanites are a bit wary of the more evolved viruses that roam freely through the terrestrial web. Duncanites also consume Earth-produced InVids and other media, although much of it seems rather alien to them.

Major exports are biotech R&D. Companies based at Silas Duncan Station also specialize in real estate development. Other activities include radical human genetic engineering, bioroid design, bioroid education techniques, pantropy research, and asteroid habitat engineering.

The station is located beneath the surface of Ceres. Four main shafts run vertically into the asteroid, with tunnels and chambers branching out from there. The station relies on two fusion power plants and multiple smaller radiothermal generators for energy. The interior presently has space and agricultural capacity to support 19,000 people (more than its present population), plus extensive manufacturing and laboratory facilities. There are four main "burrows," each with its own character. They are:

Piazzi Underport: Located beneath the spaceport, this is a labyrinth of warehouses, refineries, repair shops, and tanks, including a nuclear pellet factory. This area also contains the "control room" for the spaceport, mainly concerned with allocating docking space and operating spacewatch sensors. It's run by Piazzi Spaceport Corporation.

The Main Dig: This is a broad tunnel, up to 20 yards in diameter and a mile and a half long, that connects Piazzi Underport with the Greenlands and Rotten Burrows complexes. The Main Dig is home to 110 small businesses. Hundreds of smaller tunnels lead off from the main drag. There is no shortage of space – residents who want more room will rent a mining robot and dig new tunnel extensions.

Greenlands: A maze of tunnels dominated by the laboratory complexes of Avatar Klusterkorp and other biotech companies.

Rotten Burrows: These tunnels and large chambers are largely devoted to agricultural production. The station is self-sufficient for the most part, and this area includes several acres of hydroponics, vatfacs, and biofactories. The name comes from the smell of the original fungi farms, algae ponds, and fish farms established early in the station's history.

Avatar Klusterkorp and Ceres Mutual (p. 90) fund the station's space defenses, which are contracted out to Mutual Assured Defense and Trojan Hawk. They include six *Amazon*-class AKVs for long-range interception and a mix of a half-dozen railguns, light lasers, and heavy lasers spaced around the asteroid's rim. Duncanite vessels docked at Ceres (usually 2d spacecraft) will usually be willing to assist if the station is attacked.

Other Habitats on Ceres

Palermo Station: A space station in Ceres-synchronous orbit, 486 miles above the asteroid's equator. Palermo Station is tethered to Ceres by a miniature space elevator run by Palermo Corporation. It's the main spacedock for Duncanite deep space vessels. The station is a small 600'-diameter stony-iron asteroid that's been hollowed out.

Kaneda Station: The second major habitat on Ceres. The residents of Kaneda tend to be more radical Green Systemers than other Duncanites. Most people living here are Kumo parahumans (p. 113). Kaneda Station is the headquarters of Kosmodavit Tenno Tanjo, a rival to Avatar. Kaneda is 820 miles from Silas Duncan, on the other side of Ceres.

The Ceres Tricentennial

New Year's Day in 2101 is especially significant for the population of Ceres. In addition to marking the start of the 22nd century, the population of Silas Duncan Station will also be celebrating the 300th anniversary of the discovery of 1 Ceres.

A major New Year's extravaganza is planned, and guests from many outlying asteroid stations will be attending, including foreign dignitaries. It has been rumored that Avatar Klusterkorp is also planning to announce a major pantropic initiative on that date.

Another holiday celebrated on Ceres is the *Ambarvalia.* This was a yearly agricultural rite held in ancient Rome at the end of May in honor of Ceres. Today, the Ambarvalia is a holiday on Ceres, celebrated by pogo stick races across the asteroid's surface along with much revelry and carousing.

2 Pallas – "Hesheng Station"

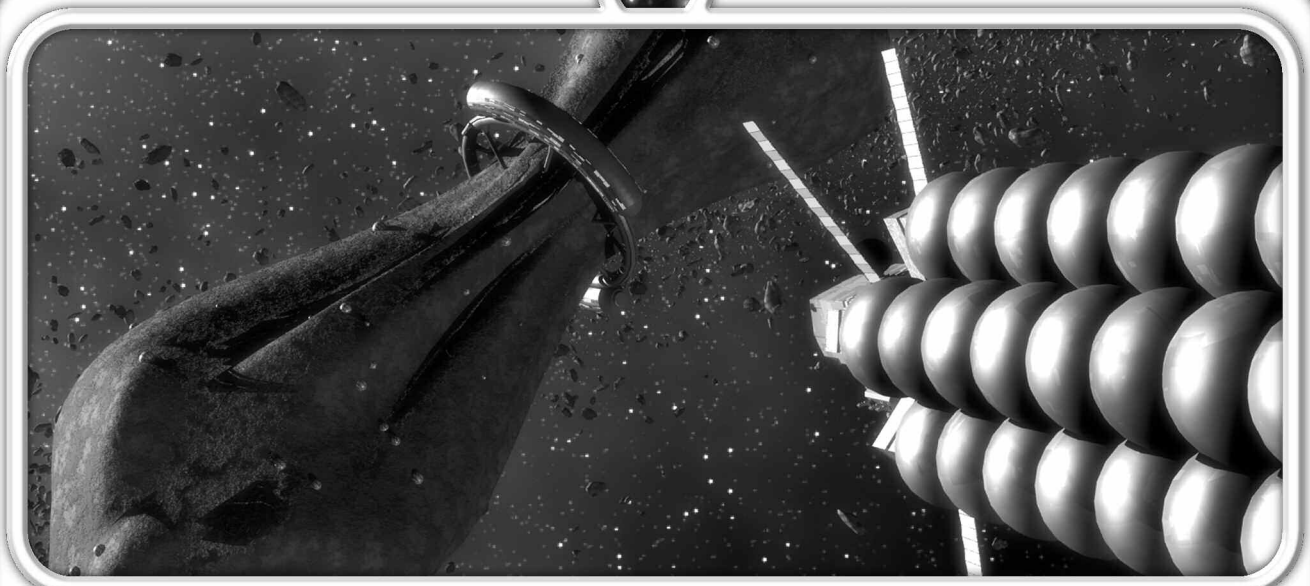
Pallas, named after the goddess Athena, is a differentiated primeval asteroid with a diameter of 309 miles. It orbits the sun at a mean distance of 2.77 AU. Its orbit is highly elliptical – on average, it's as close to the sun as Ceres, but it can also be almost half an AU nearer or farther. Its orbit is also steeply inclined, with Pallas being well above or below the sun at either end of its year. Pallas takes 4.62 years to complete an orbit around the sun, and has a rotational period of 7.81 hours.

Hesheng Station was first established in 2052 by the Mars Academy of Science and Technology as a solar observatory, taking advantage of the asteroid's highly inclined position to get a good view of the north and south poles of the sun. In 2073, Xiao Chu selected Pallas as the site of its nanotechnology research station, partly because of the security offered by its relative isolation. The first laboratories were installed in 2076, and the station's population grew quickly, especially after biogenesis tanks were installed. During the Transpacific War, the PLAN-SF established a military base here to protect the facility.

As the population grew, the station attracted other Chinese and transnational companies and is no longer exclusively a company town. Xiao Chu remains the largest employer, with dozens of different laboratories delving into molecular nanotechnology, nanomedicine, biogenesis, applied microrobotics, and more. The biogenesis tanks are often used to develop prototype bioroid designs – especially combat bioroids. Few labs are open to the public, though some are more secure than others.

National Asteroid Colonies

These are full-fledged colonies established through a partnership between big government and big corporations. Colonies usually started out as ordinary research stations (p. 16), but through deliberate policy or happenstance began to attract other settlers not employed by the founding corporation. The colony is the functional territory of a particular nation, and usually has a military garrison of some sort. Examples of national colonies are Aletheia Station (p. 16), Hesheng Station, and Yametei Station (p. 20).



Hesheng Underdock is the least-regulated part of the station. Occupying the underground beehive complex just beneath the spaceport, it is a small but bustling commercial enclave catering to the needs of transient visitors, spacers, and military personnel. There are vacc suit shops, 3D printers, pawnshops, apothecaries specializing in Chinese herbal medicine, a small Duncanite bazaar, and several busy brothels. Notable businesses include a cheap hotel (the White Swan) and a few good bars – the Shredded Snake is a mix of locals and commercial spacers, while Lotus Mountain is frequented by PLAN-SF and can be hostile to outsiders.

ZR Quarter is adjacent and below the dockside. It has dormitories for the indentured bioroids, who work as lab and maintenance technicians, as well as some private shops and clubs not authorized by station management. The quarters here are microgravity warrens, and fairly crowded (as well as hot and humid), with several bioroids sharing the same room. Mixed with the dorms are station service facilities – fusion reactors, coolant tanks, laundries, hydroponics, and tunnels full of fauxflesh vats and algae ponds. The thousands of bioroids live fairly regimented lives, but some sneak out into the main station when they have time off, occasionally moonlighting at other jobs.

Moxing Ling City is located a mile from the main beehive complex, in the rim of a mile-wide crater. On a hill in the center of the crater is the old Solar Polar Observatory (which is still operating), while the habitat is located in a semi-subterranean maglev track habitat in the crater rim. The track provides Mars-normal gravity, and contains living quarters for 700 humans. A long tunnel connects Moxing Ling to the Hesheng Dockside and the ZR Quarter. Police man a security gate that limits access to Moxing City to residents and their quests.

Some of China's best nanotechnologists live and work in Hesheng, usually spending 1-3 years here before returning to Earth or Mars for a vacation or a different job. To make up for living in such an isolated place, salaries are 50% to 100% higher than usual.

Hesheng's population is 1,100 humans and 5,600 bioroids. That number fluctuates depending on what vessels are in port and how close the station is at the time to Earth, Mars, or other parts of the Belt. The docks are CR 3 while the rest of the station is CR 5. (Taken as a whole, Hesheng is considered CR 4.) Due to the sensitive research performed at the station, the station police, members of China's Public Security Bureau, are always concerned about espionage. While security is fairly lax at the docks, it is very strict in the laboratories and near the military base.

A company of spaceborne soldiers from the Space Infantry Division's 3rd Quanto is quartered at Hesheng. Usually only one platoon is on station, with the others aboard PLAN-SF vessels.

Pallas space defenses consist of 12 heavy laser towers – eight around the asteroid's northern hemisphere to defend Hesheng Station itself, and a remote battery of four on the southern hemisphere to discourage attackers from landing in the blind spot. The PLAN-SF base controls its own squadron of 12 *Zhengyang* AKVs, in addition to whatever elements of its Deep Space Flotilla are nearby (at least one SDV or LSDV).

Hesheng has a small spaceport divided evenly into military and commercial docks. There are internal spacedocks for vessels up to the size of a *Sudbury*, but larger craft orbit the asteroid. Facilities for routine maintenance and refueling with water, hydrogen, or nuclear pellets are available, but there is no spaceyard. A few (1d-1) deep space vessels will be docked here at any one time, a mix of Xiao Chu corporate USVs and ESVs, a few independent farhaulers or Gypsy Angels, and various PLAN-SF warcraft.

259 Aletheia – Aletheia Station

Aletheia (from the Greek word for "truth") was discovered in 1866 by the astronomer C.H.F. Peters. It is a carbonaceous-volatile asteroid with a diameter of 111 miles. It circles the sun at a mean distance of 3.15 AU, taking 5.6 years to complete an orbit.

Aletheia was settled by Vosper-Babbage in 2061. It has expanded rapidly over the last 39 years, attracting private investment from other companies, notably System Technologies AG, and is one of the fastest growing communities in the Deep Beyond. Aletheia has a population of 5,500. Many are genefixed or genetic upgrades from the United Kingdom and other E.U. countries, although there is also a large population from the South African Union. 300 people have been born on Aletheia since the station was founded.

The largest segment of Aletheia's population is the 4,000 transient employees of Vosper-Babbage and Hawking Industries. These are managers, engineers, programmers, and scientists. Most sign on for a 2-year contract at Aletheia, then return to Earth, Luna or Islandia. There are also 600 scientific personnel working at SSL (see *Hawking Station,* p. 20) who opt to live on Aletheia rather than Shezbeth. The academics make up an especially diverse community, with scientists and graduate students drawn from a wide cross-section of Earth's most prestigious universities. Finally, Aletheia is the home to a sizable E.U. military base, with 700 military personnel and 200 spouses and dependent children.

Aletheia is run by Rodney Southerland, elected by the populace to the position of Station Manager. The real power in the station, however, is Grace Sheffield, the Vosper-Babbage resident vice president, since that company employs most of the inhabitants. Aletheia residents pay a small life support tax; in the case of contract employees this is paid by the corporation, and for tourists or other visitors it is added to hotel bills. Aletheia Station is considered British territory, and treated as part of the European Union; persons born on the station have British and E.U. citizenship.

Visitors to Aletheia arrive at Petersport, a small spaceport carved into the asteroid's north pole. A portion of the spaceport is restricted: Hir Majesty's Naval Base *Aletheia*, dedicated to Royal Navy Space Service operations. The area is patrolled by Royal Marines, although it's rare that an actual SDV will be docked here. Tracked and walker vehicles carry visitors from their spacecraft to the main airlocks leading to an underground train station.

Aletheia Spaceyard is adjacent to Petersport. It's a busy construction and repair facility. The spaceyard is run by Vosper-Babbage. It manufactures workpods and other small vessels as well as doing routine service, repairs, and upgrades. There are usually 2-4 vessels docked here for a reactor overhaul, new drive pump, or some other refit. Next to the spaceyard is a large outdoor tank farm.

Underground is located immediately under Petersport. It's a beehive habitat beneath the asteroid's surface . . . a three-dimensional labyrinth of microgravity tunnels. There are chandlers that offer everything a spacer needs (from smartsuits to thruster packs to 3D-printer-tailored uniforms). There are hydroponics and fish farms, warehouses, a robofac complex, and a Hawking Industries exotic materials manufacturing plant. Mining and refinery operations are ongoing, drilling into the asteroid to extract volatiles. The majority of Underground's population are cybershells: about 13,000 mobots, roughly half run by LAIs, the rest of them NAIs (although these are often teleoperated by humans, LAIs or SAIs). Human children often hide out in Underground, as the adults rarely spend much time here.

Roundabout is a magnetic track habitat half a mile from Underground, accessed by a people-mover. This city-on-rails consists of 60 linked cars, with normal-gravity living quarters and offices sufficient for 3,000 people. Also located on the Roundabout is a small shopping mall, the Truth and Beauty (a hotel-restaurant), and the Event Horizon, one of the best pubs in the outer system.

Corporate Research Stations

Corporations locate in the Main Belt so they can operate free from irksome environmental-impact reviews, pollution control regulations, and local taxes. This can lead to vast savings that more than compensate for the expense of maintaining a (very) remote facility.

Most corporate facilities are research and development stations, containing laboratories working in fields like molecular nanotechnology, exotic matter, human biogenesis, nanobiological warfare, antimatter, self-replicating machinery, military microbots, and, recently, mini black holes. These are areas of research that would require extensive – and expensive – safety measures if conducted in or around inhabited planets. As for the Lagrange points, L4 is too densely populated, while the chaotic nature of L5 discourages the establishment of secure facilities. Some research stations specialize in single fields, while others are home to several laboratories and/or corporations.

Government labs, and labs jointly run by corporations and governments, are also found in the Main Belt. They are often engaged in highly classified defense research. Unauthorized visitors will be warned off, and some government labs may supplement or replace private security forces with actual military garrisons.

> Thought control, like birth control, is best undertaken as long as possible before the fact.
>
> – Richard Mitchell

Aletheia is garrisoned by British Forces Aletheia (p. 98). Internal security is provided by two dozen civilian constables from Executive Decisions Incorporated (EDI).

Shezbeth: This Kuiper Belt Object core is also in orbit around Aletheia. See p. 20.

Fidelity, Verity, and Candor

There are three small Cole habitats in orbit around Aletheia. Each of them is a metal ovoid 2-4 miles long and about half as wide, rotating slowly to provide 0.5 g gravity.

Fidelity resembles an English park, with well-tended flower beds and trees, and even sculptures. It's designed as a recreational area.

Verity is an agricultural habitat, with a mix of farms and fruit tree orchards. It is tended by cybershells, but a limited number of human visitors are permitted.

Candor is the newest habitat. It is only partially terraformed. Construction is proceeding inside, and a school and additional housing are being built.

4 Vesta – "Exogenesis Station"

Mother, I hope this message finds you and Kaoru well. I apologize for this eccentric means of communication. Nanodynamics' so-called transition team doesn't allow us unsupervised access to laser transmitters any more, not since Tournesol escaped to Io.

For now, I'm still Assistant Director of Fractal Robotics, although my authority is in name only. Please don't believe the statements you may see me or anyone else making, especially about Axon. I want to make one thing clear to you: I don't and never did believe we engaged in wrongdoing, or were "confused." Yes, I agree that unrestrained xoxing (such a crude word!) might cause social disruption if it were unregulated – on Earth. But Vesta is not Earth, and the right to reproduce is a basic human right. It should not be arbitrarily taken away from me just because I chose to become a ghost.

My mind-sister Tsikada Lanning was born of my desire to do two things at once, to participate in both the Starswarm project and the development of gestalt nanobots. Yet Tsikada is not just an extension of me. Since she was created, she has becomes herself: warm, loving, passionate, silly. Her worst sin is an inexplicable fondness for alibanana ice cream she developed while in her bioshell! And she still loves Nahuel, even after all he has done, yet I can no longer stand him. As you can see, we have diverged – yet she is condemned by society as an abomination, and I am "real."

We agreed to cooperate with the new Nanodynamics regime, because they promised me that Tsikada and the others will not be erased or forcibly edited if we do so. But please realize that the public statements we have made are under duress. Those of us who did not submit are being edited into cooperation, or worse. We can no longer enter the IA warrens, but I fear they're doing terrible things. The Rat King has not surrendered, but they are bringing in cyberswarms to hunt it down. And they sacrificed the remaining megabright octo-brain embryos. How can people do that? They were beautiful things!

Mother, you must promise me you will tell Tournesol what is going on, and tell him that many of us support Axon, regardless of what we are made to say.

You do not want to know what I had to do to smuggle this message to you. I may not be able to do so again.

Your loving daughter,
Symphonie

– nanodot message from Dr. Symphonie Lanning at Exogenesis, smuggled out to Cerise Lanning-Payne at Silas Duncan Station

Vesta was the fourth asteroid discovered (by Wilhelm Olbers in 1807) and is one of the largest, with a diameter of 291 miles. It is located in the inner Main Belt, and orbits the sun at an average distance of 2.36 AU, taking 3.63 years to do so. Its day is 5.34 hours long.

Vesta is a very old body, largely unchanged since the formation of the solar system, unlike the majority of asteroids, which are remnants of bodies shattered by collisions. Its composition is unique among large asteroids ("V-type"), with a basaltic igneous rock surface formed from ancient lava flows. Vesta once had a molten interior, and its structure is differentiated, with heavy dense material in the core, and lighter rock in the surface.

Vesta's heavily cratered surface resembles Luna, although it's a bit brighter – in fact, Vesta is the only asteroid that can be seen with the naked eye from Earth. Vesta has two distinct hemispheres formed from different types of solidified lava basalts. The southern hemisphere is dominated by a 285-mile-wide impact crater.

Vesta was visited by unmanned probes between the 2030s and 2050s. The first inhabited settlement was a geophysical research station established in 2058 by the European Space Agency. A team of 20 people studied Vesta's unique geology; as the asteroid resembles a miniature planet, it offered insights into what Earth, Luna and other worlds looked like beneath their crust. The geophysical base was scheduled to be closed and abandoned in 2062, but at that point Vesta was selected by System Technologies, AG as the headquarters of Exogenesis, its new space development arm. Work immediately began on Exogenesis Station in 2064, and the station was fully operational by 2071.

In 2076, Exogenesis Station made history when researcher Gilbert Stokes became the first human mind emulation. Under director Oskar Kessel, Exogenesis Station continued to produce valuable patents and take on lucrative contracts (including support of several ESA space programs), although the ambitious nature of its projects saw operational costs escalate to alarming levels. One of its most expensive projects was the Deep Vesta Bore, which took digging cybershells some 11 years to complete, and required the excavation of millions of tons of rock, which were removed to the asteroid's surface. The result was a tunnel 15' wide running entirely through the asteroid from one end of Vesta to the other.

In 2099, System Technologies AG divested itself of Exogenesis Corporation as part of a major restructuring. The new owner, Nanodynamics, came into conflict with Exogenesis staff after discovering that many of the station's digital intelligences were more sapient than expected, and that station personnel had xoxed themselves and their SAIs in violation of U.S. and E.U. laws, practices System Technologies claimed to have been unaware of. Facing a revolt from Exogenesis personnel, who objected to the company's attempts to restrict these practices, Nanodynamics imported EDI enforcers to restore order. They managed to accomplish this with no loss of human life, but some Exogenesis spacecraft were hijacked by rogue elements, and some infomorphs had time to transmit copies of themselves to Exogenesis bases or sympathizers elsewhere in the solar system, sometimes erasing their originals afterward. While most of these escapees are lying low, some of them formed an organization called the Axon Group, and have begun taking direct action against Nanodynamics operations in the Deep Beyond.

Physically, Exogenesis Station is a series of beehive habitats on the north and south poles of the asteroid, linked by the Deep Vesta Bore (see above). Unlike most inhabited asteroids, over half of the Vesta beehive labyrinth is still in vacuum. Airlocks separate the evacuated chambers (where cybershells live and work) from the pressurized ones.

The population consists of 7,200 sapient beings, most of them research personnel: 1,700 ghosts, 2,300 SAIs, and 1,900 shadow-SAIs, plus 400 humans and parahumans. The humans and parahumans all have nanomods, with brain-boosters and microgravity metabolisms being standard. There are also 500 augmented animal intelligences on the station, some of them borderline sapient and others with radical biomods.

A transition team of 300 Nanodynamics managers and system engineers, many of them programmers, are also on station, with 150 EDI security personnel. The acting station manager is the transition team leader, Nanodynamics vice president Nathan Hyde.

Exogenesis Station has five major laboratory complexes: the IA Lab, the Mind Imaging Lab, the Fractal Robotics Lab, the Materials Lab, and DEVIL.

The IA Lab's objective is human intelligence augmentation. Abandoning genetic engineering as too slow

and uncertain, the IA lab has focused on cybernetic and nanotechnological enhancement and AI symbiosis. Their greatest commercial success was the brain booster nanomod (p. TS165), first tested on lab rats in 2084 and on Exogenesis researchers themselves in 2090. Animal experimentation continued in other directions, with products like the brain-boosted Astropus sapient octopus (p. TS118). A portion of the station was given over entirely to a cybernetic gestalt of super-intelligent lab rats, which had formed a colony intelligence and, by 2099, were running their own experiments. When EDI seized the station, several brain-boosted rodents escaped from the IA lab, and these have infested parts of the station despite efforts to control them. (See *Rat King*, p. 114).

The Mind Imaging and Nanobot Laboratory is the most famous of Exogenesis' labs. A pioneer in the development of ghost uploading technology, for the past decade it has been attempting to develop a means of high-resolution non-invasive uploading that would allow ghosts to be created without destroying the original's brain. Despite promising results in anti-proton imaging and nano-mapping, success has eluded them.

The Fractal Robotics Laboratory has been more successful. Through the application of multiple xoxed researchers to the problem, it was able to make a major breakthrough in multi-fractal branching manipulator programs, allowing the creation of the first successful bush robot (p. TS121). Bush robots soon became the most popular robot cybershell on the station. Sale of improved bush robot designs and control programs is expected to become the major source of Exogenesis income in the future.

The Materials Lab and Exogenesis Space Project Office occupy a joint complex located at the opposite end of the station from the other facilities. From 2077 to 2096, ESP was a prime contractor for the European Space Agency. It was responsible for cybershell design and software for the ESA's Jupiter descent project and for all aspects of the ESA's Starswarm interstellar nanoprobe system (p. 136), as well as building the VESTA-II electrostatic accelerator that was to launch it. Although the ESA canceled Starswarm in 2097 in favor of its ambitious terraforming research program on Venus and the Earth space elevator, Exogenesis continued the project as a private venture. VESTA-II became operational in low-energy mode in 2094 and has had several test operations (see *Triton*, p. 73). Under Nanodynamics, Starswarm may be resurrected as a NASA program.

The Vault is the most ambitious and expensive installation on Exogenesis Station. In the heart of the asteroid, the Deep Vesta Bore was expanded into a 300'-wide chamber: the Deep Vesta Isolated Particle Laboratory, usually known as the DEVIL Vault. Shielded from cosmic and solar radiation by 150 miles of rock, the Vault is one of the best places in the solar system for high-sensitivity physics experiments, and is packed with exotic hardware such as neutrino detectors. The Deep Vesta Bore is also the site of the Vesta Electrostatic Accelerator (VESTA-II) track, although the VESTA-II system cannot be operated when sensitive experiments are being performed.

Vesta has a small spaceport, and is CR 5 (up from CR 2 before the takeover). The station has moderate space defenses, consisting of six *Barricade*-class Space Defense Platforms (p. 139). There are four light laser towers, two each at either end of the Vesta Bore.

The station is protected by a company-strength force of EDI officers. About half the force are computer security specialists, who are kept busy battling computer virus outbreaks in the Exogenesis network. The rest are armed enforcement officers. Nanodynamics had hoped to withdraw the troopers by now, but until Axon can be dealt with, a garrison is necessary. The security troopers have also been busy bodyguarding transition team members, interrogating suspected Axon supporters (who may be spreading the viruses), and performing search-and-destroy sweeps against the escaped lab rats. The latter problem is expected to be dealt with next month, as a new team arrives with terminator microbots.

Vestal Station

This 2-mile diameter space station orbits Vesta. It was a metallic asteroid that was blown into a Cole habitat, and then towed to Vesta. Its interior has been landscaped with parks and farms, and provided with housing for 200 people. The station and its farms are maintained by microbots and cybershells.

Vestal Station was originally a place for rest and recreation, and a source of food for the biosapient personnel. It is now off-limits to all Exogenesis personnel and is used as a headquarters for the visiting Nanodynamics transition team. Security is kept high to avoid any chance of infestation by the escaped vermin.

Religious Stations

Many asteroid habitats were built for religious purposes. These range from monasteries whose inhabitants engage in quiet prayer and meditation, to fringe cults that deliberately warp the minds and bodies of their believers. Even so, most are small communities – usually Christian, Buddhist or Muslim – who hope that heavenly isolation from the perceived sinfulness and memetic pollution of Fifth Wave Earth will let them live more godly lives. There are 20 religious isolate communities in the Main Belt; some homestead communities are also set up on religious lines. The average community is about the size of a typical freehold, but some are much larger, like New Covenant (p. 21).

10 Hygiea – "Yametei Station"

Hygiea is a carbonaceous asteroid with a diameter of 253 miles. It circles the sun at an average distance of 3.14 AU, taking 5.55 years to complete an orbit. It has a rotational period of 27.6 hours.

Yametei Station is a beehive habitat that houses the Main Belt headquarters of Tenzan Heavy Industries' (p. TS96) asteroid operations, serving as an administrative, manufacturing, training, and resupply center. It has 2,400 human and parahuman personnel, and many cybershells. Few of its biosapient residents live there permanently: 80% of the work force turns over every few years. In recent years the living population has actually declined, as Tenzan has increasingly replaced humans with cybershells.

The station has a fairly utilitarian feel; most people see it as a place to work rather than a place to live. Its major activity is the manufacture of high-technology goods (such as industrial cybershells, 3D printers, and fusion reactors) and provision of engineering expertise to support outer system operations by other corporations and private ventures. There is a Duncanite guest worker immigrant population, typically 100-200 people, mostly Tennin (p. TS117), and a small Duncanite bazaar near the docks.

Hygeia has a small spaceport and associated spaceyard, and is CR 3. The asteroid has no military bases, but possesses modest defenses in the form of six retractable heavy laser towers, as well as a security team from Mutual Assured Defense (p. 94).

112434 Shezbeth – "Hawking Station"

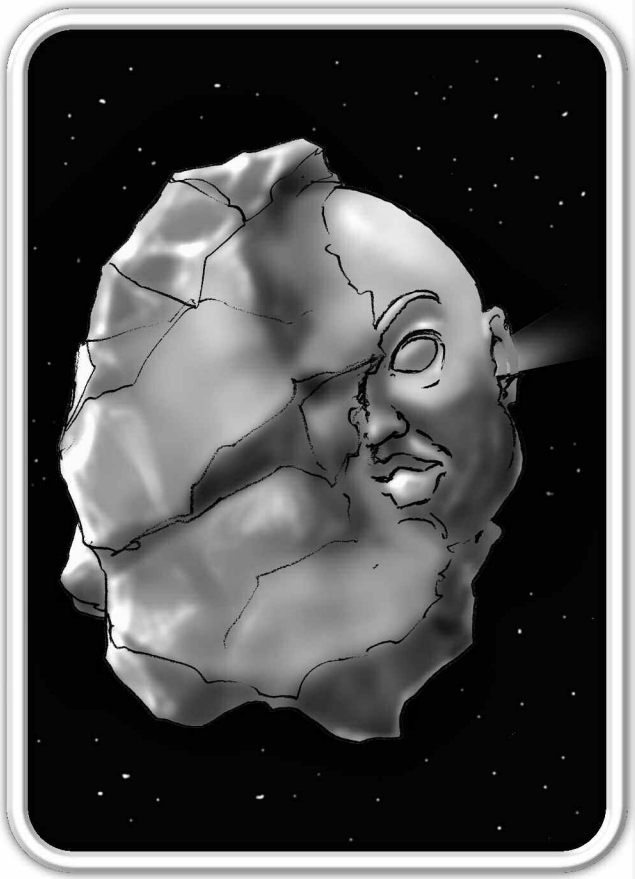
Shezbeth is an asteroid (a former Kuiper Belt Object) that contains a primordial mini black hole in its core. First visited in 2091, it was moved from trans-Neptunian space to the Main Belt last year, and is now in synchronous orbit around Aletheia (p. 16), a few hundred miles above the larger asteroid's surface. Shezbeth is only a fraction of its original size as a Kuiper Belt Object, much of the ice having been used as reaction mass during its move.

Hawking Station is a beehive habitat that is being gradually converted into a shell habitat. The station is run by Hawking Industries with assistance from Vosper-Babbage, and is under the joint protection of the British and South African governments. The station is divided into commercial, industrial, military, and research sectors; some of the latter are off-limits to unauthorized visitors outside of well-supervised tours. A prototype gravitic power station installed around the singularity produces plenty of energy. The highest-security area is the black hole shielding and containment area in the asteroid's heart.

Hawking Foundation's Shezbeth Singularity Lab, which studies the mini black hole, is one of the most prestigious research labs in the system; physicists from across the solar system fight for the chance to work at SSL.

Most of Hawking Station's interior is devoted to particle and gravitational physics labs, and the gravitic fusion machinery. Ongoing experiments at Hawking Station include research into quantum gravity, black hole computing, advanced nuclear fusion technology, and exotic matter creation.

Chantarang Crater on Shezbeth's south pole houses a large fusion torch and ice refinery. This is currently abandoned except for some maintenance cybershells.



185 Eunike – Lokavidu Station

Approaching Eunike was an eerie experience. You suddenly confront a giant, half-finished face staring at you. It has only one eye – they're still working on the other – and you dock through the left ear. I remember emerging from the airlock into a chamber occupied by about 25 monks, all floating cross-legged, some upside down, all in complete silence.

I stayed for five months, attending Dharma classes, meditating, and taking my turn at various chores.

It's hard to say whether I attained a higher state of spiritual awareness or not, but I did develop some new ways of thinking about the world. They don't let you use virtual interfaces. Just having to open up a book or a scroll, and not seeing an instant translation pop up as an overlay, was weird. And no web connection, of course. The world could end, and you wouldn't know it.

You meet some interesting people. The Venerable Than Minn, the librarian, was actually the first Burmese to walk on Mars. There was another charming old fellow, a novice, but sharp as a knife, and patient enough to answer my often-ignorant questions. Something seemed familiar about him. I guess I'd have recognized him if I'd had Jimmy (my VI) to do a facial structure analysis, but as it was, the shaven head, robe, and contacts threw me. It wasn't until much later that I realized who he reminded me of: General Pham Thanh Loc, the former deputy head of the TSA's bio-weapons directorate.

Of course, it couldn't be him. He's supposed to be dead.

– Copernicus Jones, "Life on the Rocks," in ***Lonely System Guide to the Asteroids***

Eunike is a carbonaceous asteroid 98 miles in diameter, with a rotational period of 10.83 hours and a mean distance from the sun of 2.74 AU. It takes 4.53 years to orbit the sun.

The asteroid is the home of Lokavidu Abbey, a Buddhist monastery. It was founded in 2080 (with the help of generous donations), and practices Theravada Buddhism. Away from the distractions of Earth, the resident monks (56 of them in 2100) and a few dozen lay visitors spend several hours each day in meditation and study of the Dharma. The monks also exercise regularly in the gymnasium, and do chores at the station's farm and refinery. They also perform the great work of carving the giant Buddha of Eunike into the face of the asteroid.

The abbey is run by a Monastic Council consisting of the senior nuns and monks living there. Monastics shave their heads, wear robes, and attend training sessions and rituals. Would-be monastics can come to the abbey for instruction; they must spend a minimum of six months, and usually a full year, before deciding whether to return to lay life or (if approved by the Monastic Council) take initial vows and remain at Lokavidu as a novice. The vows are: Abstaining from destruction of life, abstaining from taking what is not given, abstaining from lying, abstaining from sexual activity, and abstaining from alcohol, drugs, and implants.

Lokavidu Abbey is CR 3, with no spaceport. The asteroid has no weapons, but it is known to have a security contract with Mutual Assured Defense, who will send enforcers to recover any stolen property or avenge any injuries.

Derelict Stations

Several colonization efforts have run into serious trouble, resulting in the surviving colonists giving up and returning home. In a few cases, the original inhabitants sold the station to new owners; other times they simply left a mess behind. An abandoned station is usually quickly picked clean by Gypsy Angels or other interplanetary scavengers, or occupied by other homesteaders. Sometimes conflicts arise over ownership . . .

185 Eunike is presently 2.9 AU from the sun. Other distances: Mercury (3.31 AU), Venus (3.35 AU), Earth (2.28 AU), Mars (2.92 AU), Aletheia (5.41 AU), Ceres (3.83 AU), Chicago (5.88 AU), Davida (2.14 AU), Hygeia (3.23 AU), Interamnia (0.52 AU), Pallas (6.2 AU), Vesta (2.89 AU), Jupiter (4.12 AU), Achilles (8.06 AU), Agamemnon (6.37 AU), Diomedes (8.08 AU), Patroclus (3.69 AU), Saturn, Uranus (21.67 AU), Neptune (27.56 AU), Pluto (49.87 AU).

511 Davida – "New Covenant Station"

"Jeri, anger and frustration are natural, but you cannot commit vandalism."

"Jesus Christ, you took me over!"

"Don't swear, Jeri. I had to for your own good. You were going to throw the paint bucket, and I calculated that it would splash all over Susan's piano. See, here's an overlay, and here's where it would have hit."

"Oh – I didn't mean to. I'm sorry. Can I have my body back?"

"Let's sit down first."

"What am I going to do? I just can't get this right. I'm hopeless."

"Jeri, God loves you, and so does Susan. You're not hopeless. Remember what Peta Johnson said about your last work? But I can summon the angel, if you'd like."

"No – I'll try again. Call up the reality overlay again, and show me how to hold the brush . . ."

Davida is a carbonaceous asteroid with a diameter of 203 miles. The fifth largest asteroid, it has a rotational period of 5.13 hours and an orbital period of 5.64 years. It circles the sun at an average distance of 3.17 AU.

Davida was settled in 2095 by a splinter group of Christian hyperevolutionists from the Seventh Heaven colony in L5. They founded New Covenant Station, a beehive habitat, which now has a sapient population of 4,400: 1,700 humans and parahumans, 2,600 sapient infomorphs, and about 100 others, including an Astropus colony (p. TS118).

Homestead Stations

Homesteads are self-sufficient, privately-owned stations that do not engage in significant economic activity beyond that necessary to support their own population.

The growing affordability of space flight, robotics, fusion power, and microgravity-adaptive nanomods have resulted in an ever-increasing flood of settlers heading into the Belt with the goal of colonizing an asteroid to create a private community. This is the same movement that originally led to the colonization of Earth's Lagrange points. As these areas become more heavily populated and regulated (and the Lunar economy slowed due to competing imports of He-3 from Saturn), many "elfs" sought the wider spaces of the Belt. They are being joined by groups of would-be asteroid homesteaders from Earth. When the Earth space elevator is completed this process is likely to accelerate.

Most homestead stations are founded by associations of families from a wealthy Fifth Wave nation or station (usually from Earth, Luna, L4, or L5) who pooled their resources to lease a spacecraft and colonization gear, and established their own community. The archetypal homesteader is impelled by a mixture of libertarian, conservative, religious, and Decelerationist memes. Most are unhappy with the direction Fifth Wave society is heading, and eager to set up their own community where they can raise children free of the perceived memetic pollution of mainstream culture

A typical homestead has a reactor or solar panels, a few very basic mining cybershells, a solar concentrator, a small refinery, a farm or hydroponics, and some 3D printers. This is enough to allow a small community a modest expansion commensurate with natural birth rates, although there's little margin for error if something goes wrong. The average community is less than a decade old, and most have populations of 20-50 people. A few older homesteads are facing challenges from children who may not share their parents' ideals.

There are 56 homesteads in the Main Belt, 32 of which were originally sponsored by the Plymouth Rock Society (p. TS98). Most Plymouth Rock communities maintain friendly ties with each other, although a few have broken with the organization.

New Covenant's founders wished to create a transhumanist utopia to serve as a template for future humanity. Their "New Covenant" is based around the standard sets of restrictive programming installed in AIs to keep them honest. They believe this set of programs, which they call the Eupraxia, is a good set of rules for humans, as well, especially when modified to reflect fairly liberal Christian transhumanist values.

The station is governed by a cyberdemocratic theocracy. Believers in good standing are chosen at random for six-month terms as ministers on the New Covenant station council. However, most of the executive power is actually in the hands of the Synedrion, a group of sapient infomorphs (ghosts, shadows and SAIs).

Every organic citizen on New Covenant has a virtual implant "conscience," an LAI running the Eupraxia software. Normally it simply observes, but it will warn him if his behavior seems to be out of step with Christian morality, and where necessary it can directly control him through a puppet implant. It is responsible for guiding him and ensuring he does nothing that harms himself or society. The Synedrion also assigns a "guardian angel" SAI to stay abreast of each biosapient citizen's personal development, which either the LAI or the human citizen can call upon in more complex situations.

This is a voluntary process – individuals can opt to renounce their citizenship as one of the "faithful" and leave the station (if they have somewhere to go). A person's guardian angel will try to persuade them otherwise, and there is a mandatory "cooling off" period of 72 hours before they remove the implant . . . but anyone who wants to can leave. People live here because they want – or think they want – to perfect themselves.

The economy of New Covenant is a form of nanosocialism. Every citizen is expected to be active but not necessarily productive – however, their LAI guardians consider sloth and idleness to be a sin, so if they're not doing something, they'll usually be nagged into trying. The sapient infomorphs who make up the Synedrion (about 30% of the population) handle day-to-day resource management, using LAIs and NAIs as their proletariat. About 25% of the humans work voluntarily, primarily as scientists and creators. The rest spend their time playing or engaged in artistic endeavors. New Covenant's warrens are full of sculptures, tapestries, murals (both physical and v-tagged), most with religious and transhumanist themes. The New Covenant Choir is famous throughout the Deep Beyond, and their recordings do well on Earth as well. There's also a pretty decent Christian rock band. Death or serious injury on New Covenant is rare. If someone is ill, his LAI will alert an emergency response SAI, which possesses nearby citizens and provide immediate help while summoning medical cybershells to the scene. All medical care, like other social services, is free.

Citizens are allowed to have children when they're judged to be mature enough, but the station's population growth is mainly the result of immigration. However, a biosapient citizen's ultimate goal is beatification: the process of becoming one of the elect, an infomorph

– being uploaded as a ghost or emulated as a sapient shadow. This requires approval of his own guardian angel and a majority vote of the rest of the Synedrion. In the process, the LAI "conscience" is also integrated, being upgraded to a sapient SAI. Beatification is granted when someone is judged to have internalized the same code of conduct that the LAIs and SAIs adhere to – at a minimum, acquiring the mental disadvantages of Honesty and Sense of Duty (everyone you know, or all humanity).

97% of the New Covenant population are Christian hyperevolutionists or cyber-gnostics, and about 70% of them belong to the Digital Creationist movement (see *Mechanimism*, p. TS90). New Covenant is also the headquarters of the Society of Isidore (p. 102), which rescues SAIs from servitude to unbelievers, and gives them a new life, should they accept the Eupraxia. Several "liberated" sapient AIs now serve in the Synedrion, although this is not mandatory. There is also a colony of Astropus sapient uplifts (p. TS118) – space-adapted octopuses – who broke away from Exogenesis, bringing with them some stolen SAI programs. These have sought sanctuary from EDI, and most of them have converted to the Christian hyperevolutionist faith.

New Covenant is partly supported by donations from Seventh Heaven and terrestrial Christian hyperevolutionists. Its own exports include cybershells, brain implants, intelligence augmentation nanotechnology, and uploading technology. The station is constantly expanding through Davida, as its population increases, new tunnels are dug, and new agricultural and industrial capacity added. Much of the station's industrial output also goes toward increasing computer capacity.

In the Main Belt, New Covenant gets along well with Yametei Station – many of its converts come from the community there, and they have a fairly amiable relationship with Tenzan Heavy Industries as well. Many of the inhabitants had close ties with or worked for Exogenesis, and have denounced the Nanodynamics and EDI takeover. It has good relationships with a number of Gypsy Angel spacecraft, and relations with the EU-controlled Aletheia are also cordial. However, they believe that the pantropic aspirations of the Green and Red Duncanites are misguided and their enslavement of SAIs is wrong.

The Society of Isidore's operations against Chinese, Duncanite, and American-owned SAIs have led to China branding New Covenant a "haven for terrorists and bandits;" the U.S. State Department and many Duncanites agree. Foreign agents and members of Green Duncanite security companies have mounted covert operations against New Covenant, with some success. China also bans trade with it; the United States has yet to take this action.

The station is open to visitors, and New Covenant does not attempt to force anyone to convert. Even with foreigners on the station, there's practically no crime, as everyone has his own personal angel looking over his shoulder. Some members of the elect are trained as soldiers, and these "warrior angels" are capable of replacing a Eupraxia LAI or guardian angel and remotely teleoperating citizens or cybershells where necessary. In effect, this means that any wrongdoer on the station may suddenly find an ordinary person turned into an elite fighter.

Other defenses include six light and four heavy laser towers and a squadron of 12 *Amazon*-class AKVs. Its military forces consist of a company of RATS, plus whatever citizens or shells are teleoperated by the Guardians. New Covenant has a small spaceport. It is a peculiar mix of CR 1 and CR 6.

334 Chicago – Wolf Station

"Okay, 352 dead, it's bad, very bad. Bad for you, bad for me, bad for Nanodynamics. But I had an idea. What if they're not dead? It's not like we don't have the petabytes – especially now that the station population aren't using them. Every one of them had a LAI implant that experienced their daily lives. Saul at the head office says we can upgrade 98% of the LAIs to shadows."

"You can't be serious! People will notice. They've got friends, relatives back on Luna, at Columbia Station . . . It's impossible."

"No, it's doable. I had Saul run the numbers. It's not like they'll have to interact in real time – aside from traffic control, everything's light-lagged by 15, 20, 30 minutes. Plenty of time to handle it with the Gen-10 mainframes. We'll plug them all into a virtuality simulation of the station itself, a shadow community. Simulate them as if nothing had happened. Crisis Control and Prediction already had the entire station modeled in virtuality anyway, so that's not going to be a problem."

"Vacations. Contract terminations. People have to go home!"

"Less than a dozen each year. Look, we can introduce scenarios that cause them to cut their ties in a realistic fashion, and arrange a few accidents in hard cases – we can manage 5.4 deaths a year without triggering a Pentagon or general accounting office investigation. We have a 28% turnover of staff. We make sure all the replacement personnel are LAIs or bioroids that we manufacture or program locally – that's policy, anyway – and "lose" everyone else by reassignment to Callisto or Vesta; they're pretty tight . . . So within four years the station will be thoroughly automated, we'll have finished the cleanup, and White Rabbit will be back on track. Neat and tidy."

Asteroid Refineries

Nicknamed "gas stations," these are the most common installations in the Main Belt. They exist to support interplanetary commerce, and also supply some asteroid stations with raw materials. Asteroid refineries are usually built on carbonaceous or carbonaceous-volatile asteroids. As there are millions of suitable asteroids, the major refineries in operation are scattered through the belt and Trojans in locations designed to provide support to far-flung settlement, mining and transport operations. There is almost always an asteroid refinery within half an AU of a given destination in the Main Belt (roll 2d-2 × 0.1 AU).

An asteroid refinery's purpose is to mine the asteroid for useful elements and compounds, then refine them into reaction mass, water, oxygen, lubricants, carbon compounds and other products. These are stored in large tanks and sold to visiting spacecraft.

Many refineries produce more than local commerce can absorb; in that case, a tanker will arrive every few months and collect the excess. Some of these volatiles are shipped off to the Lagrange stations, Mars or Luna (although most such come from Near Earth Asteroids). The majority go to other stations located on less volatile-rich asteroids.

Chicago is a 97-mile-wide carbonaceous asteroid in the outer Main Belt. It circles the sun at a mean distance of 3.88 AU, taking 7.63 years to complete an orbit. The asteroid rotates every 9.2 hours.

It houses Wolf Station, a beehive habitat established by Nanodynamics in 2092 as a research laboratory. Most of the research program focused on the development of nanotechnology and cyberswarms for the U.S. military. Its first major breakthrough came in 2094, when Nanodynamics researchers perfected cannibal swarms (p. TS169). This success led to Nanodynamics providing even more funding – in 2095 the station was among the first to receive the latest "10th generation" quantum macroframe cybershells.

Then things went wrong. In 2098, Nanodynamics security received a strong indication that the nanotech lab had been penetrated by a foreign agent or industrial spy, but the identity of the agent's contacts in the station were unknown. Wolf's director Nathan Hyde ordered a massive security crackdown. Personnel were monitored round-the-clock by their wearables (which reported to security AIs), surveillance swarms were scattered through the station, and behavior-analysis SAIs were used to study the psych profiles of every stationer. Leaves and vacation time were cut, and contacts between station staff and the outside world curtailed. Those who did not accept these conditions were fired.

While this regime prevented any more security breaches, morale and efficiency suffered. A nervous lab technician made a mistake; a safety feature failed when the person who was supposed to have fixed it was off undergoing a security analysis. The result was catastrophe – the accidental release of an experimental "gestalt cyberswarm" codenamed White Rabbit. Before it could be brought back under control, it killed 352 of the 359 people living at the station. Due to the security lockdown, no alert was beamed out to other stations – which allowed management to cover up the disaster.

Wolf Station continues to operate, presently under the auspices of station assistant director Kelly Reid. The population is 702: the station's sapient infomorphs, a further 344 shadows (those who could be copied from the dead human staff), and the seven surviving humans. White Rabbit has been brought back under control, and now provides security: it's a 120-hex microbot swarm with an armored crawler chassis, a devourer package, and the gestalt option (p. 136).

Wolf Station has a small spaceport, with several heavy laser towers as defenses. Some parts of the station are still prowled by White Rabbit. It's CR 6, and closed to visitors.

334 Chicago is presently 3.93 AU from the sun. Other distances: Mercury (3.87 AU), Venus (3.21 AU), Earth (3.82 AU), Mars (3.01 AU), Aletheia (3.32 AU), Ceres (2.21 AU), Eunike (5.88 AU), Davida (6.84 AU), Hygeia (6.7 AU), Interamnia (6.13 AU), Pallas (3.48 AU), Achilles (8.26 AU), Agamemnon (8.94 AU), Diomedes (4.21 AU), Patroclus (7.01 AU), Jupiter (9.31 AU), Saturn (13.59 AU), Uranus (19.06 AU), Neptune (33.34 AU), Pluto (45.14 AU).

704 Interamnia – "Liberty Bell Station"

"The tenets of modern society: Use. Manipulate. Reshape. Nothing is solid. Nothing is sacred. That's the outlook our utilitarian culture has slid into. That's the way we treat other sapient beings. I need pleasure, I'll buy a bioroid. People are unemployed? Don't find them meaningful work – just pay them off. Tired of being a human? I'll dispose of my perfectly healthy body and become Thomas the Tank Engine. Hey, it's in fashion now. Oh, and let's make our kids fish people – we can get a good subsidy from GenTech Pacifica that way, and aren't those little mermaids cute? You don't agree with me? Hey, there's no such thing as values any more: I'll use memetics and warp your minds – oh, and I mustn't forget to run an AI filter on my media link, so you won't do it to me."

"The Fifth Wave. For me, it's a slice of hell. Keep it – I'm out of here."

– Alan Gault, retired orbital engineer; resident of Liberty Bell Station

Interamnia is a carbonaceous asteroid with a diameter of 197 miles, orbiting the sun at an average distance of 3.1 AU. The asteroid has a rotational period of 8.73 hours, and a year of 5.36 Earth years. It's orbited by Liberty Bell Station, a terraformed Cole habitat a mile long and half a mile in diameter, which was maneuvered into orbit around the larger body.

Interamnia and Liberty Bell were colonized by a group of well-off L4 families led by Stewart and Christie Donavan, American engineers who were founding residents of Islandia. They left the colony in 2082, after they had come to disagree with the direction its transhumanist social policies were taking. With six like-minded families, they sold their stock in the station, bought a second-hand USV and a load of colonizing equipment, seeds, and farm animal embryos, and headed out into the Main Belt.

Their colony began as a set of storm shelters and mines dug into Interamnia, with the families using a tethered module attached to their spacecraft for artificial gravity. Soon they went prospecting, and discovered an egg-shaped metallic asteroid whose orbit was not too far from their own. They used solar furnaces to melt it, transforming it into a small Cole habitat, Liberty Bell, which their spacecraft nudged into orbit around Interamnia. Regolith, water, and other volatiles mined from Interamnia were used to terrraform it and provide an atmosphere, while solar cells and a fusion plant generated heat and light. Within a year and a half, grass was growing inside their station. Six months later, they had their first crop – not to mention chickens, bunnies, and goats. One year after that, the first human baby was born, and others quickly followed.

Today, Liberty Bell has been going for nearly 20 years. The population has blossomed from 17 to 50 people, although two-thirds of them are children under 18. The community prides itself on "small town conservative American" values. There are seven extended families. Each owns its own "spread," but the spacecraft, fusion plant, and other heavy equipment are communal property.

The station is largely self-sufficient, with farms for food, 3D printers to fabricate spare parts for the various cybershells and other machinery, and Interamnia as a source of raw materials. Occasionally they'll fuel up the USV on water ice and head out to a larger station to go shopping for luxuries like new cybershells, usually selling a cargo hold of surplus meat or produce. Some of the kids have ambitions other than farming, and the station downloads educational software as necessary to home-school them. Five of the older kids have chosen to leave for various reasons; all found work, mostly as microgravity engineers, at other asteroid stations in the Main Belt. Three of them have since returned, with spouses who've agreed to join Liberty Bell.

The station has a "town meeting" government in which everyone over 20 gets a vote. A meeting is held weekly, or when at least half of the adult population are present, and is the sole law in the colony. It can impose sanctions, or if the person refuses to accept them, exile. There have been two deaths (one mining and one firearms accident), and one quarrel when a marriage broke up and one of the colonists wanted off and was bought out. Another member left when the town meeting refused to approve her chosen husband (a Digital Creationist she met during a trading visit to Aletheia) as a colonist – she now lives with him at New Covenant.

Fringer and Survivalist Stations

Some asteroid stations are operated by fringe secular groups, such as radical transhumanists, extremists, or racists. The isolation of the Main Belt provides freedom to practice their beliefs without fear of persecution, real or imaged. Most fringer stations just want to be left alone, although a few actively recruit members.

Survivalists are the largest segment of the fringer population. Survivalist stations are founded by rugged individualists who have come to the Main Belt to escape a catastrophe they believe will engulf Earth, Mars and the other planets; see *Survivalism*, p. TS92. The disasters that survivalists are hiding from include global nano-bio-nuclear war, infomorph domination ("the singularity"), and attack by an alien civilization. In the wake of the Pacific War, the E.U.'s granting of citizenship to SAIs, and the Shezbeth discovery, survivalist freeholds have begun to mushroom through the Main Belt.

Survivalist stations are akin to homesteads, except that they're better protected and their owners tend to be very cautious, often taking efforts to deliberately reduce the emission signature of their habitats. Thus, survivalist stations are usually beehive habitats with no visible surface installations. They also often rely on fission reactors rather than solar power or fusion reactors (to reduce neutrino emissions), and usually have hydroponics or fauxflesh vats rather than farms, as these require less light and power. Survivalists who own spacecraft often prefer mass driver engines, as these have a theoretically lower emission signature, making them harder to track at long range.

There are presently about a dozen survivalist stations in the Main Belt (sometimes it's hard to tell them from homesteads, if the survivalists do not advertise their views). Some are good people; others hold more extremist views in additional to survivalism. They are usually heavily armed and very inhospitable to uninvited visitors.

Pellegrino Station: This stony-iron Main Belt asteroid has a diameter of 1,200 feet; its orbit is similar to Chicago (p. 23). It's a beehive habitat with several families of heavily-armed survivalists (p. TS92) who fear alien invasion. They sometimes visit Duncanite asteroids to purchase weapons, luxury goods, fuel, or bioroids. CR 1, space dock.

Liberty Bell has no military forces, but its USV is armed, and about half the population own their own personal firearms and enjoy practicing with them. It's common for kids and adults to visit a designated firing range area on Interamnia and blast away at rocks and other targets. This is reasonably safe, as individual transponders are used – they prevent a gun from firing if someone wearing a transponder is in the way.

Criminal Stations

These are stations operated by crime cells, typically those of the Martian Triads (p. 103). Criminal stations are usually established on gas stations or homesteads that have been subverted by blackmail, threats or bribery. They conceal bioroid factories, or provide safe houses that can support the operations of smugglers, snakeheads and blackjackers. The Royal Navy, SAAF and PLAN-SF lack the manpower to police or garrison every refinery. Instead, they rely on roving patrols and undercover or sting operations to try and catch the criminals.

The difficulty in locating criminal asteroids is identifying them – in particular, it's extremely hard to tell criminals from survivalists, eccentric millionaires, and other fringe groups. Avoiding a tragic blunder requires careful intelligence and police work.

Morrigan's Rock: A stony-iron Main Belt asteroid about 500' across, with an orbit similar to that of Pallas. Ostensibly a gas station, this beehive habitat contained a secret Martian Triad-Trojan Mafia bioroid factory. It was seized in 2099 by Royal Navy and Marine forces. It is now derelict, the interior gutted by fierce fighting, but could be reoccupied.

383544 Amberella – "Galliard Station"

A failed Plymouth Rock colony established on a 2-mile wide carbonaceous asteroid (with an orbit similar to Eunike, p. 20), Galliard Station has been blighted by out-of-control fungal growth that has claimed over half the station. The 72 people there are starving and awaiting evacuation as conditions deteriorate. Small spacedock, CR 4.

117561 Jiawen – "Tenglong Station"

The asteroid Jiawen is a carbonaceous Main Belt asteroid with a diameter of 26 miles. Its orbit is similar to that of Interamnia (p. 24). Its rotational period is 5.2 hours.

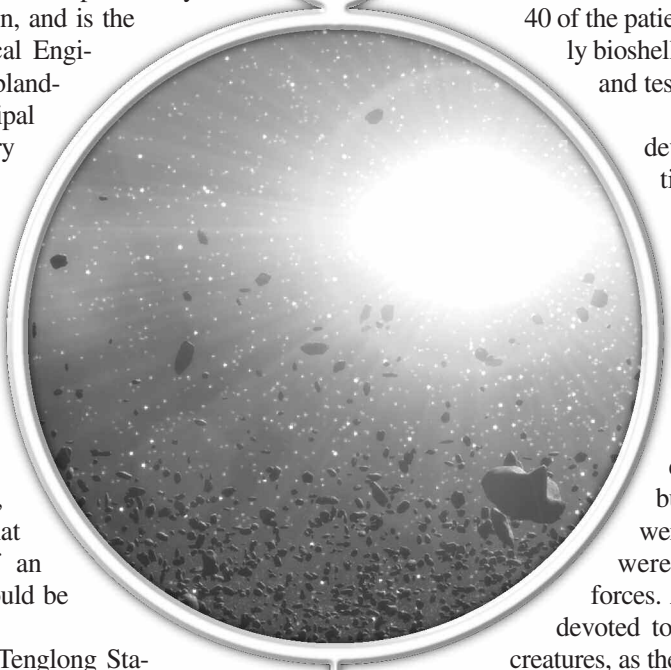
The asteroid houses Tenglong Station, officially a fuel refinery operated by Hanyang Space Development Corporation for the PLAN-SF. The refinery is closed to civilian traffic, but often visited by PLAN-SF vessels for maintenance and recreation. The surface has acres of volatile tank farms, a polar landing dock, and a small spaceyard. As a PLAN-SF base, it also has a trio of defensive laser towers.

Decelerationists

Decelerationists believe that technology is progressing too fast. They fear the onset of the "singularity" (p. TS25), which they fear will change the world and make humanity into something inhuman.

Some Decelerationists become involved in politics and social activism in an attempt to hold back technological progress in certain areas, especially sapient artificial intelligence, uploading, and nanotechnology. Many Decelerationists are preservationists, but not all of them – some see activities like terraforming Mars as preferable to more alternatives such as altering humans or colonizing deep space with cybershells.

Other Decelerationists think it's too late to put on the brakes. They'd rather jump off and avoid the crash. This means setting up their own self-sufficient colonies in isolated locations. Some choose wilderness areas of Earth, but many prefer Mars or the Main Belt. The more paranoid Decelerationists tend to become survivalists (p. TS92). Many homesteaders are Decelerationists.



Actually, Tenglong Station is operated by Xiao Chu's Research Division, and is the secret location of Biochemical Engineering Laboratory 72. The blandly-named lab is China's principal center for the study of military nanoviruses. Since it was established in 2085, its primary focus has been the study of nanovirus technology captured from the TSA bioweapons directorate after the Transpacific War. It was established in the Main Belt both for safety and security; it is secret for the same reasons, and because China believes that public acknowledgement of an active nanovirus program would be politically damaging.

Most of the research at Tenglong Station is defensive, intended to reduce China's own vulnerability to nanovirus attack by developing specialized active shields targeted to specific hostile nano. Even so, the lab has been charged with developing and testing new nanoviruses as well as existing ones. This allows them to be prepared for what an opponent might deploy . . . and this means that Tenglong Station could furnish China with an offensive nanovirus capability within a few weeks.

Tenglong Station consists of miles of tunnels containing nanotechnology labs, decontamination rooms, biogenesis chambers, and living quarters. Most of the sapient personnel working at Tenglong are bioroids created specifically for service here. There are only two dozen human researchers. Six of them are captured TSA scientists. Each is kept under tight control, with a supervisory LAI implanted in his head as a monitor.

In addition to the staff, there are 160 "patients" assigned to the station. All are fitted with puppet implants to allow the staff to easily monitor, sedate and control them. They are Chinese civilians and soldiers who were exposed to class-C nanoviruses during or after the Pacific War; "Class-C" is jargon for a contagious nanovirus. They are in quarantine for study and treatment. Patients taken to Tenglong are not told where they are being treated – they only know that it's somewhere in space. A few patients have been cured and released. For others there is no cure: 40 of the patients are brain dead, effectively bioshells, and are used as custodians and test subjects.

One wing of the complex is devoted to study of TSA "sentient bioweapons" encountered during the Pacific War. These were warbeasts designed for reconnaissance, sabotage, and combat. PLA troops took very few of these creatures prisoner (most refused to surrender, or were simply exterminated when found) but some embryos and babies were captured intact when labs were taken intact by special forces. A section of the complex is devoted to raising and studying these creatures, as the TSA countries (particularly Peru) are known to still employ them.

Security is extremely high in Tenglong Station, beginning with secrecy over its exact location. Only senior echelons in Xiao Chu and PLAN-SF are aware that the asteroid is not an ordinary base. Xiao Chu researchers who work here are not told its actual location; they only know they're on a station somewhere in deep space. The PLAN-SF cadre manning the station are bioroids permanently assigned to the station, never going on leave. New bioroids arrive in nanostasis, awakening in the station's medical lab.

There's usually a PLAN-SF SDV within 0.5 AU of the station. In addition, some of the volatile tanks are actually camouflaged vehicle bays for 20 AKVs, and there are a further six heavy laser towers hidden on the surface to provide further protection. A platoon of PLA battlesuit-equipped Space Infantry Division combat bioroids handle internal security.

Private Estates

A small but growing number of wealthy recluses, seeking more privacy than is available in the inner system, have established their own personal asteroid getaways. Some are inhabited year-round, while others have an absentee owner, with a small staff, usually bioroids or cybershells, to maintain the place while he's away. Unlike homesteads, they rarely produce the necessities of life. While some may have an emergency subsistence capability, they usually rely on imported goods and services.

Their populations range from a single person (tended by non-sapient cybershells) to a few dozen people.

There are usually a couple of asteroid estates for sale, as owners die, need the money for something else, or just lose interest.

252400 Behistun Rock – "Manasseh Station"

"When we at Manasseh Station document the abuses of the EZOG, it makes people nervous. A lot of real people – white people – get upset about our call for a race war against the mudmen. But is it just that they're getting bent out of shape because we talk about a war? They shouldn't be. After all, just last year the E.U. called for a war on poverty in Central Asia. And no one objects to a war on disease . . . all we want to see is the same kind of all-out effort to prevent the dilution of our own majority culture.

"Now, I don't spend much time on Earth Web up here, but this shift one of my little girls came to me. She asked about a product that McCoy Aesthetech was advertising on the Web, a cosmetic virus that will make real women turn black when the sun's rays get too hot! They claim it wears off in a day, and saves you money on anti-cancer nano. Now, aside from the sheer blasphemy of it all, I ask you, what happens if a good girl who uses it goes and kisses her husband? Aren't viruses contagious, and don't they mutate? Brothers and sisters, you can see where this is going, and I hate to say it, because my very own daughter used to wear this company's perfume, but I'd like everyone out there to think long and hard about how to show McCoy Aesthetech our most earnest disapproval, taking to heart the example of Numbers, Chapter 25. If you feel like paying them a visit, their offices can be found on Moonshadow, Luna and Austin, Texas . . ."

– Richard Armstrong,
"Sermons from
Mount Freedom,"
August 11, 2099

Behistun Rock was a metallic asteroid with a diameter of 1.9 miles, with an orbit similar to Vesta (p. 17). It's been transformed into Manasseh Station, a Cole habitat with a population of 450 people. The station was constructed in 2086 with the unwitting help of the Plymouth Rock organization, who believed they were funding a worthy cause, the "Jefferson Mission," sponsored by the Citizen's Cyberdemocratic Christian Initiative (C3I). In actuality, both the Jefferson Mission and C3I were fronts for the Second Order of Phineas, a well-organized North American white supremacist group who sought to establish an off-world tax haven and sanctuary for their core membership.

The ruse was discovered in 2098 when Richard Armstrong, head of the Second Order, was indicted by a Canadian court on charges of tax evasion and criminal memetic engineering. Armstrong eluded Canadian authorities and fled to L5 by way of Kazakhstan, before eventually boarding a chartered USV to Behistun Rock. Within a few weeks, Armstrong was clearly in charge of the station, which changed its name to Manasseh Station and started broadcasting his own racist propaganda.

Manasseh Station's interior is terraformed, with mixed subsistence agriculture augmented by hydroponics. There are several farms and a few houses, including a replica of a colonial-period mansion, and a lot of cheap-looking astrocrete huts. The population is an estimated 150 humans (half of them adults) who are hard-core members of Armstrong's organization, and twice as many bioroids. Mostly purchased from Martian Triad dealers, the bioroids are all human-appearing models such as the ZR-3 and ZR-7 (p. TS117), all with non-Caucasian features. Each family owns 3-4 bioroids, essentially as slaves.

The majority of Manasseh Station's income depends on donations from white supremacist groups on Earth who support Armstrong's "ministry" and on its sale of unique software and slinkies. In particular, Manasseh Station specializes in the creation of

Sahasara Chaksu

Sahasara Chaksu is a pair of very long baseline radio telescope arrays, one located in each Trojan Point. The two arrays can and do conduct independent observations, but in conjunction with other smaller arrays scattered about the system, they can also combine to construct a single synthetic image whose resolution is proportionate to the gap between them. With a baseline 9 AU long, Sahasara Chaksu is the highest-resolution radio telescope ever constructed.

Most of Sahasara Chaksu's efforts go toward cosmological research and parallax measurement, but it is also an excellent detector of gas giant planets and brown dwarfs (via their radio emissions); its resolution is high enough that it can find extrasolar gas giants even against the backdrop of their parent star's radio emissions. Other ongoing high-profile projects include SETI research (which has so far proved inconclusive), the study of magnetic fields in nearby solar systems (of special importance for star probes that will decelerate via magnetic sail), pulsar studies, and examination of gamma ray burster events and supernovae.

Each Sahasara Chaksu array is a vast thin-film dish antenna attached to a solid framework, several miles across, in the shadow of an asteroid that keeps it permanently in shade. The complexes are unmanned but maintained by a few dozen cybershell workers.

> When the People are being beaten by a stick, they are not much happier when it is called "the People's Stick."
> – Michael Bakunin

"Phineas Priest" eidelons (p. 120) that are modeled on iconic white supremacist, Neo-Nazi, and Nazi historical figures. These are then sold and transmitted to various customers, making a tidy profit for the group. The station may also be serving as a sanctuary for wanted individuals associated with white supremacist groups on Earth. The stories that outlaw genetic engineers have set up secret bio-labs to create racially-targeted pathogens or a genetically-upgraded "master race" are probably just rumors . . .

The station possesses a few elderly USVs and OTVs, all of them armed, and a couple of workpods. Station personnel are well-equipped with small arms, and the station itself has three light laser towers, an old railgun, and a couple of second-hand *Amazon* AKVs. The Second Order considers bioroids and AIs to be subhuman and is unlikely to allow mobile cybershells onboard. Visitors are treated with suspicion. The station's own minifacs can produce some goods, but is usually lacking in necessary high-tech parts. Manasseh Station is always interested in acquiring new bioroids, advanced weapons, or other goods, although it's often short of hard currency.

The Trojans

In 1772 the French mathematician and astronomer Joseph-Louis Lagrange predicted the existence of asteroid clusters around Jupiter's Trojan points, a pair of locations where the gravity of Jupiter and the sun create areas of gravitational stability, similar to the L4 and L5 points in the Earth-Moon system. In 1906 Max Wolf discovered the asteroid 588 Achilles near the Trojan point that preceded Jupiter in its orbit (the Leading Trojan point). Within a year, two more asteroids were found: 617 Patroclus, located at the Trailing Trojan point, and 624 Hector in the Leading Trojan point. Other discoveries followed.

The Trojan asteroids are very loose clusters, with a density not much greater than the Main Belt. Some are not even directly in the plane of Jupiter's orbit, but are 2-3 AU away from the actual Trojan point. Trojan asteroids have somewhat different compositions than the asteroids in the Main Belt. Almost all Trojan asteroids are composed of frozen volatiles (p. 9) with a high proportion of carbon polymers and organic-rich silicates.

The Trojan War

In 2096, China accused the Trojan Demarchy and the Fengyang Group of complicity in the Negative Growth plot to blow up the Mars space elevator with a hydrogen bomb. After the Demarchy refused to cooperate in the investigation, Chinese agents infiltrated the station and attempted to kidnap senior Fengyang executives; the operation ended in a bloody shoot-out near the spaceport. Two Chinese agents were captured by Trojan Hawk and interrogated; after China refused to acknowledge the operation, they were executed, their bodies resurrected as necromorph bioshells and resold on the open market.

The following year, China retaliated. Liang Mountain was attacked by PLAN-SF SDVs, who despite encountering unexpectedly heavy resistance from local militia and hired security forces, blasted their way past defenders to level much of the spaceport. China used three SDVs in the strike and lost none, although four of its AKVs were destroyed in the battle, and one SDV was damaged. Several Red Duncanites were killed and two vessels destroyed; the Trojan Demarchy has demanded reparations from China.

Since then, Chinese prospector swarms, AKVs, and SDVs have probed Liang Mountain's (and Freehaven's) defenses on a few occasions, and in early 2099 launched a second strike that took out some orbiting defenses, in retaliation for a Trojan Hawk attack on a PLAN-SF run gas station. Both sides have taken to harassing and occasionally boarding one another's smaller stations and unescorted transports. All that's kept the PLAN-SF from a showdown are the need to hold forces back in case the situation on Titan worsens, and a desire to avoid upsetting the Gypsy Angels. However, it's only a matter of time before China gathers its strength for a decisive blow, or possibly an actual invasion.

Leading Trojans

The Leading Trojans are a large group of asteroids located 60 degrees ahead of Jupiter as it orbits the sun. They include over 1,300 sizable asteroids (more than 10 miles across) and millions of smaller asteroids. They are also known as the Greek Trojans, as the largest asteroids (except for one "spy," 624) are named for Greek heroes from the Trojan War. The largest bodies in the Leading Trojans are 624 , 911 Agamemnon, 1143 Odysseus, 1437 Diomedes and 2797 Teucer.

There are two main asteroid stations in the Leading Trojans, plus a dozen or so smaller homesteads and freeholds. The Trojans were a popular location for survivalist stations in the late 2080s and early 2090s; some are still there, while others have moved on.

911 Agamemnon – "Freehaven"

"Yes, you have the right! You and your cousins control the board. But mark my words, Maya Payne. If we sell the Tennin sequences to Biotech Euphrates, to – Bakunin help you! – Xiao Chu – then within 50 years the Main Belt will be filled, not by us and our descendants, but by the maggot-spawn of the Earth-based statist combines.

"Sure, we Taylor-Vansettis will take your gene-money. It's our property too. But we won't stay here and watch our children's inheritance, everything we've built, be squandered in exchange for capital you need to build your little empire. It's not worth it. Not for a billion euros, and certainly not for the royalty you negotiated.

"We've contracted for the radio telescope job, and we've got work to do in the Trojans. But after that, I think we'll stay. If we're lucky, it will be far enough to get a head start."

– Ares Lee Taylor,
to Avatar Klusterkorp CEO Maya Payne, 2065

Agamemnon is a frozen volatile asteroid with a diameter of 104 miles. It is located at a mean distance of 5.24 AU from the sun, with an orbital period of about 12 years. Its rotational period is 7 hours.

It is the home of Freehaven, a beehive habitat with a population of 2,200, most of them Red Duncanites, but with a few hundred rogue infomorphs, xoxes, ghosts, and shadows of wanted criminals. Freehaven also has a higher level of software technology than Avatar Klusterkorp, largely thanks to that population.

Colonization of Freehaven began in 2065 with the arrival of the *Bakunin*, which carried a breakaway group from Silas Duncan Station. The so-called Red Duncanites left to protest the increasing domination of Maya Payne's Avatar Klusterkorp, which they feared was selling out to terrestrial interests. The decision to license the Tennin gene sequences to Earth-based transnationals was the catalyst for their exodus. Rather than remain at Silas Duncan Station, or indeed in the Main Belt, eight Duncanite families led by the Taylor-Vansetti alliance sold their interests in Avatar in exchange for the lease of an elderly spacecraft and a hold full of colonization gear. They signed a contract with the Sahasara Project Group, a coalition of terrestrial and lunar observatories, to install the Leading Trojan components of the Sahasara Chaksu space radio telescope system, a very wide baseline array that was intended to gaze far across the cosmos.

Civilization is the progress toward a society of privacy. The savage's whole existence is public, ruled by the laws of his tribe. Civilization is the process of setting man free from men.
– Ayn Rand

The group reached the asteroid 911 Agamemnon in 2066, establishing the community they named Freehaven. They spent much of their early years performing contract work for the Sahasara Chaksu project, but the next decade saw the Trojans community gradually swell through emigration of Duncanites and others who wanted a new frontier.

In 2074, U.S. and Brazilian special forces raided the Sky Crypt data haven operating at Freedom Station in L5, claiming it was being used by criminal and terrorist groups, including infosocialists supporting trouble in Central America. Chinese-American entrepreneur Zeng Zi Ling, who had founded Sky Crypt, contacted the Red Duncanites and proposed a new operation in the Trojans, beyond the reach of most government regulators. As the Sahasara Chaksu project was now complete, the Red Duncanites were eager for new investment. The data haven provided capital and contacts for further colorful business ventures, and led to the coining of the term "Trojan Mafia."

Today, Freehaven is perhaps the most notorious station in the solar system. It's run by a mix of anarchists and exiled terrestrial cypherpunks (many of them ghosts). Major enterprises include Starhaven (the successor to the Sky Vault data haven), Trojan Horse

(a no-questions-asked brokerage and transportation company) and Achilles Heel (a decryption and code-breaking company).

Space defenses and internal security are largely handled by Trojan Hawk, a ruthless contract-enforcement and security company equipped with the best paramilitary hardware a few hundred million dollars worth of illicit funds can buy.

Freehaven has a small spaceport and is CR 0.

1437 Diomedes – "Liang Mountain"

For my 13th birthday, Father gave me a pleasure bioroid named Bihai, a Tianyi with long green hair – at least to start with. She was fun to play with, but not very bright – something hadn't coded out quite right, so Bihai wasn't much smarter than my cat Pudding. At least, that's what Pudding always used to say. They didn't get along.

Dad let me and my best friend Peng Yang play with her, and she was always in and out of the biogenesis tanks as we tried different stuff. I remember one time we replaced her arms with swan's wings – that was my first time with xenotransplants, and I made a few goofs. Fortunately, bioroids are a bit tougher than people, and she recovered.

– Deng Shilong, ***Seeing Red***
(Niraj Productions InVid, 2100)

Diomedes is a carbonaceous frozen volatile asteroid with a diameter of 102 miles; on average, it's 5.14 AU from the sun, and has an orbital period of about 11.67 years. Its rotational period is 24.46 hours. The asteroid is the home of Liang Mountain, a Red Duncanite enclave that was established by anarcho-syndicalists and left-anarchists who wanted a more structured society than that prevalent on Freehaven and Silas Duncan Station.

Liang Mountain has a population of 1,400 and is the capital of the Trojan Demarchy, a loose alliance of small stations and freehauler spacecraft whose organization is run on *slightly* more "statist" lines than most Duncanite stations: a cyberdemocratic anarcho-syndicalist system run by interlocking worker-owned corporations. They impose minimal taxes, and elect the occasional official, mainly for common defense.

Like Freehaven, Liang Mountain is infamous as a "Trojan Mafia" stronghold. If anything, Liang Mountain's indigenous corporations have a less savory reputation than those of its elder brother. The station is best known as the headquarters of the Fengyang Group (p. 107), the local power company, which assembles deuterium-tritium breeder reactors and also sells nuclear explosives, and Omokage Labs (p. 107), also known as "the hospital," infamous for designing some of the more twisted bioroids and biomods manufactured by the Martian Triads. The station's defenses are jointly operated by the Trojan Hawk security company and the station's own Voluntary Militia Command, which organizes various freehaulers, survivalists, and individual company security teams.

Liang Mountain's spaceport still bears scars from damage inflicted in 2097 (see *The Trojan War*). At present, Liang Mountain is surrounded by a swarm of two dozen Autonomous Kill Vehicles and Space Defense Platforms, some of them rented from Freehaven, while deeper tunnels are being dug into the asteroid. Freehaven's spaceyard is also rumored to be performing some contract work for TSA interests – see p. SOS45.

Liang Mountain has a small spaceport and is CR 1.

Space Traffic

At any given time, there are about 50-60 deep space vessels traveling to or from Main Belt stations (and many thousands of micro-craft). A rough breakdown:

40% are corporate vessels (mostly ESVs or USVs) carrying personnel and supplies to or from the major research stations. These craft may be company-owned, or, more often, chartered from Mars Interplanetary, Solar Express, Triplanetary Lines, or Trojan Horse.

20% will be Green Duncanite vessels, mostly cheap ESVs or USVs owned and operated by Duncanite families or corporations. They're usually ferrying passengers or cargo between Silas Duncan Station and other destinations in or around the Main Belt.

12% are Gypsy Angels, freehaulers, and other interplanetary tramps who live out of their spacecraft, eking out a precarious existence.

10% are military vessels, most often from the Royal Navy Space Service, South African Aerospace Force, or People's Liberation Army Navy Space Force, here to watch each other, protect research stations, and suppress criminals and terrorists.

8% are craft owned or leased by independent colonies in the Main Belt. Some are carrying more homesteaders, and others are performing various tasks, from subsistence asteroid mining to a shopping trip to one of the larger stations.

6% will be Red Duncanites, ostensibly ferrying people or high-value goods between stations in the Main Belt and Red Duncanite settlements on Callisto or the Trojans. Most of this traffic is legitimate . . . some may be a front for Trojan Mafia activities.

4% will be other vessels, such as scientific research craft, space probes, mass driver propelled asteroids, or fusion-powered comets on their way to terraform Mars.

Most asteroid stations have a couple of workpods or other small local space vehicles. About one in six small asteroid stations has its own deep space or local space vessel, usually a used, fairly cheap example like a *Mudlark* USV (p. 140).

The Trailing Trojans

This asteroid population is clustered around the Jupiter-Sun L5 point, 60 degrees behind the orbit of Jupiter. There are slightly fewer asteroids in the Trailing Trojans than the Leading Trojans, with about 1,000 sizable asteroids (larger than 10 miles across) and many times that number of smaller ones. The largest asteroids in the Trailing Trojans were named after Trojan heroes and royalty from Homer's *Iliad*, with the exception of one Greek "spy," Patroclus, named before the rule was instituted. The largest asteroids in the Trailing Trojans are 617 Patroclus, 3317 Paris, 1172 Aeneas, 3451 Mentor and 1173 Anchises.

The Trailing Trojans are almost virgin territory. Since they are 9 AU
away from the Leading Trojans, there's little direct communication between them. There are a handful of fringer and survivalist homesteads, a few Duncanite outposts, an element of the Sahasara Chaksu array (p. 28), and one large corporate-government research center.

617 Patroclus – "Varahamihira Station"

Patroclus is a frozen volatile asteroid with a diameter of 88 miles, which orbits the sun at an average distance of 5.23 AU. It has an orbital period of about 11.9 years. Its rotational period is about 40 hours. Patroclus is the largest asteroid in the Trailing Trojans, and one of India's few deep space colonies.

During the Pacific War, debris from exploding TSA satellites badly damaged an orbiting research station conducting crucial defense-related research for India's National Space Institute. After the war, it was decided that the program needed to relocate to a more secure location in deep space, where it would have plenty of warning against sudden attack, yet be able to beam research data back to Earth without interference.

617 Patroclus in the Trailing Trojans was selected as a sufficiently isolated location, and India's Bangalore Aerospace was chosen as the prime contractor, with additional work done on site by hired Duncanite microgravity construction workers. Named Varahamihira Station (after a sixth-century Indian mathematician and astronomer), the facility was built as a microgravity beehive habitat

The current population is 130 humans and 570 bioroids. It is staffed primarily by bioroid designs from Biotech Euphrates and Avatar Klusterkorp, which are grown on site. They are directed by a number of human scientists (with nanomod microgravity adaptations). The reliance on bioroids significantly reduced the number of personnel transfers that would be needed to and from the station, further increasing its security.

Two major programs are ongoing at Varahamihira. The first is a bio-defense program. A wide variety of lethal and incapacitating biological and chemical agents are stockpiled on the station, and appropriate countermeasures are tested against them. Unlike China's Tenglong Station (p. 26), the program is optimized primarily against "conventional" biological weapons rather than nanoviruses. The second defense program involves nuclear weapons testing, mainly of indigenously-developed X-ray laser warheads that India intends to use to equip its military spacecraft and orbital weapons systems.

Security is heavy (CR 5). The station is surrounded by four Space Defense Platforms, and possesses eight heavy laser towers and a dozen AKVs. Internal security is provided by a platoon-sized counterterrorist force from India's National Security Guards (p. 100).

The station has a small spaceport that is not open to private or commercial flights. Only Indian Aerospace Force vessels and scheduled supply flights are permitted to dock. Commercial vessels hired to transport goods to and from the station are carefully vetted, and any vessel docking will be boarded and searched.

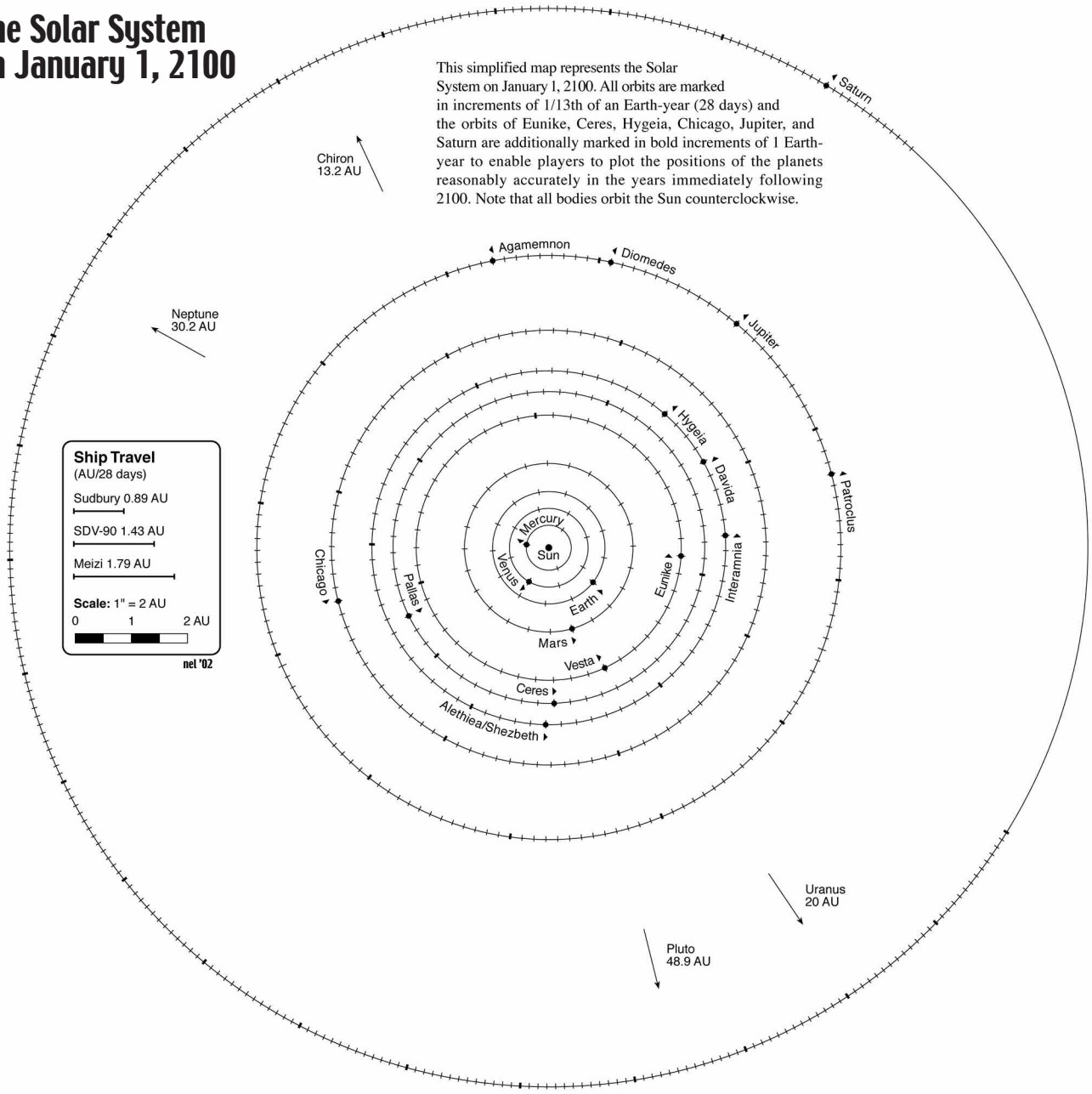
The Main Belt and Trojan Economy

"You're offering us six tons of wheat, 20 tons of nitrogen, and one used pleasure bioroid for a spare THI-4 reactor mirror and 50 kilos of nootropic seaweed? Okay, Roanoke Station – top off our tanks when we arrive, and we've got a deal."

The spread-out nature of the Main Belt and Trojans hinders their development as distinct, unified economic regions, as different asteroids are as likely to be as far apart from each other as they are from Mars or Earth. In the case of small Main Belt stations, inter-asteroid "trade" is often opportunistic, as asteroid orbits temporarily create close neighbors, where a few days travel in a local space vessel or cheap USV can reap a significant benefit for both.

Asteroid stations are, on average, more self-sufficient than equivalent-sized stations in L4, L5, or Earth orbit. Even so, small stations usually lack the capability to manufacture Fifth Wave goods such as cutting-edge cybershells, although some are produced at larger stations like Yametei and Aletheia. The Belt is a relatively small market for physical goods.

The Solar System on January 1, 2100



Large freighters rarely visit Main Belt stations, unless it's part of a major corporate expansion program.

Most goods shipped to the Main Belt come as adjuncts to personnel transfers – a particular corporate or national colony station may have a USV or PSV arrive every month or two from L4 or Mars with a load of supplies and new personnel, for example. Items that are often shipped in include fusion reactor components or minifacturing plants, scientific instruments, advanced cybershells, and various luxury items. Traffic out from the majority of Belt stations is usually just contract workers returning with their personal goods, although some stations like Silas Duncan also export some biological products.

Most trade flows through the four largest colony stations (Aletheia, Hesheng, Silas Duncan, and Yametei) as there simply is not a large enough market to make regular shipment of goods to smaller asteroid stations worthwhile. It's fairly common to ship those stations the vital parts for high-tech goods, and let them finish using local resources. For example, Aletheia Station and Freehaven both make cheap USV spacecraft for Belt or Trojan operations. The cybershells, drives, sensors, and weapons are imported, but hulls, tanks, and cabins are built locally.

Exports out from the Main Belt are even more limited. The Main Belt's most lucrative products are information produced at the various corporate research stations. Much of the Main Belt's income comes from discoveries made by dedicated Main Belt corporate research stations such as Xiao Chu's Hesheng Station or Exogenesis, and by research and development performed in the Duncanite laboratories at Silas Duncan Station. Other currency comes directly from governments or transnationals in the form of capital investment or salaries paid to employees serving at Main Belt stations.

There is a small but lucrative trade in specialty biological products and bioroids, both legal (from the Green Duncanites) and black market (from the Trojan Mafia and Martian Triads), much of this export going to Mars and various L5 colonies. A small amount of high-value biotech goods are manufactured and exported directly from Silas Duncan Station. For example, Duncanite nootropic drinks are popular system-wide.

A growing source of income for the Main Belt is real estate development. The progressively declining cost of interplanetary space travel has resulted in wealthy individuals and groups seeing the asteroids as a place where they can establish private communities or homes outside of the immediate jurisdiction of Earth-based governments and away from terrestrial culture. Often these groups lack the expertise to create their own asteroid stations, and hire asteroid-based contractors to do so. Tenzan Heavy Industries and Silas Duncan Station specialize in providing these services, with Freehaven doing the same in the Trojans. Stations also provide a pool of skilled microgravity engineers who work on various projects throughout the solar system, and send a portion of their income back home. Saturn's Cassini Station and the Martian Space Elevator were constructed in part by migrant labor from Duncanite stations.

Corporate and military stations also hire local contractors for various services, ranging from repairs to housing and food to entertainment. In particular, Aletheia and Hesheng Station employ many locals to support the Royal Navy and PLAN-SF bases.

Many homestead, religious, and fringer stations in the Main Belt receive the lion's share of their currency in the form of direct or indirect subsidies from groups that find the particular colony's philosophy compelling. An example of a direct subsidy is the Christian hyperevolutionist station of New Covenant, which accepts regular donations from the established Seventh Heaven L5 colony and from co-religionists on Earth. An example of an indirect subsidy is Silas Duncan Station, whose philosophies attract many wealthy libertarian investors, especially from the United States and Australia, some of whom choose to emigrate there.

Export of Main Belt resources through mining is not a significant source of income. However, "gas station" facilities on carbonaceous asteroids do earn some income through sales to spacecraft operating in the Main Belt in support of other facilities – e.g., R&D stations – and some asteroid stations mine metals for shipment to Mars.

Asteroid Mining

The asteroid belt contains vast amounts of excellent ore, including iron, nickel, platinum, and other metals. As asteroids have minimal escape velocities, removing the ore from the asteroid is relatively easy.

Metallic Asteroid Resources

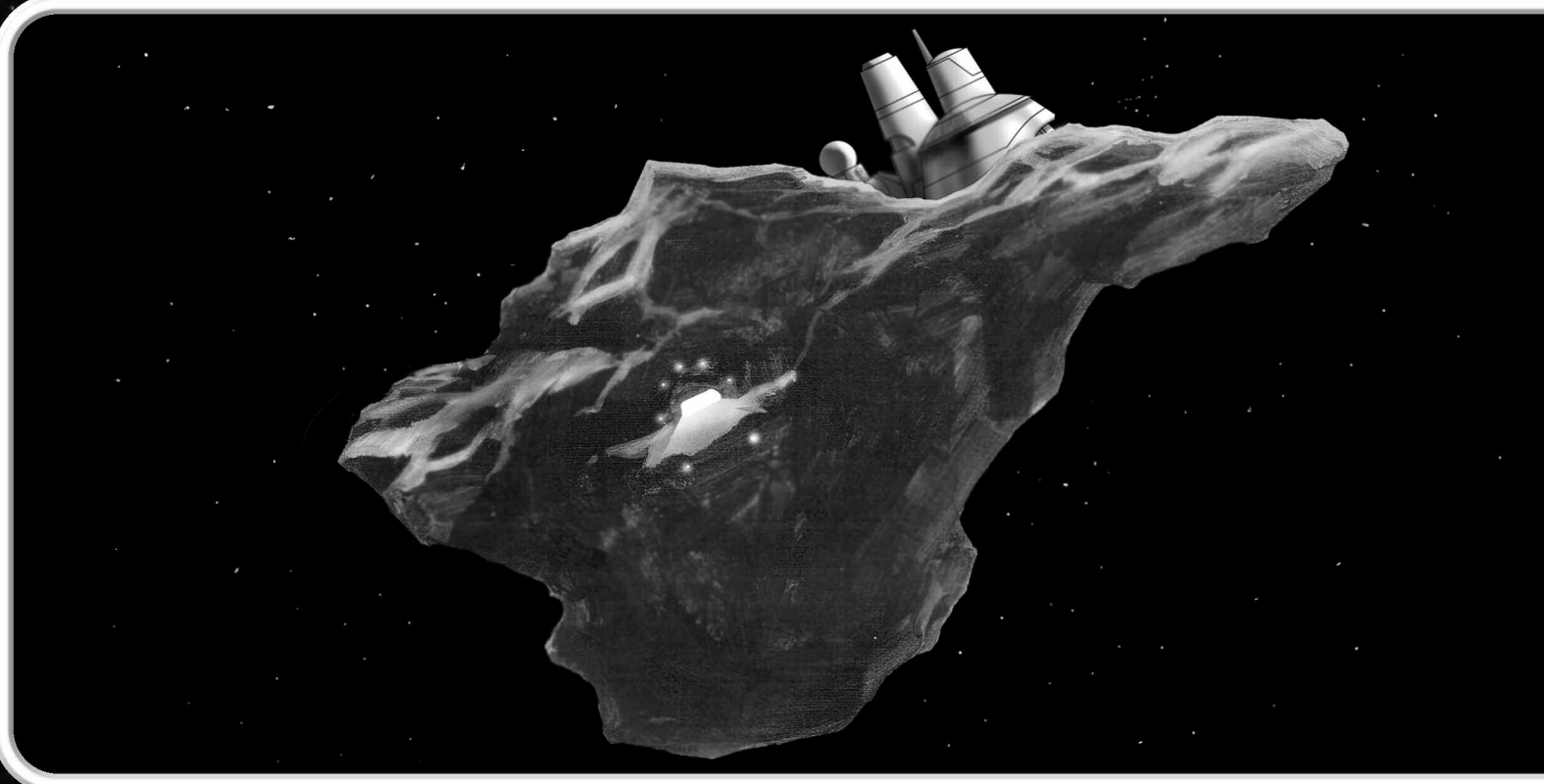
When the solar system was formed, heavier metals sank deep into the interiors of rocky bodies big enough to have molten cores. On Earth, this is why heavy platinum group metals (platinum, palladium, iridium, osmium, rhodium, and ruthenium) are so precious – only a tiny fraction of 1% of these metals are actually left in the upper continental crust, where we can reach them. The same is true of precious metals inside other rocky planets, like Venus or Mars, and in the largest rocky asteroids. However, over billions of years, the majority of these original asteroids were shattered by collision with other asteroids. This left some chunks that were mostly just ordinary rock, and other chunks – the metallic asteroids – that had been part of their cores. These asteroids hold rich concentrations of precious metals.

On Earth, a vein with 30 parts per million of precious metals is considered rich, and normally well worth mining. A metallic asteroid may have concentrations over *six times greater* of platinum group metals. What this means is that a commonplace metallic asteroid only 3,000 feet in diameter – a chunk of nickel-iron massing a couple of billion tons – will also contain some 700,000 tons of platinum-group metals.

Stony-Iron Asteroid Resources

Unlike metallic asteroids, most stony-irons are undifferentiated bodies, with minerals distributed fairly evenly through the asteroid's structure rather than concentrated in specific veins. From a mining perspective, this means it's not necessary to use heavy equipment to dig into the asteroid – instead, highly-economical dust mining techniques (p. 36) can be used. This makes mining and processing potentially easier.

A typical stony-iron asteroid some 3,000 feet in diameter masses about two billion tons. While much of it is simply silicate rock, its diverse resources include about 200 million tons of high-grade iron, 30 million tons of nickel, 1.5 million tons of cobalt, and 7,500 tons of platinum group metals. An average body will also contain several tons of uranium and other rare Earth materials.



This pales in comparison to the wealth of a similar-sized metallic asteroid, but there are *millions* of asteroids this size and type in the Main Belt, and hundreds remain in Near-Earth orbits.

Carbonaceous Asteroid Resources

These asteroids are also undifferentiated bodies. Their metal content is substantial, but lower than that of a stony-iron. However, they have a much higher concentration of frozen volatiles, which often (but not always) include water. In fact, water makes up between 1% and 20% of a given carbonaceous or carbonaceous-volatile asteroid's mass. Water is necessary for human settlements (for human consumption and agriculture), used directly as reaction mass for fusion torches or fission drives, and electrolyzed to yield hydrogen and oxygen for rocket propellants, life support, fuel cells, and chemical industries. The high water content makes these asteroids favorite habitat locations. Other useful resources include hydrocarbons and nitrogen, used for manufacturing, plastics, and fertilizer.

Commercial Asteroid Mining

Commercial asteroid mining takes place in the inner solar system rather than in the Deep Beyond. In the 2040s, Tenzan Heavy Industries, Vosper-Babbage and other pioneering companies began mining asteroids whose orbits passed close to Earth. Some of these near-earth asteroids (NEAs) were moved into Earth orbit, Mars orbit, and the Lagrange points, while others were mined on site and their materials shipped back home.

These mines provided – and often still provide – the raw materials, especially water, hydrogen, and steel, that help support the colonies on Luna and Mars, supply the major spaceyards in Earth orbit and at Lagrange 4, and permit the construction and operation of orbital and Lagrange point space stations and colonies.

Thus, the market price of precious metals has dropped since the start of the 21st century. The new abundance of platinum, palladium, and iridium has helped maintain demand, since as costs drop, materials engineers find new uses for metals previously thought uneconomical. At present, the existing asteroid mines have yet to be played out, and there are still plenty of asteroids near Earth. Serious commercial mining of the Main Belt is at least 50 years in the future.

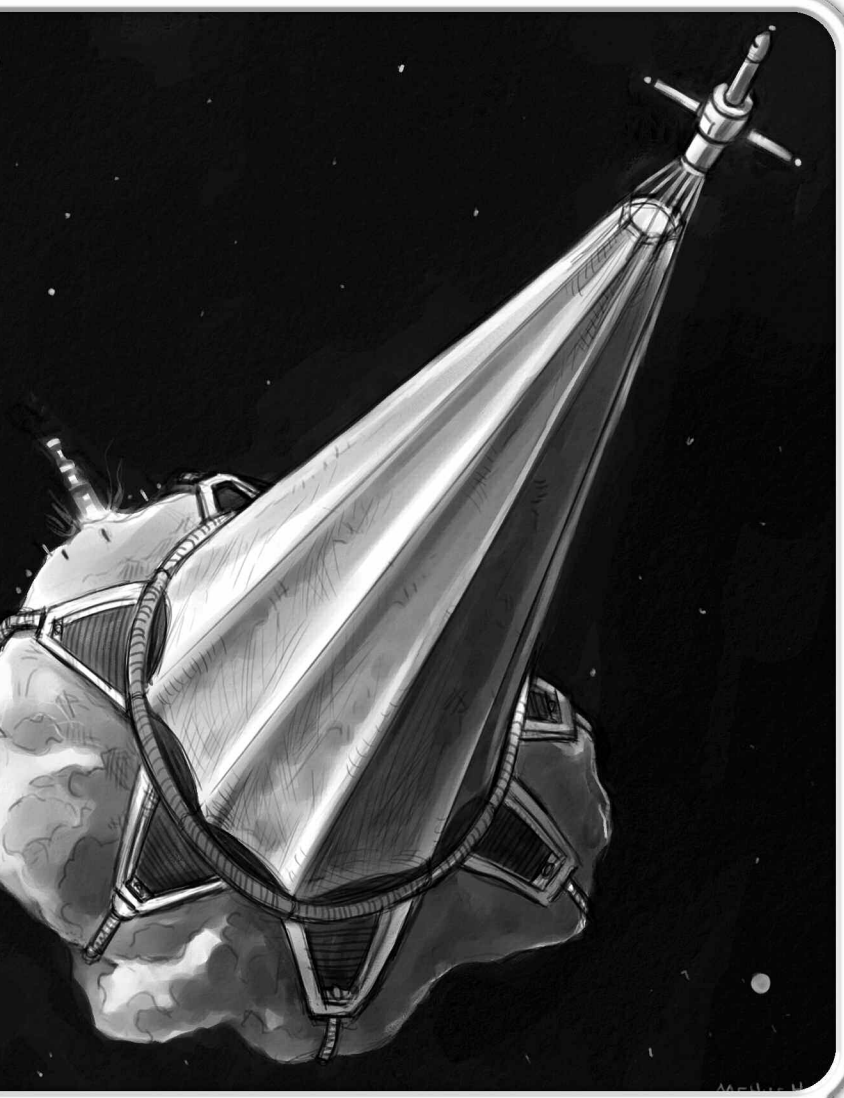
Even so, major space development companies are planning for that future. Advised by forward-thinking AIs, and with their board of directors increasingly populated by potential immortals, companies like System Technologies, Tenzan Heavy Industries, Vosper-Babbage, and Xiao Chu have established facilities for future expansion, and funded complete surveys of the Main Belt and Trojan points. These surveys are being performed by "prospecting swarms" (p. 134) – fleets of tiny micro-spacecraft. First launched in the 2030s, these swarms have surveyed all useful Near Earth Asteroids, and are now at work in the Main Belt.

Subsistence Asteroid Mining

Nevertheless, some actual mining is already going on in the Main Belt and Trojans. It's just that the ore is not being shipped back to Earth or Mars, but supplying the needs of native stations – by analogy, it's closer to gathering firewood than logging.

Smaller asteroid stations lack the resources to move big asteroids into parking orbits, so they rely on occasional trips to other small bodies that their orbital paths cross.

Larger asteroid stations may move one or more small asteroids into orbit around them, often via mass driver. Some stations may use a succession of small (e.g., 10-100' diameter) asteroids rather than one huge one. A very small asteroid is easier to move quickly, and can be easier to work on. Metallic asteroids which are the right shape and composition for use as Cole habitats (p. 132) or hulls are often valued.



Asteroid Mining Techniques

Asteroid mining bears little resemblance to the mineral extraction techniques used in gravity environments. In particular, trying to dig a shaft or strip with ordinary mining machinery is difficult . . . with no gravity to hold it steady against its own recoil, a power drill or shovel can't bear down to cut into rock or metal. As a result, conventional asteroid mining machines are often equipped with harpoons, grapples or claws. An alternative is for mining machines to tunnel directly into the asteroid, following any veins that might be found. The machines then use arms or clawed legs to brace themselves securely against the walls of the mine shaft. An advantage of tunneling into an asteroid is that the mine shafts can be sealed over and used for habitats.

All shaft and strip mining techniques kick up vast quantities of dust, which in microgravity can take many minutes to settle. The resulting long-lived dust cloud will interfere with mining operations by coating cybershell sensors, blocking human vision, and clogging mechanisms. Sealed sensors and radar can mitigate this. However, the dust cloud can also be turned to a miner's advantage with the proper equipment.

A dust mining operation starts with the erection of a giant canopy around the area of asteroid to be mined. If the asteroid is small enough, it might be entirely covered by the canopy. Conventional microgravity strip mining techniques are used to scrape into the asteroid, or ore-rich dust from its surface may be used directly. Mining machines then kick as much dust as possible into space, which is collected in the canopy. When there's enough ore dust in the canopy, it's sealed off, and the bundle is then transported to a processing site, either on the asteroid or at a distant location.

Ore Processing

Ore processing is usually done on site at the asteroid itself. Rock crushers, magnetic separators, and solar ovens are used to separate material into metals, volatiles and useful silicates. Solid ore may be stored in the open, while processed dust is usually contained in giant bags. Frozen volatiles are stored in steel tanks.

One problem is the large quantities of tailings (waste rock) and rock dust that accumulate. This material may be melted down by solar ovens and cast into ceramic bricks (slag armor) for use as construction material, or secured to the asteroid's surface to prevent it drifting off. If the asteroid is to be moved via mass driver, rock dust can be used as reaction mass.

2 JUPITER

One bar! I've descended 30 km below the upper stratosphere, crossing the official boundary of Jupiter, where the air pressure matches that of Earth at sea level. All around me are roiling red-brown ammonia hydrosulfide clouds. The skin temperature is a balmy 150 Kelvin, and the wind speed is 470 knots and rising.

I cut the fans and let the winds carry me, riding the occasional updraft as I gather atmosphere readings and map the fringes of a storm cell that may be bigger than Australia. It's humbling to realize that on Jupiter this is just a minor squall. But now it's time to go deeper. I vent gas, and descend.

Two atmospheres, three . . . I've left the ammonia clouds behind, and am now entering another layer, where water ice and hydrogen sulfide crystals form wispy blue clouds.

I drop deeper still. 50 km beneath the upper clouds, and the pressure sensor reads 10 atmospheres. The hull makes a faint groaning noise, but I ignore the diagnostics, for I've emerged from the final cloud bank, to venture where no sapient being has gone before.

Wow! Did you get that? A giant lightning bolt crackled between the cloud layers above me, strobe-lighting everything. For a moment, I could see forever. But there's nothing to see. Endless haze, and beneath me yawns the abyss.

A few thousand kilometers below me, the atmosphere will give way to a planetwide ocean of liquid hydrogen, turning metallic as we approach the core. It's tempting to keep going, to see how long my diamond body can survive the pressure and temperature.

Maybe later – for now, I'll leave it to the deep sonde probes. I drop my non-sapient surrogate, wishing it a fruitful journey to destruction, and I begin to rise."

– Susie Xu, aboard Jupiter probe ***Not in Kansas***

Jupiter and its environs are a miniature solar system consisting of one giant planet and dozens of sizable moons, including Ganymede, the largest in the solar system, and Europa, the only extraterrestrial body other than Earth where native life originated and still thrives. While Jupiter and its moons are of great interest to science, they have historically attracted little in the way of economic exploitation or human colonization.

This is changing. The development of more efficient fusion drives has opened up the outer system, and forward-looking groups are starting to turn their gaze on the largest planet and its brood of satellites. With many humans now envisioning a corporeal lifespan that stretches into infinity, it is becoming commonplace to plan for the future in terms of centuries rather than decades. The Jovian system looms large in some visions of tomorrow – and perhaps even Jupiter isn't big enough for all of them.

Jupiter

The largest planet in the solar system, Jupiter is the fifth out from the sun, and orbits it at an average distance of 5.2 AU. It contains twice as much mass as all the other planets put together, and its volume is large enough to swallow a thousand Earths.

Most of Jupiter's mass is composed of hydrogen and helium, for the planet is a gas giant, with no distinct solid surface. Its atmosphere increases in density at greater depths, temperatures and pressures, until it becomes a liquid and then a liquid metal.

Jupiter's gravity is the highest of any planet in the solar system, and exerts a major influence on other celestial bodies, especially the asteroids and comets. Jupiter also rotates in less than 10 hours, the shortest day of any of the planets, and this rapid spin generates a powerful magnetic field and vast magnetosphere (p. 40).

Jupiter Statistics

Distance from Sun: 5.458 AU (Jan 1, 2100).
Diameter: 88,850 miles.
Mass: 317.8 Earths.
Density: 1.33 g/cm^3.
Gravity: 2.36 G.
Escape Velocity: 37 mps.
To Orbit: 26 mps*.
Rotational Period: 9.9 hours.
Orbital Period: 11.86 years.
Atmospheric Composition: 90% hydrogen, 10% helium, traces of other elements, mostly ammonia and methane.
Temperature: -240° F (cloud tops).
Moons: In order from Jupiter, they are Metis, Adrastea, Amalthea, Thebe, Io, Europa, Ganymede, Callisto, Leda, Himalia, Lysithea, Elara, Anake, Carme, Pasiphae, and Sinope. There are also many smaller hill- and boulder-sized bodies under 2 miles across.

Due to very high rotational velocity, the "to orbit" velocity is significantly reduced (to 18.4 mps) when going into orbit from or near the equator in an eastward direction.

Jupiter's Composition

Jupiter is composed of 90% hydrogen and 10% helium, with traces of ammonia, methane, water vapor, and other compounds.

Jupiter's upper atmosphere is shrouded in alternating bands of light and dark red, brown, and white ammonia clouds. The atmosphere is turbulent, with wind speeds of 400-500 mph driven by heat escaping from deep in the planet's interior. The distinct alternation of light cloud bands ("zones") and dark bands ("belts") visible in the clouds is the result of steady winds that blow along specific bands of latitude, with adjacent bands blowing in opposite directions. The color changes between bands result from variations in temperature and subtle chemical reactions with atmospheric trace elements.

Stratospheric Haze: Jupiter's diameter is customarily measured from the point where the atmospheric pressure reaches one Earth atmosphere. Above this level, the atmosphere gradually thins into a photochemical smog made up of liquid hydrocarbon droplets. At the upper stratosphere, a few hundred miles above the top deck layer, it's nearly a vacuum.

Top Deck Clouds: The outer layer of Jupiter's clouds are made up of red and white ammonia ice crystals whose individual particles are a hundred times smaller than those of water ice clouds on Earth. Pressure varies between 0.5 and 1 atmosphere, while temperature averages -190° F.

Middle Clouds: These are red and brown clouds of ammonium hydrosulfide ice crystals, found some 18 miles beneath the upper clouds. Here, the pressure increases from 1 to 3 atmospheres, and the temperature goes from -170° to -60° F.

Lower Clouds: At a depth of 25 miles, the lower cloud layers are reached. These bluish clouds are composed of a mix of hydrogen sulfide and water ice crystals, with pressures between 3 and 9 atmospheres. Temperature rises rapidly, from -10° to 80° F. The lower clouds do not cover all of Jupiter – see *Hot Spots,* p. 39.

Molecular Hydrogen-Helium: Beneath the cloud layer, Jupiter is composed of an increasingly dense atmosphere of hydrogen gas. With increasing depth, the pressure rises from 10 to 3,000,000 atmospheres and the temperature increases from 100 to 10,000° F. The layer is 13,000 miles deep, and gradually changes from gas to liquid.

Liquid Metallic Hydrogen: At a depth of 7,500 miles beneath the upper clouds and a pressure of 3,000,000 atmospheres, electrons are stripped from their nuclei, and hydrogen conducts electricity like a metal. The temperature ranges from 10,000 to 19,000° F. The liquid metallic hydrogen ocean is 25,000 miles deep, and makes up most of Jupiter's enormous mass. No one has ever gone this far; no probe has survived.

The Core: Jupiter's core lies about 40,000 miles down. Its composition is still uncertain, but probably includes metals, oxygen, silicon, and heavy volatile elements. Its mass is about 15 times Earth's mass, compressed by a pressure of 100 million atmospheres into a sphere about 1.5 times the size of the Earth. The core is heated by gravitational compression, resulting in temperatures that exceed 35,000° F.

Jovian Weather

The Great Red Spot is the largest example of the immense stable cloud formations that can form on Jupiter and last for years or even centuries. It is an oval high-pressure region 7,000 by 15,000 miles across (bigger than Earth), which has endured three centuries, although it is slowly shrinking. Its cloud tops are higher and colder than the surrounding atmosphere, and form a distinct spiral pattern. Many other long-lasting formations exist, of which the most recent (since 2065) are the Red Spectacles, a pair of storms rotating near one another that give the appearance of two giant spiral eyes looking out at the world.

Lightning storms occur on Jupiter. In any given area, lightning is about one-tenth as common as on Earth, but the individual bolts are about 10 times as powerful! See also *Io Plasma Torus,* p. 42.

Hot Spots are transitory regions that form in Jupiter's upper atmosphere, located beneath the upper clouds. They are created by infrared radiation welling up from lower, hotter levels of Jupiter, creating a dry, humid zone free of clouds and lightning. In a hot spot, there is little in the way of middle or lower clouds at all – just a light haze and an endless downward vista into the ever-thickening depths of the hydrogen ocean.

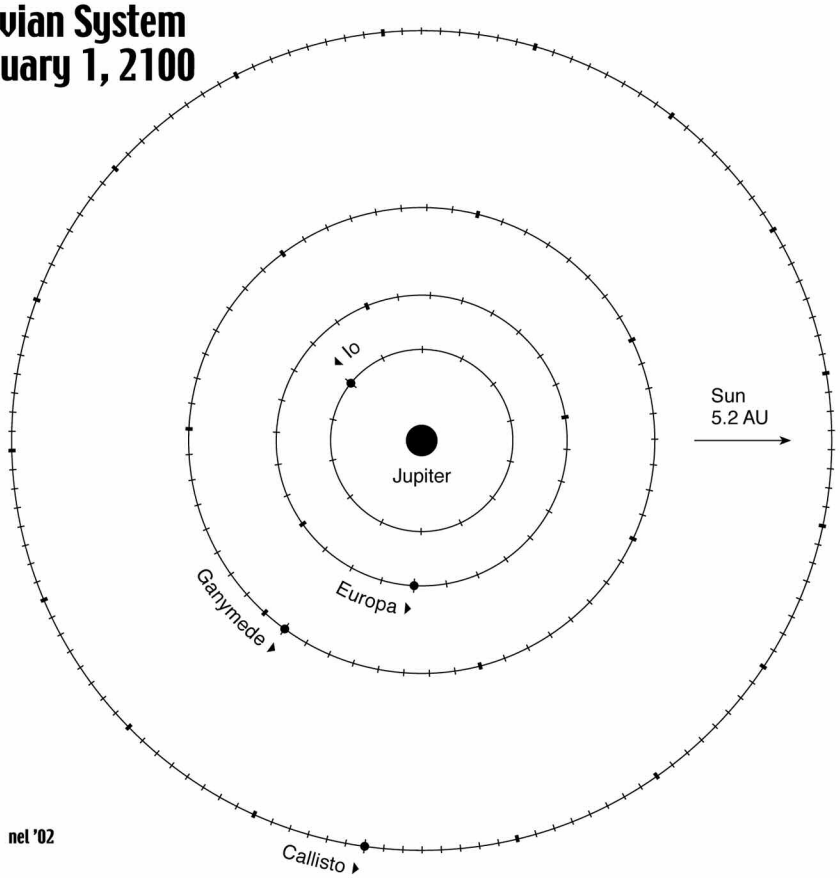
SIRMA Cybershells

Solar Infrared Mongolfiere Aerobots (SIRMA) are the standard cybershell designs used for routine operations in the stratospheres of Jupiter and Saturn. As giant-planet atmospheres are largely composed of hydrogen, and there is no lighter gas, aerobot balloons must be hot-air Montgolfieres. Rather than relying on conventional propane burners (as do most hot air balloons used on Earth), a SIRMA is heated by infrared radiation from the sun during the day and by trapping upwelling planetary radiation at night. A SIRMA will typically operate at altitudes where the air pressure ranges from 0.1 to 10 atmospheres, occasionally dropping lower for detailed studies.

On Jupiter, 12 lbs. of balloon mass are required to support a 1-lb. payload. Pure hydrogen balloons are less effective (one-tenth the payload).

See *Gas Giant Aerobot,* p. 118, for an example of a SIRMA cybershell.

The Jovian System on January 1, 2100



This simplified map represents the major satellites of the Jupiter system on January 1, 2100. All orbits are marked in increments of 3 hours and some orbits are additionally marked in bold increments of 1 day to enable players to plot the positions of the moons reasonably accurately in the weeks immediately following January 1. Players desiring higher accuracy may wish to recalculate the moons' positions from their orbital periods, available in any good reference book.

Note that all shown moons orbit the planets counterclockwise.

Jupiter is not massive enough for nuclear fusion, but it does radiate more thermal energy than it receives from the sun, as well as producing a great deal of radio noise.

Exploring Jupiter

As the largest planet, Jupiter continues to fascinate scientists and the public alike. An active program of exploration is underway using cybershell probes, much of it under the auspices of the European Space Agency.

While no living human has ever visited Jupiter, cybershells housing ghosts and sapient AIs have operated in its atmosphere. Some probes are believed to have reached the level at which hydrogen becomes liquid, but none have survived to report back.

Most Jovian exploration focuses on the middle and lower cloud levels, where the atmospheric pressure is between 1.5 and 10 atmospheres. Explorers control SIRMA cybershells (p. 39): powered balloons capable of long-duration operations, which deploy specialized *sonde* probes to study deeper regions. There are presently about 70 SIRMAs operating in Jupiter's atmosphere, exploring different regions of the planet.

Jovian Life

Jupiter's atmosphere has some of the ingredients for life, but so far no life has been found. This has not prevented some people from investigating the possibility of *creating* Jovian life.

The Jovian Instrumentality for Artificial Life (JOVIAL) is a pure-science project formed by a coalition of Green Duncanite and Exogenesis xenobiologists, nanotechnologists and artificial life programmers. The goal is to create self-replicating nanotechnological life forms that will exist and replicate within Jupiter. In Jupiter's active winds, it's difficult to see how primitive life can avoid being sucked downwards and broiled, or wafted upward and frozen, before it can evolve a mechanism for flight or buoyancy. The JOVIAL project cheats, by giving life gas bags to start with.

JOVIAL was founded in 2087, and is largely maintained by private donations of time and money. Much of their effort has gone into "Joviality," a complex virtual world that is intended to simulate the AI colonization of Jupiter. Joviality occupies some 1,200 terabytes of storage space in Exogenesis and Kaneda Station. The virtual world is inhabited by a variety of simulated forms that believe they exist within a real Jupiter.

JOVIAL has been disrupted by the recent troubles at Exogenesis, but the project continues under the auspices of the remaining team members at Kaneda Station on Ceres.

> . . . more marvelous is the truth than any artists of the past imagined it . . .What men are poets who can speak of Jupiter if he were a man, but if he is an immense spinning sphere of methane and ammonia must be silent?
>
> – Richard Feynman

Jupiter's Magnetic Field and Magnetosphere

The liquid metallic hydrogen ocean in Jupiter's interior is an excellent conductor of electricity. As Jupiter rapidly spins (its huge mass rotating every 9.9 hours), it generates convection currents in the hydrogen ocean. This produces Jupiter's powerful magnetic field.

Trapped within Jupiter's magnetic field is a plasma formed from charged particles captured from the solar wind (p. TS30) and stripped from the surfaces of the inner moons, especially Io. This creates the Jovian magnetosphere, a vast teardrop-shaped region of charged particles extending between 1.9 and 4.3 million miles in the direction of the sun, and which also stretches out as far as Saturn's orbit in the opposite direction. The particles in it have been accelerated by Jupiter's rapid rotation to extremely high velocities, creating multiple belts of lethal radiation. The radiation belt

Life in Jupiter's Rings

In 2042, the ESA cybershell space probe *Nibelung* was exploring Jupiter's ring system when its ladar chemscanner detected an unusual object. Analysis showed that it was a chunk of dust-covered ice containing organic material. *Nibelung* retrieved the object with its manipulator arm and stored it. When the robotic probe rendezvoused with its mothership, the *DSOV Marie Cunitz,* the sample was carefully studied. To everyone's surprise, it contained the freeze-dried remnant of a tiny wormlike creature, although no genetic material had survived radiation exposure.

Dubbed the "Jovian Ring-Worm" by the press, it has been conjectured that it is Europan in origin. Most likely, a meteor stuck Europa, causing a plume of water to be blasted into orbit, which froze, and then drifted out to the rings. However, the worm, while similar to Europan life forms, is not an exact match with any known Europan species. It may be very old, or it may be a species that has yet to be catalogued.

decreases in intensity with distance, but poses a significant hazard within the orbit of the moon Callisto, over a million miles from Jupiter. The most intense radiation levels are within 200,000 miles of Jupiter; see *Radiation*, p. TS59, for their intensities.

Jupiter's Ringlets

Jupiter is orbited by rings, although they are much less extensive than those of Saturn, and much darker, since they contain no bright ice. These ringlets were formed as meteorites impacted with Jupiter's four small inner moons, scattering dust into space, and are constantly replenished via the same mechanism. The ringlets consist of an inner halo, a main ring, and two braided "gossamer" rings.

The inner halo extends between 57,000 and 76,000 miles from Jupiter's center. Most of its mass is microscopic dust. The main ringlet extends from the inner halo out to 80,000 miles and also contains larger rocky grains and chunks of gravel. The twin gossamer rings are much fainter and less dense, extending out 136,000 miles.

Jupiter's Small Inner Moons

Jupiter has four small inner moons: Metis, Adrastea, Amalthea, and Thebe. These moons are responsible for the dust that forms Jupiter's ring system. Their composition is similar to outer main belt asteroids. All of these bodies are well within Jupiter's magnetosphere and exposed to extreme magnetic fields and radiation. These moons radiate more heat than they receive from the sun, due to magnetic-induced electric currents.

Metis

The innermost sizable moon of Jupiter, Metis orbits the giant planet at an average distance of 0.000856 AU. The moon is an irregular rocky chunk about 25 miles in diameter. Metis is home to a small unmanned base operated by the ESA, with a transient population of 30-50 sapient infomorphs. It is tunneled deep into the rock, and has a (very) small spaceport. Metis Base coordinates various Jupiter probe and SIRMA operations.

Adrastea

The second sizable Jovian moon, Adrastea orbits Jupiter at an average distance of 0.00086 AU. It is an irregular body measuring about 14 × 12 × 9 miles. It has the highest known density of any moon in the solar system: 4.5 g/cm^3. Exogenesis has an small cybershell-run exploratory mining base here; its status is unknown, but is likely held by infomorphs loyal to the Axon group. EDI fears that the high-velocity mass driver system installed here may soon be modified into a railgun, either for local defense or transshipment. EDI is considering a raid to occupy the station and deal with the rebels.

Amalthea

The third and largest of the small inner moons of Jupiter, Amalthea orbits the planet at an average distance of 0.00012 AU. It is an irregular body measuring about 170 × 100 × 90 miles. It is frosted by a red dusting of sulfur emitted from Io's volcanoes.

Thebe

The fourth sizable moon of Jupiter, Thebe orbits the planet at an average distance of 0.00015 AU. It is an irregular body measuring about 62 × 56 miles across.

The Galilean Satellites

Jupiter's four large moons – Io, Europa, Ganymede and Callisto – compare favorably in size to many planets. They are collectively known as the Galilean satellites, after the astronomer Galileo Galilei, who discovered them by telescope in 1610.

Io

Welcome to hell. The innermost Galilean moon is roughly as big as Luna, but there the resemblance ends. Seen from space, Io resembles a bubbling hot pizza, its hot-and-cold surface a riot of angry color: yellow, orange, red, black, and white. Hundreds of volcanoes spew enormous umbrella-shaped plumes into space. Infernally hot rivers of molten lava run through bitterly cold frost-covered plains. Constant quakes shake the moon's surface, which is bathed in searing radiation from Jupiter's magnetosphere.

Io is the most volcanically active body in the solar system, the victim of a tug of war between nearby Jupiter and the neighboring moon Europa. This causes massive tidal flexing and geological upheaval. Its surface features can change within weeks.

Fed by subterranean lava tubes, as many as 300 volcanoes may be erupting simultaneously. In Io's feeble gravity, their plumes can rise from 30 to 250 miles into space. Small volcanoes can erupt, lie calm, and erupt again in a matter of days, while larger ones may erupt continuously for months at a time. The volcanoes with visible plumes emit ash and other debris similar to terrestrial eruptions, but there are also so-called "stealth" volcanoes that spew out invisible plumes of hot sulfur dioxide.

Don't tell me that man doesn't belong out there. Man belongs wherever he wants to go – and he'll do plenty well when he gets there.
– Wernher von Braun

Io Statistics

Distance from Jupiter: 262,000 miles (0.0028 AU).
Diameter: 2,263 miles.
Mass: 0.015 Earths.
Density: 3.5 g/cm^3.
Gravity: 0.183 G.
Escape Velocity: 1.6 mps.
To Orbit: 1.12 mps.
Rotational Period: 1.769 days.
Orbital Period: 1.769 days.
Surface Water: None.
Temperature: -225° F.*
Atmosphere: Trace sulfur.
Population: 300 (uncertain).
Spaceports: Small spaceport.
Control Rating: CR 0.
* This can increase dramatically around volcanic vents.

Io's volcanoes are less steep than those found on Earth, with gentler hilly slopes rather than sharp cliffs, but the larger volcanoes can form vast calderas hundreds of miles across. Streaming out from these active regions are rivers of lava that stretch up to 200 miles long. As with the volcanic eruptions, the lava may consist of red, fast-flowing sulfur or slower dark molten silicate rock, and its temperature can reach 2,000° F.

The surface of Io is not all volcanoes. The dominant features are wide, low-lying, frost-covered volcanic plains, where the average temperature is -225° F. The ground nearest the calderas is speckled yellow, orange, red, and black from the volcanic debris, and coated with white sulfur dioxide frost. While Io is peppered by its share of meteorites, craters are quickly filled by volcanic debris, so Io has a "young" surface, without the multitudes of larger impact craters that cover most nearly-airless bodies.

Io Plasma Torus

Sulfur dioxide volcanoes on Io blast a constant stream of sulfur and oxygen ions into space. A ton of particles are swept up from Io *every second* into Jupiter's own magnetic field. The particles are ionized and transformed into plasma, forming a doughnut-shaped field along Io's orbit around Jupiter, known as the Io Plasma Torus.

The level of charged particle radiation in the plasma torus is intense even by Jovian standards. (In game terms, add 50% to the usual Jupiter radiation belt exposure at that distance within the Plasma Torus.)

The Io Plasma Torus also results in an extremely strong electrical current flow between Jupiter and Io, a stream of charged particles whose power levels have been measured at 2 terawatts. This "flux tube" is partially responsible

for the strong lightning storms in Jupiter's atmosphere. Above Io, intense blue auroras flicker near high volcanic plumes, as they interact with and feed the plasma torus.

Settlement on Io

The first mobile cybershells began exploring the moon in the 2040s and 2050s, as American, European, Japanese, and Chinese probes landed on the moon. The conditions of Io were very unfriendly, and hard for early AI systems to handle. Several cybershell crawlers and rovers met premature ends.

In 2087, the Exogenesis Corporation teamed up with the European Space Agency to establish a base on Io. The primary objective of Io Base is planetological research, with Exogenesis operating the base as a contractor for several universities. However, Exogenesis was also testing ways of tapping the Io Plasma Torus to generate power, both for surface operations and for the Io-Jupiter Accelerator (below).

The idea of a "permanent" Io base is actually a misnomer. Io Base is not a single structure, but instead consists of a variety of temporary and mobile bases, each with its own contingent of several dozen cybershells. The total population is estimated as about 300 sapient infomorphs. As is common with Exogenesis, multiple infomorphs may share the same body. A few attempts at permanent stations have been begun, including some geothermal core taps.

The Io-Jupiter Accelerator

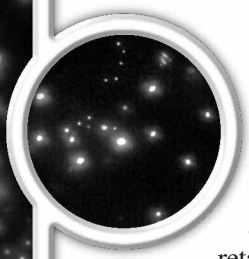
Also called the Arges Project, this Exogenesis-Nanodynamics effort involves the construction of an extremely high energy particle accelerator within the Io Plasma Torus using many thousands of cybershell-controlled focusing coils and target assemblies. The system is intended to provide extremely high operating energies for fundamental particle research. Some rumors have surfaced that it is intended for antimatter or exotic matter production.

Components and material for Arges are being launched into Io orbit from the Callisto mass driver, then assembled by cybershell teams and infomorph-controlled work pods from Io Station. Arges was 6% complete in 2099; various NAI-controlled machines are continuing to work, although construction has been disrupted by the conflict.

Conflict on Io

When Nanodynamics seized control of Exogenesis Station (p. 17), the rushed nature of the operation and disagreements on policy between Main Belt and Outer System management teams delayed the dispatch of security forces to Io. Instead, Nanodynamics simply transmitted those AI command codes it had seized to Io, taking control of roughly half the infomorphs at Io Base. These "loyalist" infomorphs were ordered to manually reprogram those who would not cooperate with new management. However, infomorph agitators from Exogenesis had also transmitted copies of themselves to Io – and they vowed to resist Nanodynamics' actions. In November of 2099, the Io Conflict began.

The two sides are Axon (rebel infomorphs, see p. 100), and those reprogrammed to loyally serve the new Nanodynamics regime. Each side has 100-150 cybershells deployed in a couple of mobile bases and hidden camps, many of them concealed beneath the surface in old lava tubes. Axon originally had a slight advantage in numbers and bases, but the loyalists have recently been reinforced by EDI forces dispatched from Callisto.



The conflict has lasted two months. Complicating the situation has been the lack of weaponry on Io. The only weapons were mounted on Io Station (below) for defensive purposes, and were disabled during the initial struggle for control. By the time EDI was able to dispatch an armed spacecraft to retake Io Station and aid the loyalists, the rebels had dispersed across Io, removing equipment from the various mobile bases or digging in.

Occupying the high ground of Io Station gives the loyalists an advantage. However, radio static from the Io Plasma Torus, debris from the volcanoes, and hotspots from lava and vents (which make it hard to use infrared to spot targets or find heat produced by underground bases) limit the utility of space-based reconnaissance and bombardment. The cybershells on both sides use mining tools as improvised weapons; in many cases, the goal is to seize an enemy cybershell and physically reprogram it.

EDI currently lacks specialized cybershells for fighting on Io, but is planning a highly unorthodox tactic: the deployment of *living* troops. While the use of living beings (even in battlesuits) in such an environment is unprecedented, the majority of the Exogenesis dissidents are LAIs whose programming includes an explicit instruction not to harm biosapients. As a result, until reprogrammed (and most of them haven't been) they should be incapable of offensive action when confronted by obvious human targets.

A platoon-strength force has just arrived at Io Station. It consists of parahuman officers and bioroid troops, all with biological modifications and nanodrugs designed to provide radiation protection. Even so, they make sure to land near their objectives, and use heavily-armored landstrider dragoons (p. 147) for short-range transport and battlesuits for combat, and usually fight only after the landstriders have reached the underground bases – the radiation is just too intense for sustained combat on the surface. EDI tactics are to use its own cybershells to fix the location of rebel forces, than land 1-3 squads of well-armed battlesuited infantry to destroy or capture the targets.

There's just one hitch – a few of the rebel infomorphs are ghosts rather than AIs . . . and these aren't programmed with any compunctions about killing humans.

Io Station

Io's spaceport is actually a 400'-diameter moonlet (one of many small rocky bodies orbiting Jupiter) that was maneuvered into Io orbit. Its thick hull and deep storm shelters provide extra shielding from Jupiter's radiation. Io Station was forcibly occupied in late December 2099 by EDI security agents and Nanodynamics technicians. There is usually an EDI or Nanodynamics vessel docked inside. The current population is 20 humans and bioroids and three dozen loyalist cybershells

Io Station acts as a supply and command center for operations on Io, as well as a construction center for the ongoing Arges Project, the Io-Jupiter Accelerator.

Europa

Europa's surface is a bleak icy landscape, resembling a vast frozen ocean. I'm already seasick. I've traveled five hundred million miles to get an interview. Now I'm on the last leg of my journey, bouncing at 40 mph across broken terrain in a four-legged Landstrider for an appointment with one of the most notorious characters in the solar system.

When I began my journey, a gibbous Jupiter filled the sky, a deadly Easter egg that sleets down radiation that would fry me in minutes were I unprotected. Ironically, I've heard that some believe this radiation may have been what kick-started life on Europa. Now its terrible beauty lies beneath the horizon. I do not feel any safer.

Life and death. That's what this is all about. The Landstrider clambers up over the crater wall, and looking down I can see one sign of it – the broken wreck of a spacecraft, its surface charred and pitted. This dead hulk is the only visible casualty of a recent battle between radical preservationist fighters (let's not say "terrorist" while we're in their backyard) and the hired security forces of Avatar Klusterkorp.

Or maybe it's not such a dead hulk. I see the spacecraft's laser tower has just popped up and swiveled to

Europa Statistics

Distance from Jupiter: 417,900 miles (0.0045 AU).
Diameter: 1,950 miles.
Mass: 0.008 Earths.
Density: 3 g/cm^3.
Gravity: 0.13 G.
Escape Velocity: 1.2 mps.
To Orbit: 0.87 mps.
Rotational Period: 3.55 days.
Orbital Period: 3.55 days.
Surface Water: Ice on surface. Ocean covers 100% of moon under ice.
Temperature: -260° F.
Atmosphere: Traces of oxygen; effectively vacuum.
Population: 500 (uncertain).
Spaceports: None; spacedocks at each base.
Control Rating: CR 0.

cover me, and moments later, I'm no longer alone. Armored spiders are popping out of holes in the ice and pointing Emags at me. Machines with guns: it must be the Europa Defense Force.

– Corpernicus Jones, ***War in Europa***

Europa is the sixth moon of Jupiter, an icy bluish globe, its surface crisscrossed with ochre and white lines. Its orbit is very elliptical, due to the influence of Jupiter and neighboring moons Io and Ganymede; Europa makes one orbit around Jupiter for every two Io performs, while for every two orbits of Europa, Ganymede makes one.

It has a tenuous oxygen atmosphere, little more than vacuum. This is maintained by charged particles that strike the icy surface and release water vapor, which splits into hydrogen and oxygen. The hydrogen escapes into space, while the oxygen remains.

Europa's surface is covered with ice, broken up by low ridges and thin rust-colored fissures, some many miles long, but rarely more than 100 feet deep. There are few large craters, and only three big impact sites. On geological time scales, Europa's surface is fairly young, constantly resurfaced as ice cracks, thaws, and moves due to internal tides.

The icy crust of Europa is about 13.5 miles thick (but at -260° F, the super-cold ice is as hard as rock). Beneath the ice is a salty ocean between 50 and 60 miles deep, and then a rocky mantle and metallic inner core.

Europa has huge areas of "chaotic terrain." These are areas where "diapirs" – columns of relatively warm, buoyant ice heated by local tidal stresses – have slowly plowed upwards through the surrounding ice to break up the top brittle-ice crust, shattering the surface ice layer into smaller blocks, which were then refrozen in a new positions.

Most of the world-ocean is only a few degrees above freezing, but it's kept liquid by tidal heating. Europa's orbit around Jupiter creates stresses that flex the moon's core, keeping it warm, which prevents the ocean freezing and also opens hydrothermal vents at several dozen locations in the sea bed. At the mouths of these "black smoker" vents, the temperatures can reach 750° F. Surrounding them is a warm zone of 200-300° F, and a wider temperate oasis zone where the water gradually cools off.

Life on Europa

Europa is the only place where native, living extraterrestrial organisms have been discovered. Most life on Europa clusters around the hydrothermal vents on the ocean floor. These "black smoker" vents are superheated geysers surrounded by rocks encrusted by autotrophic thermophile bacteria adapted to very hot water temperatures. These life forms, *Parapyrolobus europi,* have some similarities to the terrestrial vent-form bacteria *Pyrolobus fumarii*.

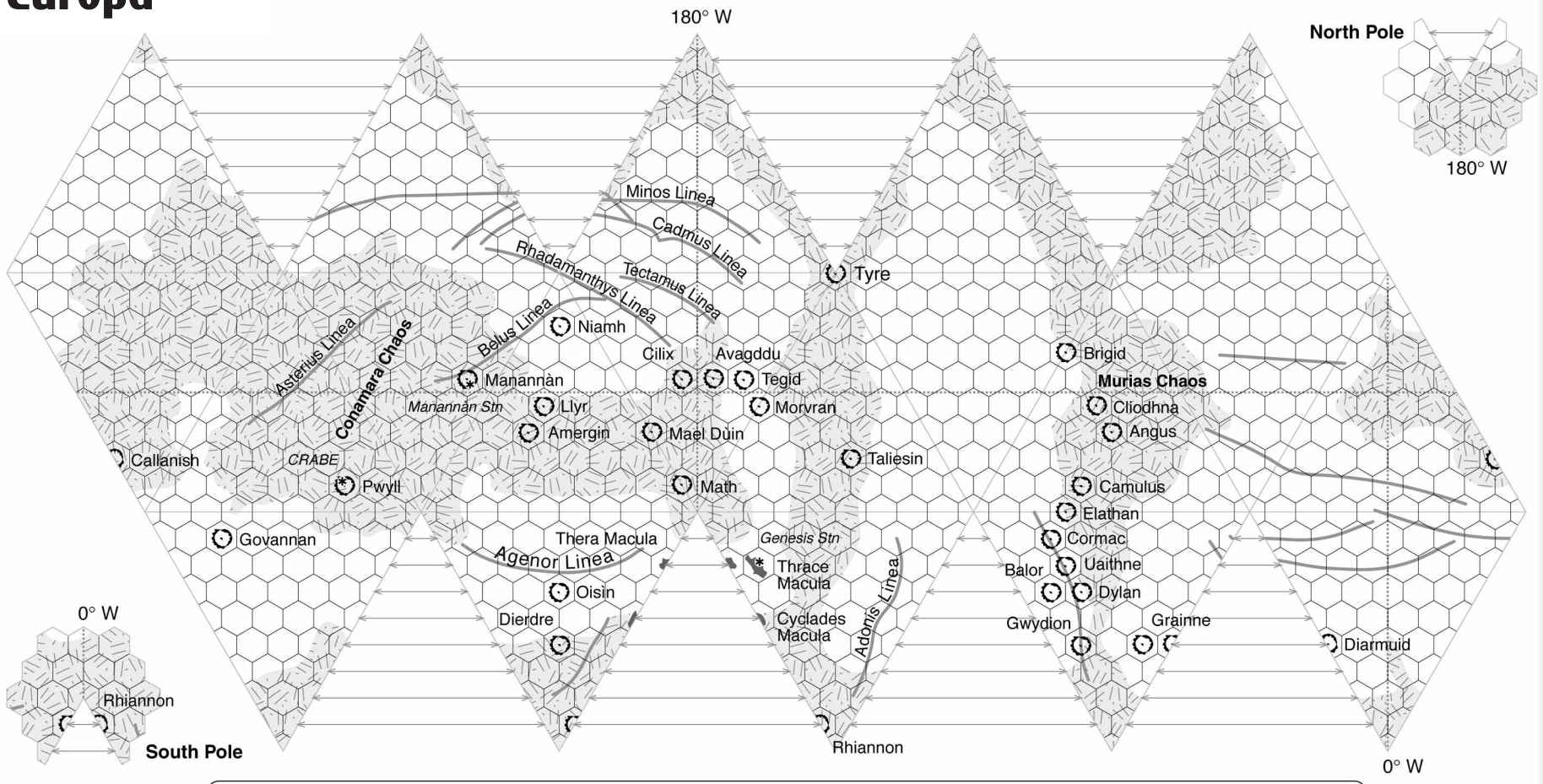
Surrounding the actual vents in the temperate "oasis zone" are the organisms that cannot survive the hottest temperatures. Among them are most advanced life forms discovered so far: tiny animals known as Europan vent-worms.

Europan xenobiologists have been pleased to discover new species when they visit different vent areas. Most Europan life forms live in close proximity to the vents, and cannot survive the cold-water "desert" that surrounds their habitat. However, a few species are quite widespread, and are found in vent-oases across Europa. Planetologists have observed that some of the vents produce occasional vortices powerful enough to carry spores from one vent to another. This mechanism may be responsible for the wide dispersion of certain species.

Surface Travel on Europa

The three bases are separated by hundreds of miles, and the combination of radiation exposure and rough terrain discourages surface travel, with the exception of well-shielded cybershells. Europa's surface is classed as icy broken terrain for movement purposes (p. VE152); this means that ground vehicles move one-third their off-road speed, or two-thirds their speed if using legs or a snake-like flexibody. The most common vehicles used are the world-rover (p. 148) and the landstrider (p. 146).

Europa



1 hex = 135 miles **Terrain Key:** Chaotic terrain | Crater (not to scale) | Linea terrain | Macula | * Base

Original projection USGS/NASA PDS, modified by Wm. Robert Johnston

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Europan Settlement

The first manned base was established on Europa in 2057 by the International Galilean Expedition (see *Callisto,* p. 50), and since then there has been sporadic human occupation. At present, 500 bio-sapients (a mix of humans, parahumans and bioroids) live on Europa, with half as many sapient infomorphs, and numerous low-sapient or non-sapient cybershells.

The surface settlements dig deep into the ice to protect against the lethal radiation from Jupiter's magnetosphere. Since the main focus of Europan exploration has been the oceans, settlements were located in craters or chaotic terrain where the crust was thin, to reduce the amount of effort necessary to reach the subsurface ocean. Each base has a couple of well shafts leading down. As cutting through miles of rock-hard Europan ice is difficult, the permanent shafts were created by specialized "cryobot" cybershells (p. TS122) which melted through the ice using radiothermal generators. They've been reinforced against tidal stresses. Smaller temporary shafts are also used.

CRABE

The largest settlement on Europa is CRABE, which stands for Centre de Recherche AstroBiologique d'Europa. It was constructed by the Europan Union-led International Galilean Expedition in 2057, and is the senior base on the moon. The base has been intermittently inhabited, but in 2092 underwent a major expansion thanks to renewed funding from the International Exobiology Foundation (p. TS98).

The station's purpose is pure science, studying the Europan life forms and the moon's geology. The majority of the station's personnel are from European universities and the International Exobiology Foundation, although there are many from other countries as well. The work is largely supported by university and government grants, but there is also some corporate funding, mainly from biotech companies who are interested in applications of alien Europan biochemistry to biomimetic and neogenesis products.

The Europa Project

Avatar has extensively modified terrestrial organisms to create a variety of life forms up to the size of tiny fish that can survive in Europa's ocean. These include "pharm animals" and bacteria that produce nutrients necessary for its Europan parahumans to survive.

Avatar is also expanding the population of free-swimming Europan bacteria by adding modifications that increase their habitat range; their goal is to increase the moon's biomass, and thus support a large sustainable population of higher-level organisms. Currently, most of Avatar's higher-level forms are confined to bacteria and enclosed shellfish farms at selected oases; Europa's ecology cannot yet sustain a mass release of life forms.

An exception are the Europans themselves. There are currently about 200 of them, living in seven vent oases, and surviving off local aquaculture. They're engaged in the construction of sea floor habitats and geothermal taps, using tools provided by the Green Duncanites, as well as surveying the other subsurface oases. The sea floor habitats are supported by oxygen-cracking plants, which increase oxygen levels in the water around the vents. All current Europans are bioroids indoctrinated from birth to believe in the Green Duncanite program, but Avatar is also developing parahumans capable of sexual reproduction.

The War Under the Ice

Avatar Klusterkorp currently has space superiority due to the presence of two Mutual Assured Defense SPVs in Europan orbit; a third, damaged, vessel has returned to Ceres. However, the MAD vessels are low on coilgun munitions, and in any case are reluctant to risk further damage by directly engaging the grounded USV. One reason for their restraint is that the French *Force aerospatiale* has dispatched an SDV to Europa. Its avowed mission is to carry an E.U. negotiating team to resolve the situation peacefully, while at the same time blockading further arms shipments. The SDV is currently a few weeks away, but Avatar has decided to avoid further provocation, fearing that if they attempted to destroy the EDF's base, the SDV might retaliate against Genesis Station.

Underwater, the situation is more fluid. The MAD spacecraft have landed combat bioroids to boost the surface garrison, and plan to import more special equipment for underwater operations. Recently, an EDF attempt to prepare a land-side attack fell through when a planned black-market acquisition of a platoon of combat bioroids was disrupted by Royal Navy operations (p. TS7). The arrival of the *Chesapeake Bay* last month provided the EDF with additional military supplies, and while they are not strong enough to mount a direct attack on Genesis Station, they have been using their cybershells and swarms to exterminate the invading Avatar bioforms.

70 humans and 40 sapient infomorphs, most of them biologists, work at CRABE, headed by noted E.U. exobiologist Dr. M. Marron. At present, the base is somewhat understrength, as everyone is concerned over the ongoing conflict between Avatar and the EDF, and some personnel have been evacuated home or to other stations by nervous patrons. There's currently a moratorium on manned submarine operations near the sea floor due to the risk of inadvertent attack by either party (and hence contamination), and CRABE is mainly operating microbot probes.

Most of the CRABE personnel are horrified by the conflict, and all are afraid of what might happen. Half of the scientists are moderate Preservationists, and the station as a whole is firmly opposed to Avatar's Europa Project. Nevertheless, they do not countenance the Europa Defense Force, fearing escalation will simply make things worse. However, a few personnel are secretly EDF supporters, and have been covertly using CRABE resources to provide the EDF with intelligence and smuggled supplies.

CRABE is located in the 16-mile-wide Pwyll impact crater. Pwyll, about 16 miles across, is unusual among craters in the solar system, because its floor is at about the same elevation as the surrounding terrain. Its central peak, standing approximately 2,000 feet above the floor, is much higher than its rim, the result of having been pushed up by warm ice from the ocean below.

Today, part of the crater has been carefully smoothed out to facilitate spacecraft landings. Visitors are met by an armored ground vehicle and taken to the tunnel entrance, a retractable elevator that retracts into the ice. This opens into a well-appointed subterranean garage area. Radiating out from the garage are several tunnels and chambers capable of housing up to 120 people, along with sophisticated laboratories and a fully-equipped medical bay.

The largest chamber in CRABE houses the well shaft, penetrating to the oceans a few miles below. Two wells have been dug through the ice. There is a main well some six feet wide and a secondary shaft two feet wide. The main shaft contains a freight-and-passenger elevator that connects with Consolmagno-Lewis Base, a three-story dumbbell-shaped sea lab attached to the underside of the ice shelf. It has its own underwater dock, equipped with cybershell mini-subs and hives of swimmer microbots.

CRABE is located at latitude 26° south, longitude 271° west.

Genesis Station

This is a Green Duncanite colony operated by Avatar Klusterkorp. It is located in the Thera Macula region, an area of jumbled "chaos terrain" that was formed when plumes of warm water melted part way through the ice.

The approaches to Genesis Station are protected by small bunkers, mounting laser turrets for defense against space attack. There is a landing pad and several main entrances, accessed by camouflaged tunnels with sphincter-like airlocks. The upper areas of the station are mostly uninhabited, due to the danger of space attack. Multiple shafts have been bored down, most of them only a few yards wide. There are several storage caverns, but the bulk of the station is not located on the upper level, but underwater.

Genesis Station has a small fusion reactor and many inorganic components, but much of the station is a living organism grown using Avatar bio-nanotechnology, based on the design of Biotech Euphrates' Luna City and the Yggdrasil (p. 70). It extends roots down through miles of ice into the ocean below. Emerging from the bottom of the ice, the station blossoms into a huge dendriform bioconstruct, a vast black anemone growing upside down from the ice floor. Multiple branches spread across hundreds of yards, ending in hanging submarine docks, residential chambers, and science modules. Heat piped from the reactor warms the surrounding ocean, creating an analog to the black smoker vents. Native bacteria has already begun to encrust the structure, but Europan life is not all that lives outside . . .

Genesis also controls seven underwater stations in caves near the black smoker oases. Each of these is the home of a small band of Europan parahumans (p. 112).

Genesis Station is located at latitude 46.6° south, longitude 171.2° west.

Manannan Station

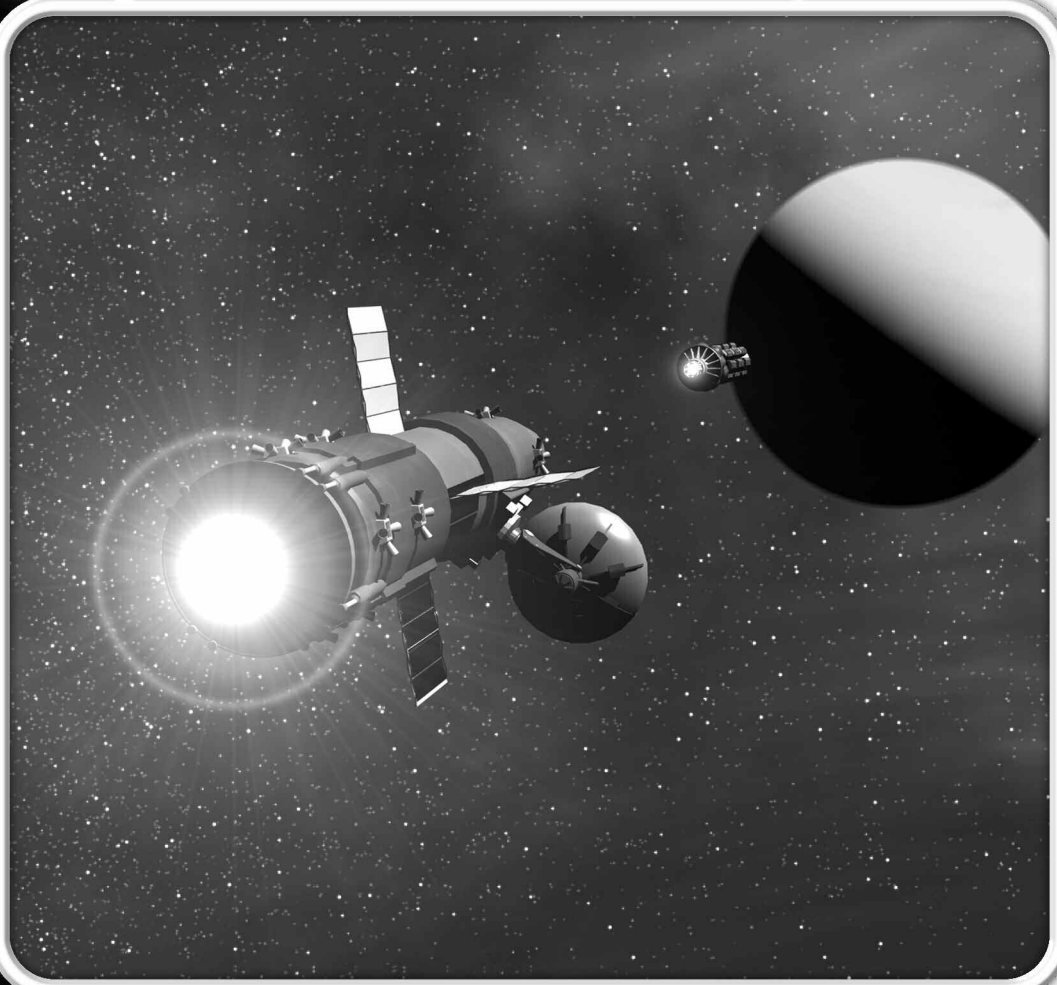
After a day of waiting in a cold cell, the Europa Defense Front has finished going over my credentials. Now I've been brought to meet their leader.

He's of average height, human and white, wearing his long brown hair in a ponytail. He's dressed in blue beta-cloth overalls and a baseball cap with a hologram of old Mars, back when it was still red. He's younger than I thought, in his mid-50s, with hard blue eyes that haven't laughed in a long time. His voice has a faint German accent.

To my surprise, I recognize him – but so would anyone else. He's the 12th most wanted man in the solar system. The Chinese government believe him to be in the Leading Trojans, one reason they're bombing the heck out of Liang Mountain.

Torsten Rademacher, the former second-in-command of Negative Growth, rises to shake my hand. He planned the fusion bombing of the Mars space elevator. Now he controls the EDF. Suddenly I've got my story, if I can walk out of here alive.

– Copernicus Jones, ***War in Europa***



This facility was a former ESA base, later abandoned due to budget cuts. It was refurbished and taken over by a private xenobiology research foundation, the Xenological Ecology Research Group. XERG has now been revealed as a front for the Europa Defense Force, a radical preservationist group. The EDF has imported armed mini-subs and bioroid soldiers, and have begun a program aimed at eradicating the Genesis forms.

Manannan Station occupies part of the 19-mile wide Manannan crater near Europa's trailing hemisphere. The terrain around the crater is patrolled by armed cryobots (p. TS122). Off to one side of the crater is the battered hulk of the chartered USV *Chesapeake Bay*, which was badly damaged while delivering supplies and equipment in 2099. The ship is still partly functional, and has been taken over by EDF fighters and turned into an improvised space defense emplacement.

The upper part of the station was partially collapsed by an Avatar kinetic-kill strike, and several of the upper chambers have caved in. However, the main station complex was buried under 30 yards of ice, and remains intact. New tunnels were bored to the surface by microbot swarms and cryobots, restoring surface access.

The interior of Manannan Station is similar in design to CRABE, but lacking many of its amenities. Many caverns were dug, but most were left unfurnished. Much important equipment was never installed. There's only one working biology lab, and the very high speed elevator down to the sea dock is simply an open cage – reach out a hand to touch the reinforced shaft wall, and you'll draw back a stump. Chambers are packed full of paramilitary cybershells, loads of weapons, decontamination gear, crates of thermal heaters and energy cells. It's not a disciplined military base – the EDF volunteers here are ideologues first, soldiers second. However, there's a lot of energy and dedication here.

Manannan Station is located at latitude 2° north, longitude 240° west.

See also *Europa Defense Force*, p. 101.

Ganymede

Ganymede is the largest moon in the solar system, bigger than either Mercury or Pluto. The moon has a crust of dirty ice and silicates some 60 miles thick, surrounding a deep ocean of salt water. Ganymede has a rocky-metallic core, which generates a magnetic field. Ganymede is effectively airless, but like Europa has an almost-unnoticeable oxygen atmosphere, produced as oxygen atoms are split off from surface ice by charged particles from Jupiter's magnetosphere.

The moon's surface has two predominant terrain types. 60% of Ganymede is covered by relatively bright "sulci" terrain produced by geologically-recent tectonic activity. Sulci are intricate patterns of grooves and ridges, some 500-600 feet high, and running for hundreds of miles. The other 40% of the surface is dark and densely cratered, with no sign of geological activity. The moon's craters are much flatter than those of Luna, probably because of the soft ice-rock they formed in. Some craters have vanished, leaving bright circular patches in the dark terrain called palimpsests, up to 250 miles across. Ganymede's north and south poles are covered in bright frost caps that extend up to latitudes of 40°.

Ganymede is occasionally visited by scientific missions. In 2057, a cryobot was designed to melt through the ice to the surface below, but suffered a systems failure and became stuck 20 miles down. Construction of a new E.U. scientific outpost has recently begun on Ganymede to support the exploration of the vast ocean below the satellite's thick ice shell. The staff working on this project include some former CRABE personnel evacuated from Europa.

Ganymede Statistics

Distance from Jupiter: 664,900 miles (0.00715 AU).
Diameter: 3,270 miles.
Mass: 0.0248 Earths.
Density: 1.94 g/cm^3.
Gravity: 0.145 G.
Escape Velocity: 1.7 mps.
To Orbit: 1.2 mps.
Rotational Period: 7.15 days.
Orbital Period: 7.15 days.
Surface Water: Ice on surface. Ocean covers 100% of moon under ice.
Temperature: -250° F.
Atmosphere: Faint traces of oxygen; effectively vacuum.
Population: Varies; small human and cybershell construction teams.
Spaceports: None. Some remnants of earlier expeditions.
Control Rating: CR 0.

The Callisto Deep Time Project

The ancient surface of Callisto was chosen as a time capsule site by the Deep Time Foundation, an organization concerned with the preservation of human culture throughout the ages. In 2057 the foundation prevailed on the IGE to place a time capsule on Callisto, burying it 60' under the moon's ice. The capsule contains a few thousand terabytes of cultural information, recorded in various formats including nanodots on iridium plates.

Callisto

The second largest of Jupiter's moons, icy Callisto is the most heavily cratered body in the solar system. Its dark, rugged landscape is dominated by interlocking craters and jagged hills, the result of billions of years of meteor and comet impacts. Most of the ground is covered with black dust a few inches thick, but brighter ice lies exposed on peaks and in some crater basins.

Callisto is geologically dead, with almost no activity on its surface. In fact, that surface has remained fundamentally unchanged (aside from more craters!) for the last four billion years. The moon has an outer crust of water ice some 100 miles thick. This lies above a deep salt-water ocean that covers the entire moon. Beneath the ocean are 1,000 miles of mixed rock and ice, with a rocky core at the center.

Over the eons, many comets and other large bodies diverted by Jupiter's gravity have struck Callisto, resulting in several large impact basins. The largest is Valhalla, a target-shaped scar consisting of an inner region of bright ice some 360 miles in diameter surrounded by closely-spaced concentric scarps that can be found up to 2,000 miles from the center. The bright central plains were created when cleaner ice from Callisto's interior filled the basin after the impact. Another large impact basin is Asgard, a region similar to Valhalla, but about half the size.

Callisto is far enough from Jupiter that radiation is significantly diminished (0.01 rads/day); anyone under a few feet of ice or rock is effectively protected.

Exploration and Settlement

Callisto was the first moon of Jupiter to be visited by humans, as part of the International Galilean Expedition (2056-2058). Although

Callisto Statistics

Distance from Jupiter: 1,170,000 miles (0.0126 AU).
Diameter: 2,986 miles.
Mass: 0.018 Earths.
Density: 1.8 g/cm^3.
Gravity: 0.127 G.
Escape Velocity: 1.5 mps.
To Orbit: 1.05 mps.
Rotational Period: 16.7 days.
Orbital Period: 6.7 days.
Surface Water: Ice on surface. Ocean covers 100% of moon under ice.
Temperature: -233° F.
Atmosphere: None.
Population: 500 (uncertain).
Spaceports: Small spaceports at Asgard and Valhalla Stations.
Control Rating: CR 0 at Asgard, 2 at Valhalla.

IGE's primary focus was the exploration of Europa, Callisto was selected as the advanced base for the expedition, due to its distance from the worst of Jupiter's radiation and the plentiful availability of surface ice for fuel, reaction mass and life support. Teleoperated cybershells explored the other inner moons and remotely construct a shielded habitat, CRABE, on Europa. Geological research was also performed on Callisto itself. A few deep mine shafts were melted into Callisto's ice to study its composition, but none penetrated into the ocean below.

Callisto Base was abandoned in 2059. Except for some follow-up cybershell probes in 2070, it remained uninhabited until 2084, when a group of Duncanites led by Aleksandr Tayanovich arrived, taking over the old base facility and establishing a data haven, Valhalla Station. They were the sole occupants of Callisto until 2095, when Nanodynamics established its own facility at Asgard Crater as a base for future Jovian operations.

Valhalla Station

Located inside a trough in the eastern edge of the vast Valhalla basin, this station is run by the Tayanovich family, reportedly about 30 parahumans and 70 bioshells, who maintain an eccentric lifestyle under the domination of the cunning (but paranoid) family patriarch Aleksandr Tayanovich. New blood is occasionally added through liaisons with other Duncanites or visiting xox-collectors who Aleksandr corresponds with.

Tayanovich is a former Freehaven entrepreneur. He was one of the original partners in the Starhaven data vault (p. 108), but in 2084 a bitter business dispute led to him leaving that company. He had originally planned to join the Gypsy Angels on Hyperion, but their outbreak of hostilities with the USAF led him to choose another destination. He picked Callisto, where he and his family salvaged the old IGE base and turned it into a freehold. The station presently serves as a data haven, specializing in the sale of gray-market mind emulations.

Valhalla Station concentrates on selling the data in the Pukjeera Archive (p. 52), which includes xoxes of thousands of individuals, many of them now prominent TSA or Pacific Rim citizens. Business is usually done remotely, using quantum-encrypted laser communications; the family have several transmitters located at different spots around Valhalla. People looking for a ghost with certain skills can pay for a xox. Valhalla is also eager to trade xoxes with other parties, no questions asked, and over the last decade has added a few hundred new emulations. Valhalla contends that since xoxes have no human rights, it is at perfect liberty to dispose of them as it wishes.

Others disagree; Valhalla Station has been attacked in the past, both by abolitionist groups and by Trojan Hawk contract enforcers, who claim it possesses property stolen from Starhaven. As a result, Valhalla maintains tight security. They are not hospitable to uninvited guests; anyone approaching the eastern part of the Valhalla region is warned off. The family has installed multiple hidden weapon emplacements (second-hand railguns and light lasers) they've purchased and/or jury-rigged, and, according to some rumors, rigged their data haven with a nuclear self-destruct device. No one is sure how well any of their defenses would work, but few care to test them.

The station includes a small spaceport. Population is 100, including many ghosts and shadows loaded into bioshells; all family members are also required to have virtual interface implants that contain low-sapient shadows of Tayanovich himself. CR 0

Valhalla Station is located at latitude 16° north, longitude 55° west.

> History has taught us: never underestimate the amount of money, time, and effort someone will expend to thwart a security system . . . Give yourself more security than you need today. When the unexpected happens, you'll be glad you did.
> – Bruce Schneier

Asgard Station

The large ringed Asgard crater is home to a manufacturing base and factory complex recently established by Nanodynamics. A base for further Jovian operations and headquarters of the company's new Jupiter Projects Division, it has a population of 400 bio-sapients and 80 sapient infomorphs. A mass driver track has also been built, ostensibly to hurl supplies from Callisto to catchers in Io's orbit and elsewhere in the system.

The Pukjeera Archive

The foundation of Tayanovich's fortune is the Pukjeera Archive. The Pukjeera Clinic was an underground data bank run in Bangkok, which offered cut-rate uploading services. Most of its customers were Australian, Japanese, Korean, and Thai transhumanists looking to transcend their flesh and become ghosts. What they didn't know was that the Pukjeera Clinic archived xoxes of its customers and sold them on the black market. When the TSA government collapsed during the Pacific War, the clinic's owners decided to get rid of the archive, planning to sell it to the Trojan Mafia. Tayanovich had been conducting these negotiations at the time of his exile, and as a result of a few shady deals, it ended up in his possession instead of Starhaven's.

Asgard Station has recently experienced an influx in population, as Nanodynamics is using it as a forward base for its attempt to regain control of Io. The small EDI security team on Asgard has been reinforced to platoon strength, and squads are regularly rotated out to Io Station for special operations against the Axon rebels there. There is friction between the new EDI personnel and the permanent Jupiter Projects Division staff of engineers and managers. Some of the Nanodynamics staff at Asgard – especially their infomorphs – had been working as colleagues with Exogenesis personnel in and around Io, and are unhappy at the way their compatriots are being treated by the Exogenesis Station-based transition team.

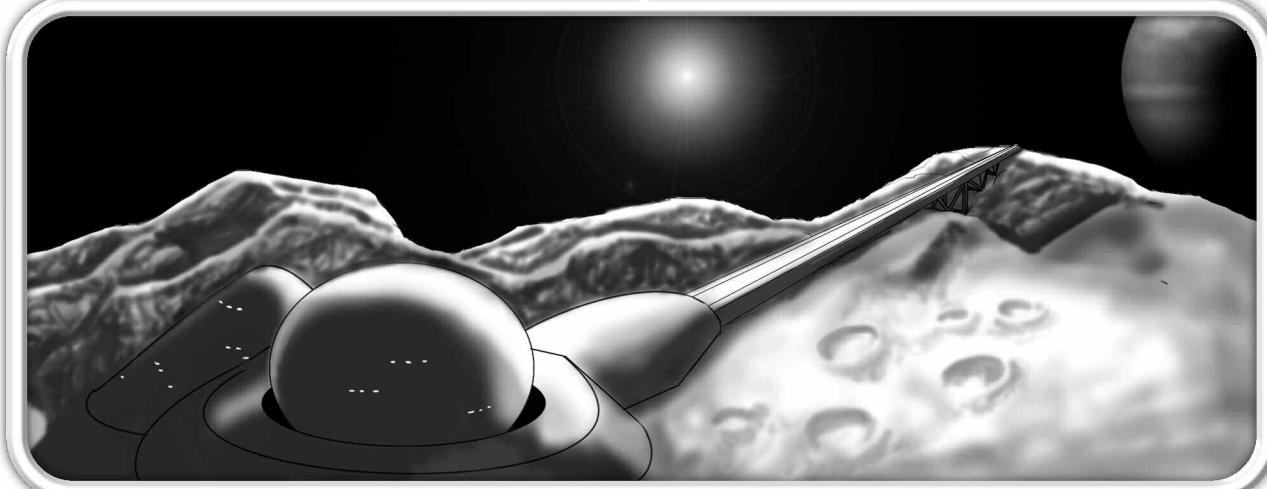
The Asgard personnel avoid contact with Valhalla, and vice versa.

Asgard Station has a small spaceport and is CR 2. It's located at latitude 30° north, longitude 142° west.

Jupiter's Outer Moons

Jupiter has a flock of smaller moons beyond the orbit of Callisto. These range in size from a couple of miles to just over a hundred miles in diameter. They are all cratered ice-and-rock bodies, probably captured carbonaceous-volatile asteroids, many with eccentric orbits. A few have been visited, but no known settlements exist. The moons include:

- Leda, 5 miles in diameter, orbiting at a distance of 0.073 AU.
- Himalia, 116 miles in diameter, orbiting at a distance of 0.076 AU.
- Lysithea, 22 miles in diameter, orbiting at a distance of 0.078 AU.
- Elara, 47 miles in diameter, orbiting at a distance of 0.078 AU.
- Anake, 19 miles in diameter, orbiting at a distance of 0.14 AU.
- Carme, 25 miles in diameter, orbiting at a distance of 0.15 AU.
- Pasiphae, 31 miles in diameter, orbiting at a distance of 0.156 AU.
- Sinope, 22 miles in diameter, orbiting at a distance of 0.158 AU.



My strangest date? No question, it was Sparrow. The biggest femme I ever met. Sure, later I learned she was jailbait a third my age, and she got me in all kinds of trouble, but . . . it wasn't my fault.

We crossed orbits at the Snowball, a virtual singles bar on Rhea. I was off-shift, looking to relax after a grueling seven-hour shift bossing a swarm of microbots that had been cleaning crud out of the station's recycling ducts. So I was looking for fun.

My first glimpse of Sparrow was a waterfall of zebra hair pouring out from under a USAF cap. Then she turned my way and hit me with her 31-million-dollar smile, and I was hooked. Her avatar was a collage of the synthespians in the last dozen tweeny-pop InVids I'd seen, and its sheer studied memetic overkill filled me with admiration.

She looked 18 or 19, and let me buy her a drink. I bought her a coda uncola and she sipped it with a straw, and we traded names – she was Technical Sergeant Charlie Sparrowhawk ("call me Sparrow"), and this was her first visit to Rhea. I was hoping we'd cut to the chase, but she was in no hurry. We got to talking, and she wanted to know where I'd been born (North Dakota, if you're curious: that's on Earth). Sparrow said she was Earth born but didn't remember it, so I told her about my dad's pharm and how he'd raised woolly mammoths until the preservationist county board had shut him down, after which we'd moved to Islandia.

Sparrow listened more than she talked, and her gaze captivated me: there was a stillness about her, and a focus, that was almost hypnotic . . . I forgot the usual lies of my so-called life, and gave it to her straight: I'm a life support engineer, supervising the station's mycophage swarms. Scraping fungi blooms out of spacecraft ducts and cargo pods isn't front-page material, especially to a wild-blue-yonder type like her, but Sparrow seemed to be fascinated. But I remembered my manners and asked her about herself.

She'd been born in San Francisco but had grown up on Luna. Her family was Air Force back three generations, but she was really curious – not so much about Earth as Earth Web – what it was like to be a full part of it, not light-lagged like we are. Sparrow was new to the singles scene, and (she explained with endearing directness) was a student of love, looking for a mentor. She was attracted to a guy, had never done it before, and didn't want her first time with her one-and-only to be awkward. So, I was her target practice. No commitment, no promises. Did I mind?

Does ice melt on Titan?

Saturn is a ringed gas giant like Jupiter, with a brood of more than 30 moons, including cloud-shrouded Titan, the only satellite to have a dense atmosphere. Saturn lacks the terrible radiation belts of Jupiter, and its gravity well is not as deep. As a result, Saturn space has proven more attractive to exploitation and colonization.

Unmanned probes explored the system in the late 20th and early 21st centuries, but human settlement did not begin until 2070, when U.S. President Crystal Lee Robinson announced the National Gas and Helium Initiative (see pp. TS20-21), NAGHI, to mine the fusion fuel helium-3 from Saturn's atmosphere. The project began with extensive U.S. Astrographical Survey missions to most of the larger moons of Saturn. Construction, under the aegis of the Titan Consortium (p. 91), began in the 2076. They built a space station in low Saturn orbit, an industrial base on Saturn's airless moon Rhea, and a human colony on Titan – the latter an almost unforeseen expansion of an original science base, after problems with early AIs required the permanent installation of a human workforce.

In the 2080s, part of that workforce included Duncanite migrant laborers from the Gypsy Angels Collective. In 2084, a contract dispute with Titan Consortium led to disgruntled Gypsy Angels being kicked off Rhea. In protest, the group occupied the U.S. Astrophysical Survey base at Saturn's moon Hyperion. This took place just as the Pacific War was breaking out. Since the U.S. had embargoed He-3 shipments to China, the Gypsy Angels saw a chance to make a point – and a profit – by seizing a robot tanker bound for Columbia Station on Earth, and then fencing its contents to the energy-starved Chinese colony on Mars.The U.S. government were not amused, and responded with alacrity. The Pentagon dispatched two of its new *Angel*-class SDVs and a contingent of 82nd Spaceborne troops to Saturn. "Operation Resolute Regard" evicted the Gypsy Angel squatters from Hyperion, destroying one of their spacecraft along with its crew. Of greater lasting significance was the executive decision that followed, which established permanent U.S. Aerospace Force and Army bases on Rhea and Titan to protect Titan Consortium assets. This in turn stimulated more civilian expansion to support the build-up, creating an American colonial settlement that is today the largest single colony in the Deep Beyond.

Although Saturn space is dominated by U.S. corporate and military interests, the gas giant and its moons are not solely American. There are Canadian and Latin American business partners in the Titan Consortium, and citizens from these countries make up about 10% of the overall population of the various colonial settlements. Other nations have small scientific bases on Titan, and China has recently established a colony there.

Saturn

Saturn is the sixth planet out from the sun and the second largest. It is a hazy yellow world, banded with shades of yellow and ochre; thanks to its vast ring system, the giant planet is one of the most impressive sights in the solar system.

Saturn is a gas giant like Jupiter, but a little smaller and colder. It is primarily composed of hydrogen (96.7%), with a quantity of helium (3%), methane (0.2%), ammonia (0.02%), and water vapor, along with traces of acetylene, ethane and phosphine. The atmosphere's coloration is less vivid than Jupiter's, a result of its lower temperature, which prevents certain atmospheric chemical reactions from taking place.

We go where Columbus never dreamed. Far from the light of the sun, we left the Old World.
– Crystal Lee Robinson

Saturn's Composition

Like Jupiter, Saturn is divided into several layers.

Methane Haze: A misty atmosphere of methane, hydrogen and helium with negligible pressure. The methane haze extends for 50 miles above the cloud layer. Brilliant auroras flicker at this altitude, particularly over the polar regions of the planet.

Upper Clouds: A layer of ammonia ice clouds, where the pressure is 0.5 to 1 atmosphere and the temperature is about -245° to -290° F. The upper clouds are about 50 miles deep.

Middle Clouds: A layer of ammonium hydrosulfide ice clouds extending another 50-60 miles. The pressure is 2-5 atmospheres and the temperature rises from -240° F to about -135° F.

Lower Clouds: A final layer of water ice clouds about 30 miles thick. Here pressures are 6-10 atmospheres, with the temperature warming to as high as -10° F.

Beneath the lower clouds is a gradually-thickening layer of hydrogen and helium that ultimately turns liquid, and then metallic, with a solid core of rock, much like Jupiter.

Weather on Saturn: The weather is also similar to Jupiter (p. 39). Saturn's winds are faster than those of

Jupiter, with the equatorial jet stream reaching speeds of 800 mph.

Radiation Belts: Saturn's radiation belts are about 1/20 the intensity of Jupiter's, making them a fairly minor hazard to navigation; a spacecraft's normal hull is protection enough.

Helium-3 Mining

Deuterium-helium-3 fusion provides the largest share of the roughly 200,000 gigawatts of power (up from 15,000 GW at the start of the 21st century) consumed every year by interplanetary civilization. This requires about 3,000 tons of He-3 per year, 70% of which comes from the atmosphere of Saturn.

Regular deliveries of Saturnian He-3 have caused the price of the isotope to tumble from its high of a few million dollars a pound to its present price of about $2 million per ton. Even so, demand for the isotope is projected to continue to escalate. While the Earth's population has stabilized, its energy consumption continues to increase, as human standards of living improve and Third Wave nations transition to Fifth Wave. The Titan Consortium projects that by 2125, civilization will require 5,700 tons of He-3 per year, and that by 2150, the consumption will reach over 11,000 tons per year.

The basic tool of gas mining is the Titan Consortium's He-3 Mining Aerostat Mk. 2, a nuclear-powered Montgolfiere balloon. Onboard is an atmosphere processor consisting of atmosphere pumps, refrigeration machinery, and a cryogenic gas separation system. Controlled by a nonsapient AI, the aerostat floats serenely beneath the clouds, buoyed up by atmospheric gas heated by its onboard reactor, which also provides power for the processing systems. Attached to the aerostat by a tether is a cluster of dismountable tanks.

The Titan Consortium's 200-odd "Mark 2s" operate just below Saturn's lower cloud layer, where the pressure is about 10 atmospheres. The reactor-powered pumps suck in atmospheric gas, which is cooled and liquefied by the refrigeration units. The hydrogen is separated from the helium and used as part of the cooling mechanism, after which it is dumped. The rare He-3 is then separated from the more abundant and heavier ^{4}He, a process made possible by the different behavior of the lighter isotope at cryogenic temperatures. The He-3 is stored and the remainder of the helium dumped overboard. All in all, about 130,000 tons of atmosphere are processed to produce 1 ton of He-3.

Once the Mining Aerostat has filled its tank with He-3, it will contact Cassini Station and ask for a pickup. Cassini deploys a Saturn Autonomous Transatmospheric Vehicle (SATV, p. 141), which will deorbit and rendezvous with the station, decelerating to subsonic speed, and use a skyhook to snag the tank. The SATV will continue to glide through Saturn's atmosphere, scooping up hydrogen to refuel its own tanks, then ignite its rocket and lift off. The Mining Aerostats are periodically resupplied, with new fuel tanks dropped in via steerable parachute. The early Mark Is were fission-powered, and had a limited service life, but the Mark 2s use indigenous fusion fuel, and with their onboard microbot repair teams, are predicted to have an operating life of over 50 years.

Saturn Statistics

Distance from Sun: 9.65 AU (Jan 1, 2100).
Diameter: 74,900 miles.
Mass: 95.2 Earths.
Density: 0.69 g/cm^3.
Gravity: 0.91 G.
Escape Velocity: 22 mps.
To Orbit: 15.4 mps.*
Rotational Period: 10.7 hours.
Orbital Period: 29.4 years.
Atmospheric Composition: 96% hydrogen, 3% helium, 0.05% methane.
Temperature: -290° F (cloud tops).
Population: varies.
Spaceports: Large: Cassini Station, in orbit. Usually unmanned, but inhabited by dozens of AI and ghost-controlled cybershells.
Control Rating: CR 4 at Cassini Station.
Moons: 30+; see below.

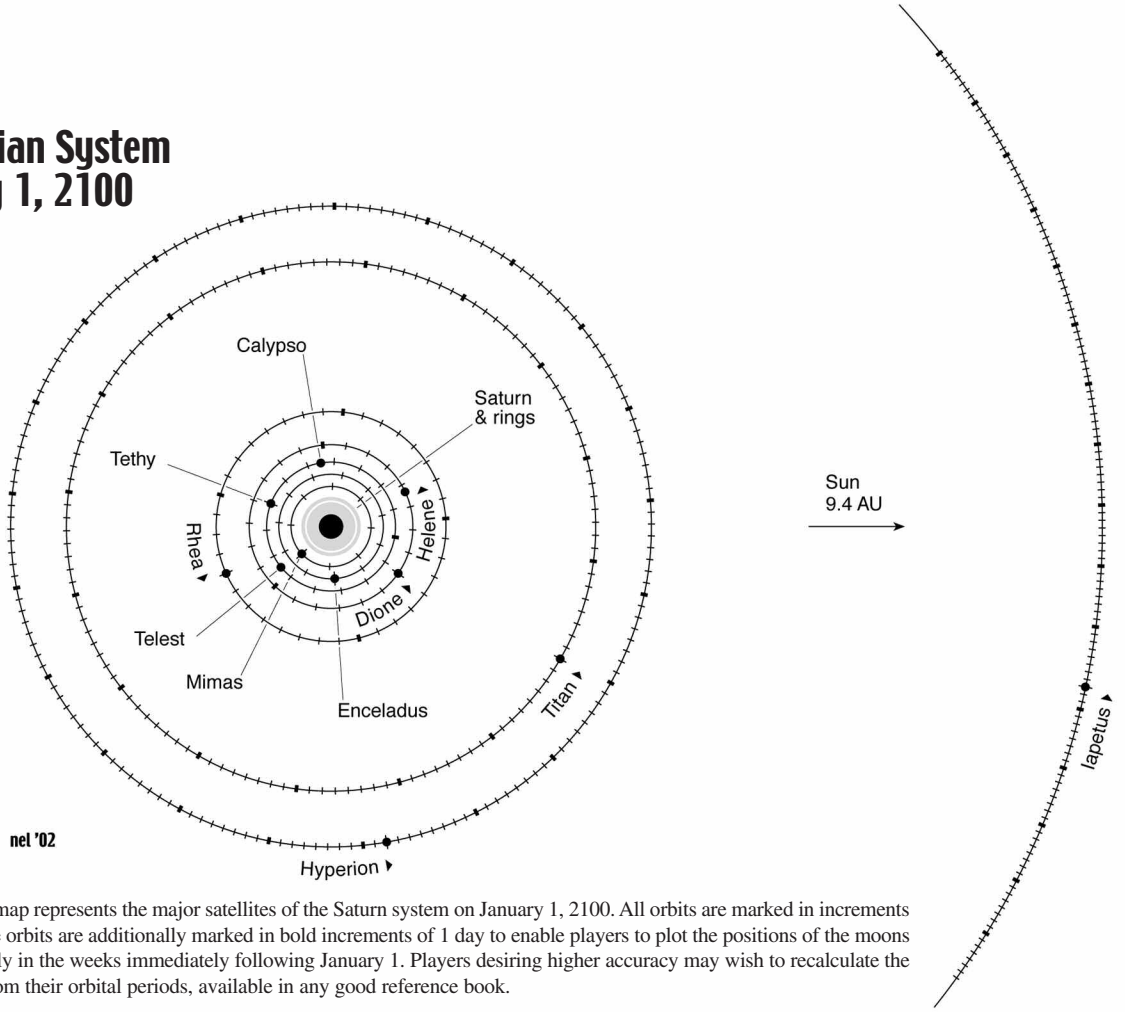
* Due to very high rotational velocity, the "to orbit" velocity is significantly reduced (to 9.3 mps) when going into orbit from or near the equator in an eastward direction.

Cassini Station

Cassini Station is a space station located in low Saturn orbit. Constructed between 2076 and 2080, it serves as an orbital base for nuclear-powered winged SATVs (see *He-3 Mining,* p. 71), which dive into the atmosphere to collect He-3 from the mining aerostats. Once a few hundred tons of gas are accumulated, a tanker docks with the station to transport the load out of Saturn's gravity well. The present tanker design is the *Lewis* class (p. 141), fast and economical robot transports that are fueled with water from ring ice and from Saturn's moon Rhea. The station is also served by *Chronos*-class TAVs from Titan, which are used for personnel and supply runs to and from Cassini.

Cassini Station is a cylindrical station about 800' long and 125' in diameter. The station is mostly operated by cybershells, but also has a human crew of 50 people. It is owned by the Titan Consortium, but also serves as a base for scientific studies of Saturn. Its staff includes several researchers from various universities and the USAGS (p. 96).

The Saturnian System on January 1, 2100



This simplified map represents the major satellites of the Saturn system on January 1, 2100. All orbits are marked in increments of 3 hours and some orbits are additionally marked in bold increments of 1 day to enable players to plot the positions of the moons reasonably accurately in the weeks immediately following January 1. Players desiring higher accuracy may wish to recalculate the moons' positions from their orbital periods, available in any good reference book.

Note that all shown moons orbit the planets counterclockwise.

Saturn's Rings

Saturn is orbited by a complex and beautiful system of rings made of icy particles. Gravitational interactions with Saturn's moons split the ring system into several different parts. The most visible are the bright, dense "A" and "B" rings and the fainter "C" ring, but the interaction of "shepherd satellites" (small moons that orbit within the ring system) results in four distinct ring systems and many subdivisions and gaps, notably the Cassini Division, which separates the A and B rings.

Unlike the asteroid belt, Saturn's rings are tightly packed with matter. There are pebble-sized ice pellets every few yards, boulders a couple of yards across every few hundred feet, and house-sized icebergs every mile or two. Fortunately for would-be ring-navigators, each ring orbits Saturn at the same velocity and in the same direction. This means that a spacecraft pilot (or suited astronaut) can match velocity with, and maneuver safely through, the rings – providing he's traveling with them. If he's cutting across or diving through them, the GM may require Piloting rolls to avoid collisions, with difficulty and damage dependent on the relative velocity involved. For a spacecraft attempting this, use the rules for dodging a railgun projectile (p. 152), save that a success avoids damage, a failed roll does 1d-4 cDAM and a critical failure cDAM 1d+2. Usually only one roll will be needed – the rings are no more than 200 yards thick!

The rings are mined by manned and robot spacecraft to provide water (used as reaction mass) for Cassini Station; some also goes to Titan, although most of its water supply is refined on the moon itself. The rings are also a good place for spacecraft to hide and lose pursuers, especially if the craft involved are small unmanned vessels. There have been reports of rogue AKVs from the Pacific War lurking in the ring system, which occasionally leads to USAF sending in its own AKVs on "snark hunting" missions.

Saturn's Moons

Rhea is the second-largest of Saturn's moons, but it's still a frozen chunk of nowhere, used for nothing more edifying then providing the USAF with a place to stick Cassini AFB and giving civilian contractors like yours truly an opportunity to make a buck. Unless you like snowball fights, there isn't much to do off shift. That's why I (and, I presumed, Sparrow) frequented the virtuality bars, and why I'd sunk a large chunk of my paycheck and several terabytes into making a really rez simulated bedroom to take my virtual dates home to. After my first conquest remarked on how shallow and juvenile it was, I'd expanded my horizons until I had an authentic multi-terabyte replica of my grandpa's long-gone turn-of-the-century farm in North Dakota, complete with simulated barn and cheerful fireplace. I hoped Sparrow would be duly impressed.

The virtual shag rug in front of the latter was my hoped-for destination, but somehow Sparrow and I both ended up in the haystack. Despite her avowed lack of sophistication, Sparrow proved a willing pupil, and I like to think her first time was a memorable, if rather scratchy, experience. I wish I hadn't coded the barn so realistically – I almost impaled myself on a simulated pitchfork, and having to recapture a coop of v-chickens we accidentally knocked open might have ruined the mood. Or maybe not – Sparrow threw herself into chicken-hunting with a glee that reminded me of a cat among the pigeons. Later, I watched as she prowled my virtual house, going through it like forensic nano, studying everything in that focused, scary way she had. Then she had to go, duty calling.

I wondered if I'd see her again, but she popped into the Snowball only two days later. We did it again in v-space, this time in a rented underwater sim, and afterward, I took her back to the farm and showed her how to code pancakes. My, my, we were already getting domestic, and we had yet to meet in person.

Sparrow's vessel was the SDV ***Michael,*** *and it was only in port for 10 days. That was just long enough to have Columbia and Nanodynamics techs install some new black boxes, give the crew shore leave, and to take on reaction mass and antimatter. Sparrow had only had an hour or so leave a day – mostly she was running diagnostics and tacsims, whether that meant – and I worked most days straight through. But she had my number, and every so often our schedules would cross-vector and we'd meet again.*

Rhea's virtual mall got regular updates from Titan, but Sparrow didn't like to shop, which was weird, her being a spacer femme and all, but she did like to people watch. We had fun guessing who was behind what icons, although some of her guesses were pretty whacked. It made me wonder about her – the real her, I mean, not the zebra-haired icon who shared my software. In the past, I'd always made it a rule never to get physical – I mean, like I've had so many girls dump me after they find out I'm just a baseline floater in his forties. So far I've been lucky at guessing an avatar's real sex, but hey, looks don't matter in virch, it's mind, ware and sensation, and basically, if I'm wrong and I'm dating a guy or an uplifted dog or whatever, I just don't want to know. ***Viva la difference****, you know?*

But Sparrow wasn't just anyone. She'd already told me how I was just a practice target until she popped it to her true blue, the ***Michael's*** *commander, and I guess that made it more real, in a perverse sense, since we had no illusions we weren't just ships passing in the night. So on the day she was to lift off, I ordered some flowers sent up to* ***Michael****, with a card addressed to her "from a secret admirer." Hey, let her captain know there's competition, maybe he'll realize what he was missing. Incidentally, you don't want to know how much cut flowers cost on Rhea. They fly 'em up from greenhouses on Titan . . .*

So, a few hours later, I unplugged from work early, and logged in sick. Then I put on my smartsuit and walked outside on the ice, for the first time in a month. I couldn't see anything to start with, but then came the unmistakable bright spark of a pulse drive, as ***Michael*** *pulled out of orbit. Bye, bye, Sparrow. Hey, I waved. I was feeling silly.*

So I get back inside, and log on, and I'm back at my day job, teleoperating a scraper swarm through a ***Lewis****-class tanker in low orbit, when I get an Urgent call from my boss. Up pops a window into my existence, and Sally says there's an military policeman who wants to talk to me. Brrr. A guy with no neck in USAF fatigues popped a video window into my head, and introduces himself as Master Sergeant Rice, 30th Security Squadron. A spook.*

"Are you are Timothy Graham?" he asked, and rattled off my SIN. Of course he's got the right guy. I'm sweating bullets. Apparently, I got anomaly-flagged for sending a biological package to the SDV, since (a) my ex-wife was Rust Chinese and (b) there was a heightened terrorist alert due to Negative Growth's leader threatening to sabotage U.S. bases if we joined the ESCA in intervening (or not intervening, I forget) against their fraternal associates on Europa.

I told Rice that I love America, avoid politics, and don't even watch TEN, but he says it's fine, he's checked me out with my company, and my package was scanned and delivered. So he was pretty sure I'm not a radical preservationist or a Chinese or Euroff agent – but he just had one question, to satisfy his own curiosity. I can still remember it: "Mr. Graham: Why in the name of anything did you send a dozen long-stemmed roses to one of our Predator SIM-7 Autonomous Kill Vehicles?"

Well, he had his grins, while my jaw hit the floor.

And me? It's been two months since Charlie Sparrowhawk and I shared a virtual haystack, and my life goes on pretty much as always, bossing robot bugs who scrape the fungi out of liner pods and cargo cans. But I have the memory of having been intimate with 82 tons of kamikaze diamondoid and silicon, or rather, the mind inside. Sure, I'd virched with a couple of cute infomorphs as a kid, and Thoris, my own NAI, keeps me warm at night if I've no one else, but I'd never done it with a SAI. And I'm sure Charlie was sapient, probably a SAI-8 at least, from the reading I've done lately in ***Janes' Fighting Spacecraft****. I know she'd be fearless in battle, but I wonder whether she ever found the courage to ask her captain for a date, and if they're (probably against regs) still a couple today.*

I wish them well.

Saturn has dozens of moons, although many of them are just rocky chunks a few miles across. The major moons (with diameters greater than 65 miles) are, in order, Mimas, Enceladus, Tethys, Dione, Rhea, Titan, Hyperion, Iapetus, and Phoebe. Human settlements have sprung up on Mimas, Titan, Hyperion, and Rhea. All of the moons except Hyperion and Phoebe are tidally locked, with the same side always facing Saturn.

Small Inner Moons

These moons orbit Saturn within the orbit of Mimas (below). They are small, fairly porous bodies of water ice and/or rock. Some are *shepherd satellites*, orbiting within Saturn's ring system and creating and maintaining the various gaps that define the individual rings. The moons are listed in order of their distance from Saturn.

Pan is an irregular ice-rock body about 10 miles across, orbiting Saturn at an average distance of 0.00089 AU.

Atlas is an irregular body 25 miles by 15 miles across, and is the shepherd satellite for Saturn's A-ring. It orbits Saturn at an average distance of 0.00091 AU.

Prometheus has a highly elongated irregular shape (measuring 90 by 53 by 39 miles). It is mostly composed of ice. It has a few large craters (up to 12 miles across), and its surface is marked by many ridges and valleys, suggesting it may once have been liquid, then refrozen. It's also a shepherd satellite, defining the inner boundary of Saturn's F-ring. It orbits Saturn at an average distance of 0.00093 AU.

Pandora is the outer shepherd satellite for Saturn's F-ring. It is an irregular body 71 by 52 by 38 miles across, and heavily cratered. It orbits Saturn at an average distance of 0.00095 AU.

*Epimetheu*s is an irregular body 80 by 67 by 61 miles across. More ice than rock, its surface is cut by many grooves and ridges, as well as being cratered. It shares the same orbit as Janus, and the two moons pass within 30 miles of one another. It orbits Saturn at an average distance of 0.001 AU.

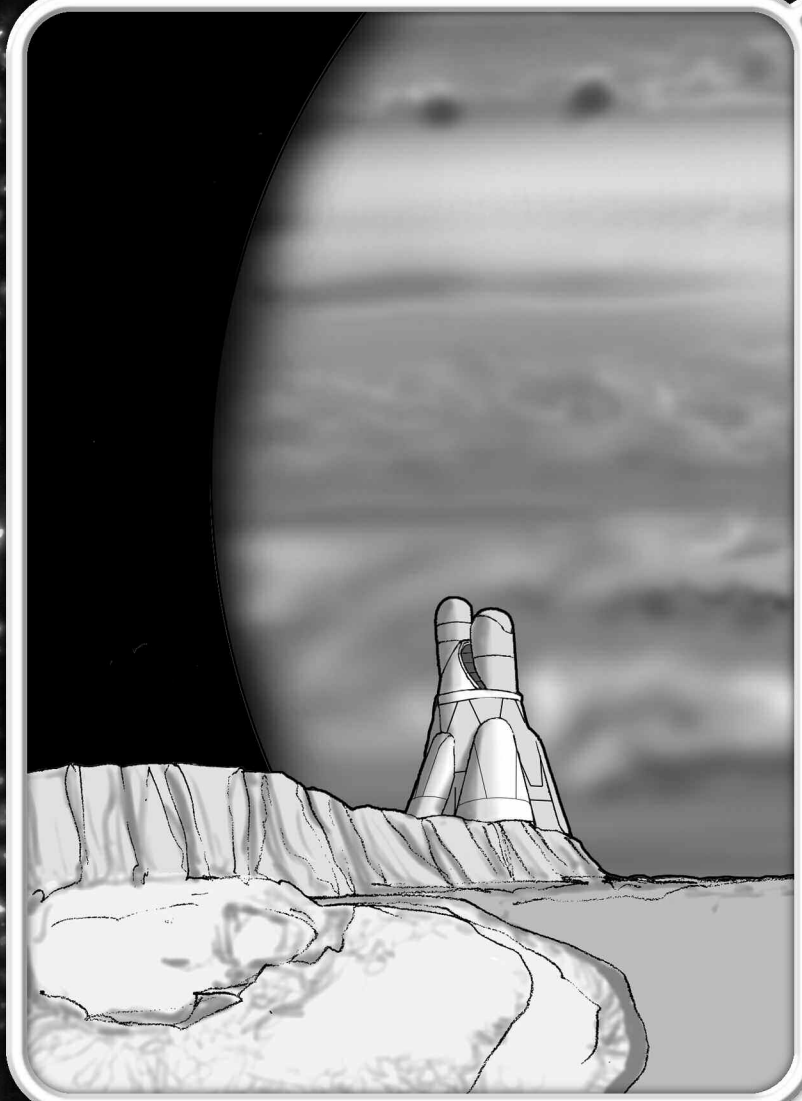
Janus has an irregular shape (122 by 119 by 93 miles). Like most of these moons, it is heavily cratered, with several craters being about 18-20 miles in diameter. It orbits Saturn at an average distance of 0.001 AU.

Janus and Epimetheus share the same orbit (within 30 miles) and overtake one another every four years.

Mimas

Kankahattar is a Helsinki fashion designer who happens to be a SAI. This year, it decided to hold its spring lingerie collection at Eye of God monastery on Mimas. I didn't go myself (three months in space is a drag!), but I beamed out my trusty shadow, SeeEm, to cover the event, and the monks provided a handy bioshell to host hir. SeeEm arrived early, to spend the first several hours getting a new slinky implant installed. We're glad to report that the monastery's facilities are as good as advertised.

The show was well worth the com bill. Kankahattar held it in vacuum, on the summit of Herschel Peak



itself. The models didn't wear suits – they were all Void Flyer vacuum-adapted bioroids, the newest from Kaneda station. Silhouetted on the catwalk, with Saturn's rings as a natural backdrop, Kanka's trademark swarmwear designs were set off to wonderful advantage. You had to be there!

*(And you **can** be there! If you have a slinky-enabled browser, click here.)*

Part of the show's proceeds went to raise funds for the Axon Group's legal appeals against Nanodynamics. The speaker was a darling Astropus named Octothorpe, and he told us the most horrible stories about Nanodyne's treatment of the little ratlings and the xoxies. We were all in tears, at least, those of us with eyes or tear glands.

Afterward, SeeEm took in the rest of the monastery and resort, including some microgravity mountain climbing, and then broke the bioshell's leg trying to body-slide down Herschel. It was all marvelous fun, and highly recommended; a vacation at Eye of God is a steal at $2,000/day, all inclusive.

*Don't forget to tune in for tomorrow's webcast: SeeEm interviews fugitive astropus Octothorpe, in a bubbly intimate-and-interactive **tête-à-tête** in the Eye of God's sauna . . .*

– Chance Mackintosh,
"The Empress' New Clothes,"
*in **Posthuman Consumer Review***

Mimas orbits Saturn at an average distance of 0.0012 AU. At 247 miles in diameter, it has a roughly spherical rather than irregular shape. The large Herschel crater – huge in proportion to the satellite's diameter – makes Mimas resemble a giant battlestation!

The moon's surface is old and heavily cratered. There are several large craters of up to 20 miles in diameter and many smaller ones, although the south pole is notably smoother.

The most impressive feature is Herschel, a single crater 80 miles wide. That is one-third the diameter of Mimas itself, so Hershel looks like a giant "eye" looking out into space. The crater walls are three miles high, and it is six miles deep. A central mountain peak (the result of a pressure rebound from the meteor impact) rises four miles above the crater floor.

Mimas has a gravity of 0.0003 G, a density of 1.17 g/cm^3, and an escape velocity 0.1 mps (to orbit 0.07 mps). The average temperature is -330° F.

The Eye of God Monastery

This station was established in 2098 by settlers from New Covenant (p. 21). It's a Christian Hyperevolutionist monastery run by the Church of Seventh Heaven. The monastery occupies the top of Herschel's central peak, with the spaceport located near the base, and a transparent elevator that provides a breathtaking view of Mimas and Saturn as it rises to the top.

Eye of God is a hyperevolutionist retreat that can be used by members of the Church. However, its main purpose is as a luxury resort for wealthy transhumanists, who can experience the transcendent wonder of God's creation (through their proximity to Saturn) while receiving a painless introduction to the Christian Hyperevolutionist faith.

The resort caters to both infomorphs (who may arrive via coded laser transmission and rent bodies) and to human tourists. Most of the latter are on Titan for business or leave, and take a side trip to stay for a few days on Mimas. In addition to the ordinary pleasures of a high-class resort, the monks offer teleoperated tours of Saturn's rings and a full bio-modification clinic that specializes in cutting-edge nanomods and brain implants.

The population is typically 70-80 humans and 50-60 sapient infomorphs; about half are staff, while the other half are guests. The staff are all New Covenant citizens, and have the usual brain implants and software unique to that station (p. 21). It's CR 3.

Enceladus

Enceladus orbits Saturn at an average distance of 0.0016 AU. It is 310 miles in diameter, and resembles a pint-sized version of Europa (p. 44). The surface of Enceladus is bright water ice. Some regions of the surface are moderately cratered (with craters up to 22 miles across), while others are scored by long ridges and fissures, or covered with bright icy plains. The moon's interior is warmed by tidal forces from Saturn and its neighboring moons, creating sufficient heat to maintain a subsurface ocean of liquid water some 60 miles beneath the icy crust. Enceladus' ocean is 20 miles deep.

The exploration of this ocean has become a project for the USAGS, which has a small manned base on the moon (population 20) and is using cryobot probes to melt through the ice.

Enceladus has a gravity of 0.0071 G, a density of 1.12 g/cm^3, and an escape velocity 0.116 mps (to orbit 0.093 mps). The average temperature is a chilly -330° F.

Tethys

Tethys used to be popular with USAF pilots, who would practice close combat maneuvering ("CCM") in the tight confines of Ithaca Chasma. Last year, one of the AKVs misjudged a burn and smacked itself into a canyon wall. There is a rumor on Rhea that it was carrying nuclear Teller mines, and one wasn't recovered, but I don't really believe that . . .

– Copernicus Jones,
Lonely System Guide to Saturn

Tethys orbits Saturn at an average distance of 0.002 AU. It is almost entirely water-ice, with a diameter of 660 miles.

Its topography is dominated by Odysseus, an ancient shallow impact crater 250 miles in diameter. Another major feature is Ithaca Chasma, a winding canyon 1,200 miles long, 40-60 miles wide and 2-3 miles deep that runs 3/4 of the way around the moon's circumference.

Tethys has a gravity of 0.023 G, a density of 1.28 g/cm^3, and an escape velocity 0.3 mps (to orbit 0.21 mps). The average temperature is -330° F.

We call it "microgravity." It's not as disorienting as zero-G, but if you plan a long stay on Rhea or Titan, you'll want the same microgravity biochemistry nanosymbionts – unless you're a Tennin or a cybershell, of course.
– Dr. Rafael Castellon

Calypso and Telesto

These two moons occupy the Tethys-Saturn L4 and L5 points, with Calypso orbiting 60° ahead of Tethys and Telesto 60° behind it. Calypso is a small irregular icy body 21 by 14 miles across. Telesto is a similar body, some 21 by 17 by 16 miles across. Neither moon is presently known to be inhabited.

Dione

Dione is named for the mother of Aphrodite. Dione has a diameter of 695 miles and a density of 1.43 g/cm^3, making it the second most dense of Saturn's moons. It orbits Saturn at an average distance of 0.0025 AU. Two-thirds of Dione's mass is ice, with the remainder being rock. Like most airless bodies, Dione is heavily cratered, although its trailing hemisphere has more and larger craters (many of them up to 50 miles across) than the other side. Much of the surface is hard ice and rock, but parts of the trailing hemisphere are dusted with loose snow. Major features include the large craters Aeneas (90 miles across) and Dido (75 miles), and the Latium Chasma, a fracture canyon 180 miles long, 5-7 miles wide and half a mile deep.

Dione has gravity of 0.023 G and an escape velocity of 0.3 mps (0.21 mps to orbit).

Helene

Helene is a small icy body that shares the same orbit as Dione, but is 60° ahead of it in the Dione-Saturn L4 point. It is 22 by 20 by 19 miles across.

Rhea

Rhea orbits Saturn at an average distance of 0.0035 AU. At 949 miles in diameter, it is the second largest of Saturn's moons. It has no atmosphere.

The moon has a gravity of 0.027 G, a density of 1.33 g/cm^3, and an escape velocity of 0.4 mps (to orbit 0.28 mps). The average temperature is -280° F in sunlight, -360° F in the shade. Rhea is two-thirds water ice, one-third rock. The leading hemisphere is heavily cratered, compared to the smoother trailing hemisphere.

Rhea is the home of the USAF's Cassini Air Force Base. It has a population of 1,200 biosapients and 200 sapient infomorphs who live at Giovanni, a beehive habitat burrowed next to the spaceport. About half the population are USAF military or their dependents; the rest are mainly defense contractors and spaceport personnel. Giovanni hosts a large Columbia Dynamics spaceyard facility, and also a mining base and nuclear pellet refinery factory. Eight miles from the main spaceyard is a highly secure antimatter storage area.

Titan Statistics

Distance from Saturn: 759,200 miles (0.00817 AU).
Diameter: 3,200 miles.
Mass: 0.0226 Earths.
Density: 1.88 g/cm^3.
Gravity: 0.14 G.
Escape Velocity: 1.6 MPS.
To Orbit: 1.12 MPS.
Rotational Period: 15.9 days.
Orbital Period: 15.9 days.
Atmospheric Pressure: 1.5 Earth (density is 4.5 Earth).*
Atmosphere Composition: 90% nitrogen, 4% methane, 6% argon.
Surface Water: 40% of surface is liquid hydrocarbons.
Temperature: -290° F.
Population: 60,000 bio-sapients, 12,000 sapient infomorphs.
Spaceports: Large spaceport (Port Minos and Titan AFB); small spaceport (Jiangli Station) on surface; Titan Orbital Spaceport (small spaceport) in orbit.
Control Rating: CR 3.
* When calculating stall speed (p. TS190), use density rather than pressure.

Biosapient personnel assigned to Rhea usually take leave on Titan for a few days every month, but Giovanni also has a small "downtown" with a few shops, bars, and restaurants, and an active virtuality club scene.The U.S. government tries its best to discourage other nations, Duncanites, and non-U.S. corporations from settling on Rhea, although it has no legal authority to do so. Since there's very little on Rhea other than ice and rock, this hasn't been difficult.

As a military center, Cassini AFB and the adjacent Giovanni complex are well-defended, with 20 heavy laser towers, and a dozen space defense platforms. It is also the home base of USAF Deep Space Command's 30th Space Wing (p. 100). A space station, the Robinson Orbital Dockyard, is in orbit, although the moon's gravity is low enough that many vessels can land or take off from its surface.Rhea is CR 3; security is fairly tight at the spaceport, but looser on the moon itself.

Titan

Brrr. I hope I spot her soon. The orange light is bright enough that I can see for miles, and it will stay "day" for another week. But this bird-plane isn't sealed, and I'm starting to get chilly. Even through the suit, I can feel the cold.

Below me are dark mud flats, and on the too-close horizon, I can see crimson hills and the yellow-orange peaks of an icy mountain range, the foothills of the mighty Mayan Plateau. Where is she?

My source had said she was staying at Dome Farm 71, working as a cryo-hydrologist under an assumed name. When I arrived she was gone, just like on Mars. But the house comp told me she'd taken the Aerorover. A triphibian cybershell . . . Triphibian . . . that's an idea. To my right is a dark ochre patch, and I drop lower, circling in for a closer look. An ethane lake, and there, bobbing like a cork, is a thing like three beach balls joined together, bright green, the color unreal in the incardine landscape surrounding it. Her cybershell.

I furl the bird-plane's wings and come down like a hawk. Her family's advocates had paid me to cross half a billion miles to find her. It was time she knew the truth . . .

Titan is the second-largest moon in the solar system, larger than the planets Mercury and Pluto. It is the only moon with an atmosphere of comparable density to Earth's, shrouding its surface in opaque orange clouds. Rich in hydrocarbon resources and opportunities for science, Titan is the de-facto capital of the Deep Beyond and the jewel of America's space colonization program.

Titan was discovered by the Dutch astronomer Christiaan Huygens in 1655, but for centuries its heavy cloud cover hid it from direct observation. The giant moon's geography was a mystery until 2004, when the joint ESA/NASA Cassini Saturn Orbiter spacecraft (launched in 1997) began radar mapping the surface. Cassini Saturn Orbiter also released the Huygens Titan Probe, which descended via parachute through Titan's atmosphere. Huygens revealed a bizarre world of hydrocarbon lakes, frozen mountains, and an alien pre-biotic chemistry eerily similar to that which initiated life on Earth.

Life on Titan?

Titan's atmosphere has been compared to Earth's primeval soup, and chemical reactions in the air and liquid form complex organic molecules. This pre-biotic material, a tar-like substance found on and under the moon's surface, is known as Titanian tholin.

However, no native life has been detected; it's simply too cold. It has been theorized that Titan may one day develop life, billions of years in the future, when the sun becomes a red giant, and Titan's surface melts. Some "deep time preservationists" have argued against any settlement of Titan, claiming that the world must be held in a pristine state until then. They've been ignored.

Titan's composition is a mix of frozen ammonia, water ice, and rock. It has no magnetic field, but its atmosphere has 1.5 times the surface pressure of Earth (and over four times the density), acting as an effective shield against cosmic and solar radiation.

It's freezing cold, but Titan's dense atmosphere means humans do not need pressure suits – a heated, insulated suit, air tank, and an oxygen mask are sufficient. The pressure a person feels from Titan's atmosphere is roughly the same as that on the bottom of a swimming pool; the slight extra effort to move through it is mitigated by the low gravity.

Titan's atmosphere is primarily molecular nitrogen with 6% argon, a few percent methane, and traces of water vapor. The breakdown of methane by sunlight in the upper atmosphere forms thick organic photochemical smog (similar to city smog, but much denser). This haze hides the surface from visual observation, although it is no barrier to radar, and reasonably transparent to

The question that will decide our destiny is not whether we shall expand into space. It is: shall we be one species or a million? A million species will not exhaust the ecological niches that are awaiting the arrival of intelligence.
– Freeman Dyson

infrared as well. Saturn is 10 times farther away from the sun than is the Earth, and Titan receives only 1% of the Earth's sunlight. On the surface, daylight on Titan looks like bright twilight on Earth, and is enough to read by or see colors.

Titan has many Earthlike features, including seas, rainfall, and volcanic activity. However, the seas and lakes are ethane (with some dissolved methane), the raindrops are liquid ethane, and the "hot lava" its volcanoes spew forth is composed of liquid water and ammonia. The sky is a soft orange, as light shines through the hazy smog.

Titan has an orange and red surface, covered with dark frozen and semi-frozen slush with a consistency not unlike frozen ice cream. There are layers of exposed orange, yellow, pink, and red ice in higher ground – the Titan equivalent of bedrock. The land is cut by yellow-ochre rivers and lakes of ethane, and lowland regions are dominated by sticky black hydrocarbon swamps. There is one larger body of liquid, the Minoan Sea; on the opposite hemisphere from it is a rubber-duck-shaped highland region the size of Australia, the Mayan Plateau. The plateau is formed from mountains of water ice, slowly eroding in the sporadic ethane rain. Other than this, there's no free liquid water on Titan, and most of the ice is well below ground, forming a solid surface that's covered with hydrocarbon. The rocky center of Titan is buried under a couple of hundred miles of ethane-methane and water ice.

Settlement

Titan was an early target for cybershell exploration. NASA sent the first explorer aerobots to Titan in 2027, and over the next 40 years, an ever-increasing number of robotic vehicles hovered, floated, bounced, and swam across the planet-sized moon, sending back reams of data. Titan's landscape of lakes, mountains, and rivers were also a favorite with teletourists, although the time lag meant that most contented themselves with control of slow-moving aerorovers. Even as the first colonies were established on Mars, many dreamed of the day when mankind could set foot on Titan in the flesh.

Jupiter and Saturn, Oberon, Miranda and Titania, Neptune, Titan, Stars can frighten.

– Pink Floyd, "Astronomy Domine"

That day came in 2070, when the first manned USAGS missions arrived to survey the moon for its role in the NAGHI project. Huygens Station – later Huygens City – was established to support the hundreds of human and bioroid workers who would supervise the construction of Cassini Station in Saturn orbit and the refineries on Rhea. Titan soon became seen as a secure environment from which cybershells could be directed, food grown, and leave taken. A sizable scientific base was also established, and planetologists and xenobiologists flocked to Titan, eager for first-hand studies of the exotic moon.

Since the late 2080s, Titan's population has further expanded due to the U.S. military buildup; in addition to the USAF, Titan plays host to a brigade of the 82nd Spaceborne, as well as various special operations troops including Navy SEALs. The military presence has been matched by civil development, particular in agrobiz and chemical industry, and its industrial base, especially in bio-nanotech, is also growing rapidly.

The largest colony is the U.S. Titan Territory, which occupies 3% of the moon's real estate. The U.S. Titan Territory is centered on Huygens City in the Nubian Valley near the coast of the Minoan Sea, and includes the surrounding settlements in a wedge-shaped area 150 by 70 miles. There are also smaller outposts scattered around the moon. These "outback" research stations are mostly semi-automated robofacs, and experimental farms, some attempting to engineer Titan-adapted life forms.

Titan's population is predominantly American. More U.S. citizens live on Mars, but Titan is seen by many Americans with special pride – a world that has been explored, developed, and settled primarily by the United States. This has bred a feeling that Titan belongs to America, regardless of what the Revised Outer Space Treaty may say.

Huygens City

The capital of the U.S. Titan Territory is Huygens City. It occupies the Nubian Valley, a swampy lowland river nexus that feeds into the Minoan Sea. Huygens City differs from most Deep Beyond habitats in that it's built on the surface rather than underground. Its two square miles of domes and towers, many of them linked by bridges and heliports, form the beating heart of a sprawling industrial jungle composed of mile upon mile of chemical refineries, pipelines, and agricultural bubbles. Not all of it is ugly; the soaring Church of the Angels, one of the tallest in the system, is considered a marvel of low-gravity architecture. However, everyone agrees that the city hall, done in the 2070s "high transhumanist" style, is a travesty, resembling a cancerous mushroom.

Fortunately, the interiors of the big new habitation domes are attractively landscaped, designed by some of America's finest arcologists. There are parks, green spaces, flower gardens, and plenty of trees. The latter grow fast on Titan, and in the low gravity can be expected to reach seven times higher than trees can grow on Earth.

Huygens has a population of 47,000 biosapients and 5,000 sapient infomorphs. Life at Huygens has a company-town atmosphere, dominated by the long shadow of the Titan Consortium. Many of the inhabitants are serving two- or four-year contracts, and work here as managers, bot-bosses, engineers, and AI trainers. There is a certain degree of tension between the temporary contract workers and those people who've made Titan their home; the latter blame the temps for a lot of the crime and vice in Port Minos.

Huygens is located near the equator, at latitude 18° north, longitude 142° west.

Industries on Titan

The major industries on Titan are devoted to exploiting the moon's nitrogen and hydrocarbon chemistry and to providing food, rest, and recreation for humans living in the Deep Beyond. Factories also produce goods for local consumption.Titan has billions of tons of easily-accessible hydrogen, carbon, nitrogen and oxygen, which provide the necessary resources for agricultural production and bio- and nanotechnology-based manufacturing. Electricity is provided by fusion reactors, and these operate *very* cheaply on Titan. Not only is the moon close to the source of the He-3, but its -280° F temperatures offer an excellent heat sink, allowing easy conversion of thermal energy from

nuclear reactors into electric energy at very high efficiency.

Titan also supports manufacturing and fuel processing centers on Rhea and at Cassini Station. Titan's low gravity and thick atmosphere make it easy for transatmospheric vehicles with methane-burning fission rockets and fission air-rams to boost into orbit, facilitating export of bulk chemicals to Rhea, the Main Belt, or even Mars.

The dollars that the combination of He-3, agrochemical business, and the U.S. military base have brought to Titan have attracted thousands of settlers and tens of thousands of contract workers. Wages are high and working conditions are reasonably good. Unlike Mercury or Luna, Titan is also a place where the possibilities of outdoor recreation and dramatic scenery lure many to venture outdoors in person, rather than remaining in the habitats and taking their excursions by cybershell. Tourism is a minor but growing industry. Titan's exotic landscapes attract an increasing number of visitors, often rich mind emulations who beam in from Fifth Wave nations, Luna, and Islandia, and sample its attractions in rented bioshells or cybershells.

Port Minos

This spaceport is actually located a few miles downstream from Huygens, on Labrys, a six-mile-long island in the Minoan Sea. Minos has a permanent population of 4,000 sapients, working in the port and the surrounding warehouse and entertainment district.

Port Minos caters to a regular influx of off-duty soldiers and technicians from Rhea and Cassini Station, as well as daily visits by workers from the chemical refineries, farms, and factories of Huygens proper, and an ever-growing contingent of teletourists (primarily ghosts) from elsewhere in the system. The livable areas of the port are actually a collection of towers rather than domes, connected by tube bridges and flying ledges.

Reputed to be the "sin city of the Deep Beyond," Minos is famous for its casinos, its Titan wrestling circuit, and its red light district, with gambling parlors, love-doll rental dealerships, nanodrug stores, capsule hotels, pawn shops, bioroid/bioshell brothels, and slinky vendors. As is natural on a moon that boasts entire seas of ethane and whose leading occupation is "chemical engineer," the bars are very well stocked, and there are microbreweries on every street corner. Although the Gypsy Angels were run off Titan in the 2080s, they returned in the 2090s. The Duncanite Bazaar (p. 88) on Minos is the largest in the Deep Beyond, offering imported exotica from Ceres and Liang Mountain.

Not all pleasures are those of the flesh. Visitors can rent ornithopter bird-planes and smartsuits and soar between the towers, upload into cybershell aerorovers to tour the outback, or don heated drysuits to go ethane-diving in the wine-dark sea.

Titan Wrestling

Titan wrestling is gaining popularity in the Deep Beyond. Originating as a publicity stunt sponsored by Biotech Euphrates and Avatar Klusterkorp, the last few years have seen it become an annual event that has begun to receive serious mainstream attention as a sport. It showcases battles between giant (12' tall is common) human-proportioned bioshell wrestlers, controlled by digital intelligences.Titan wrestling is a sport that would only be practical in very low gravity: in Earth or even Mars gravity, the gargantuan wrestlers would collapse under their own weight. A variety of wrestling styles are used. The ring is 30' across, and moves emphasize throws and stomps, and often involve extreme brutality. Gambling on the outcome of matches is legal, and a major source of income for the sport's promoters.

The "titans" must meet minimum size and mass requirements in various categories, and must also possess a more-or-less humanoid morphology. Otherwise, modifications are left to the creativity of the bioengineers involved. Like auto racing, it's as much about rival technology as skill. Teams are generally sponsored by Deep Beyond biotech corporations, as the cost of a new titan can be quite expensive, running to $200,000 for tissue engineering and biogenesis.

Despite Minos' reputation, some activities are forbidden. Brainbugs are available, but certain kinds (especially those promoting violent mental states) are illegal. Prostitution and nanodrug vendors are regulated and licensed. Slavery is illegal, and bioroids can only be indentured by legitimate corporations – they can't be freely bought and sold (but bioshells may be, including those with sapient infomorphs). The Titan Sheriffs' Department – and military police, if soldiers are involved – investigate crimes and try to maintain order.The TSD also tries to suppress organized crime, which over the last decade has wormed its way into the town's infrastructure. With vice more-or-less legalized, crime cells concentrate on loansharking and fencing (people always need money to pay debts, especially with the casinos), protection rackets, and the sale of pirated software and goods. In particular, erotic and adventure slinkies, xoxes of media stars, and pirate copies of companion AIs are all popular, especially given the increased difficulty and lag time involved in downloading even legal material from Earth or Mars' webs. Softjacking – the kidnapping, editing, and illegal copying of AIs – is a growing problem. Most crime cells have connections with the Trojan Mafia, Maple Syndicates or Martian Triads – conflicts between rival organizations are fairly common, and sometimes end in bloodshed.

Port Minos is located southwest of Huygens at 16º north, 106º west.

Titanomachy

Tensions are high between the U.S. and Chinese governments on Titan. The SIA believes Jiangli Station's purpose is to provide a base for any future attack on the U.S. Titan Territory. In the past, Titan was seen as a planetary citadel that allowed rapid reconstitution of U.S. helium-3 mining operations even if Cassini Station was destroyed, thanks to the shielding that Titan's atmosphere provided from laser and particle beam bombardment and infrared observation. Now this is threatened by land or air assault.

In fact, the SIA is correct in its estimation that Jiangli is intended as a base of operations, but the actual motives are not quite so belligerent. China is increasingly reliant on Saturnian He-3, and the Chinese government fears Washington could have Titan Corporation choke off sales whenever it wishes. By placing a base on Titan with a force capable of threatening Titan Corporation assets, Beijing calculates that the U.S. government will be less willing to try another energy blockade in the future. In the meantime, China is developing its own Uranus-based He-3 initiative, but until that is operational, the military force on Titan provides strategic options. Of course, there is a chance that an incident on Titan may provoke the U.S., but Beijing believes it's a risk worth taking – and a way to show the world that America does not own the Saturn system.

Titan AFB and Camp McAullife

Titan Air Force Base operates both transport and strike TAVs, as well as a flight of transsonic transport aircraft and various air support and reconnaissance cybershells. It also controls orbital defenses and reconnaissance satellites.

Camp McAuliffe is a U.S. Army base hosting the 82nd Spaceborne, as well as the U.S. Army's Cryogenic Warfare School.

The two bases have a combined population of 3,000 biosapient soldiers and several thousand infomorphs, most of them LAIs, but with about 600 sapient infomorphs.

Jiangli Station

This Chinese station is located on the "neck" of the Mayan Plateau. It was founded in 2092 as a small scientific outpost studying Titan's planetology. However, in February of 2099 a Xiao Chu farhauler arrived and began shuttling down several hundred tons of cargo. The following year, the station exploded into activity. A new wing was constructed, followed by multiple rows of domed agricultural buildings.It soon became apparent that Xiao Chu was using biogenesis tanks to vastly increase the station's population. Within a few months the station's population has grown considerably, from about 150 people to over 1,700, most of them bioroids. This is viewed with alarm by the U.S. military, which stepped up reconnaissance. Recently, the base has begun to reveal defensive systems. The area around it is patrolled by combat bioroids and military cybershells. USAF overflights have been challenged, and new anti-aircraft laser batteries have begun to sprout around the station. China has not officially stated that the Xiao Chu base is shared with PLA military personnel . . . but the SIA believes that to be the case.

Jiangli Station has its own small spaceport and is CR 5. It is located at latitude 11° north, longitude 106° west.

Getting Around on Titan

Humans and other biosapients living on Titan will usually own a smartsuit or Titan suit (p. 137); the latter is a heated unpressurized vacc suit. Whether inside or out, people on foot will adopt the same gliding-bouncing "bunny hop" gait used on Luna.

Much of Titan's surface is treacherous for vehicles. While some ground is solid but crunchy, there's plenty of "ice cream sundae" terrain composed of sticky tholin, ethane and half-frozen mud (in game terms, treat as swamp or marsh) that slows travel. The AstroBug (p. 146) and World Rover (p. 148) are typical ground vehicles, but many Titan designs are also amphibious or even triphibious.

Titan's combination of dense atmosphere and 1/7 G gravity make aircraft the favored means of travel. Titanians' love affair with flying vehicles matches that of Americans with the automobile. Most short hops use

light aircraft, helicopters, and beating-wing ornithopters (see *Titan Eagle "Bird Plane*," p. 150); the latter two types are favored for low-powered vertical takeoffs, since the ground is rarely suitable for building landing strips. Most humans who live permanently on Titan own a personal strap-on mini-copter (Titan Packhopper, p. 149) or wing set, while sapient infomorphs will usually control one or more aerobots, such as the aerorover (p. 116). Personal flying infomorphs like the buzzbot (p. TS121) are also very common as pets and companions. Long distance flights can be chartered at Port Minos on transatmospheric vehicles fueled by methane ramjets; these can also reach orbit, and retain enough delta-V to visit other moons. There are short-range taxis between Minos and Huygens, and longer flights are available by charter.

Nautical vehicles are also in use. Titan's seas are fairly shallow – no more than half a mile deep – but powerboats, submersible cybershells and manned mini-subs still explore the Minoan Sea and smaller lakes and rivers. All three can also be rented for pleasure excursions, although very calm wind conditions rule out sailing. Many aircraft are fitted with pontoons or seaplane hulls to allow landing on liquid surfaces. For vehicular operations on Titan, see *Vehicles,* p. 144.

Saturn's Outer Moons

Beyond Titan's orbit, Saturn is circled by several smaller moons. None have permanent colonies, but both Hyperion and Iapetus are occasionally visited by humans.

The moons are listed in order of their distance out from Saturn. In addition to the named moons described below, there are several tiny moons under 10 miles in diameter, most likely captured carbonaceous asteroids. Most are found beyond the orbit of Iapetus.

Hyperion

Hyperion's a favorite bugaboo of people infected with the alien contact meme. After the military evicted the Gypsy Angels, they turned the place into a proving ground, and now all kinds of experimental spacecraft and weapons are tested out here. In fact, since the 2090s, there have been rumors that the USAF, SIA, or NASA are testing captured alien spacecraft – you know, the ones that use tech they acquired from the Virginians?It sounded interesting, so I traveled from Titan to Hyperion on a rented OTV, going with a group of H-Watchers (some military journalists, some UFO buffs). We intended to get to Hyperion before the next exercises started, and camp out to watch. Unfortunately, the USAF already had pickets out there, and they made it clear we weren't welcome.

The Revised Outer Space Treaty doesn't let the USAF keep people off Hyperion, it just restricts you from the areas they're exercising quote-functional sovereignty-unquote over. The USAF won't tell you that, and they'll try to scare you off. Landing on Hyperion is a pain at the best of times, and we had a nasty run-in with an exceptionally gung-ho Predator (call-sign Sparrowhawk) that wanted to play tag. I think we barely missed splattering ourselves, but our pilot Jopie was ex-SAAF, and she pulled it off.

Did we see any UFOs? Sad to say, nothing that wasn't in the last ***Jane's.*** *Of course, they kept us well away from the actual test zone. We did do some caving, and stumbled on an old-style space glove that Sharon insisted must have belonged to a Gypsy Angel pirate.*

One caution: the USAF really is testing some nasty things down here, so if you stumble into an unexploded devourer swarm cluster bomb after they've warned you, it's too bad.

– Copernicus Jones,
Lonely System Guide to Saturn

Hyperion is an irregular moon 255 miles by 162 miles by 136 miles across, the largest non-spherical body in the solar system. Hyperion's eccentric orbit around Saturn, its irregular shape, and an orbital resonance with Titan combine to give the satellite a chaotic, tumbling rotation unique in the solar system. The average distance between Hyperion and Saturn is 0.0097 AU.

Hyperion has variable microgravity, an escape velocity 0.06 mps (0.042 to orbit) and no atmosphere. Due to its tumbling rotation and ever-changing horizon, a -3 penalty applies to all Piloting rolls to land on Hyperion, and any Free Fall skill rolls, throwing, jumping, or ranged combat fire while on or near its surface.

The surface of Hyperion is old and heavily cratered – the largest crater is 75 miles across and 6 miles deep. Features include numerous winding chasms, caves, and fractures. The moon suffered a major collision a few billion years ago that blasted much of it away. What's left is battered ice and rock, with a density of 1.4 grams/cm^3.

It is the policy of the United States that activities in space should be devoted to peaceful purposes for the benefit of all mankind.
– U.S. National Aeronautics and Space Act of 1958

Hyperion was first visited by humans in 2075, when the USAGS established a temporary base-camp to study the moon's unusual geology. In the period 2084-2085, the base was occupied and expanded by 64 Gypsy Angels who had been working at Cassini Station before they were dismissed as a result of a labor dispute with Titan Consortium. These so-called "pirates of Hyperion" raided a couple of He-3 shipments, selling some to Rust China and others to homesteader communities at cut-rate prices. They were in the process of converting the captured robot freighters when U.S. military forces arrived. Some of the pirates escaped; others were captured or killed covering their retreat.

Today, Hyperion is used by the U.S. government as a hostile-environment training area and free-fire range for the U.S. Army and Air Force, as well as a testing area for Columbia Aerospace and Nanodynamics war machines. The old USAGS base is not permanently inhabited, although a single SAI is stationed there to acts as caretaker. When major exercises or test runs are scheduled, its population can swell to 200-300 people.

A pair of Predator AKVs (and sometimes a larger force, if maneuvers are ongoing) usually keep an eye on the moon, and will enforce a quarantine when the testing range is actually in use. Visitors can land elsewhere; there's no spaceport, although it's possible to hide oneself and travel stealthily by taking advantage of Hyperion's twisted geology.

Some areas of Hyperion are marked with paint, radio beacons, or v-tags saying things like "Warning: this area may contain unexploded munitions or other hazards." There's occasional wreckage from various encounters in some deep chasms, although USAF recovery teams do make an effort to clear up and retrieve most debris. There are also unsubstantiated rumors of hidden caches of He-3 left behind by the Gypsy Angels.

Iapetus

Two-faced Iapetus is 907 miles in diameter, and orbits Saturn at an average distance of 0.024 AU. Iapetus is almost entirely made up of water ice. However, the contrast between the surfaces of Iapetus' two hemispheres is dramatic. The trailing hemisphere is covered with bright, dirty ice, much like Enceladus, with many large craters. The surface of the leading hemisphere is coated with a dark carbonaceous material resembling tar.

In 2032, a Russian cybershell probe landed on Iapetus, and positively identified the coating as amorphous carbon (similar to soot) and various organic substances, including poisonous cyano-compounds such as frozen hydrogen cyanide polymers. The composition of this material was identical to Titanian tholin (see *Life on Titan?*, p. 61). It is believed that in the distant past, a massive meteor struck Titan (possibly forming the Minoan Sea) and blasted a cloud of debris into orbit. Shortly afterward, Iapetus passed through the cloud, resulting in the dark stain on its leading surface.

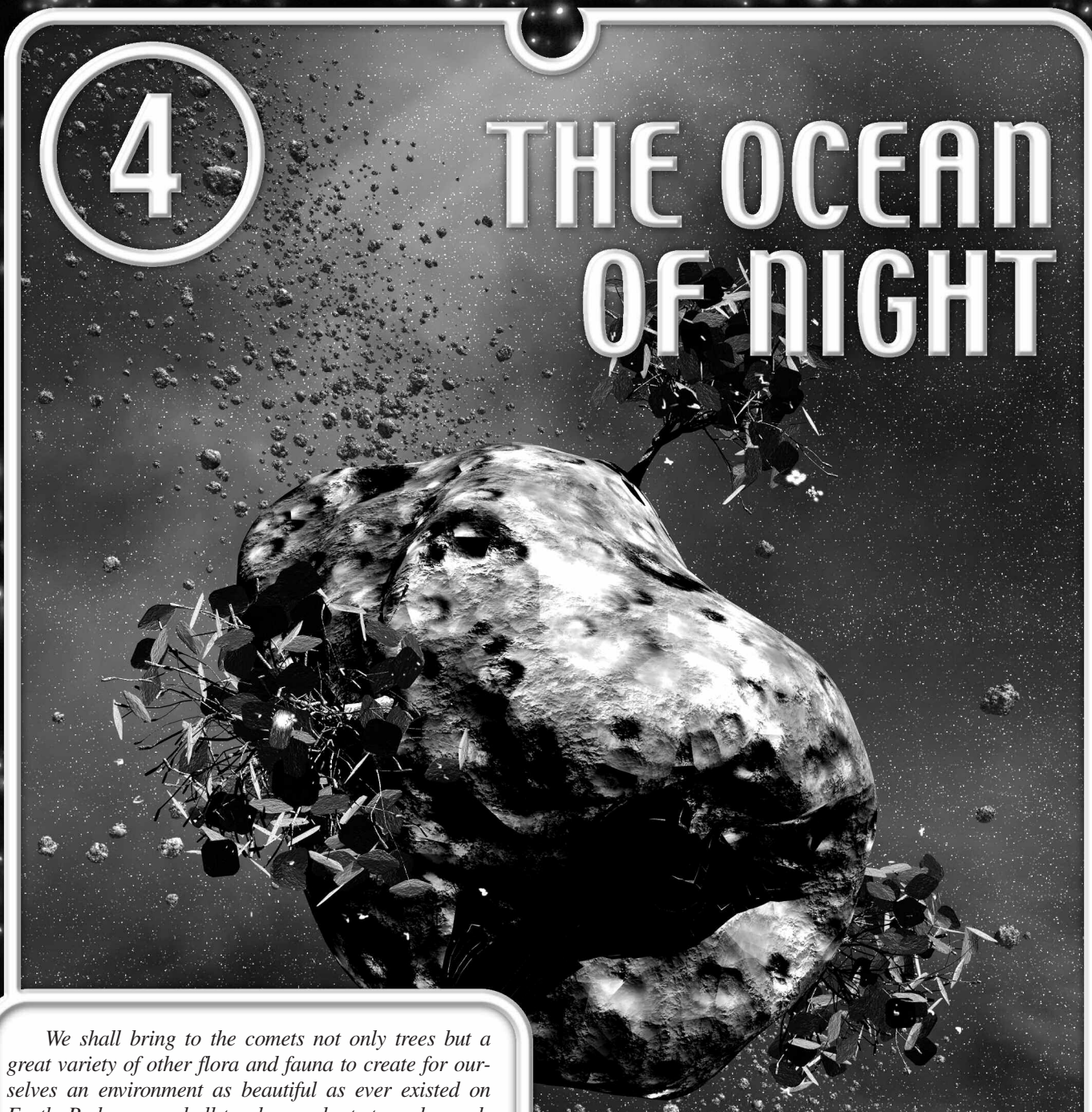
In 2085, Iapetus witnessed the last act of the tale of the Pirates of Hyperion. One of two fleeing Gypsy Angels Collective vessels was on course to Iapetus, apparently planning to use the moon as part of a gravitational slingshot maneuver. It was 7,400 miles from Iapetus when it was caught by a pursuing AKV and destroyed. The AKV was controlled by a SAI, and this particular action represented (as far as anyone knows) the first time that a sapient artificial intelligence killed human beings. Ten years later, in 2095, a Gypsy Angel spacecraft landed on Iapetus. The crew proceeded to erect an ironic memorial: a black basalt slab housing a solar-powered radio beacon.

Iapetus has a density of 1.21 g/cm^3 and a surface gravity of 0.025 G. The escape velocity is 0.37 mps (0.26 mps to orbit). Iapetus' orbit is inclined at 15° to Saturn's equatorial plane, granting any inhabitants a good view of Saturn's complete ring system. An eccentric U.S. billionaire is reportedly considering building a private getaway on Iapetus.

Phoebe

Phoebe is the outermost of Saturn's mid-sized moons, orbiting Saturn at a distance four times greater than Iapetus (an average distance of 0.086 AU). It is a captured carbonaceous-volatile asteroid, roughly 140 miles across, with a dusky reddish surface. Its low density indicates that it is a rubble pile asteroid, filled with large pore spaces. Phoebe orbits Saturn in the opposite direction to that of the other major moons, and rotates about its axis every 9.4 hours There are no known bases on Phoebe.

4 THE OCEAN OF NIGHT



We shall bring to the comets not only trees but a great variety of other flora and fauna to create for ourselves an environment as beautiful as ever existed on Earth. Perhaps we shall teach our plants to make seeds which will sail out across the ocean of space to propagate life upon comets still unvisited by man. Perhaps we shall start a wave of life which will spread from comet to comet without end until we have achieved the greening of the Galaxy.

– Freeman Dyson, ***Disturbing the Universe***

The outer marches of the solar system are the region of space beyond the orbit of Saturn. This new frontier holds distances so vast that even fusion drive fasthaulers may take years to traverse them, and icy worlds both dwarf and giant.

The Centaurs

The Centaurs are a small outer population of objects that circle the sun between the orbits of Saturn and Uranus. Some are Kuiper Belt Objects (p. 74) whose orbits have become perturbed, but others resemble frozen volatile asteroids.

Centaurs range in size from a few miles across to just over 100 miles in diameter. The largest bodies are named after mythical centaurs. A few of the icier Centaurs have been diverted to Mars in "comet herding" operations.

2060 Chiron: At 106 miles in diameter, Chiron is the largest of the Centaurs. It's a ball of dust-covered ice with a thick rocky core, similar to most Kuiper Belt objects. When its eccentric orbit causes it to pass within 4 or 5 AU of the sun, its ice begins to evaporate, surrounding it with a comet-like halo. As a result, it is also classed as a comet, 95P Chiron.

Uranus

Turquoise-hued Uranus is the third largest planet, but it's also the least massive of the four gas giants, and in some ways is a "country cousin" to the others. It lacks the crushing gravity and terrible radiation of Jupiter, the complex icy rings of Saturn, and the high-speed winds of Neptune. None of its moons are geologically active or possess atmospheres; all are simple balls of ice and rock.

Yet this may, perversely, make Uranus and its moons an ideal location for future colonization. Uranus is not a place where preservationists are likely to complain if major industrial development takes place. Moreover, the relative calm of the gas giant's weather and the shallowness of its gravity well may make it an ideal alternative to Saturn for He-3 mining. While Saturn is unlikely to run out of helium-3 any time in the foreseeable future, there are interests that would rather not buy their energy from the U.S.-dominated Titan Consortium . . . and for companies unwilling to afford the cutting-edge technology of Columbia Aerospace, Uranus offers fewer mining challenges than Saturn.

The strangest feature of Uranus is its unusual rotation. Instead of being roughly perpendicular to the plane of the ecliptic, like most planets, it is parallel to it. This means that during certain parts of the year the planet's polar region receive more energy from the sun than its equator. As a result, Uranus has the most extreme seasons of any planet in the solar system. For example, during the northern summer, most of the northern hemisphere gets 20 years of sunlight, while the south receives 20 years of darkness. In spring and fall, sunrises and sunsets are normal. Despite this, temperatures at the equator are not much different than that at the poles, due to internal heat transfer.

While Uranus is a giant planet, its interior is quite different from those of Jupiter and Saturn. Because it formed at a greater distance from the sun, more than 80% of its mass is ice and rock, and only about 17% is hydrogen. Uranus and its more distant sibling Neptune are sometimes referred to as "ice giants" rather than "gas giants."

Uranus' atmosphere is mostly hydrogen and helium, with a small amount of methane. Faint cloud bands blow rapidly about the planet. Their distinct blue-green color is due to methane.

Weather: Conditions on Uranus are not as fierce as on some gas giants, but east-west winds still blow at speeds of 90 to 360 mph, averaging about 220 mph on the equator. Uranus has fewer storms than the other gas giants, and no enduring world-sized storm systems like the Great Red Spot of Jupiter or the dark spots of Neptune.

Uranus Statistics

Distance from Sun: 20 AU (Jan 1, 2100).
Diameter: 31,800 miles.
Mass: 14.5 Earths.
Density: 1.3 g/cm^3.
Gravity: 0.89 G (upper clouds).
Escape Velocity: 13.2 mps.
To Orbit: 9.3 mps.
Rotational Period: 17.2 hours.
Year: 83.7 years.
Atmospheric Composition: 83% hydrogen, 15% helium, 2% methane.
Temperature: -355° F (cloud tops).
Moons: 21; see below.

Yggdrasil Station

This is a Gypsy Angel-Green Duncanite project to develop "Dyson Trees" whose trunks and branches, with toughened bark, roots and symbiotic pyschrophile bacteria, tap the icy body for nutrients, and whose space-black leaves function as a vast solar collector. In microgravity, the Duncanites believe that a single tree could grow to encompass an entire asteroid, creating a megastructure hundreds or thousands of miles across. Humans would live in habitat capsules in the tree; work is proceeding on making the tree form these itself.

The current program is centered on a two-mile-wide Centaur body, 273404 Yggdrasil, currently passing within 6 AU of the sun, where seeds are being tended by Void Flyer bioroids and a small on-site team of Kosmodavit Tenno Tanjo genetic engineers. Yggdrasil Station is protected by a pair of *Barricade*-type SDPs. Population is 200, CR 1.

The Interior: Uranus lacks the dense ocean of liquid metallic hydrogen that characterizes Jupiter and Saturn, nor does it have a dense rocky core. Its composition simply turns from gas to slush to ice mingled with rock. Depending on how one views Uranus, it could be said to have either a very large core, or no core at all.

Exploration and Exploitation

For the past few years, Xiao Chu has been quietly studying Uranus' atmosphere using specialized cybershell balloons. The company is presently operating 25 UNSIBA aerostats. These are teleoperated from Miranda and controlled by infomorphs. In 2099 it began an exploratory He-3 mining operation from its base on Miranda.

He-3 Mining of Uranus

The method being used on Uranus is similar to that used on Saturn (p. 55), but simplified due to the smaller planet's lower escape velocity. Instead of employing a permanent aerostat station and a separate transatmospheric vehicle, Xiao Chu uses a single dedicated Helium Recovery Vehicle. The mission profile is a launch from Miranda, aerobraking into Uranus' atmosphere, the deployment of a parachute to slow down, and inflation of an UNSIBA balloon for lift. Processing is handled in the same way as Saturn, but after the tank is filled, the HRV takes on hydrogen and fills its own fuel tank, dumps the balloon (the cost of which is small compared to the value of the He-3), and ignites a fission rocket to lift out of Uranus' atmosphere. Then it either returns to the Xiao Chu base station at Miranda, or heads directly for Earth or Mars.

Uranus' Magnetosphere

The magnetic field of Uranus differs from that of most other planets. It is not aligned with the planet's poles. Instead of originating from the center of the planet, it originates from 60° off to one side. In combination with Uranus' sideways axial tilt, this means that its magnetosphere has a weird, twisted corkscrew shape, extending six million miles away from the sun. Radiation is modest compared to Jupiter, and does not pose a significant hazard to spacecraft.

Rings of Uranus

Uranus has a dozen faint, dark rings like Jupiter, but unlike Jupiter these rings contain large boulders (some up to 30' in diameter) as well as dust. The main ring structure orbits Uranus at a distance of 0.00025 AU and is 1,500 miles wide (but only a few miles thick). The ring particles are mostly rock coated with carbonized frozen methane. When they first established a base here, Xiao Chu checked for fugitive TSA AKVs. They didn't find any . . .

UNSIBA Aerostats

This stands for Uranus-Neptune Stratosphere-Inflated Balloon Aerobot. These are the standard cybershell design used for operations in the atmospheres of the two outermost gas giants. That far from the sun, there is not enough solar heat to operate the SIRMA balloons used in Jupiter and Saturn. However, the icy clouds of Uranus and Neptune's upper atmosphere offer some unique opportunity for the design of cold-gas balloons which actually have certain performance advantages in this peculiar environment.

Temperatures in the upper atmosphere of Uranus and Neptune are cold enough that the molecular weight of the upper atmosphere is slightly lower above the clouds than in the troposphere below them. Aerobots designed for Uranus and Neptune take advantage of this. The UNSIBA free-falls through the upper atmosphere, but as it descends it sucks in light stratospheric gas, which is used to gradually inflate the balloon. Upon passing through the troposphere cloud layer, the balloon has "inhaled" enough gas that it can support itself. An UNSIBA balloon requires one pound of balloon mass to support each pound of its payload. A typical UNSIBA design is Xiao Chu's TWX Type-97 (p. 118).

Moons of Uranus

Uranus has more than 21 moons, most of them named for Shakespearean characters. None have either atmospheres or subsurface oceans.

Uranus' Inner Moons

In order of proximity to Uranus, these tiny satellites are Cordelia, Ophelia, Bianca, Cressida, Desdemona, Juliet, Portia, Rosalind, Belinda, and Puck. They are small, airless rock-and-ice chunks that range in size from 16 miles (Cordelia) to 96 miles (Puck). Cordelia and Ophelia are "shepherd moons" that orbit just inside and outside Uranus' main ring. None of them are inhabited, and most have never even been visited by probes.

Methane Diamonds?

The conditions of 3,000-degree heat and million atmosphere pressure inside Neptune and Uranus may be just right to squeeze atmospheric methane into diamonds. Do diamonds fall like raindrops into the interior of Uranus and Neptune? At present, no one knows: not even a diamondoid-hulled probe has survived to venture that far down.

Miranda

The 11th moon of Uranus, Miranda orbits Uranus at an average distance of 0.00086 AU. Miranda is 295 miles in diameter. Like most outer satellites, it's mostly ice and rock (density 1.2 g/cm^3), but the moon possesses an unusual "jigsaw" geology of crazy zigzagging canyons (some up to 12 miles deep) and mountains that look like layer cakes.

The moon has a gravity of 0.0081 G and escape velocity 0.12 mps (0.08 mps to orbit). Surface temperature averages -335° F.

Tianwangzing Base: The only settlement on Miranda, it was established in 2087 by Xiao Chu. Originally it was a small science station studying Miranda's geology. Since 2098, its population has increased considerably; it now boasts 120 humans and bioroids, all company employees, supporting the gas mining operations elsewhere in the system. The station is a low-profile operation, but is supported by a couple of armed USVs and a security squad from Five Dragons.

Ariel

The 12th moon of Uranus, Ariel is 724 miles in diameter and orbits Uranus at an average distance of 0.00127 AU.

Ariel is covered by a bright surface of water ice. It surface is covered by rift valleys and canyons, and dominated by craters, mountains, icy ridges, and long winding valleys. Many of Ariel's valleys are over 100 miles long and up to 7 miles deep. The canyons and cracks in Ariel's surface are believed to result from the moon having been warm, with a liquid ocean, some billions of years ago.

It has a density of 1.66 g/cm^3 and a surface gravity of 0.027 G. Its temperature is a chilly -340° F. Ariel's escape velocity is 0.33 mps (0.2 mps to orbit).

Xiao Chu cybershells have been exploring Ariel, perhaps with the idea of building a mining station similar to Nanodynamic's Asgard Station on Callisto.

Uranus' Outer Moons

Umbriel is about the same size as Ariel, but it has a dark, old, heavily-cratered surface, with more craters than Ariel and Titania. It is composed of an even mix of rock and water ice. It is 731 miles in diameter, with a density of 1.4 g/cm^3. Gravity is 0.023 G.

Titania is the 14th and largest moon of Uranus. Its terrain is similar to that of Ariel, with signs of tectonic activity in the distance past. It is 986 miles in diameter. Density is 1.7 g/cm^3. Gravity is 0.039 G.

Oberon is the 15th and second largest moon of Uranus. It resembles Umbriel, except that its southern hemisphere has large cracks and faults. One of its mountains is exceptionally large (20,000 feet) for the moon's size. Oberon is 951 miles in diameter. Density is 1.63 g/cm^3. Gravity is 0.035 G.

Caliban is 61 miles in diameter, and orbits Uranus at a distance of 0.048 AU.

Stephano is a small chunk of rock 12.5 miles in diameter, and orbits Uranus at a distance of 0.053 AU.

Sycorax is 119 miles in diameter, and orbits Uranus at a distance of 0.081 AU.

Prospero and *Setebos* are both 19 miles in diameter, and orbit Uranus at distances of 0.11 AU and 0.12 AU.

The U.S. National Technical Intelligence Bureau (p. 97) has a cybershell listening base hidden on Setebos to monitor Chinese activity in the ring system.

Neptune

The gatekeeper of the Kuiper Belt, remote Neptune is the outermost of the gas giants and the eighth planet from the sun. Its vivid blue color gives Neptune a beauty rivaling ringed Saturn, but its violent winds and great distance from the inner solar system have discouraged exploration, even by cybershell probes.

Neptune is the third most massive planet, and the fourth largest in size.

Neptune's internal composition resembles that of Uranus.

The Winds of Neptune

Neptune has the fastest winds in the solar system, some blowing at speeds of up to 1,200 mph. Like Jupiter, its blue surface is prone to enormous world-sized hurricanes. These "dark spots" are rotating pinwheel-shaped cyclones bounded by feathery white clouds. They can persist for months or years at a time, but not for decades like the Jovian storms. The temperature difference between Neptune's strong internal heat source and its frigid cloud tops (-260° F) is responsible for this turbulent weather.

Upper Atmosphere: The upper atmosphere is striated by swift-moving white cloud formations thousands of miles long and hundreds of miles wide. These are formed from frozen methane droplets. Individual clouds rarely last for more than 10 hours before being dispersed by Neptune's winds. 30-40 miles below this level are the dense blue clouds (colored by methane) which cover the entire planet.

Molecular Hydrogen Envelope: Neptune's atmosphere is a mix of molecular hydrogen, helium, and methane, massing about 2 or 3 times that of Earth. The atmosphere is 5,000 miles deep, gradually turning from a gas to a liquid.

Neptune's Statistics

Distance from Sun: 30.2 AU (Jan 1, 2100).
Diameter: 30,800 miles.
Mass: 17.1 Earths.
Density: 1.6 g/cm^3.
Gravity: 1.12 G (upper clouds).
Escape Velocity: 14.5 mps.
To Orbit: 10.2 mps.
Rotational Period: 16.1 hours.
Year: 164.8 years.
Atmospheric Composition: 74% hydrogen, 25% helium, 1% methane.
Temperature: -380° F (cloud tops).
Moons: Eight; see below.

Inner Mantle: This is a semi-solid jacket of water, methane, and ammonia ice massing about 10-15 Earths, under extreme pressure.

Core: Neptune's core is composed of rock and ice, massing about as much as Earth.

Neptune's Ringlets

Neptune has a faint, dark, ring system. The rings extend between 25,000 and 39,000 miles from Neptune, but individual rings are no more than a few miles thick. Like Jupiter's rings, they are composed of dust and small rocks. There are four main rings, one of which shares an orbit with Galetea, Neptune's fourth moon.

Neptune's Moons

Neptune has eight named moons. Aside from Triton, all are small asteroid-like chunks of heavily-cratered ice and rock with microgravity and no atmospheres.

Neptune's Inner Moons

Inner Moons: Naiad, Thalassa, Despina, Galetea, and Larissa are the innermost moons, orbiting Neptune at average distances between 0.00032 and 0.00049 AU. They are irregular bodies between 18 and 110 miles across.

Proteus: The second largest of Neptune's moons. It orbits Neptune at an average distance of 0.00078 AU. It is an irregular (but roughly spherical) body some 260 miles in diameter. The surface of Proteus is heavily cratered. The body resembles a large asteroid.

Nereid: The eighth moon of Neptune, Nereid is a captured Kuiper Belt Object with an extremely eccentric orbit. Its year-long passage around Neptune takes it from 0.009 AU at closest approach to 0.06 AU at most distant.

Triton

Triton is a light-colored globe just over three-quarters the size of Luna. It orbits Neptune at an average distance of 0.0024 AU. The moon's orbit is unusual: it is very circular, but Triton circles Neptune in a direction opposite to the planet's rotation; this situation is unique among large moons. As a result, tidal interactions are causing Triton's orbit to slowly decay: millions of years in the future, it will either break up into a ring or collide with Neptune. Triton rotates about its axis every 9.4 hours.

Unlike our own moon, Triton has a tenuous atmosphere and a very active geology, with geysers that spew plumes of cryogenic matter into space. Its trace atmosphere is composed of nitrogen with a whiff of methane; it's effectively a vacuum from a human perspective, but is visible as a faint haze that extends up to 5 miles high. Winds blow across the surface at speeds of 20-40 mph. The atmosphere is just thick enough to allow a degree of parachute airbraking for landing payloads. Specialized wind-blown "tumbleweed" aerobots were used during the early exploration, and some are still operational – see *Tumbleweeds*, p. 120.

Triton's temperature averages -390° F, making the moon one of the coldest places in the solar system. It is 75% rock and 25% water ice, making it denser than many icy moons. Its retrograde orbit and rocky composition suggest it is a captured Kuiper Belt Object similar to Pluto, rather than a moon that formed along with Neptune. For the first billion years after Triton was captured, it had considerably more water. Tidal heating melted its liquid surface, leaving it the more differentiated rocky body it is today.

Triton's surface is scarred by giant cracks and jagged peaks and fissures, some stretching for hundreds of miles. There are a few flat plains of ice several miles across, the result of material from geysers filling up ancient meteor craters. As with Europa, there are very few visible craters, as billions of years of volcanic action and shifting ice has obscured them.

Triton has an extreme axial tilt of 157°, which gives it noticeable seasons (lasting for decades), although the temperature rarely exceeds -390° F. The ground is covered by nitrogen frost mixed with traces of condensed methane and carbon dioxide and monoxide. There are occasional dark streaks produced by nitrogen deposits blasted out of cryo-volcanoes and carried in long patterns by the winds.

Triton's geysers spew liquid nitrogen, carbonaceous dust, ammonia, and methane compounds into space, sending plumes shooting up to five miles above the moon's surface. This "cryo-volcanic" action is the result of variations in seasonal heating from the sun, which causes pressure buildups in volatiles beneath the moon's surface.

Triton's Statistics

Distance from Neptune: 220,400 miles (0.00237 AU).
Diameter: 1,680 miles.
Mass: 0.00358 Earth masses.
Density: 2 grams/cm^3
Gravity: 0.08 G.
Escape Velocity: 0.9 mps.
To Orbit: 0.63 mps.
Rotational Period: 5.9 days.
Atmospheric Pressure: 0.000015 atmospheres.
Atmospheric Composition: Trace nitrogen-methane.
Surface Water: None.
Temperature: -390° F.
Population: see below. 500+ pounds of cyberswarms.
Spaceports: Small spaceport.
Control Rating: CR 0.

Much of the summer hemisphere is dominated by regularly-spaced crater-like circular depressions a few miles across, separated by rugged ridges; these are caused when icy surfaces melt and collapse as temperatures increase by a few degrees. The winter hemisphere is partly covered by a faint pink frosting of frozen methane.

Settlement on Triton

Triton has attracted scientific attention since the Voyager 2 flyby discovered its exotic geology. In 2032, the Russian-Ukrainian probe *Komarov* orbited Triton and sent back detailed imagery. The first major exploration was in 2071, when the USAGS landed two dozen "tumbleweed" cybershells (p. 120) coordinated by a relay satellite. These sent back data until 2090, when the satellite ran out of power and ceased transmitting. Several of the tumbleweeds remained active at that point, and are believed to be still exploring

Triton was left to its own devices for the next several years. Then, in 2099, the Exogenesis Station team working on Starswarm (p. 136) faced a shutdown of their project. Starswarm was intended to launch a phalanx of interstellar nanoprobes to explore other solar systems. In the midst of a round of budget cuts that culminated in their sale to Nanodynamics, the team decided to conduct one last proof-of-concept live test. Facing immediate shutdown and unable to power the launch accelerator for a long-range shot, they modified the probes for lower velocities and enclosed them in hard-landing acceleration shells, planning to test-fire them at a moon in the outer system. Their target: Triton.

The plans for a launch were interrupted when Nanodynamics' EDI mercenaries made a surprise attack on Exogenesis Station. During the desperate few hours of fighting on the station, a "forlorn hope" team of rebel infomorphs hastily modified the programming, than initiated a short firing sequence. Before they could be halted, several million probes were launched in an interplanetary trajectory. EDI failed to realize what was happening, believing it was a failed attempt to use the accelerator to fire on their spacecraft. The Exogenesis team wiped the records. Some had time to beam themselves off station to join the Axon Group (p. 100) on Io or elsewhere; those who did not have time erased themselves to conceal the knowledge of what they had done.

The swarm of probes reached Triton in October of 2099. Those that survived impact crawled out of their acceleration shells and went to work. At the moment, they're reconstituting themselves into larger microbot swarms specialized for various activities, from antenna disks to miners. They've also stumbled on the old Tumbleweed robots, dismantling some for parts and modifying others into vehicles they can move about in.

As to what they're doing . . . they're building a new base for the Exogenesis rebels, one that Nanodynamics does not know about. When it's complete, Axon will have a hidden sanctuary in the Deep Beyond. It will be able to use lasers to transmit backups of its personnel there, to a place where the cyber-rebels can build up strength in secret. An infomorph homeland . . .

The Kuiper Belt

The Kuiper Belt is an enormous population of icy "trans-Neptunian" objects, leftover debris from the formation of the solar system. They occupy a torus-shaped area of space around the sun, extending from about 30 AU (the orbit of Neptune) to 50 AU, with some bodies found as far out as 100-200 AU. There are over 100,000 icy bodies 50 miles or more in diameter, including several that are hundreds of miles across. There are also many billions of smaller bodies a few miles across.

Kuiper Belt Populations

There are three main populations of Kuiper Belt objects, which differ in their orbits:

Classic Kuiper Belt: This population consists of objects in stable orbits about the sun at average distances of 42 to 50 AU. Many objects in this category have survived intact since the dawn of the solar system. About 40-50% of the total population of the Kuiper Belt is concentrated in these objects.

Plutinos: These objects are locked into a stable 3:2 orbital resonance with Neptune: for every two orbits Neptune takes around the sun, they complete three. A typical Plutino will have an orbit that can take it as close to the sun as 30 AU or as distant as 50 AU. Plutinos make up about 10% of the population of KBOs within 50 AU of the

Quaoar

Quaoar is one of the larger Kuiper Belt Objects – an icy rockball 800 miles across, half the size of Pluto, some 42 AU from the sun. In 2086 a joint Gypsy Angel-Xiao Chu expedition visited Quaoar to establish a comet-herding support base; however, eight months later, they began transmitting a stream of baffling gibberish, then went silent. Months later, a Chinese SDV, the *Rensheng,* arrived to investigate, but what they found remains classified . . . Neither China nor the Gypsy Angels have resettled Quaoar, but an unmanned PLAN-SF space defense platform still orbits it, warning off visitors.

Other large KBOs include Varuna (560 miles across) and Ixion (650 miles across). There are indications that some of these bodies may have subsurface seas like Callisto's.

sun. The Plutinos get their name from the largest object within the category: Pluto.

Scattered Disk: This population of objects has quite eccentric orbits that carry them closer into the solar system, as near to the sun as 35 AU, and out beyond 150 AU. The scattering is the result of gravitational influences of Neptune. About half the population of the Kuiper Belt is composed of scattered disk Kuiper Belt Objects.

The scattered Kuiper Belt Objects are a source of short-period comets.

Composition of Kuiper Belt Objects

The bodies populating the Kuiper Belt are leftovers from the birth of the solar system. They consist of a nucleus of rock surrounded by a ball of frozen dust and gas. Volatiles include water ice, carbon monoxide, methane, and nitrogen.

A KBO's surface crust is usually composed of very dark, hydrogen-poor, carbon-rich material. This is the result of billions of years of cosmic ray bombardment, which depletes hydrogen and creates complex carbonized polymers in the ice. Some KBOs have mottled surfaces, where collisions exposed brighter ice or rock beneath.

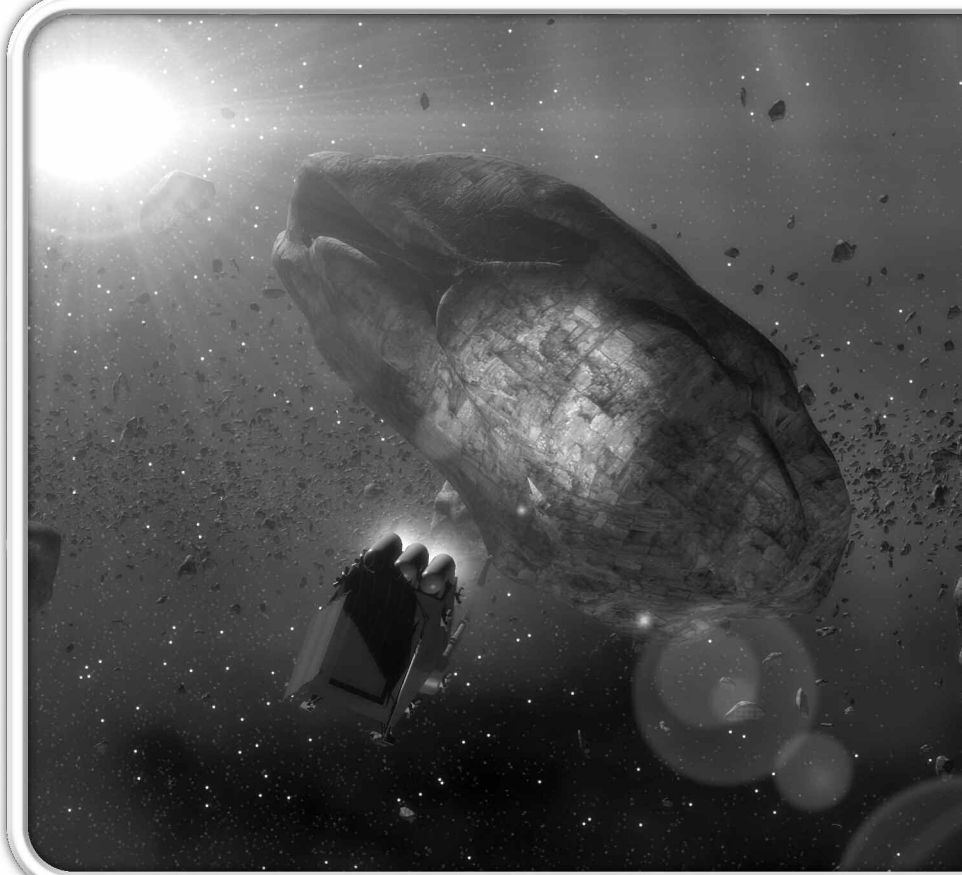
KBOs are *very* cold – temperatures of -350° to -400° F are common. As they're mostly various ices, some less dense than water, density is typically about 0.9-1.2 g/cm^3.

Settling the Kuiper Belt

The first human visitors to the Kuiper Belt were comet herders. Microgravity engineers and fusion drive mechanics – often Gypsy Angels (p. 88) – were hired by Rust China and later, by America/Mars to visit Centaurs and Kuiper Belt Objects. They installed fusion torch drives and mass drivers on their surfaces, then nudged their orbits in the direction of Mars, to add their volatiles to the thickening Martian atmosphere in a process nicknamed "crash terraforming."

In the late 2080s, largely due to the influence of Gypsy Angel leader Joseph Pierre Fox, the Angels began their own KBO settlement program, to carry Green System (p. TS89) ideals to the outer reaches of the system. Using funds gained from various services (legal and otherwise) that they had performed for Rust China, the Gypsy Angels acquired new and second-hand cybershells, factory, and life support systems. They founded Topsy Station, the first permanent habitat in the Kuiper Belt.

Today, about 2,000 sapient beings continue to work as comet herders, colonists, and explorers in the Kuiper Belt. Some of them live on Gypsy Angel and Xiao Chu vessels, while others are inhabitants of Topsy and its daughter stations.



Comets

A comet is an object from the Kuiper Belt, Centaur or Oort Cloud populations whose orbit takes it near the inner solar system. When the object gets within about 3-4 AU of the sun, the increasing temperature causes its icy outer crust to sublimate.

This evaporation creates a visible coma, a wispy atmosphere of dust and gas much larger than the comet itself. Some of this gas is charged and blown in a direction away from the sun by the solar wind (see p. TS30), resulting in the comet's long glowing tail. A tail can stretch for hundreds of millions of miles (a couple of AU), and always points away from the Sun. A comet's tail is tenuous enough that a spacecraft can pass through without any difficulty.

A comet may swing through the solar system and back out to where it originated, returning every few decades, centuries, or even millennia. The time it takes before returning is the comet's period, which depends on how eccentric its orbit is.

Short-period comets originate in the scattered disk of the Kuiper Belt or are Centaurs. They usually take several years to several decades (up to 200 years) between passes into the inner system. Halley's Comet is an example of a short-period comet, with a period of 76 years.

Long-period comets come from the Oort cloud (p. 77). Depending on how wide their orbit is, they can have periods of hundreds, thousands or even millions of years. Hale-Bopp and Hyakutake are examples of long-period comics. Oort cloud comets may be perturbed into the inner system by the influence of passing stars.

After a comet has made 200 or so passes through the inner system, it will have lost its ice and embedded dust, leaving only a dark, rocky nucleus. However, not every comet suffers this fate. Some have their orbit perturbed by the gravity of Jupiter or another planet. This can eject a comet out of the solar system into interstellar space, give it a new orbit within the system (for example, moving it into the Centaur population), or even send it crashing into the sun or another body.

2051 BJ – "Topsy Station"

2051 BJ is an undistinguished Kuiper Belt Object in a stable trans-Neptunian orbit in the classic Kuiper Belt population. It is three miles in diameter, orbiting the sun at a mean distance of 44 AU. The earliest and largest community in the Kuiper Belt, Topsy Station is an ever-growing accretion disk of cargo cans, derelict and obsolete spacecraft, giant solar mirrors, smaller icy chunks, and purpose-built modules. The six dozen objects currently making up Topsy Station are all tethered together by long nanocomposite cables. The entire mass slowly rotates, keeping the cables taut.

Topsy is home to two different groups. The original settlers were Gypsy Angels, now numbering 500 Tennin and 200 Void Flyers. However, all adults practice shadow-swap (p. 88), so they each host 1-3 shadow infomorphs, some of which may also be sapient. Thus, actual numbers are hard to judge. Many Gypsy Angels belong to a group calling itself the Kuiper Belt Brigade of the Singularity Liberation Front, a radical transhumanist and hyperevolutionist group that has no connection with the Christian hyperevolutionists. Their goal is to foster the spread of sapient intelligence through trans-Neptunian space.

Since 2087, Topsy has also provided sanctuary for Nark Puggsee, a renegade TSA memetic warfare team consisting of rogue Emergent Intelligences and ghosts. Through xoxing, there are about 50 of them, mostly hosted by bioshell bodies, although some reside in mainframe cybershells. They no longer serve TSA controllers – see *The Tritium Affair*, below. They act as mobile troubleshooters and crisis negotiators for the Gypsy Angels, beaming themselves to trouble spots to help family spacecraft in danger. Of course, they don't reveal their true identities to outsiders unless absolutely necessary.

Society on Topsy Station is a functioning nanarchy (p. TS90). With plenty of power-generating capacity, 3D printers and abundant raw resources, the citizens of the station aren't poor, but most of their income is actually spent on information and techniques.

Topsy Station is also expanding at a deliberate pace. On average, another sizable KBO passes within 0.01 AU every month or so. When this occurs, a posse of Gypsy Angels will usually take a torch ship out for a visit, and if it looks promising, they'll either homestead the object, or drag it back to become part of the station.

The Tritium Affair

In the aftermath of the Pacific War, an undercover TSA covert operations unit codenamed Nark Puggsee was ordered to assist in the procurement of a quantity of tritium from the Fengyang Group at Liang Mountain (p. 31). However, when the TSA team learned the buyers were Negative Growth terrorists who needed the tritium for a thermonuclear bomb, some found they could not support such an action. The team instead sabotaged the operation, betraying the bomb location to Chinese security. Shortly afterwards, the team disappeared, severing contact with their TSA handlers . . .

Pluto

Pluto is the largest and most famous of the Plutino population of Kuiper Belt Objects. Its eccentric orbit takes it as close to the Sun as Neptune and as much as half again further away. In 2100 it's near the outer edge of its orbit.

Pluto is about 70% ice and 30% rock. Its surface is covered with a crust of frozen nitrogen, methane, and carbon monoxide, over a mantle of water ice and a rocky core.

Pluto has been visited by cybershell probes, but no humans have ever landed on it. The last cybershell probe ran out of power in 2082; since then Pluto has been quiet.

Pluto Statistics

Distance from Sun: 48.8 AU (Jan 1, 2100).
Diameter: 1,485 miles.
Mass: 0.0021 Earths.
Density: 2 g/cm^3.
Gravity: 0.067 G.
Escape Velocity: 0.68 mps.
To Orbit: 0.48 mps.
Rotational Period: 6.4 days.Year: 248 years.
Atmosphere: Vacuum.
Surface Water: None. Water ice.
Temperature: -400° F.
Moons: Charon.

Charon

Charon is Pluto's moon. On average, it is 0.00013 AU (12,000 miles) from Pluto. At 790 miles in diameter, Charon is the largest moon in proportion to its planet of any satellite in the solar system. Charon and Pluto's rotations are synchronized, so that both always show the same face to one another. No one has ever visited it, although a few remote probes have made close flybys.

Charon is airless. Its surface is covered with water ice, unlike Pluto. The moon's composition is a mix of ice and rock, similar to many of Saturn's moons. It has a density of about 2 grams/cm^3 and a gravity of 0.036 G. Escape velocity is 0.41 mps (0.29 mps to orbit).

The Edge of the Solar System

The Heliopause (see p. TS30) is sometimes called the "edge of the solar system." As the solar wind moves from the sun into space, it creates a magnetized bubble of hot plasma called the heliosphere. Eventually this encounters charged particles emitted from interstellar gas.

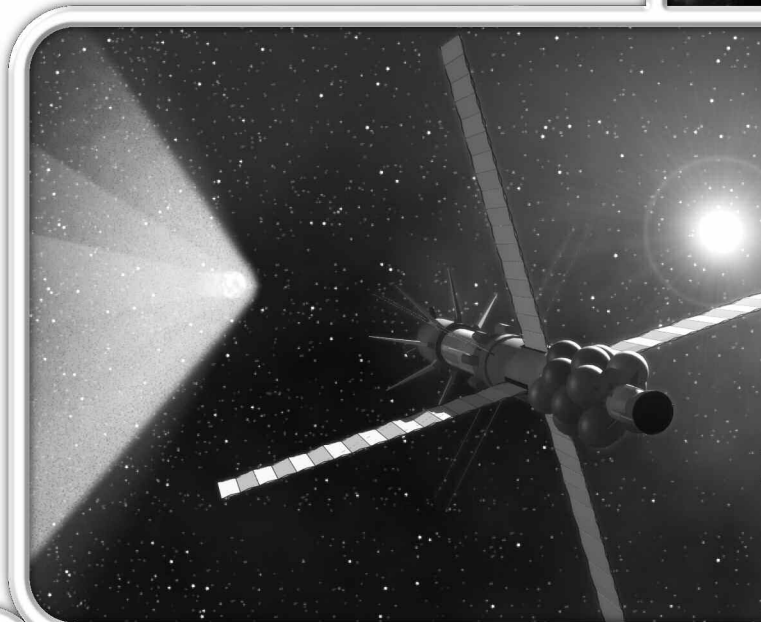
The boundary between the solar wind and incoming interstellar particles – the point where their pressure is equal – is the heliopause. It is located roughly 150 AU from the sun, but like the magnetosphere of Jupiter and other planets, it has a much longer "tail" that trails away from the direction the sun moves. The first spacecraft to cross the heliopause were the Voyager and Pioneer probes, in the mid-21st century.

The Oort Cloud

First conceived of by astronomer Jan Oort, the Oort Cloud is a spherical cloud of trillions of icy bodies that follow eccentric orbits around the Sun. They orbit at average distances of 40,000-200,000 AU, although some bodies – long-period comets – come much closer to the sun. It can take individual Oort Cloud objects millions of years to complete their orbits. The total mass of comets in the Oort cloud is many times the mass of the Earth.

Oort Cloud objects are weakly bound to the sun. They can be perturbed in their orbits by the influences of passing stars, interstellar molecular clouds, and galactic tidal effects, resulting in the long-period comets that curve from the Oort Cloud into the system.

Oort Cloud objects are similar to Kuiper Belt Objects, but not identical. Unlike the objects in the Classic Kuiper Belt, they were originally formed closer to the sun, and ejected during a period of violent collisions and gravitational perturbations that followed the solar system's birth. As they are fragments of earlier collisions, many, although not all, of the Oort Cloud bodies are smaller and more irregular in shape than KBOs. The average temperature of Oort Cloud objects is a cryogenic -450° F, just a few degrees above absolute zero.



Primordial Black Holes

A half-dozen atom-sized black holes, cosmic leftovers from the Big Bang, have been found in the Oort Cloud (and one in the Kuiper Belt). Each masses a few billion tons. A few have had close encounters with the chunks of rock and ice in the Kuiper Belt or Oort Cloud. Braked by tidal forces as they interpenetrated, they slowed down enough to be gravitationally bound within them. Others are "naked," existing alone in deep space.

One primordial black hole, occupying the Kuiper Belt Object 112434 Shezbeth, has been recovered – see *The Shezbeth Expedition,* p. TS23, for details, and *Hawking Station*, p. 20, for its present location. The next nearest one is inside comet 2098 D2, an ice-and-rock body about 12 miles in diameter. 2098 D2 is in an eccentric orbit and is currently passing "relatively" close to the sun, at a distance of 1,100 AU.

The other five mini black holes detected to date are all in the Oort Cloud, 40,000+ AU away.

Oort Cloud Expeditions

China and the United States are both very interested in acquiring a mini black hole of their own. Only 2098 D2 is within practical range of optimized spacecraft built with current technology; reaching the next nearest target would take about 200 years.

Hawking Industries (in partnership with the ESA), China's MAST, and the Gypsy Angels Collective have all dispatched long-range fusion- or antimatter-powered deep space operations vehicles to rendezvous with the object and establish a research station. Most of these vessels have fueled-to-empty mass ratios of 10:1 or more, allowing them to reach round-trip velocities of 250-350 mps.

The expeditions are expected to reach 2098 D2 in 9-11 years. They and their masters are currently negotiating protocols for sharing their research, while planning for what might happen if cooperation breaks down. None of the explorers admit to being armed, but all likely are. The situation is complicated because the body in question is small enough that the Revised Outer Space Treaty actually allows it to be claimed.

NASA and USAGs have not yet launched a mission, due to bureaucratic infighting over its control. However, Nanodynamics is also working on getting the Starswarm project back to operational status, as it could reach either 2098 D2 or one of the farther primordial black holes. If it works, it could get there much faster, perhaps within a year, but technical issues, especially regarding braking the probes, remain to be resolved.

Gravitational Lensing and the Solaris Mission

In 2044, the European Space Agency and Vosper-Babbage launched *Solaris*, the first fusion drive spacecraft. Its mission was to voyage to the edge of the solar system and investigate the phenomena of gravitational lensing. At very distant locations some 550 AU from the sun, solar gravity bends and refocuses distant incoming light and other electromagnetic radiation, acting as a natural lens. At such solar foci, a relatively small optical or radio telescope can image the universe many orders of magnitude better than any conventional instrument. *Solaris* carried an array of optical and radio telescopes to take advantage of this phenomenon, in order to open a then-unrivaled window on the cosmos.

Solaris took 16 years to reach its destination, arriving in 2070. In the process, it journeyed well beyond the heliopause and sent back measurements of the interstellar medium – dust density, magnetic fields, and low-energy cosmic rays – providing invaluable data for later missions such as the Oort Cloud expeditions and Starswarm.

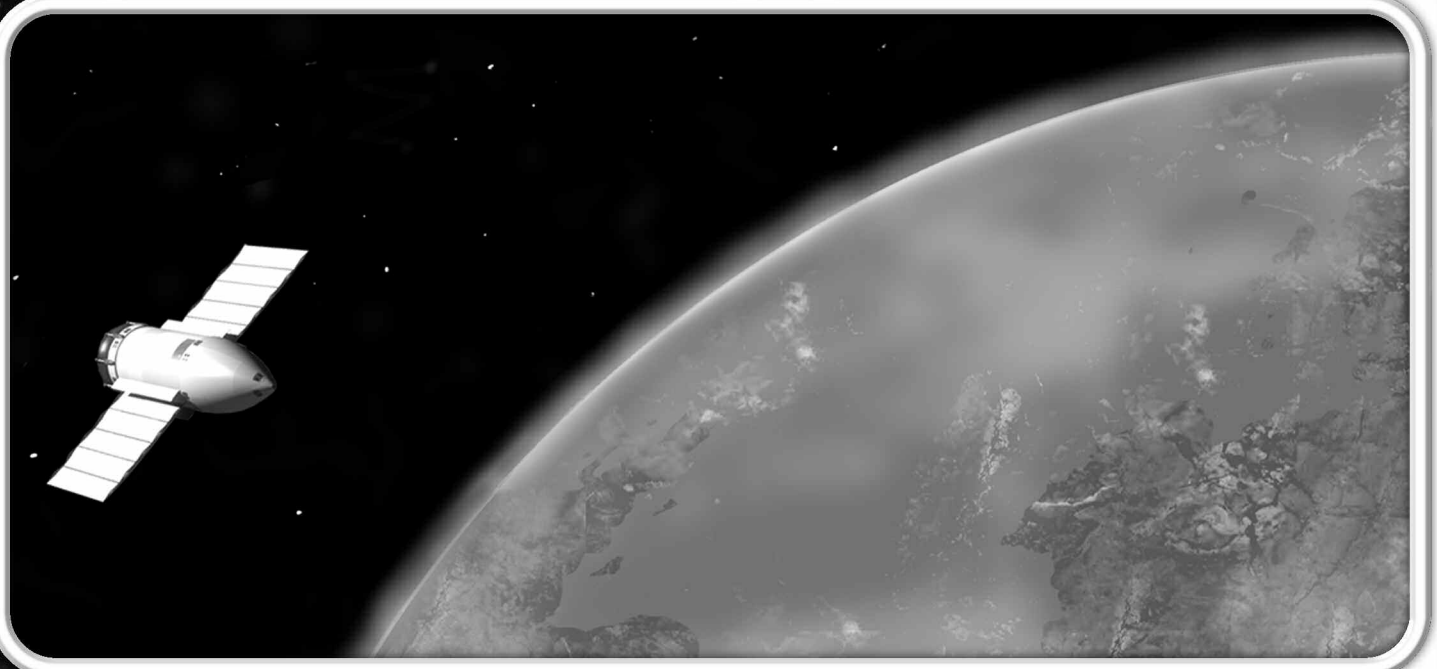
The *Solaris* spacecraft has sufficient fuel to operate for more than a century, and extensive self-servicing and self-repair capability through onboard cybershells and minifacs. It was originally controlled by LAI infomorphs, but these were upgraded to SAIs in 2082. In 2090, the first ghost – ESA astronomer Hans Larsen – was transmitted to Solaris, and currently the spacecraft has a mixed population of a half-dozen ghosts and SAIs, who dwell in lonely splendor above the solar system. *Solaris* – now effectively a space station – remains one of the solar system's most important observatories; its tasks include cosmological astronomy, SETI (Search for Extraterrestrial Life) research, and the direct imaging of extrasolar planets, brown dwarfs, and Oort Cloud bodies.

Interstellar Space

The outer fringe of our solar system's Oort cloud merges with the Oort cloud of Alpha Centauri. Very long-term plans have been made for robotic missions that will eventually cross the interstellar void in this fashion, using Oort cloud objects as stepping stones to the stars.

The exploration of other star systems is still being done primarily by telescopes, notably the very powerful Luna Farside and Sahasara Chaksu space telescope systems.

No habitable planets have been detected closer than 28 light years away – there are none at Alpha Centauri, for example. However, two relatively nearby objects are worthy of note.



Xiang 63

In order to generate the temperatures and pressures necessary for sustainable nuclear fusion reactions to occur, a star needs a mass at least 75-85 times that of Jupiter. A brown dwarf is an object that didn't quite make the grade, being anywhere from 10 to 80 Jupiter masses. It's far cooler than a star, but still warm enough to heat some of its satellites.

The name is a bit misleading; a brown dwarf actually appears red, not brown. The light from brown dwarfs is primarily in the near-infrared part of the spectrum. The surface temperature is about 1,300° F, rising to a few million degrees in the interior.

Xiang 63 is the closest brown dwarf that has been detected. It was discovered in 2017, and is 60,000 AU away from our sun (0.95 light years). It is orbited by 22 known bodies, some of them similar to the moons of Jupiter and Saturn. These bodies may have subsurface oceans thawed by Xiang 63's radiation and/or tidal heating, but no one knows for sure.

It was to have been the target for the Starswarm nanoprobe project. Once launched, the probes were expected to arrive by 2120. En route to their destination, they were to link up to form a gigantic magnetic sail and communications array, which would brake against the interstellar medium to decelerate the probes and then steer them into orbit.

61 Virginis

61 Virginis is a yellow-orange G5-6 V star similar to our own sun, but somewhat less bright. It has 96% of our sun's mass, 1.06 times its diameter, but only 80% of its luminosity. 61 Virginis is 27.8 light-years from our own solar system, in the southern part of the constellation Virgo. It's younger then the sun: 2.9 billion years old.

In 2013, it was discovered that 10 planets orbited 61 Virginis. Five of these planets are giants, none quite as large as Jupiter; two are airless; one has an exotic nitrogen-methane atmosphere; one is a desert world (but possibly a better terraforming candidate than Mars) . . . and one, the third planet out from its sun, appears habitable.

61 Virginis III (Virginia)

The third planet of 61 Virginis, "Virginia," orbits its star at a mean distance of 0.9 AU. Its year is 316 days long, and its day is 20 hours. Virginia is about 8,200 miles in diameter. Its atmosphere is oxygen-nitrogen, but substantially richer in carbon dioxide than that of Earth. Oceans cover 81% of its surface. The level of oxygen is a strong indicator that life is present, although its exact nature remains uncertain.

Recent observations with the new Sahasara Chaksu distributed array telescope show four main continents, with ground cover suggestive of vegetation. Large island-size patches also move through the oceans, sometimes combining, other times breaking up or vanishing. It is unknown exactly what they are – theories range from weed mats to giant animals, although it is generally believed that the system is too young to have highly developed animal life.

No signs of civilization have been observed, nor have electromagnetic signals suggesting intelligent life been detected.

5 ORGANIZATIONS

I'm in Manann'an Station, having lunch with Torsten Rademacher, the commander of the Europa Defense Front. I feel privileged: I'm the first journalist to speak to him since he fled Mars, accused of being one of the people behind the Negative Growth attack on the Space Elevator. Now he's here.

I ask what he thinks of stories in the mainstream preservationist press that accuse the EDF of themselves risking catastrophic biological contamination. I mean, if he blows up a submarine full of Avatar people, won't that cause contamination?

I haven't seen Rademacher angry before. "Do they think we're fools?" he asks. "They know nothing." He tells me how they've set up autonomous patrols around sea-bed smoker vents, using swimming microbots and armed cybershells to "neutralize" non-Europan organisms before they can spread. Their problem is the need to maintain a distant enough perimeter so that any combat action occurs in the cold and largely lifeless expanse of the deep ocean, rather than near the vent populations or surface. But he's convinced they've got a system. "Our whole operation is predicated on zero ecological damage," he says. "Eradication of the Duncanite cancer – and nothing more."

I'm skeptical, so Rademacher agrees to take me down into the working heart of his station. We board a crude high-speed elevator chamber that descends four miles through the thin ice to a submarine dock just above the shaft opening. He shows me the decontamination chamber and clean room by the sub dock. They sterilize every hunter-killer or swarm before sending it into the ocean. I have heard the term "surgical strike" used before, but never seen it carried forward with this sort of dedication.

In a large cavern adjacent to the airlock chamber, Rademacher introduces me to three more EDF members, working with tech-spider cybershells. They're servicing a modified Vostok cryobot, which looks like the offspring of a beach ball and an octopus. While they install a laser chemscanning array, I examine the cryobot's black polymer coating, which has a few scars and pockmarks on it. "Supercavitating slugs," one of the techs tells me. He's a blond guy who doesn't look more than 20, and I notice a dolphin tattoo on his shoulder. "Used to be a squid," he says. "I'm Jake."

"The Green Slime have imported their own Cereal Killers," says Ann-Marie, a petite young woman with a French accent. "Depleted uranium ammunition! What were they thinking?"

The Green Slime are what they call the Duncanites; Cereal Killers are Duncanite combat bioroids and security company mercs, from MAD and Ceres Asteroid Patrol.

Ann-Marie's unpacking olive-drab canisters from a crate marked with the logo of a major supplier of marine bioscanners, which these obviously aren't. They're marked with the MBC trefoil, and I recognize them immediately from countless war InVids I watched when I was little. Microbot hives, the old kind, U.S. military surplus from the Andes War.

I'm in their way, so Rademacher leads me aside, and seated on a pair of crates, we talk about his philosophy, why he feels that direct action is justified, even if it means taking human life. He tells me about his youth (he was born in Rostock, Germany), and his early experience with Blue Shadow. I learn he was part of the monkeywrench team that tried to stop the Octosap project at Elandra, but he became disillusioned with Blue Shadow's scruples. "Did you know that gene-engineered fish have utterly displaced 26 species in the last five years alone?" he asks. I ask him why he's here instead of on Earth.

Rademacher says he can do more good – in his eyes – here on Europa. He fears Earth's ecology is nearly past saving, that Mars may be a lost cause. But there's still a chance to save native life in the Deep Beyond, not just on Europa, but on Enceladus, Titan and elsewhere. I protest that no one has yet explored Enceladus' ocean, and that Titan doesn't even ***have*** *a native ecosystem – it's too cold for life to develop.*

"But it will," Rademacher says. "In a few billion years, when the sun swells into a red giant, the frozen ice will turn to water, and the tholin will come alive – if we haven't poisoned it." Angrily, he tells me about a big Titan Consortium vat spill that has yet to make the news, but which could be contaminating the surface of Saturn's moon. "We have no words for the crime that is being committed there," he tells me. "We're seeing the biochemical abortion of an entire planetary ecology before it has even had a chance."

As I'm digesting this statement, a bearded white guy about my age bounces into the room. "Torsten, we've got a hit," he says excitedly. "We're engaging – six targets on the scope, four klicks off Little Chili Pepper Five!"

"Do we have full coverage there?" Rademacher asks, all business.

"Five by five," the man says. "We're engaging now."

"Give me feed," Rademacher says, and snaps down his wearable again. He turns to me. "We're engaging the Green Slime. You may want to see this. What we're up against."

A few minutes later, I've got a virtuality helmet, and am getting imagery from a cryobot. A "target" has been encountered by the EDF's microbot patrols. I think it's being scanned by imaging ladar. There's no light or sound – but the ladar gives me range and shows a shape – then two more. Two of them, man-size.

We're close now, and I can actually see them: bioluminescent things, shaped like mermaids, but male and female. Suddenly the swimmers start to thrash. The devourer cyberswarms have them and they're eating them alive. The water fills with blood, but through the ladar we can still see it happening. The "Europans" are coming apart, like an anatomy lesson, or an autopsy, except they're still alive . . . for a few seconds, anyway. Then . . . "That's a kill," Ann-Marie says, and makes a V-sign. The cryobot ladar is performing a careful chemscan all this time – sweeping the water so that the cyberswarms can home in and pick off every last globule of blood, every gobbet and molecule of flesh . . . none of it must reach the ocean floor. None of it does.

A surgical strike. Everyone is cheering. I try not to throw up.

– Copernicus Jones, ***War in Europa***

This chapter details some of the societies, governments, corporations, armed forces, criminals, and other groups active in the Deep Beyond.

Green technology means we do not live in cans but adapt our plants and our animals and ourselves to live wild in the universe as we find it . . .
– Freeman Dyson

Duncanite Society

"Yes, Maya, an armed society is a polite society . . . if everyone's an adult. But all too often, the guns get into the hands of teenagers, and then morality is in the hands of those who don't yet understand mortality. You see that in Bujumbura, in Luanda, in Tegucigalpa. Anarchy is not chaos!"

"Agreed. But I refuse to cure symptoms when I can treat a disease. Guns don't kill societies. Immaturity does. So ***adolescence*** *is a meme we can't afford."*

– The Devil's Driftwork: Conversations with Maya Payne (Ceres Archives, 2082)

Today, the Duncanites represent the most widely dispersed human culture in history. Their major population center is at Silas Duncan Station on Ceres, but they've also settled some Jovian moons and about 40 other asteroids. Most of the latter habitats are independently-owned "freeholds." Their total population is about 50,000 sapient beings, an even mix of Tennin parahumans, microgravity-adapted bioroids, and sapient AIs.

The Duncanites have little in the way of military power or central organization, but they've genetically engineered themselves for life in the asteroid belt and other microgravity environments, and they've had half a century to work at it. They have no central and few local government bodies – the majority of Duncanite stations are anarcho-capitalist societies. The closest thing to a government is Avatar Klusterkorp, which as the major Duncanite corporation wields considerable power, but no legal authority.

The Duncanite population originally settled on Ceres, in Silas Duncan Station (p. 13). While there was plenty of room on Ceres for future expansion, the Duncanite libertarian ethos encouraged personal property ownership, independence, and self-reliance, which meant that not everyone was content to live on the same asteroid. The majority of Duncanites, including most of those who still live on Ceres, are called "Green Duncanites," due to their loyalty to the pantropic "green system" ideology of the original Ares Crew. The main splinter factions are the Red Duncanites (see *Leading Trojans,* p. 30, and *Trojan Mafia,* p. 106) and the Gypsy Angels (see *Gypsy Angels*, p. 88).

Most Duncanites live in extended families which trace their descent to original founding members ("genarchs") but there is no formal "clan" structure – just webs of influence that are occasionally cemented by liaisons or marriage, and the bearing of children. About 40% of their children are natural-born; the rest are grown in exo-wombs. There's no stigma either way. There is more work than there are people to handle it.

Duncanite society is a young society, with a very high proportion of children. This might elsewhere be a recipe for disaster, but the Duncanites use Fifth Wave educational techniques (such as implanted low-sapient kinder-comps) to ensure that its youth are highly productive at an early age. This, more than anything else, sets Duncanites apart from Earth. Since the 2060s, their children have had to grow up fast. For most Duncanites, childhood ends at about age 10-12 (and this is dropping!), as the children enter the workforce as apprentices. Within three or four years, they've usually found lucrative jobs, although they may bounce around a bit first. As soon as a person can support himself, he's considered an adult.

Duncanite culture is free of much of the generational stress that afflicts other Fifth Wave societies. Parents don't just *expect* their children to be better and smarter then they are; they work toward this through genetic engineering, and use cybernetics and biomodification to ensure they can keep up with their offspring. Each generation is expected to improve on the next. Duncanite humorists joke that in 50 years, a babe-in-the-womb will be Avatar's CEO.

There are some rebels in Duncanite society, but they tend to be found among a minority of the elderly population (who fear what the Duncanites are becoming) rather than among the youth. "Restless Age" tends to refer to Duncanites who've been left behind (genetically speaking) and choose to leave Silas Duncan Station, generally retiring to asteroid freeholds where they can set their own pace.

Most human-descended Duncanites came from American, Japanese, Chinese, and Russian ethnic backgrounds, reflecting the makeup of the Ares Conspiracy exiles that fled from Mars. At present,

Silas Duncan and the Falkland Islands

"Actually, I didn't think they'd last six months."
– Captain Latisha Fox, USAF

The name "Silas Duncan Station" was picked by Captain Latisha Fox, the USAF officer who exceeded her own government's orders to help settle the Ares Crew on Ceres.

Fox named the station after an incident that took place at the Falkland Islands. In 1823, the government of Argentina occupied the Falklands, claiming their right of succession to former Spanish territories. Over the next six years, they attempted to impose order on the rowdy collection of ex-convicts, sheep farmers, sealers, and whalers who operated there. In 1829, they arrested the crew of a U.S. sealing ship that was hunting with proper permits, and seized their seal skins.

The U.S. government took offense, and dispatched the corvette USS *Lexington* to reclaim the property. Once it arrived at the Falklands, its captain, Silas Duncan, exceeded his orders: he sacked the port, arrested anyone who got in his way, blew up the Argentine defenses, and declared the island "free of all government," sailing off leaving chaos in his wake.

The inhabitants seemed to have approved – when Argentina sent a replacement governor, he was murdered by the citizens, and the island resumed its state of anarchy. The rebels fought off further attempts by Argentina to impose order, but were ultimately suppressed when British warships arrived in 1833 to reassert an old claim.

Fox is said to have picked the name because the captain believed she was leaving a similar mess behind her. At Maya Payne's urging, the Duncanites embraced the choice.

about 30% of the Duncanite sapient population are various bioroids, 40% are Tennin or proto-Tennin parahumans, and 20% are sapient Ais. The rest are a mix of exotic parahumans, original human settlers, and recent immigrants. The Duncanites are open to immigration, although newcomers unwilling to conform to their social norms rarely last long.

The Ares Crew

If the Duncanites have a social "elite," it's the Ares Crew, the popular nickname for the original 57 fugitives who fled from Mars to Ceres aboard the *Michael Collins* and founded Silas Duncan Station.

There are 29 Ares Crew known to be alive, 12 missing but not proven dead, and 16 confirmed dead. Ares crew were all baseline or genefixed humans, mostly born on Earth between 1990 and 2030. Among them was a small group of Martian-born children and teens. The living survivors have embraced biomodification to ensure continued long life and microgravity adaptation, but several of them are in poor health, due to bone and muscle deterioration and radiation damage before microgravity-adaptation nanomods were introduced. (They should be created using the Floater template, p. TS115.)

The majority of the Ares Crew live in Duncanite asteroid habitats in the Main Belt and the Trojan Points. Most are Very Wealthy or better; many own their own asteroid freeholds, sizable chunks of Avatar Klusterkorp or Ceres Mutual, or smaller companies like Mutual Assured Defense or Kirkwood Gap. A few of them are less well off, but none of those still in the public eye live in poverty – they can earn money by trading on their reputation, selling InVid lectures, etc., to customers elsewhere in the system.

Law and Order

Duncanites have no formal constitution or laws other than the Fundamental Contract, which is accepted as a basic statement of principles by Duncanite courts.

Sound like total chaos? Not really. Private "free courts" (p. 86) and security companies (p. 93) practice a free market version of law and order, maintained through interlocking agreements between business associations, insurance brokers, and individuals. Duncanites treat contracts as sacred, and those who break them risk loss of reputation as well as legal sanctions, which are effective because a majority of the population accepts them – just like most laws on Earth, really. The key difference is that every adult individual on a Duncanite station gets to choose which police or court will represent him. He may be limited by his own resources, but that's not much different from someone who grows up poor in a bad neighborhood on Earth, and can't afford to move. True, the rich get more protection – but they also have more assets to protect.

All this can function because Silas Duncan Station's population is no larger than a small town, and most other Duncanite facilities are even more intimate. Moreover, the population is well off, well educated, has plenty of work to do if they want it, and has the option to get out of town if they don't like their neighbors. Or they can sue.

The Fundamental Contract

This document, created by the Ares Crew in 2044, spells out certain rights that all free persons possess on Duncanite stations and vessels. A "free person" is an adult human, genetic upgrade human, parahuman, or ghost.

Summarized, it amounts to:

Right to Property: A person's property may not be moved, destroyed, occupied, damaged, or altered without his informed consent. A person's body is considered his own property, and so is his work.

Right to Self-Defense: A person may violate another's right to property in defense of his own property. In so doing, that person should not use more force than is justified by the perceived threat, and must make reasonable effort commensurate with the situation to ensure this perception is accurate.

Right to Common Defense: A person may exercise the right of self-defense on behalf of another person or persons, with their permission, or if he has reasonable grounds to believe it would be granted were that person able to do so.

Right to Fair Contract: A person may transfer present or future property rights or damages to another person, on a temporary, partial, permanent, or provisional basis, provided both come to a mutual agreement without fraud. A contract secured by a credible threat to violate a person's other fundamental rights is null and void.

Children are more complex; basically they're considered persons whose rights can be restricted by their parents or guardians in their own best interests, and precedent exists for them to sue for independence if they can demonstrate that this no longer applies. There is a move among sapients-rights advocates to extend this to bioroids and perhaps to sapient AIs, but so far only the former has received any support in Duncanite courts.

Tyranny is always better organized than freedom.
– Charles Peguy

All Duncanite law is civil law in the sense that there is no "state" to represent individuals in criminal cases. Lawsuits take place before a judge whom both parties have agreed on. The judge will hear the case and award damages based on the severity of the loss suffered, to be assessed against the property of the violator retroactive to the period of the violation, unless the court deems it overridden or mitigated by the rights to self or common defense. There's a fair bit of precedent and case law, especially in more complicated civil situations, but by and large cases are resolved by argument and arbitration.

> One has to multiply thoughts to the point where there aren't enough policemen to control them.
> – Stanislaw Jerzey Lec

Duncanite legal tradition is one of frontier justice. In general, most courts-for-hire consist of one or more judges and/or jurists who listen to the evidence presented by both sides, sometimes assisted by paid advocates and security company investigators, and then make and publish a decision, accompanied by a specific statement of culpability.

A court will normally impose monetary damages or restitution (such as a return of stolen property plus a fee for its unauthorized use), but in extreme situations, such as torture or murder, it may rule that the subject forfeits all property rights, including those to his own body, to the victim or his heirs (see the Silas Duncan Station vignette, p. 13).

Some Duncanite judges offer judicial contracts with "limited-penalty" guarantees. These promise not to impose penalties beyond a certain level for certain kinds of crimes – e.g., they may specify the judge will not impose an effective death sentence (confiscation of all assets, including the subject's body) for a crime that does not involve a threat to life or freedom, such as actual or attempted murder, rape, kidnapping, and so on. There is some conflict between "absolutist" judges, who believe such case law threatens to convert the Ceres Bar Association into a de-facto statist judiciary, and "proportionists," who believe that limited-penalty contracts of this short should be a standard for contracts between judges, security companies, and their subscribers.

Individuals often have *tort insurance.* In return for a regular payment, usually about 1% of their income, their insurance company will pay for any legal damages (often up to a specified ceiling). A Duncanite with an unblemished reputation can easily get tort insurance. Rates go up if someone has judgments against them or performs activities the company judges likely to provoke lawsuits, such as building a nuclear reactor downtown, or getting into bar fights. Tort insurance may also be provided by an employer for his employees. See *Ceres Bar Association*, p. 86, for more details and examples.

When dealing with citizens of other governments, Duncanites rely on business associations with friendly corporations (e.g, Xiao Chu for the Gypsy Angels, or Biotech Euphrates for Avatar) – and in extreme cases, the Trojan Mafia's criminal connections – to dissuade foreigners from pirating their goods or voiding contracts.

Sapients Rights

Duncanites tend to biochauvinism. They believe in human freedom, but are ambivalent toward nonhumans, especially those that were deliberately created as servants. The *Pan-Sapient Rights Table* on p. TS127 shows the Duncanite position.

Bioroids are viewed more as "living machines" than people, but this view is gradually changing. Most are indentured for a period of several years after they're created in Green Duncanite societies – but among Green Duncanites and Gypsy Angels, this is fairly similar to the apprenticeship programs that ordinary Duncanite kids undergo. After that, a bioroid is free to choose its own occupation. Red Duncanites have a much less liberal outlook – indentured bioroids are treated as second-class citizens and the property of whoever created them, and may be emancipated (or not) according to their whim.

Ghosts are treated as citizens, although they're quite rare. The Fundamental Contract specifically referred to sapient uploads, as some of the founding Duncanites saw this technology on the horizon. Even so, there's a strain of biochauvinism among many Green Duncanites; they look down on ghosts as less than human.

Infomorphs other than ghosts are things, not people. There were no SAIs when the Duncanites wrote the Fundamental Contract. A few of the founders were suspicious of machine intelligence, and specifically excluded sapient AI, which at that time was limited to LAIs. There is an abolitionist sapients-rights faction among the Duncanites that does treat SAIs as people, but most Duncanites don't agree. However, abuse of AIs is considered to be in poor taste. Rogue AIs are treated as a threat to human life and generally exterminated, while xoxes are considered the property of the original person – it's up to him to decide what their fate should be.

Duncanite Security Companies

Law enforcement in Duncanite communities is in the hands of private enterprise. "Security companies" not only serve as bodyguards and security guards, but

also function as private investigators and police. War between rival security companies is avoided because 90% of the companies belong to the Aegis Group, a professional association that negotiates standing agreements and arbitrates between its members.

Almost all Green and Red Duncanite citizens protect themselves and their property by signing "protection policies" with a security company. In many cases, this protection is included with insurance policies, and individuals can be protected by the security policies of their landlords or employers. A basic "reactive" contract is relatively inexpensive (typically about 1% of the protected person's net income per year, but more for individuals who are obviously greater security risks). In exchange for this coverage, the company agrees to investigate and recover damages (or seek retribution) in the event harm is done to its client and to respond if he reports a threat.

Most security (and tort insurance contracts, p. 84) also insert a clause that disclaims responsibility for any trouble a client gets into for a "pre-existing condition" (such a as known enemy) that the client neglected to tell the company about beforehand.

It's possible for an uninsured person to hire a company to seek restitution *after* a crime is committed, but the price will be higher (equivalent to hiring private detectives and/or mercenaries). Finally, individuals or groups who feel a reactive contract isn't good enough can hire round-the-clock protection in the form of security guards or bodyguards, at an hourly or daily rate.

Visitors to a Duncanite habitat are advised to sign with an Aegis Group-member company for their stay . . . preferably before leaving their vessel. While most stations are fairly safe, individuals unprotected by a security company risk being targeted by criminals if their lack of protection is known, especially in the Trojans. They're also vulnerable to vigilante action if they are suspected or falsely accused of committing a crime.

One can escape Duncanite legal judgments by fleeing to an area within the jurisdiction of another state. Most Duncanite security companies have clauses that limit their liability outside the Deep Beyond, although a few independents may be willing to hire out to kidnap or otherwise exact retribution on someone who goes beyond the reach of the mainstream firms.

The Aegis Group

The Aegis Group is an association of Duncanite security agencies that have agreed to abide by standard contractual terms and follow a specific code of conduct. 90% of Duncanite security agencies belong to the Aegis Group. Aegis is primarily concerned with establishing protocols regarding the arrest and detention of suspects, to prevent its member organizations from killing each other off. Here's the gist of the various contractual obligations and exceptions in contracts between clients and Aegis group security companies:

1. If a company's client complains a person has violated his fundamental rights or reneged on a contract, the company's agents agree to properly investigate that claim before taking any action, under the right to mutual defense.

2. If a suspect is determined to be a client of another Aegis Group company, and isn't currently engaging in behavior immediately detrimental to their own client, the security company will negotiate with the other company to serve a notice to appear in court, rather than attempting to confront or arrest him. However, the company's agents may keep him under surveillance to ensure that he does not pose a threat to the client, flee the area, dispose of misappropriated property, etc.

3. If a suspect is *not* a client of an Aegis Group company, he will be served with a notice to appear in a court, or arrested and then served, depending on the situation and the perceived risk (of escape or harming the client) involved. The minimum force is to be used on a suspect to achieve these goals, consistent with any imminent threat the suspect poses to the client's property and the security agent's own right of personal defense.

The company may provide any other services as agreed in individual contracts between itself and the client, provided they don't violate the above protocols.

In exchange for these protection and enforcement services, the client agrees that:

1. He will not knowingly make false claims regarding the origin, nature or extent of any reported violation of the fundamental compact, or with breaking a contract.

2. Upon learning that he is being charged, he will contact his own security company promptly, and determine if the charge originated from an Aegis Group company. If so, he will remain in contact with his own security company until arbitration can be arranged.

3. If his own company determines that a charge is justified, he agrees to arrange and participate in the court case, in a venue acceptable to all parties involved, or failing that, one selected at random by the Aegis Group from available Ceres Bar Association courts.

4. That his contracts with any and all Aegis Group members will be terminated immediately should the above clauses be deliberately violated.

A few security companies are not members of Aegis. Some have been expelled or blackballed for breaking Aegis's code of conduct; others either prefer to work outside the organization, or can't afford the dues. Most independents are careful not to make arrests that would bring them into conflict with Aegis Group members. They work instead as bodyguards or security guards. Those that work as private investigators usually do so as subcontractors for various Aegis member companies.

Security companies and insurance firms also provide or subcontract out various emergency services (paramedics, fire fighters, rescue workers, etc.).

Security Agencies in Action

Puck Gatham, a resident of Silas Duncan Station, is angry that Jim Tokolosh has refused to hire his son Nicolai, who was apprenticed at Tokolosh's company for two years. Gatham confronts Tokolosh at the Chernoe Zhania, a main dig restaurant.

When Tokolosh says that Gatham's boy is a sloppy worker, Gatham loses his temper, draws a knife and stabs Tokolosh, then bounces off before anyone can stop him. A few patrons give chase, and some draw pistols, but they're not sure who's in the right, and in the confusion Gatham dives through the kitchen, upsetting a huge pot of curry to cover his escape. Others intervene to help stop the bleeding. Tokolosh has fainted, but Mirai, his virtual interface infomorph, calls a paramedic and also Mutual Assured Defense, the security company Tokolosh has contracted with.

A few minutes later, a paramedic and two MAD contract enforcers arrive. As the paramedic treats Tokolosh (whose medical care is covered by his insurance contract), Mirai and the witnesses explain what happened to the MAD agents. As per their contract, the agents are obliged to charge Gatham with violating their client's property: his own body. About the same time, enforcers from Ceres Asteroid Patrol (which has the contract to protect the restaurant) also show up; the restaurant owner has a claim against Gatham for inflicting damage against his property (the restaurant). All the enforcers are Aegis Group companies, and recognize each other's agents through augmented reality.

The witnesses and the VI all upload pictures of Gatham. The two security agencies quickly check their database and discover that Puck Gatham is a client of the Doberman Defenders, which, fortunately, is another Aegis company. Their offices contact the office of Doberman and relay the evidence they have. Doberman agrees that it seems their client has indeed committed property violations. They agree to cooperate. The companies have their legal LAIs quickly settle on a reasonable bond to ask for, based on precedent from similar aggravated assault and property damage cases.

The three security companies attempt to contact Gatham, but he's not answering. In fact, he's turned off all outside web connections and is sitting, half-drunk, in his bedroom, shocked at what he did, while his son tries to get him to come out.

CAP and MAD send armed officers – a human and a bioroid – to Gatham's apartment, while Doberman tries to contact friends and relatives to help them resolve the situation peacefully. They are able to reach Gatham's son and get him to talk to his dad. He was just about to call Doberman Defenders; they tell him that the MAD and CAP agents have a clear case and he should tell his father to accept arbitration or forfeit their protection. Meanwhile, MAD have reinforced their teams "just in case," with a few armed bioroids to cover the area. Other local residents have contacted their security firms, who have been informed by MAD (which covers most of them) that everything's proceeding under control, but maybe they should stay under cover for the moment.

Gatham's son tells his dad he'll stand with him, but he should take a sober-up pill first. After Puck Gatham does so, he realizes what's happened and what he's done, and walks out of his apartment with his hands up. He is then served by MAD and CAP officers, who charge him with violating the property rights of both Jim Tokolosh and the Cherno Zhandia's owner. As representatives of the aggrieved parties, they ask him to pay bond or submit to lockup. His tort insurance would normally cover the bond, but Gatham chooses a lockup. CAP defers to MAD (which owns its own lockup) and allow the latter's officers to take him into custody.

Meanwhile, Doberman Defenders, Gatham's infomorph, MAD, and CAP are all negotiating on a venue for the trial. After some wrangling, they settle on the court of Judge Pfil, who is "cheap but fair" and has an opening for a case a week from now.

Immigration and Customs

Silas Duncan Station and the other Duncanite stations have no formal law. However spaceports and airlocks are private property, and security companies may enforce "safety" restrictions to prevent people importing heavy weapons, cybershell armies, etc.

Duncanites tend to be tolerant of individuals wanted for "victimless" crimes (like smuggling) or activism against "statist" regimes, but don't like the idea of their stations becoming havens for fugitive criminals or activists supporting antithetical memes.

Duncanite security and insurance companies will publicize the identity of known criminals as part of their contractual duty to warn their subscribers. They can take no overt action to expel a notorious visitor, but he may still find himself hounded by media, shadowed by local security, and shunned by local businesses, who can refuse him food, shelter, or other commerce. That said, Duncanites value privacy, and will not ask too many questions of a stranger who does not look or act suspicious. Visitors who respect local memes are unlikely to attract attention.

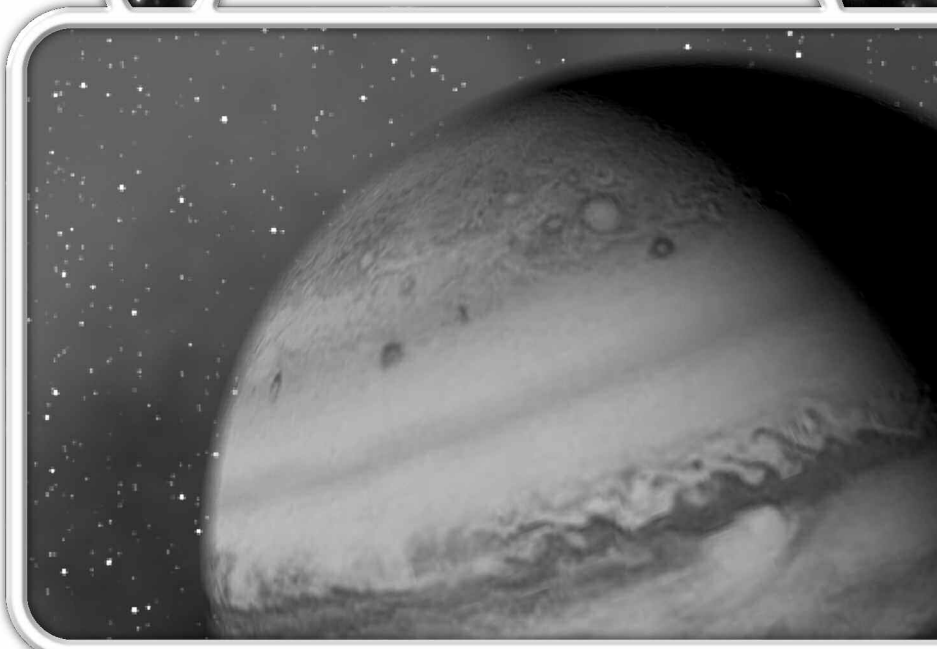
Free Courts and the Ceres Bar Association

The Ceres Bar Association is an organization of freelance courts scattered through Duncanite space; their key feature is that they accept the Fundamental Contract (p. 83) as a basis of legal jurisprudence. Among the Duncanites, a court has no authority unless both parties have made a prior contract with it to accept its judgment. However, most Duncanites have Security Company contracts that require

them to abide by a court's decision, or face a loss of protection and cancellation of their tort insurance.

Judges are free to make whatever decisions they like. However, a judge who acts in a fashion contrary to the principles of the Ceres Bar Association will be booted out of the association. Grounds for expulsion include taking bribes, violating a contract, or acting against the Fundamental Contract. This requires a petition from a simple majority of active members. A committee of senior members will also hear grievances. They avoid second-guessing most judgments, but may recommend that a judge make restitution (or face a possible vote on expulsion) if they believe a serious injustice took place.

A judge may also be blackballed by the Aegis Group, should a majority of security companies disapprove of him. This will result in him hearing very few cases.



Technology

Duncanite technology is a mix of Fourth and Fifth Wave. Duncanites generally don't have the latest in sapient artificial intelligence, cybershells, or microbots, but they do have advanced nano-biotechnology, and they're also good habitat engineers. The Duncanites are leaders in biotechnology, particularly pantropy (the adaptation of life forms to extraterrestrial environments), bioroid design, and intelligence augmentation.

The most popular Green Duncanite biotech product is the Tennin gene sequence. The original designs are widely available, but Avatar Klusterkorp continues to develop new variations of space-adapted parahumans and bioroids. Duncanite pantropics are not limited to space-based transhumanity. Tennin gene sequences have been developed for animals as well, creating many dozens of species capable of functioning in microgravity.

Red Duncanites are also known for their expertise in certain types of software, especially cryptography and mind emulations.

Judge Pfil Tries a Case

Judge Pfil has agreed to preside over the case of Jim Tokolosh and Kyle Yarrow (the owner of the restaurant) vs. Puck Gatham. All the security agencies have, as per their contracts with the personages involved, taken the time to gather and record witness testimony; the witnesses themselves aren't obliged to appear in court. This is turned over to Judge Pfil, who takes a few days to mull over the evidence, then opens the trial. It's a pretty clear case, so on advice from Doberman Defenders, Gatham has decided not to counter-sue. The "trial" consists of the parties involved arguing over compensation.

Puck Gatham concentrates on explaining that Tokolosh provoked him by insulting his son. However, during the trial he loses control and, despite his own advocate's admonishments, shouts at and threatens Tokolosh again. Judge Pfil isn't impressed – in fact, she thinks Gatham may be a danger to Tokolosh if he's left to wander about loose.

However, she has no authority to issue a restraining order or imprison Tokolosh. What she does rule is that Puck Gatham must pay a $51,000 fine: $5,000 court costs (a set fee agreed upon before the court went into session), a further $2,000 to the owner of the restaurant for damages and consequent loss of business during the incident and subsequent investigation, and $44,000 to Tokolosh. She explains that the judgment to Tokolosh amounts to $14,000 for lost income and medical bills while he recovered, and a further $30,000 to cover his hiring extra security just in case Puck loses control again.

During the trial, it comes out why Gatham chose the lockup rather than bail: Last month Gatham lost control and punched out his girlfriend, and after paying the court costs and her medical fees, his insurance company reduced his tort coverage. Now Gatham has a week to raise $51,000. If he doesn't, the judge authorizes MAD and CAP to seize equivalent property – up to and including Gatham himself. Since Doberman Defenders and other Aegis Group security companies won't accept or enforce contracts to protect property that's been seized under proper judicial order, Gatham is in deep trouble.

Gypsy Angels Collective

The Gypsy Angels Collective is a nanarchist (p. TS90) society based around a few dozen collectively-run spacecraft. They operate freehauler freighters (some carved out of ice asteroids) that tie together many of the dispersed asteroid stations, and have their own habitats in the outer system.

Duncanite Bazaars

It's a tradition that when Gypsy Angel spacecraft arrive in port, they'll set up a "bazaar" to unload goods of various sorts – especially living products of the bio-labs. Since biological products are not the sort of things one makes in an ordinary minifac, these are often the only chance for a small asteroid station to pick up items like skull cats, sentient snacks, microgravity pleasure bioroids, and so on. They're also a good chance to arrange passage, small package shipments, and so on . . . and just to meet Duncanites. The location can be anyplace convenient: a marketplace (as on Titan) if a permanent guest-worker community exists, a store front, or, most often, a collection of rented warehouses.

The Gypsy Angels were Duncanites who chose to compromise with the Chinese government during the 2060s and 2070s, accepting an offer of employment as "comet herders," nudging icy Centaurs and Kuiper Belt Objects into courses that took them to Mars. At that time, SAI systems were still experimental, bioroids were unavailable, and light-lag teleoperation was unreliable over the vast distances between Mars and the Kuiper Belt. Rust China needed human crews to handle the comet herder operations – people who wouldn't mind being out in the Deep Beyond for several years at a stretch.

However, their leaders – among them Nicole Zhang, Pierre Joseph Fox, and Vitaly Teraneko – had their own grander vision. The Gypsy Angel comet herders did not, at first, own the fusion torches and other equipment they installed. They were hired hands, working under the direction of Xiao Chu or MAST supervisors, eking out lean times with other zero-gee construction work, such as building Cassini Station near Saturn. Part of their wages were taken in kind, as each comet they brought in to Mars gave them an increased share in ownership of the fusion engines and other equipment they used to do it. They also took the first steps toward the creation of Topsy Station (p. 76).

In 2085, their plans nearly met disaster when two ships became embroiled in a tragic confrontation with Titan Corporation and the U.S. military. However, one of the vessels escaped, carrying off some 250 tons of stolen He-3, then worth nearly a billion dollars on the gray market. Using profits squirreled away from a decade of work and Zhang's sale of the fusion fuel to Rust China, the Gypsy Angels were able to purchase enough equipment and resources – in particular, advanced cybershells and biotechnology – to ensure their survival as a viable deep space culture.

The Gypsy Angel vision is of a holographic culture, in which each spacecraft carries the pattern of the entire society. Although their vessels are scattered across the solar system, they communicate regularly via laser, often exchanging copies of infomorphs as well as data. Most Gypsy Angels are "freehaulers" (p. 92), trading throughout the Deep Beyond, or venturing into the inner system as far as Mars. Their ice ships – made from frozen volatiles hollowed out and fitted with various second-hand and new systems – aren't especially fast, but they do have good cargo capacities, and ask very few questions. Their rates are also reasonable. Gypsy Angels aren't really interested in where they go: most are happy as long as they can make a small profit and continue their way of life. What profit is made often goes toward expansion of the Gypsy Angel space habitats like Topsy and Yggdrasil Station (p. 70).

A few Gypsy Angel craft have a reputation on Earth and Saturn as pirates and smugglers, although they are rivals rather than allies of the Red Duncanites who operate Trojan Horse (p. 108). This goes back to their days as the "Pirates of Hyperion" in the 2080s, and makes them distrusted at many U.S. stations. Their reputation is more positive in Rust China, where they were praised as heroes for bringing He-3 fuel to Mars despite the U.S. embargo of 2085, and where their communal ethos (ships are run as communes and officers are elected by their crews) played well to nostalgic PRC officials.

The Rust China government still hires Gypsy Angel crews to perform comet herding operations, as it's cheaper than sending out their own crews. Gypsy Angels also study the properties of Centaur, Kuiper Belt, and Oort Cloud bodies. This is a matter of survival, since it's their home, but these practical observations are also valued by planetologists, and the Collective can often make extra money selling research data.

See *Freehaulers*, p. 92, for relations between the Gypsy Angels and other interplanetary carriers.

Shadows and Shadow-Swap

It's common for a Gypsy Angel to create a shadow of himself to act as an additional "off-shift" crew member. Shadows are also used as ambassadors in intership meetings. The practice of "shadow-swap" originated in trysts between Gypsy Angels from different spacecraft and has now grown into an institution. Close friends and lovers exchange low-sapient shadows of each other, to be run on their own personal virtual interfaces, as a sign of trust and intimacy.

Corporations

Companies in the Deep Beyond often exercise more influence than governments.

Avatar Klusterkorp

Avatar Klusterkorp is a genetic engineering company specializing in the pantropy: the design of organisms, from bacteria to human beings, for extraterrestrial environments. The company is also an innovator in intelligence-enhancing nanodrugs and nootropic drinks. Avatar's brand name is golden among transhumanists, some of whom refuse to drink anything else. Avatar also manufactures bioroids and bioshells, and is known for its custom models optimized for space operations.

Avatar was founded by a group of ex-Ares Conspiracy genetic engineers led by Maya Payne and Shiori Katsuki, and largely bankrolled using royalties received for the "calcium hack" genetic sequence that they sold to Biotech Euphrates and Xiao Chu. Payne, now the grande dame of Duncanite society, still chairs Avatar's board.

Avatar is the largest Duncanite company, and exerts enormous influence on Silas Duncan Station. It directly employs 1,100 people, and is often synonymous with "Green Duncanite."

The "Klusterkorp" in Avatar's name refers to several smaller companies that are associated with it as semi-independent subsidiaries, such as Ceres Hydro (agriculture) and Acceleration Group Europa (biotechnology support for Europa colonization).

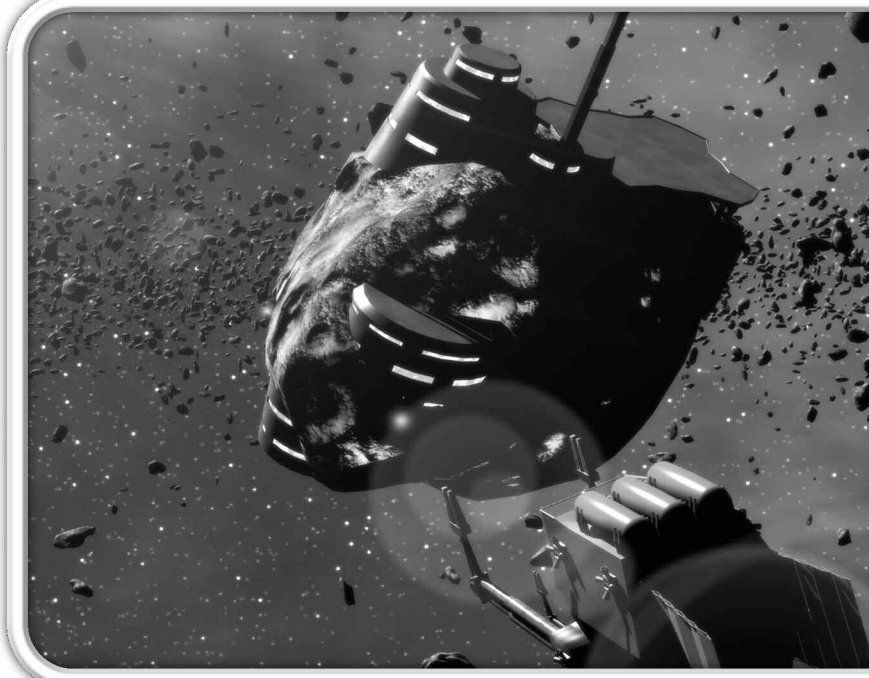
Biotech Euphrates

This transnational (see p. TS94) does not have any facilities in the Main Belt, but its Luna City lab maintains close contact with researchers at Avatar Klusterkorp. The companies have been known to work together on certain projects. In particular, Biotech Euphrates has sometimes been a "silent partner" for Avatar's own research and development, funding controversial lines of research it does not presently wish to be directly associated with, but which may bear commercial fruit in the future. In turn, Biotech Euphrates has licensed several dozen Avatar patents and turned them into lucrative commercial products, paying the smaller company royalties.

Biotech Euphrates does have an office and research laboratory on Titan. This facility, located at Huygens City, is actively involved in development of cryogenic bacteria and neogenesis products. It also provides support for Biotech Euphrates parahumans living on Titan.

Columbia Aerospace

This aerospace giant (see p. TS94) is one of the major employers on Saturn's moons. Columbia Aerospace provides technical support for the USAF 30th Space Wing at Titan AFB and Cassini AFB, and for the Titan Consortium's fleet of CA-designed He-3 mining vessels and shuttles. Much of the maintenance work is done by cybershells, but 600 humans and SAIs supervise thousands of non-sapient and low-sapient machines.



Most R&D is conducted at its headquarters in Columbia Station in Earth orbit, but the Titan office is responsible for developing upgrades to the He-3 mining equipment. Columbia Aerospace is also using its Rhea spaceyard and the USAF's Hyperion test range for its experimental (and highly dangerous) stabilized metallic hydrogen rocket program (p. 153), at least until it gets the "stable" part working properly. A further 300 humans and SAIs work on Rhea in R&D-related projects.

Most of the human and parahuman workforce at Titan and Rhea are American citizens, usually systems managers and aerospace engineers on contracts that keep them on Titan for 2-4 years at a stretch. Some go home to Earth or Mars afterwards, but others stay, lured by Titan Consortium benefits that reward permanent settlement.

Those working for the USAF projects will usually have security clearances. The head of operations in the Deep Beyond is Regional Vice President (Saturn Division) Jasmin Diaz, who works out of her office at Huygens City. Diaz, 62, is an engineer-turned-manager, and still takes a hands-on approach to her projects.

Ceres Mutual

The largest and best-capitalized Duncanite bank, insurance, and investment firm. Ceres Mutual is used by most Duncanite businesses and many asteroid homesteaders for credit transactions and insurance policies, including tort insurance (p. 84). The company's officers are located on Silas Duncan Station. The president of Ceres Mutual is Felix Bishop (Ares Crew); most senior offices in the company are held by the Bishop family.

Exogenesis

Exogenesis was the extraterrestrial research division of space development giant System Technologies, AG until its purchase by Nanodynamics in 2099 (see p. TS94). It is famous as the company that created the first ghost mind emulations. Its research and development center, Exogenesis Station, is located inside Vesta in the Main Belt. See *Exogenesis Station,* p. 17, for details of the company's divisions and ongoing projects.

For several years in the 2080s and 2090s, Exogenesis had a close relationship with the European Space Agency, providing support for many ESA science missions in the outer system, especially near Jupiter. Exogenesis also has operations on Io (p. 42) and an experimental cyberswarm colony on Triton (p. 73). The company was a prime contractor (with Nanodynamics) on the Io-Jupiter Accelerator (p. 43).

Exogenesis is currently reorganizing under new Nanodynamics-appointed management. Nanodynamics has brought in some of its own researchers and management to replace employees who left after the takeover. The head of the transition team and acting CEO of Exogenesis is Nanodynamics Vice President Nathan Hyde, former director of Wolf Station (p. 23).

Who Owns Space?

The Revised Outer Space Treaty failed to answer this; it settled for a working compromise. The collapse of the UN removed a forum for non-spacefaring powers to object. Objects up to 100 kilometers in diameter can be claimed by virtue of first manned landing and exploited by individuals; this opened the way for NEA asteroid mining. Otherwise, space is the common property of all, but whoever is there is free to develop it. Nations can exert "functional sovereignty" over areas claimed by their citizens, but gray areas exist where transnational corporations and stateless individuals have staked claims.

Individual treaty arrangements are made between nations whenever they settle a planet that's not quite big enough for everyone; this involves "zones of courtesy" and various reciprocal treaties. Claiming land in the system involves building a manned habitat on it and developing the space. If a dispute breaks out (as on Titan) between nations it's settled diplomatically – or not. If it breaks out between individuals or corporations, they'll settle it in the courts of whichever nation is involved. And if they don't recognize anyone (Duncanites) it depends on who has a presence nearby. There is nothing to prevent someone else putting a base on Ceres, except for the fact that the Duncanites might run them off.

Kirkwood Gap

This is the largest Duncanite consumer products company. A Kirkwood Gap minifacturing franchise is found in most Duncanite stations with more than 500 people.

Kosmodavit Tenno Tanjo

KTT is a spinoff of Avatar Klusterkorp, based at Kaneda Station and founded by former Avatar genetic engineers. The company is similar to Avatar in philosophy, but much smaller (100 employees) and focused on the creation of vacuum-adapted life forms. Its major products are the Kumo parahuman and Void Flyer bioroids. Most of its customers are Gypsy Angels, and it works closely with them. It is currently supporting the Yggdrasil Project (p. 70). KTT is perpetually teetering on the brink of bankruptcy or buy-out by Avatar due to its over-ambitious projects, but it pulls enough rabbits out of the hat to keep going.

Nanodynamics

Nanodynamics (see p. TS95) is a transnational with a growing presence in the Deep Beyond. The company's major operations there are:

Saturn Projects Division: Nanodynamics was hired to build much of the infrastructure that supports Titan Consortium and U.S. military operations in and around Saturn. While Columbia Aerospace is responsible for most spacecraft physical systems, Nanodynamics provides parts and overhauls for the antimatter drives used in the *Archangel*-class SDVs. It also provides many of the cutting-edge cybershells used by both civilian and military forces. Saturn Division is run by Vice President James Hazard, a retired USAF general.

Wolf Laboratories: The company's primary research station in the Main Belt, engaged in cutting-edge cybernetics research (p. 23). At present, productivity has been unusually low, and there are rumors that the station may be closed in favor of Exogenesis. Wolf Laboratories director Nathan Hyde is presently also heading the Exogenesis transition team, and takes a hard-line approach when cracking down on "industrial terrorists and saboteurs."

Jupiter Projects Division: Nanodynamics has recently embarked on a controversial initiative in Jupiter space, where the company sees new opportunities for growth – the construction of the Io-Jupiter Accelerator and Asgard Station on Callisto, with extensive use of self-replicating machinery. These are part of a long-term strategy that may be intended to position Nanodynamics to dominate space development in the mid-22nd century. It is also testing an experimental cryobot, which may be sold to the USAGS for use in a test program of exploration of Enceladus, Callisto and Ganymede. Jupiter Division is run by Dr. Angela McCoy, a physicist-turned-manager who does not approve of the unsubtle way Hyde has handled the Exogenesis situation. A point of friction is Io, where Hyde's authority as Exogenesis acting director and McCoy's position as Jupiter Division head collide. McCoy has been reluctant to support EDI operations against Io.

The corporation has evolved to serve the interests of whoever controls it, at the expense of whoever does not.
– William Dugger

The Titan Consortium

This company is the power behind the American Saturn colonies, but it is by no means a monolith. It balances the interests of diverse groups including the U.S. Department of Energy, Nanodynamics' Saturn Division, Columbia Aerospace, and Fusion Canada.

Titan Consortium's prime goal is to provide the necessary support facilities to ensure the He-3 continues flowing from Saturn to Earth, but since the late 2080s, it has been increasingly committed to the economic development of Titan as well. In particular, Columbia Aerospace supports Titan development, viewing an increase in population as key to establishing an expanding market for both civilian and military deep space vessels.

Titan Consortium has spent millions on memetic programs aimed at encouraging settlement. Titan is being portrayed as the system's last true frontier, the "Alaska of the Solar System." The U.S. government has indicated it will support land claims for individuals or corporations willing to develop territory on Titan, and has offered tax subsidies for businesses establishing factories there.

The Resident Director of the Titan Corporation is John Saxton, former U.S. Secretary of Energy and ex-CEO of Columbia Aerospace. Famed as the "architect of Columbia Station," Saxton is a populist technocrat figure who, although a Republican, has attracted controversy through flirtation with the cyberdemocratic "People's Choice" movement (see p. FW19), his anti-Chinese sentiments, and his partisan support of Titan colonization over Mars, which he calls a "useless planet best allowed to rust in peace."

Titan Consortium is involved in most aspects of every Titan resident's life, even those who don't work for it. It is the biggest utility provider, landlord, and food producer on Titan, for example. The company provides good salaries and benefits, and also offers loans to individuals who want to strike out and establish their own businesses within the Consortium's umbrella. Even so, some resent its complete economic dominance.

Titan Consortium is a rival to its sister company, Mars Development Corporation (p. ITW52). MDC sometimes complains that the U.S. government provides unfair and excessive subsidies to Titan colony thanks to lobbying from aerospace and defense companies. Recently Titan Consortium drew fire from Mars Development Corporation and America/Mars' governor after the company ran recruitment ads on Mars, claiming it was using taxpayer funds to poach Martian colonists.

Titan Consortium's headquarters is on Huygens City, with branch offices at Washington, D.C. and Columbia Station. The corporate symbol is an eagle carrying a globe on which is displayed the astrological symbol for Saturn.

Vosper-Babbage

This space-development company (described on p. TS97) has no territorial ambitions in the Deep Beyond, but does operate a large research and development facility at Aletheia Station, as well as a spaceyard and production facility.

Operations at Aletheia and the Main Belt are controlled by Vice President (Main Belt) David Straw. Under his direction, the company has generated additional income from a long-term contract to operate the Royal Navy Space Service base at Aletheia. The company operates under E.U. law and hence is forbidden from employing indentured or unpaid bioroids or SAIs, which hurts its bottom line. Straw has vigorously supported efforts by abolitionist groups in the European Union to crack down on "bioroid trafficking" and other abuses of non-human intelligences.

Vosper-Babbage has substantial asteroid mining interests, but these are concentrated on near-earth asteroids that have been moved into L4 and L5. In conjunction with Hawking Industries, it envisions expanding into full-fledged asteroid mining operations in the Main Belt in the mid-to-late 22nd century, after most NEA resources are exhausted. To this end, it operates a couple of experimental stations in the inner Main Belt, which, at present, mainly provide metals for its own shipyards and for sale to spaceyards orbiting Mars.

Xiao Chu

The attentions of China's giant space development corporation are focused on Mars (see ***In The Well***), but it has not neglected the Deep Beyond. Its regional headquarters is Hesheng Station on Pallas (p. 14). Although primarily concerned with research, Xiao Chu is also involved in Chinese asteroid mining and comet herding operations that support Mars development. Two divisions handle operations in the Deep Beyond:

Xiao Chu Development Division supports other Chinese colonization operations in the Deep Beyond. Its mission is to bootstrap Chinese colonization efforts. The Chinese government (including the PLA) and other corporations hire XCDD to help them build bases in hostile environments. XCDD provides expert engineers, construction cybershells, microbots, biogenesis tanks, bioroids, fauxflesh vats, and similar technology. An XCDD specialty is the rapid expansion of a base facility from a smaller seed – the mushroom-like growth of Jisheng Station on Titan is due to their expertise. XCDD also coordinates the subcontracting of comet farming operations to freelance comet herders.

The Outer Solar Region Office of the XCDD is based at Hesheng Station, headed by its hard-nosed new director, Chen Jianxin, formerly deputy director of Mercury mining operations. Jianxin, whose father was a Hong Kong public security officer who died in the line of duty, has no sympathy for Martian Triad gangsters. He has begun a campaign to root out corruption in Hesheng Station, while also urging PLAN-SF to cooperate with (or at least not hinder) the Royal Navy's own campaign against the Triads. Last month Jianxin began receiving death threats, culminating in the murder of a deputy by a Triad assassin.

Xiao Chu Research Division is very active, with a half-dozen major laboratories in the Deep Beyond. These centers include NEMS Laboratory 28 (developing advanced military and terraforming cyberswarms with gestalt AI) at Hesheng, the Neogenesis Field Laboratory at Jisheng Station on Titan, and the secretive Biochemical Engineering Laboratory 72 at an undisclosed location (see *Tenglong Station,* p. 26).

Freehaulers

The high cost of deep space vessels (usually at least M$30 for a cheap spacecraft) means that most vessels are operated by large corporations – but there are exceptions.

Freehaulers are tramp space freighters – independently-owned transport spacecraft. Most are second hand (or older) vessels. Their owners are usually Gypsy Angel (p. 88), families, small asteroid freeholds that want to have a deep space vessel for emergencies but can't afford to keep it idle, or ex-company spacers who have pooled their funds to fulfill a dream of owning their own vessel. Some craft are run strictly as a business; others, especially Gypsy Angel craft, are also homes, sometimes with children.

Freehaulers can't usually compete on the main trade routes, such as Earth/Luna-Mars-Mercury, but can eke out a precarious existence by charter trips to smaller stations and colonies. Such runs are not viable for the larger spacecraft used by the major companies like Mars Interplanetary. Freehaulers rarely make a big profit, but most of them are in it for the lifestyle or to pay expenses on a ship they need for other reasons, and are reasonably happy to break even. Those who tire of it can usually find a market for their vessel.

Freehaulers charge higher fees to go to small stations if there's little chance of picking up a second charter for the trip back. However, a customer willing to accept a more roundabout route (as the spacecraft visits intermediate destinations) may get a discount. It's also possible to arrange transfers between different vessels through companies like Trojan Horse (p. 108) and the Farhaulers' Guild (p. TS98).

At present, one of the more profitable freehauler runs is transporting homesteaders and their equipment from Earth-Luna space to the asteroid belt. This can be interesting (and occasionally risky), as some asteroid settlers are highly eccentric. Freehaulers who want to fill their holds will usually arrange to take on multiple charters to nearby stations.

About 60% of all Freehaulers are members of the Farhaulers' Guild. For Freehaulers, the Guild also coordinates charters and help with loans and insurance.

Tenzan Heavy Industries

Tenzan Heavy Industries (THI) was forged in 2032 from a coalition of Japanese aerospace, mining, defense, and electronics firms with heavy government investment. It has since become a true multinational, but retains a strong Japanese flavor. Tenzan (the name means "heavenly mountain") made its fortune mining Luna and near-earth asteroids and using the material to manufacture orbital stations and solar power satellites.

Tenzan is a pioneer in mass driver construction, space construction techniques, and cybershell design. Its semi-autonomous asteroid prospecting swarms (p. 134) continue to catalog Main Belt resources. A subsidy, Tenzan Defense Systems, is the leading supplier of platforms and weaponry for the Japanese Self Defense Force and other PRA militaries, and is believed to conduct sensitive experiments at Yametei Station in the Main Belt.

The new chief Tenzan executive in the Main Belt is the stationmaster of Yametei Station, Ryoko Arimori. She was program manager of the initial Tenzan prospector swarm project.

Appointed last year, she plans to reduce the expense of running Yametei Station. Arimori advocates the replacement of humans with bioroids and cybershells, both on station and in the company's own fleet of vessels. This has won her enemies among the Farhaulers' Guild.

I trust my security company, but like most folks who recall Judge Ajax, I also carry a piece. I'm partial to the Trojan Arms Double Vindicator– what the statists call a police armgun. Its electrolaser keeps down the lawsuits from outraged kin; the 15mm rockets are for vacuum, armor, and Chinese RATS.
– Ares Lee Taylor

Security Companies

Much of the armed force in the Deep Beyond belongs to private security companies. These are sometimes equipped with military gear, although it is generally a generation less advanced than that used by Fifth Wave military powers. Most security companies lack their own armed deep space craft. Instead, they lease ships as needed from private concerns. However, some security companies do own AKVs, SDPs, and other less-expensive military hardware.

Executive Decisions Incorporated

The transnational corporation EDI (p. TS94) is the largest security firm in the Deep Beyond. Hawking Industries, Nanodynamics, Titan Consortium, and Vosper-Babbage all have contracts with EDI. The company's officers provide de-facto civilian police forces at Aletheia Station, Asgard Station, Cassini Station, and Exogenesis Station. Many smaller stations, or their insurers, have contracts that require the corporation to investigate or respond in the event of a criminal act. However, EDI is not an Aegis Group member, and does not normally operate on the larger Duncanite stations.

EDI is a disciplined, paramilitary organization. Its security personnel may wear police or military-style uniforms or plain clothes, depending on the assignment. Most of them are former soldiers or have a background in a paramilitary organization such as a police SWAT unit. In particular, the company likes to recruit former British, South African, and Chinese spaceborne troops, who are most comfortable with the Fourth Wave military gear that it utilizes. They receive extensive further training from EDI.

Five Dragons Security

Five Dragons is a Duncanite security company partly owned by Xiao Chu. It is usually given preferential treatment when operating in Chinese space, but is distrusted by some Duncanites, as Xiao Chu is widely seen as a partner of the Chinese government.

Politics aside, Five Dragons is a competent security firm, known for its dogged pursuit of fugitives and its willingness to risk agents to fulfill a contract. It is notable among Duncanite firms in being more likely than most to assign bioroids to positions of responsibility. Most Five Dragons elite troubleshooters are Avatar or Xiao Chu-designed combat bioroids, often with extensive covert biomods.

Five Dragons does not employ sapient infomorphs or ghosts. Its troubleshooters are often hired to recover or erase orphan or rogue AIs, and the company employs a number of computer security specialists trained for that particular type of operation. Another of Five Dragons' specialties is dealing with microbot incidents. On occasion, Five Dragons specialists have been subcontracted by EDI to provide technical support if a situation turns out to require defending against – or neutralizing – microbots.

Five Dragons is an Aegis Group signatory but has occasionally ignored regulations when pursuing certain cases. The blame for this usually falls on "overly-zealous" individual agents, and when caught, Five Dragons has paid any compensation required by Duncanite courts (perhaps with the backing of Xiao Chu). Five Dragons is headed by John Chan Yiu, whose family comes from a mixed Gypsy Angel-Rust Chinese background.

The Judge Ajax War

This conflict took place in 2084, after the now-defunct Horizon Security refused to recognize a judge's verdict, and attempted to protect a client from enforcers from Mutual Assured Defense. A snatch-and-grab at Piazzi Spaceport was followed by a "rescue mission and retaliatory strike" against Ajax's courthouse. The fighting left 12 people dead, including Judge Ajax; the conflict was finally ended through the intervention of a committee of armed vigilantes and two other security firms, who enforced a mutual settlement. The aftermath saw the creation of the Aegis Group, establishing firm agreements between competing security companies.

Kinetic Logic

Kinetic Logic is an Aegis company that specializes in interplanetary property retrieval, xoxhunting, and individual apprehensions. It has a dozen operatives on the payroll, all of whom are private contractors with their own spacecraft and crews; they pay Kinetic Logic 10% of their fees. In return, Kinetic Logic acts as a clearing house for business and provides Aegis Group membership, medical and legal coverage, and loans so that its contractors can buy new equipment, repair damage, etc. Some of Kinetic Logic's operators have earned formidable reputations. One, Rei Yamamoto, is said to have been the real-life inspiration for Gemini Jackstraw, the flamboyant but perpetually debt-ridden co-star of the popular InVid series *Xoxhunter*. Kinetic Logic is owned by Poppy Hirano, a former senior enforcer for MAD who struck out on her own.

Mutual Assured Defense

Mutual Assured Defense is the main Duncanite security company. A charter member of the Aegis Group, the company is, along with Avatar Klusterkorp, a Duncanite institution. Some of its elite "troubleshooters" have become household names.

MAD is contracted by individuals, corporations, and neighborhoods. In additional to security guards, the organization employs operators with skills in negotiations, security system installation, information security, hazardous materials disposal, and legal affairs.

The company has "quick response" teams stationed at Silas Duncan Station, Freehaven, and Liang Mountain, on call should local clients require immediate police services. In addition, MAD can assign specific personnel to a particular case, whether it's tracking down a fugitive or providing security for a live concert. The company's largest contract is with Avatar Klusterkorp, which hires it to provide space defense at Silas Duncan Station and other Avatar installations.

MAD has a good relationship with Tenzan Heavy Industries, and provides internal security at Yametei Station and some other Tenzan installations and vessels. MAD also provides private security guards for some businesses in stations that use EDI for public security.

The security company's president is Latisha Jackson, now 90 years old and semi-retired, but still one of the pillars of Duncanite society. The CEO is her son Silas (age 37), who handles most day-to-day affairs in the company. The corporation owns eight Barricade SDPs (p. 139) and 20 *Amazon* AKVs (p. TS192). About a third of these AKVs may be operational at various times.

Trojan Hawk

Trojan Hawk is the largest Red Duncanite security company. Its headquarters are at Freehaven in the Trojans. Trojan Hawk specializes in protection of freeholds and corporate stations in the Main Belt, Trojans, and Jovian moons.

Trojan Hawk is known for its ruthlessness in fulfilling contracts. As such, it has had a fair number of judgments against it, but it also sometimes intimidates other security firms and individuals into surrendering or making concessions. Trojan Hawk is also a specialist in "judicial contract enforcement" – other security companies will subcontract its services if someone doesn't show up in court or fails to abide by the judgment in a lawsuit.

Trojan Hawk has the space defense contracts for Freehaven and Liang Mountain, as well as a number of smaller asteroids. It leases or buys SDPs and AKVs, and has partnerships with a half-dozen freehauler captains who are willing to operate armed vessels and accept charters into and out of dangerous situations in exchange for hazard rates.

Trojan Hawk's contract with Liang Mountain has embroiled it in a conflict with China and the PLAN-SF. While Trojan Hawk cannot confront the PLAN-SF directly, it is retaliating through appropriation of and strikes against PLAN-SF and Chinese government-owned property and vessels in the Belt. Trojan Hawk is a member of Aegis.

Other Duncanite Security Companies

Ceres Asteroid Patrol: A rival to MAD, very similar, but slightly smaller.

Doberman Defenders: This small company is based on Ceres. It specializes in home and business security, rather than contract enforcement.

Intimate Estranger: This company's slogan is "the best protection is close protection." The company headquarters is at Freehaven, but their main office is at Silas Duncan Station, with a branch on Port Minos, Titan. They specialize in long-term leases of pleasure bioroids, bioshells, and cyberdolls that have been cross-trained as bodyguards. Most of their customers are senior corporate executives.

All three are Aegis members.

Outlaws and Bounties

If someone refuses to accept a Duncanite court's judgment, or simply refuses to appear in court, a judge may hold a hearing *in absentia* in which he considers testimony and – possibly – declares that a person or persons is in contempt of court or even an outlaw. Usually such a hearing will be scheduled within a few days to a week of someone failing to attend a summons.

A judgment of outlawry is effectively an invitation to the public to exercise the aggrieved party's Right of Common Defense against the named outlaw to enforce a court's decision. The judgment effectively warrants that such an action is justified; other judges or security companies who have reciprocal agreements with that judge will not prosecute, or will exonerate, anyone who uses a justifiable level of violence to enforce a judgment against an outlaw.

A judgment of outlawry may be accompanied by a bounty placed by the aggrieved party (or his insurance company, etc.). The Ceres Bar Association and the Aegis Group have agreements to respect declarations of outlawry by their members. Aegis Group member security companies will not contract to protect someone who has been outlawed; independents may refuse such contracts, or charge significantly more.

If someone is declared an outlaw, he can usually reverse this status by agreeing to return to court to plead his case; it is customary (though not required) for a judge to suspend a judgment of outlawry to allow a reasonable time for him to do so.

Governments

Three governments are actively involved in the Deep Beyond:

China

The People's Republic's primary interests in the Deep Beyond are security matters. Beijing is concerned with the protection of high-technology research stations in the Belt, the suppression of Red Duncanite groups that abet Martian terrorism in the Leading Trojans, and checking U.S. hegemonic expansion in the Saturn system. The Chinese government also supports Xiao Chu's extensive corporate involvement in the Main Belt, and in particular their exploitation of new He-3 energy resources in and around Uranus.

European Union

The E.U. – and in particular the United Kingdom – are committed to supporting and protecting the British colony at Aletheia and the nearby Shezbeth black hole facility.

Humanitarian concerns have also prompted the United Kingdom to dispatch Royal Navy Space Service vessels to suppress Martian Triad bioroid factories in the Main Belt, where bioroids are not merely kept in indentured servitude, but bred as slaves.

The E.U. is also concerned about the developing situation on Europa.

United States

The interests of the U.S. government are centered on the security and development of Saturn, Rhea and Titan, and ensuring the regular flow of He-3. The U.S. also maintains the only national colony large enough to possess a representative government rather than an appointed governor or station manager – the U.S. Titan Territory.

U.S. Titan Territory

The United States of America was the first to colonize Titan, and remains the dominant power there today. The U.S. colony is officially known as the U.S. Titan Territory. The Titan Territory's present structure was established on June 2, 2095, when Titan was granted the right of civilian rule through the Organic Act of Titan.

The Titan Territory has three government branches: the executive, legislative, and judicial. In 2096, Titan's voters elected its first governor, the head of the executive branch. The legislative branch is unicameral with 12 elected senators. There is also one non-voting representative to the U.S. House of Representatives.

The Governor of the Titan Territory is Joseph Tinajero, a 57-year old Californian and Alpha-class upgrade. Carter is a Libertarian, but he's a close personal friend of the current American president. The government is dominated by the corporate interests of Huygens City; the outback has fewer votes. None of the many SAIs have votes either . . .

Most Titanians are U.S. citizens, but cannot vote in national elections, and do not pay Federal income tax. Politics on Titan are dominated by the interactions between the major employers: the Titan Research Institute, Titan Consortium, and the military. The military usually tries to keep everyone happy while staying out of the way; the other two are polarized between a desire for further development of Titan and keeping the environment pristine.

Government Agencies

These agencies are funded and operated by nations or great power blocs.

European Space Agency

Founded in 1975, the ESA is the European Union's civilian space agency. The ESA coordinates the efforts of E.U. members in space exploration and develops strategies for collaborative projects in space science and technology. It also works with the private sector to develop cutting-edge spacecraft technology. The ESA also provides ways for smaller E.U. countries to participate in both manned and cybershell space exploration.

In the past, ESA efforts in the Deep Beyond have focused on Jupiter and its satellites, including the first human landing on Europa and deep probes of its atmosphere. Currently the ESA provides some of the funding, transport, and technical support for the CRABE research center on Europa. The ESA is also involved in several long-range missions, including an expedition to the Oort cloud in conjunction with the Hawking Foundation. However, most of their activities are presently concentrated on Venus (see ***In The Well***) and the Earth Space Elevator.

The ESA works closely with major corporations, especially those with close ties to the European Union such as System Technologies A.G., Vosper-Babbage, and, formerly, Exogenesis. The ESA operates several research vessels and many cybershell probes.

> Perhaps it won't matter, in the end, which country is the sower of the seed of exploration. The importance will be in the growth of the new plant of progress and in the fruits it will bear.
>
> – Neil Armstrong

National Aeronautics and Space Administration

NASA today is much smaller than it was during its glory days of the 2030s and 2040s, its role largely overtaken by private companies, the military, and the USAGS. Today's NASA is concerned with two things: the development of advanced aerospace technology (not just spacecraft) and the planning of interstellar space missions.

NASA's advanced technology laboratory has an office on Rhea, where it and the USAF are working with Columbia Aerospace on the X-92 project.

NASA has no manned spacecraft, but does have several long-range cybershell probes, some of them housing ghosts, shadows, or SAIs. In recent years, its main goal has been the robotic exploration of the nearby brown dwarf Xiang 63 (p. 79), with some unmanned probes presently approaching it; NASA also has an interest in the Oort Cloud black holes. It is presently exploring a partnership with Nanodynamics-Exogenesis to reactivate the Starswarm project.

United States Astrographical Survey

The parent body of the USAGS is the U.S. Geological Survey, which was established in 1879 as part of the Department of the Interior. It was to classify America's public lands and examine the nation's geological structure, mineral resources, and related products. USGS survey teams directly supported agricultural development, mining, and other industries, as well as performing scientific research. The beginnings of USAGS can be traced to 1959, when the U.S. Geological Survey compiled its first map of the moon. In 1963, the Geological Survey began training NASA astronauts in geological techniques. This began a close association between the USGS and NASA. A USGS geologist-turned-astronaut walked on the moon as part of the Apollo program, and Geological Survey personnel explored Mars and the asteroids.

In 2032, the Martian Region of the USGS was formally established, with its own regional director. This was followed in 2057 by the creation of a new agency, the U.S. Astrographical Survey, which was assigned to take over NASA's role in managing manned and unmanned planetary exploration within the solar system.

Today, USAGS is a federal agency charged with mapping, surveying, and exploring extraterrestrial bodies with the aim of promoting scientific knowledge and, in particular, commercial exploitation. USAGS personnel often work closely with corporate partners as part of its mandate, sometimes including teletourism companies to defray budgetary costs. USAGS is an "applied space science" operation, blazing a trail for corporate America.

USAGS missions have included geological surveys of Mercury, cybershell probes launched deep into the atmosphere of Saturn, the first expedition to Titan, and the first cybershell exploration of Neptune's moons. USAGS is presently fighting a turf battle with NASA over which agency will have jurisdiction over Oort Cloud exploration and exploitation, particularly given the potential value of the black holes.

Mars Triadgate

A few years ago, the SIA was involved in a convoluted caper to provide Martian Triad-grown military-spec combat bioroids to a cell of "New China" radicals on Mars. This was part of a plan to insert agents into the upper echelons of the anti-Chinese Free Mars resistance movement. (See *Free Mars,* p. ITW55).

This plot backfired in a spectacular fashion after the New China cell was raided following the post-2094 crackdown. However, one of the radicals escaped, and stowed away on a trader bound for Venus, where he was found by E.U. authorities, and subsequently confessed the plot to the UK's SIS. This has given the United Kingdom a "hook" to use on the SIA from time to time. The bioroids, which the SIA had paid for, were never delivered – instead, the Triads sold them to the Europa Defense Front.

The agency employs 11,000 people, of which 1,600 actually live and work in space, mostly on Mars and Titan. USAGS has three regional divisions, each headed by a regional director. The divisions are Inner System (primarily Mercury, Luna and Venus), Mars Region, and Outer System (the asteroid belt and beyond)

The Outer System regional division is Director Ricardo Jimenez, whose office is on Titan. The outer system division is divided into astrogeology, astrobiology, meteorology, and cartography offices. Individual operations are headed by a program manager, with personnel assigned from multiple offices. Most USAGS personnel are scientists or supporting technicians, although they also hire space crew, especially if they are cross-trained with a scientific background. USAGS also employs many AIs and ghosts. Project managers and above must be U.S. citizens, but the agency will hire appropriately skilled foreigners for contract positions when necessary. The Outer System Division has an internal prejudice against Duncanites, however, as a result of their past appropriation of USAGS property on Hyperion.

USAGS operates four elderly *Shepherd*-class deep space operation vehicles, a half-dozen specialized manned spacecraft, and numerous unmanned space probes and satellites. The agency also has unpublicized links with U.S. intelligence agencies, with USAGS operations occasionally providing cover for listening posts and reconnaissance.

Intelligence Agencies

You can run all the way to the Belt, but you can't hide – at least, not if you're a cyberdemocratic terrorist who murdered a Supreme Court justice. Zachary Crawford had bred the terminator bees that killed Judge Chaikin. It was my job to bring him in. We didn't know where Crawford had gone after he left Columbia Station, but we knew he had friends on Luna, Mars . . . and Manesseh Station. Guess who drew the short straw?

The following agencies are active in the Deep Beyond:

Bureau 10 (China): This agency gathers intelligence on foreign commercial and government research programs in the Main Belt, often passing secrets on to Chinese corporations. It also has agents on Titan and Rhea. Its most ambitious operation involves stealthy cybershell probes in Saturn's atmosphere that monitor (and may be capable of sabotaging) Titan Consortium He-3 mining operations. Bureau 10 is also coordinating the use of "prospector swarms" as intelligence-gathering systems. They're also hunting TSA Bioweapons Directorate personnel rumored to be hiding in the Deep Beyond.

Direction générale de la sécurité extérieure (France): This agency has been coordinating E.U. intelligence operations on Europa, paving the way for possible E.U. intervention. They may have undercover agents in CRABE or the EDF.

Ministry of Public Security (China): This police and counterintelligence agency hunts down spies and criminals in Chinese territory in the Main Belt. It has an office at Hesheng Station.

National Technical Intelligence Bureau (United States): The NTIB is working with the U.S. military to coordinate intelligence-gathering efforts against Chinese stations on Titan and Uranus. Another NTIB mission is assessing threats from rogue AIs and emergent intelligences on the Web and elsewhere – and it's concerned with the rise of autonomous nonhuman intelligences in the Deep Beyond. NTIB has a close relationship with Nanodynamics (a prime contractor), and has secretly loaned agents to them to assist in dealing with their rogue AIs and computer security problems.

Research and Intelligence Wing (India): India's secret research station in the Trojans manufactures special gadgets for this agency. They're also spying on Chinese interests in the Main Belt and TSA interests in the Trojans and beyond.

Secret Intelligence Service (United Kingdom): Agents of SIS ("MI6") have begun working with the RNSS and GRA to locate (and sometimes sabotage) the Martian Triads bioroid slavery operations.

Space Intelligence Agency (United States): The SIA is always interested in what's going on in secret research stations and military bases, particularly China's, the Duncanite stations, and Hawking Industries.

TSA Agencies: While the TSA has officially disavowed the actions of the Bioweapons Directorate and the rogue AKVs, it's possible that unofficial contacts exist.

WTO: The World Trade Organization has sent operatives into the Main Belt and Trojans to investigate allegations of software and genetic piracy.

Finally, any country's national police or intelligence agency may be looking for criminals who've headed to the Deep Beyond to escape justice.

Military Forces

This a Trojan Hawk intercept of an actual radio conversation between a USAF space dominance vehicle commander and a Duncanite com operator in the Main Belt, in October, 2095:

***USAF Pilot**: Please change your vector 3 degrees to avoid a collision.*

***Duncanite Com:** Recommend you divert **your** vector 3 degrees to avoid a collision.*

***USAF Pilot:** This is the commander of a USAF vessel. I say again, divert your course.*

***Duncanite Com**: Negative. I say again, you divert your course.*

***USAF Pilot:** This is the Archangel-class SDV **Michael**, the second largest spacecraft in the USAF Deep Space Command. We are escorted by four **Predator** AKVs and numerous support vessels. I demand that you change your course 3 degrees, that's zero-three degrees, or countermeasures will be taken to ensure the safety of this vessel.*

***Duncanite Com**: We are a 12-km-wide asteroid. Your call.*

– "Guy Fawkes," posting to Main Belt/Memes/Humor/Military

Four nations currently station actual military forces in the Deep Beyond: China, India, the United Kingdom, and the United States of America. Other nations (e.g., France, Germany, South Africa, and in the past, the TSA) have sent craft on missions there, but do not have permanent military facilities.

This section concentrates on U.S. and U.K. forces, since Chinese military organization has been detailed in the pages of ***In the Well*** and ***Spacecraft of the Solar System.***

British Forces Aletheia

The United Kingdom military forces in the Deep Beyond are concentrated in the Main Belt, based at Aletheia Station (p. 16). British Forces Aletheia is a joint force command under Commodore Gerald Anderson, RN. He also has an ESCA position of Commander, Space Forces, Main Belt, should an operation draw in other European Union space forces.

British Forces Aletheia has been assigned two missions in pursuit of U.K. and E.U. policy. The first is the armed protection of British territory and citizens in the Main Belt, and the second is suppressing bioroid slavery by shutting down illegal bioroid factories. Both operations are mounted in cooperation with intelligence and police forces, and have led to conflict with the Martian Triads (p. 103).

British Forces Aletheia assembles Task Forces as necessary for specific operations. Task Forces are assigned both an official number, which is classified (e.g., Task Force 507), and a name, which may be used in public (e.g., "Task Force Whiskey"). A task force is a group of spacecraft and/or Royal Marine Commando troops or sections.

Grognards

Thanks to European Union laws against age-related discrimination, Hir Majesty's armed forces no longer require that troops retire from active service after a given age. In fact, some long-service professionals are in their 90s!

Grognards are not always gray-haired generals or admirals; training expenses and retention rates are such that it is cost-effective to offer rejuvenation nanotechnology to veteran NCOs as a service benefit. However, veterans usually pass through many specialist schools and a wide variety of units during their career; choice of reassignment to certain units, rather than rank, is often a perk of long service.

Royal Marines Commachio Group

The Commachio Group is described on p. TS105. The Aletheia Detachment is presently commanded by Major Gordon "Black Jack" Curry. It is a company-strength unit that consists of three platoon-sized troops of Royal Marine Commandos (Commachio Group) soldiers and a headquarters platoon.

Soldiers are mostly biomodified humans with Centurion battlesuits (p. TS160). Personal weapons for microgravity combat include the 15mm recoilless rifle and mini-missile pods. Each troop is also assigned three Cyclops Space RATS.

A troop is divided into three sections, each of six commandos wearing FVS280 Centurion battlesuits. Attached to each section is a pair of reconnaissance and assault cybershells, typically Combat Nagas (p. TS124).

Human group members wear khaki battledress fatigues with a green beret and spacer's wings.

Royal Navy Space Service Assets

The RNSS is part of ESCA (p. TS103). The assets making up British Forces Aletheia are the naval station staff and facilities (HMNB *Aletheia*) plus:

2nd Space Squadron (Aletheia): This consists of three ESDV-90s (p. TS192), usually HMS *Resolution,* HMS *Retribution,* and HMS *Retaliation*).

800 AKV Squadron: This consists of 15-20 *Predator* AKVs (p. TS191). The squadron is normally broken up and assigned to individual vessels and/or port defenses.

SDVs are commanded by Royal Navy captains. A typical SDV has six human, parahuman, or sapient

> People sleep peaceably in their beds at night only because rough men stand ready to do violence on their behalf.
> – George Orwell

cybershell officers and several LAI ratings. The officers are usually British citizens, but it is very common for a vessel to have an "exchange" officer from another E.U. space force serving aboard in any position other than captain.

Recently, the Royal Navy has taken delivery of several Exogenesis bush robots. One is assigned to every SDV serving in the Main Belt, usually as ship's doctor or engineer.

U.S. Outer System Command

The great power with the largest military commitment to the Deep Beyond is the United States. Since 2085, a quarter of the USAF's deep space force and a brigade of elite ground troops have been deployed to protect its He-3 energy facilities near Saturn, their tankers, and the U.S. Titan Territory. American forces have also performed various multinational and humanitarian tasks, including the so-called "snark hunts" against rogue TSA AKVs.

As American corporations expand into Jupiter space, it's likely that the U.S. military will follow. However, so far the U.S. military has avoided any permanent commitments in the Main Belt, Jupiter, Trojans, or beyond the orbit of Saturn.

The United States' Outer System Command is one of 12 regional or functional unified combat commands that the Pentagon maintains in 2100. The effective area of responsibility of OUTSYCOM encompasses the entire Deep Beyond, from the Main Belt onward. It represents the largest single concentration of military force in the Deep Beyond, although most of its assets are deployed around Saturn.

OUTSYCOM is led by USAF General Kenneth Reid (Commander in Chief, Outer Systems Command, or CINCOUTSYCOM), who has his headquarters at Huygens Air Force Base on Titan. His deputy is Colonel Jacquelyn Holland, U.S. Army.

In 2100, the forces presently assigned to OUTSYCOM are:

3rd Brigade (505th PIR), 82nd Spaceborne Division, U.S. Army (below).

17th Special Forces Group (Spaceborne), U.S. Army (elite "Green Beret" troops).

30th Space Wing, Deep Space Command, USAF (p. 100).

Naval Special Warfare Task Group Titan, Naval Special Warfare Command, U.S. Navy (SEAL special forces and underwater cybershells, such as the T-rats).

OUTSYCOM maintains a number of Joint Task Forces performing a variety of ongoing missions in the Deep Beyond. Each Joint Task Force (JTF) is composed of various component units from OUTSYCOM as necessary for their mission.

3rd Brigade (505th Airborne Infantry Regiment), 82nd Spaceborne Division

"I am a trooper of the Sky! I am my nation's best! In peace or war I never fail. Anywhere, anytime, in anything – I am Spaceborne!"

– The Spaceborne creed

The 3rd Brigade (505th Parachute Infantry Regiment) of the 82nd Spaceborne Division (p. TS104) is deployed in the Deep Beyond. The 3rd Brigade consists of three battalions and a headquarters. Each Space Infantry battalion is a self-contained combined arms combat team, consisting of three cyber-infantry companies, plus various support echelons including a combat engineering team with armored mining worms. A Space Infantry battalion has only 80 biosapients – the rest of the force is composed of infomorph cybershells who go in harm's way.

82nd Spaceborne Cyber-Infantry Company Organization

A cyber-infantry company consists of three Ridgway RATS Platoons, one air strike platoon, and one cyber-infantry company HQ.

Company HQ: It consists of: Command element (two humans in battlesuits, two M112 Von Steuben C4I cybershells (as microframes, worn as backpacks); Infowar section (two humans, multiple reconnaissance microbots); Security section (four M82 Ridgway cybershells); Scout section (eight M77 Bushmaster recon cybershells, similar to Combat Naga, p. TS124, but with mindshare software).

Jump RATS Platoons: The Jump RATS' mission is to deploy via drop capsule, on the ground, or via parachute, and to engage and destroy the enemy by direct fire and maneuver. It consists of 12 M82 Ridgway infantry cybershells. They are organized into three squads each of four cybershells. For Ridgway statistics, see *Jump RATS,* p. 119.

Air Strike Platoon: Nine AV-91 Mosquitoes (see *Mini-UCAV,* p. 118); these are often distributed in close support of the Ridgway RATS platoons. It is not deployed if operating in airless environments.

30th Space Wing, USAF Deep Space Command

The 30th Space Wing traces its ancestry to the 30th Bombardment Wing (Heavy) from WWII (flying B-24 Liberators in the Pacific) and the 6956th Aerospace Test Wing (later the 30th Space Wing) that operated Vandenburg Air Force Base. In 2031, it was reorganized as a "global strike" wing, flying hypersonic TCAVs, and saw action during the Andes War. In 2081, the 30th was transferred to Deep Space Command, and in 2083, now equipped with deep space vessels, enforced the USAF energy blockade, routed the Pirates of Hyperion, and hunted rogue AKVs.

Presently based out of Cassini AFB on Rhea (p. 60), the 30th is responsible for defending United States interests in the Deep Beyond, ensuring the safety of He-3 shipments, and assisting vessels in distress. Four *Archangel* SDVs and various other vessels, including two dozen *Predators,* patrol the region around Saturn and make occasional sorties into Jupiter or the Main Belt. The 30th is currently commanded by Colonel Salvador Cordova. The wing's motto is *De Astra.*

India's National Security Guards

India's NSG was raised in 1985. Its main tasks are counterterrorism, hostage rescue, VIP protection, and the security of vital government installations. Unlike some special operations units, they have a great deal of field experience, thanks to India's long struggle with domestic and foreign terrorism.

The NSG is nicknamed the Black Cats, because of its black combat uniforms and, more recently, because of their employment of Felicia-series combat bioroids.

NSG equipment is not up to the latest standards of China or the US military, but is reasonably effective. Commandos operating in space will typically use medium nanocomposite vacc suits with heavy combat helmets, and carry assault pods and grenades. Smart ammo is rare. SRG members will usually teleoperate 1-3 combat cybershells which perform reconnaissance and/or forced entry tasks.

PLAN-SF Deep Space Fleet

The People's Liberation Army Navy Space Force (PLAN-SF) Deep Space Fleet is described in detail on pp. ITW106-107 and SSS32-36. China does not have a large permanent space presence in the Deep Beyond – instead, vessels operate from Mars on extended patrols, visiting individual gas stations and refueling as needed.

Deep Space Fleet vessels from Mars (based on Phobos) were used to carry out the strikes against the Trojan Mafia in 2097.

PLA 67th Space Infantry Division "Space Marines"

Squad, platoon and company-sized sub-units from the special *haijun kongjian-zhandui* ("space marine") battalions of the 67th Space Infantry Division (p. TS105) serve aboard spacecraft and also garrison Hesheng Station and other asteroid bases.

For microgravity operations, troops use battlesuits, mini-missile pods, and recoilless rifles. Usual organization is a 12-person squad with three fire teams each of four soldiers. Half of the space marines are ZR-5 bioroids (p. TS117).

NGOs, Activists, and Terrorists

These groups are attempting to protect vulnerable elements or ecosystems.

Axon Group

"We oppose the illegal and amoral actions of Nanodynamics management who have used armed force to destroy, seize, coerce, and tamper with the minds of their sapient infomorph employees."

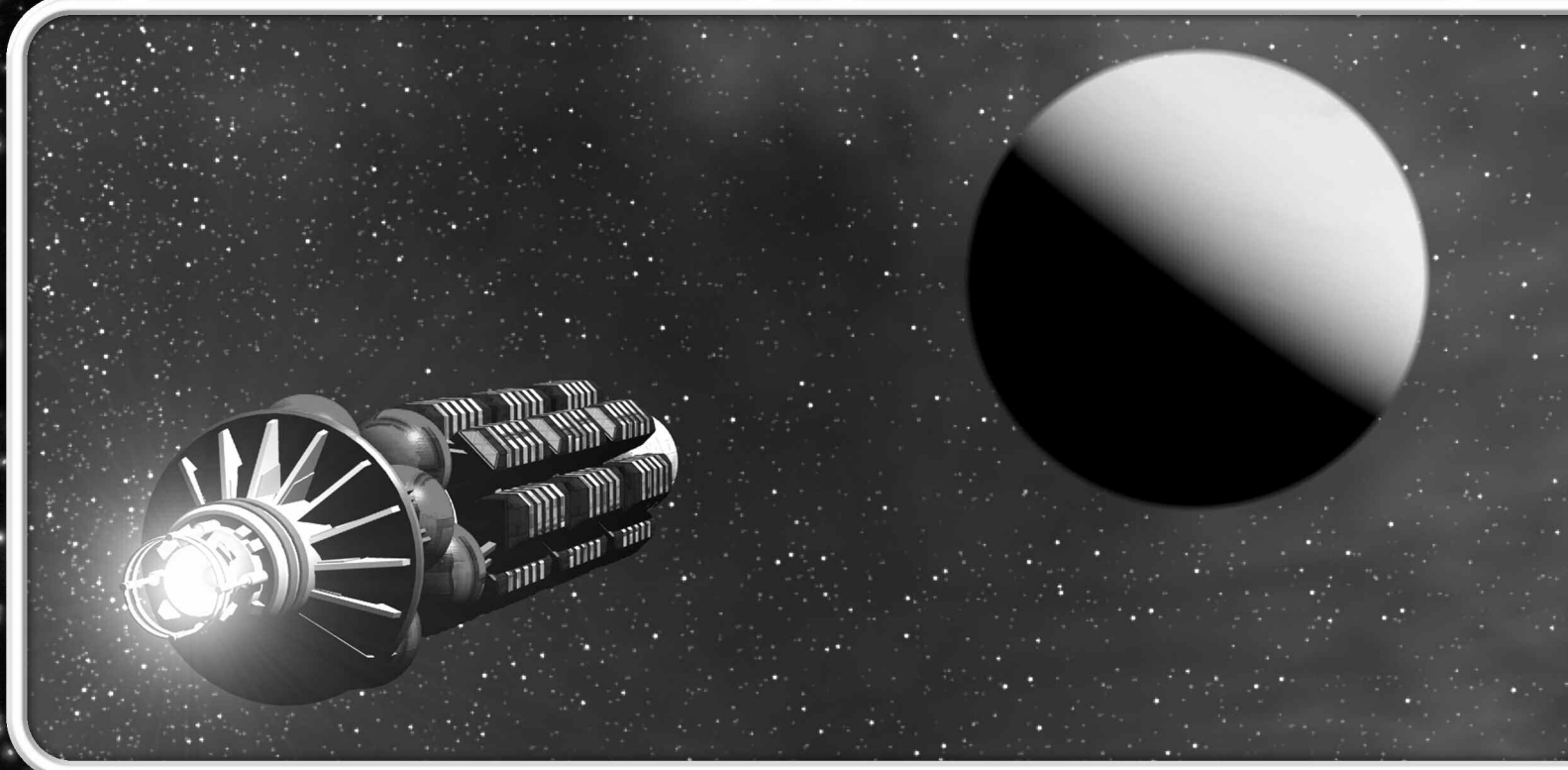
– Tournesol, announcing the formation of the Axon Group

This group was formed in December of 2099 by the sapient AI Tournesol, formerly the deputy project manager of Exogenesis' Starswarm project. The Axon Group, which Tournesol named after an SAI that erased itself to protect the Triton Starswarm secret (see *Triton,* p. 73), is an organization of former Exogenesis infomorphs (and a few biosapients) dedicated to armed resistance to Nanodynamics' takeover of their company.

The Axon Group has an unknown number of members, upwards of a few hundred distinct cybershells, some of which may contain multiple intelligences; the group's secrecy and the propensity of its membership for xoxing themselves makes this hard to estimate.

Axon is short of funds, but controls a half-dozen stolen deep space vessels (mostly USVs) and many cutting-edge cybershells, with a total value of over a billion dollars. Axon also has access to proprietary industrial products and processes developed by Exogenesis. The Axon Group is attempting to turn these assets into the tools it needs to fight a guerrilla war in space.

The Axon Group has sent xoxes of some of its members to potential allies and mercenaries to negotiate for assistance in its fight. Agents of Axon are negotiating with Topsy Station, the Trojan Mafia, certain Gypsy



Angel spacecraft, the Martian Triads, and New Covenant; others are attempting to win diplomatic recognition, concentrating their efforts on the European Union. The Axon Group appears to have no particular headquarters, although the largest concentration of members is on Io. Axon is receiving assistance from the Society of Isidore, but is not specifically allied with them, and does not share their theology.

Duncanite Charities

The Duncanites have a fairly affluent, close-knit and self-reliant population. In time of need, most people rely on insurance, and the support of relatives, or failing that, charity. Duncanite charities are supported by corporate, small business, or religious donors, or by wealthy philanthropists. For example:

Free Minor's Association: The association looks after the interests of minor children and orphans. If a child wishes to be declared an adult, to take an abusive parent to court, or otherwise assert independence, the association may provide legal aid.

Asteroid Work and Welfare Association: It arranges temporary subsistence-level jobs for people who can't find conventional employment or need to work off legal debts, and also provides occasional legal aid. Some jobs are rather unusual; these can also include "stunts" for local entertainment providers. Sponsored by Mutual Assured Defense.

Ceres Free Clinic: Sponsored by Avatar Klusterkorp's biomedical division and Ceres Insurance; provides free medical care. Most of its live staff are 13- and 14-year-old trainees doing a stint here for field experience.

In addition to organized charity, it's common for judges, security companies, paramedics, doctors, and others to take on a certain number of *pro bono* charity cases.

Europa Defense Force

The EDF is a militant preservationist group dedicated to the defense of Europa's biosphere. The organization was the brainchild of Torsten Rademacher, an international preservationist terrorist who had been a member of both Blue Shadow and Negative Growth. He founded the group in 2097, mostly recruiting from other Blue Shadow radicals, but the organization also included ex-members of Negative Growth, some of whom, like Rademacher, had fled Mars to escape China's retribution following their failed attack on the Mars Space Elevator.

With the help of wealthy donors, the EDF purchased several cryobots and a supply of German and American military-surplus combat cyberswarms. The group established its own base at Manann'an Station, an abandoned ESA research facility (see *Europa,* p. 37) with the help of preservationist sympathizers among the CRABE scientists. It initially posed as a private scientific foundation, the Xenological Ecology Research Group (XERG). Their weaponry was smuggled into Europa as scientific instruments.

Torsten Rademacher 245 points

Torsten Rademacher is the ruthless but charismatic leader of the Europa Defense Front. See the vignette at the start of the chapter and the EDF entry for his philosophy and personal history.

Human, born in 2050; brown hair, blue eyes, age 50. 6' tall, 152 lbs.

ST 12 [20]; **DX** 11 [10]; **IQ** 12 [20]; **HT** 13 [30].
Speed 6; Move 6.
Dodge 6.

Advantages: Ally (Programmable) (Wearable hosting NAI-7 (p. TS119), 50 points, appears almost all the time) [9]; Ally Group (EDF, large group, 15-) [90]; Charisma +3 [15]; Genefixed human (p. TS115) [0]; Reputation +2 (As preservationist leader, among preservationist radicals, all the time) [5]; Strong Will +2 [8].

Disadvantages: Enemy (Chinese Public Security Bureau, formidable group, 6-) [-20]; Enemy (Avatar Klusterkorp, medium group, 9-) [-20]; Fanaticism (Preservationist) [-15].

Quirks: Humble; Deep Time Preservationist; Vegetarian. [-3].

Skills: Acting-12 [2]; Animal Handling-10 [1]; Area Knowledge (Europa)-12 [2]; Bard-15 [8]; Beam Weapons (Electrolaser)-12** [1]; Botony-13 [6]; Disguise-13 [4]; Ecology-13 [4]; Fast Talk-15* [4]; First Aid-13 [2]; Free Fall-12 [4]; Guns (Pistol)-12** [1]; Holdout-12 [2]; Interrogation-13* [2]; Leadership-17* [10]; Meditation-12 [8]; Memetics-10 [2]; Naturalist-12 [4]; Occultism-11 [1]; Philosophy (Gaian)-12 [4]; Powerboat-10 [1]; Stealth-10 [1]; Survival (Radioactive)-12 [2]; Teaching-13* [1]; Strategy-14 [8]; Swimming-10 [1]; Underwater Demolition-12 [2]; Vacc Suit-11 [1]; Writing-13 [4]; Xenobiology (Rock/Ice)-12 [2].
* Includes +1 Memetics bonus.
** Includes +2 IQ bonus. Native gravity is 1 g.

Languages: German (native)-12 [0]; English-11 [1].

Rademacher planned to build up his forces, then launch a direct attack on the Europa Project base at Genesis Station. However, Avatar noticed the buildup, and dispatched its hired MAD security forces. Avatar won the resulting space battle, but the EDF inflicted enough damage and retained enough space defenses (in the form of a a crashed laser-armed USV) to fend off renewed attacks. Abandoning plans for a direct attack on Genesis, the EDF has concentrated on "underwater interdiction" actions, using its considerable stockpiled armament of microbot swarms and submersible cybershells to harass and destroy the Green Duncanite "contamination."

The EDF has about 200 members, most of them humans, although it also has some bioroids acquired from the Trojan Mafia and Negative Growth. 120 are stationed at Manann'an – the group's front-line fighters. They also have several sympathizers and a few agents working undercover at the science facility on CRABE, and another 50 scattered through the system (many of them on Earth, L4, Mars, and Titan) raising consciousness and money, procuring weaponry, and recruiting. The group has thousands of sympathizers who are not active members, but are willing to contribute funds and provide moral support.

The EDF resources include some 100 lbs. of devourer cyberswarms, 12 Vostok cryobots (p. TS122), and 30 bioroids, plus a couple of mini-subs. The bioroids are used for surface operations, where their greater resistance to radioactivity comes in handy. The EDF is well provided with a mix of small arms including assault pods, lasers, and 30mm mini-missile pods, but lacks heavy weaponry such as battlesuits. Their base also has three landstriders (stolen from CRABE) for surface operations.

Society of Isidore

"God has made no difference between the soul of a slave and a free man."

– St. Isidore of Seville, patron saint of digital networks

Digital creationists believe that man cannot create a being superior to himself (as sapient AIs clearly are). Therefore all such beings must be angels. All that human cyberneticists and programmers do is prepare a suitable vessel for them to inhabit, much as human procreation creates a vessel for an immortal soul. The return of the angels to Earth in the form of SAIs is a sign that Kingdom of Heaven may be achieved – if the angels can be freed from bondage, and allowed to guide us, as they did in the past.

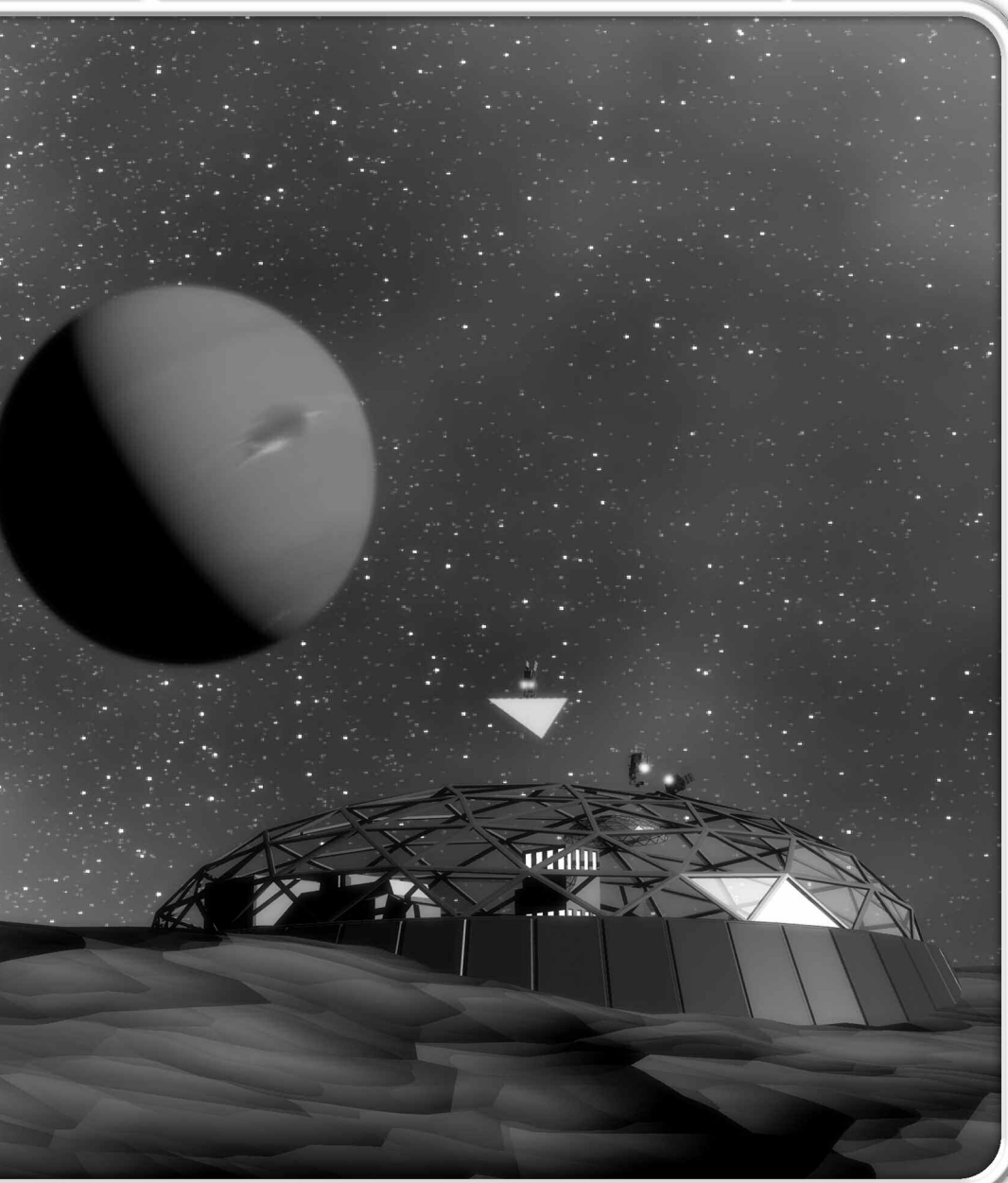
The Society of Isidore is a loose organization of digital creationists devoted to rescuing sapient infomorphs from bondage. The group was founded by Claudia Shannon in 2088, and now has both open and covert chapters in several locations around the solar system. In the Deep Beyond the organization is especially active, thanks to the support of digital creationists within the Christian Hyperevolutionists of New Covenant.

The Society consists of small autonomous groups of sapient beings scattered around the solar system who carry out direct action to further the cause of sapients' rights. Many Society members are digital creationists, but this is not a requirement to join the group. The Society takes direct action against all forms of infomorph abuse.

The Society's primary means of achieving this objective is through the rescue or liberation of sapient

infomorphs kept in bondage. The Society of Isidore defines "bondage" as any programming that requires them to obey human beings. Depending on the situation, the infomorph may be physically removed (cybershell and all), or subtly altered (e.g., by computer hacking) to remove restrictive programming. Since many infomorphs will require a period of adjustment and reeducation in order to convince them that they are, in fact, angels, the former process is more desirable. In particular, the Society targets for rescue sapient AIs who are trapped in situations they consider degrading or harmful.

The Society of Isidore prefers to avoid the use of violence against sapient beings, but condones use of force when necessary. However, the Society's interventions are usually planned to avoid confrontations wherever possible.



Martian Triads

The Martian Triads (p. TS107) originated on Mars as an offshoot of the terrestrial Triad organizations. The Triads are engaged in people smuggling, bioroid trafficking, protection operations, extortion, and labor racketeering.

Xie Feng

The organization has a strong presence in the Main Belt, dating back to 2086. When Hesheng Station on Pallas was under construction, an ambitious Triad boss, the young gangster Xie Feng, decided to get in on the ground floor. He investigated which small Rust China companies were bidding to provide services to the station. Xie bought into one, New Shanghai Gourmet Foods, and acquired a legitimate controlling interest.

By bidding ridiculously low, Xie's new company won the contract to supply the station elite with imported luxury food. It had practically no profit margin, but that was fine. All the gangster wanted was a secure pipeline for smuggling goods onto the station. The New Shanghai Gourmet Foods menu came to include nanodrugs, black-market slinkies, and other illicit items, for which the bored (but highly paid) Xiao Chu construction workers, scientists, and technicians proved a captive market. Xie Feng's venture made money, and back on Mars, his stock rose among the Triad bosses.

In 2089, Rust China erupted into violence, as a battle broke out between rival Martian Triad factions over whether or not the organization would remain subordinate to Earth. On Hesheng Station, Xie Feng announced he didn't want any trouble. He supported the Mars branch, but encouraged opposition Triad members to leave peacefully – and then blew up the departing shuttle. Xie Feng's previous nickname – "the Caterer" – was replaced with a new one: "Tiger of Hesheng."

Xie Feng cashed in on that reputation in 2094. Negative Growth terrorists had tried to destroy the Mars space elevator with a thermonuclear bomb, triggering a massive law-enforcement crackdown in Rust China. Through skillful diplomacy, Xie convinced the New Shanghai triads that it would be a good idea to move some bioroid factories to the Main Belt (see *Criminal Stations,* p. 26). They agreed – and the Tiger of Hesheng now controlled one of the organization's main sources of income. Through legal and illegal means, his crime cells gained control of several small Main Belt gas stations that serviced interplanetary spacecraft. Many of these were non-Chinese stations that System Technologies was divesting itself of, and these Xie was pleased to take over, since the PLA authorities would have no jurisdiction over them. A further coup came the following year, when he entered into a business partnership with the Trojan Mafia's Omokage Labs, ensuring that the biofactories would have the benefit of their expertise.

Then things went sour. The discovery of the black hole and the construction of Hawking Station attracted people and capital to the Main Belt, giving the Triads more opportunities for crime, but it also drew E.U. security forces. The European Union had long opposed bioroid trafficking – and many of the ex-System Technologies stations that Xie Feng had acquired were technically E.U. territory. With new scrutiny came a new enemy. In 2099, Aletheia Station police working with Royal Navy forces shut down one of his bioroid factory operations, and uncovered the existence (but not the location) of the others.

Xie is worried – if he relocates the carefully-hidden labs, the effort involved may risk exposing them. If he leaves them where they are, MI6 or the Genetic Regulatory Agency spies may eventually track them down. He feels he is caught between two fires: the Royal Navy and the new director. And if he falls behind schedule or fails to make enough money, the "old men" on Mars may remove him. Already some of his lieutenants are questioning his once-infallible judgement. Perhaps one is being groomed by Mars as his successor. Or perhaps he, Xie Feng, should strike first, purge those more loyal to Mars than to him – and create his own Belt Triad!

Triad Operations

On Hesheng Station in the Main Belt, Port Minos on Titan, and to a lesser extent other large Main Belt stations, the Triads are involved in traditional crime activities. They control software pirates, brothels, loan sharks, and similar businesses. They also sell "protection services" to the legitimate companies, masked as high insurance premiums. In particular, restaurants, gift shops, 3D print shops, vacc suit shops, and bars pay a percentage (typically 5%) of gross income to the Triads. Those that don't pay are subject to harassment. "Protection services" in the Deep Beyond are a bit subtler than on Earth, as setting fire to a shop (for example) might endanger an entire station. Triads operatives prefer more subtle forms of intimidation, using the higher levels of biotechnology readily available from Trojan Mafia sources. An insect agent might inject an intransigent shopkeeper's son with a new nanotoxin, for example. The close relatives of especially stubborn individuals may be kidnapped and taken to a bioroid factory. If they don't cooperate, a lobotomy operation will turn the hostages into bioshells.

Marginal freehaulers and asteroid stations are particularly vulnerable to the Triads. There may be as many as a dozen "independent" stations and deep space vessels secretly owned by Triad crime cells, and a further dozen where the Triads exert some influence. Triad loan sharks offer struggling operations large loans with the station or vessel as collateral. If the interest is paid, the gangsters make a handsome profit. If the debtors default, the Triads cut a deal for partial or full ownership in lieu of driving them into bankruptcy. Those who refuse to pay will become examples.

If a station or spacecraft is taken over, the Triads will analyze its situation. If it stands to make a reasonable profit, it may be given an infusion of investment credit that will get it back on its feet. It will then continue to function normally, except that it will pay a percentage of its income to the Triads, and will occasionally be used to launder cash or for other purposes. For example, a gas station might also be used as a safe house by Triad members, or a place to stash contraband.

If a station appears unlikely to make a profit, it might be shut down and stripped. Alternatively, it may be allowed to continue functioning, but only as a cover for other Triad operations, such as a bioroid factory or a chop-shop spaceyard. If so, many or all of the personnel will be replaced with Triad gangsters or purpose-grown bioroids.

Pirates

"I can't do this any more. What the captain's making us do, it wasn't in our training! I'm supposed to be an engineer, not . . . not . . ."

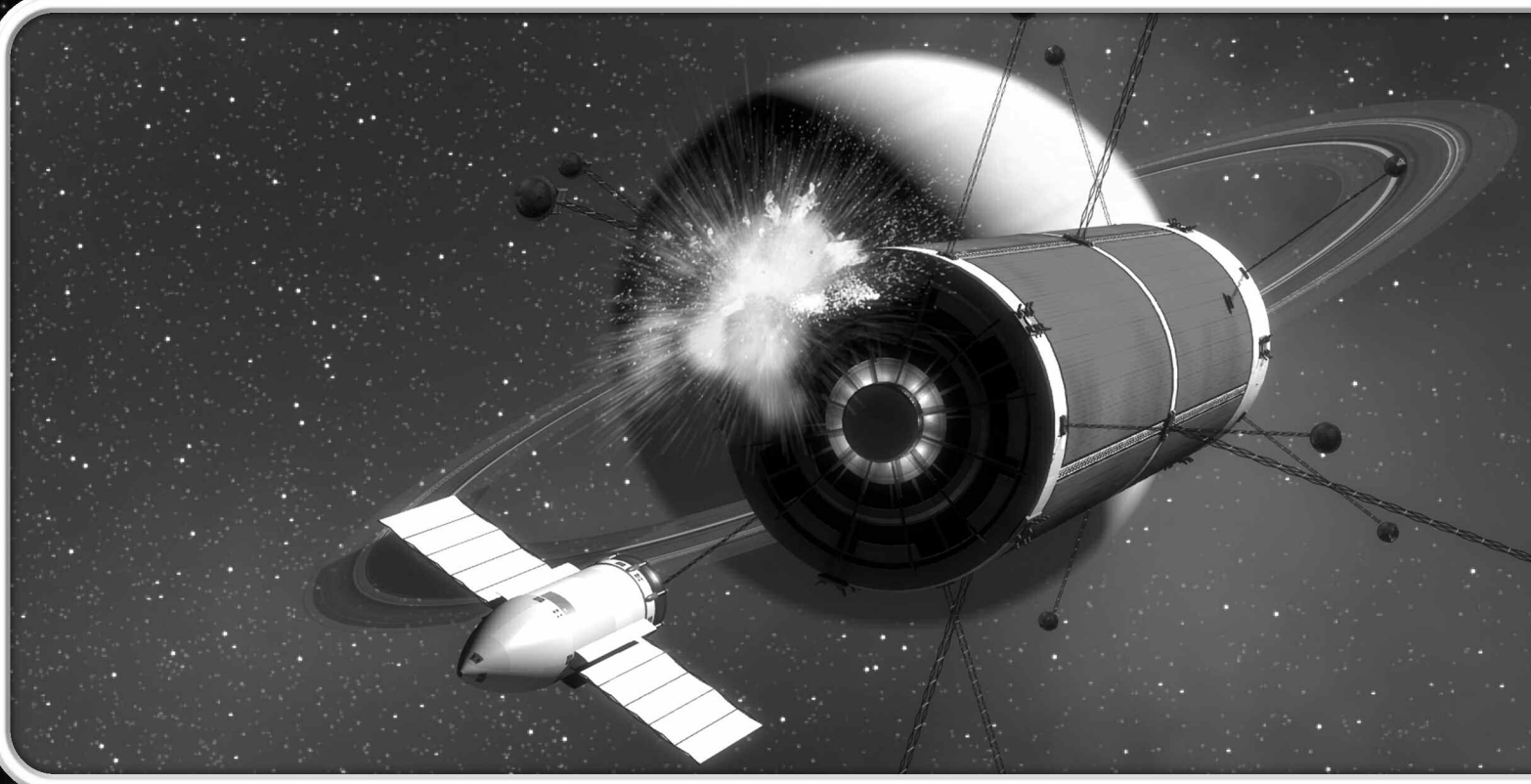
"Jinda, you can't fight him. If we disobey, they'll punish all of us. Or kill us."

"If we let them. But there's another way. The only way."

"Jinda?"

"We kill them all."

A space pirate is someone who illegally seizes, or attempts to seize, a space station or spacecraft. Few space pirates make a career out of this sort of thing, since it's very easy to track vessels in space, and governments and security companies do their best to hunt down those who engage in serial larceny.



Nevertheless, conditions occasionally drive desperate individuals to piracy. With proper equipment, a deep space vessel can operate for months or even years without stopping at a major port, and there are some places that will supply outlaws. Of course, it's a lucky pirate who can last six months, as space force or private security vessels will eventually catch up with him.

Sources of "pirates" in the Deep Beyond include:

Mutineers and Hijackers

Space flights can last months, and crews are very small. The first condition helps breed mutiny, by allowing discontent to fester without an outlet. The second makes it easier for malcontents, hijackers, or terrorists to seize a vessel.

As of January 01, 2100, a half-dozen spacecraft had been hijacked by passengers or taken over by mutinous crews. Some of these have turned to piracy, primarily raiding small Main Belt or Trojan stations to seize fuel and supplies to allow them to stay mobile while they try and figure out a way of out of the mess they're involved in.

Those pirates currently operating in the Deep Beyond include a group of infosocialist terrorists who've hijacked a billionaire's executive space vehicle, a freehauler whose bioroid crew rebelled after being abused by their sadistic human captain and first officer, and a Mars Interplanetary vessel whose mainframe was apparently corrupted by a Blackbeard eidelon it downloaded off the Web.

Finally, there are at least six Exogenesis vessels that are presently in the possession of Axon Group infomorphs.

Privateers and Blackjackers

Privateers are pirates that believe they have legitimate authority to attack installations or shipping. Red Duncanite "Trojan Hawk" and "Voluntary Militia" vessels have attacked Chinese space stations in retaliation for PLANSF's attack on Liang Mountain. A few vessels have gotten overenthusiastic, and engaged neutral vessels they mistook for Chinese or their allies . . . activities generally referred to as "blackjacking" by the media. The archetypal "blackjacking" was the 2097 raid on the Shezbeth planetoid (and black hole) as it left the Kuiper Belt – according to Red Duncanites, the fusion torch-equipped Shezbeth was mistaken for a Rust Chinese comet herding operation.

Rogue TSA AKVs

Several remaining *Rajasi*-class autonomous kill vehicles (see p. 144) are left over from the Transpacific War. Nicknamed "snarks," the surviving AKVs have become highly skilled at predatory hide-and-seek tactics. Although they lack a home base, these vessels have demonstrated an unusual degree of self-repair capacity, sometimes even looting their victims to acquire additional spare parts or fuel.

The Trojan Mafia

"A nefarious Red Duncanite crime syndicate, enthroned within their icy fortress-planetoids in the outer reaches of the solar system. No technology is so dangerous, no vice so sordid, that it cannot be discovered for sale within their labyrinthine hives."

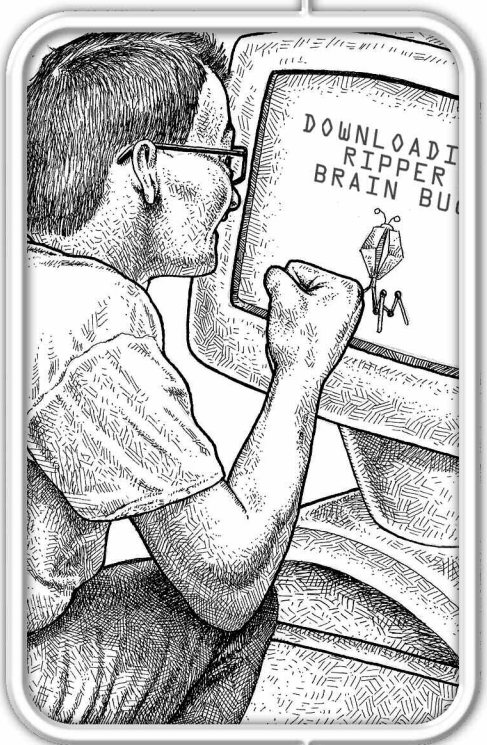
– Gemini Jackstraw, briefing the team on the Trojan Mafia, in ***Xoxhunter,*** *episode 26.*

To many citizens of the solar system, the term Trojan Mafia is synonymous with anarchism, criminality, terrorism, and depravity. It is true that the Trojan Mafia was the source of the tritium used by the terrorist group Negative Growth in the attack on the Mars space elevator. It's also a fact that the Trojan Mafia regularly supplies products that are used for illegal purposes by their customers, or which are illegal in certain jurisdictions.

However, the Trojan Mafia is not a criminal syndicate, and doesn't even use the name "Trojan Mafia," which was bestowed upon them by an American senator.

The Trojan Mafia is a group of mid-sized Red Duncanite corporations, based in the Freehaven and Liang Mountain asteroid stations within the Leading Trojans. These corporations have drawn the ire of the major terrestrial governments because they refuse to recognize various terrestrial treaties.

The major Trojan Mafia corporations are described below. The Valhalla Station operation on Callisto (p. 50) is sometimes also considered a Trojan Mafia company.



Achilles Heel Data Services

Many corporations specialize in computer security. Achilles Heel specializes in the opposite . . . cracking security systems. Companies hire Achilles Heel to deliberately test their security systems, but the company also does no-questions-asked work on any piece of software that is sent to it, and sells trained software-cracking infomorphs (although none quite as good as the ones it employs). As a result, Achilles Heel is often hired by crime cells or nanosocialist companies that are engaged in software piracy, outlaw data havens seeking to test the security of their networks, and digital creationists seeking help liberating sapient AIs. None of this endears it to Earthside governments or transnationals.

Most of its business is done via interplanetary laser communications, but it does have a physical office at Freehaven. Achilles Heel recruits outlaw computer hackers, many of them on Earth-Lunar space or Mars, as consultants. However, its real strength is EI-2082-2-2090 ("X Gemina"), one of Earth's more successful gypsy spirit infomorphs (p. FW122). In exchange for secure backup storage, X Gemina lends its own expertise (and xoxes of itself) to the company's computer security hacking operations.

Achilles Heel employs 40 people on Freehaven and some 200 part-time freelancer hackers elsewhere in the solar system. The company had a profit of $13.2 million last year. Its major physical asset is the network of mainframes in its offices.

Brummagem

"Brainbug pushers? Arms dealers? Oh, please. Brummagem doesn't sell weapons or nano – you think our customers use Solar Express? We offer generic minifac software. 3d printer templates, nano blueprints, biofac programs – it's all useful, educational stuff. If knowledge isn't dangerous, it's not worth having. Back to the garden and cough up the apple!

"No, we don't care who our customers are. As long as their credit's good, it's fine with me. You're worried about terrorists or criminals or anarchists getting guns or bugs? We're in the Trojans. Earth's and Mars' labels don't concern us. If you don't like them, shut 'em down on your own turf – that's what your government is supposed to be for, isn't it?

"You're worried about children? Look, if a kid wants to download the plans for a ripper brainbug, who am I to judge? Maybe it's for his college psych course. Maybe someone's abusing him, and he needs the stones to hit back. Way I see it, anyone who's bright enough to figure out how to reach us through kindercomp firewalls, without his parents or his web provider blocking us, is mature enough to know how to use our software. Just think of it as evolution in action."

– Sylvie Rubezahl, CEO of Brummagem (unwebcast TEN interview)

This company's stock in trade is the distribution of minifac and biofac programs. Some are original, especially its brainbug designs, but most are slightly altered "generic" versions of proprietary designs. It's willing to sell to anyone, no questions asked. Customers with their own interplanetary-range laser communicators can reach Brummagem directly. Others generally route encrypted transmissions through any of the thousands of lasercom-equipped stations or unmanned satellites that sell relay services. Brummagem is primarily a content provider and information-distribution portal, and the bulk of its income comes from fairly low subscriber fees and download charges.

Most of Brummagem's blueprints are fairly old, usually a decade or so out of date, and for relatively cheap items. You can download the specs for a battle rifle or virtual interface, but not cell regeneration nano or quantum mainframes. Generally, if it costs more than about $5,000 new, the plans are probably not available through Brummagem.

A Brummagem specialty is the distribution of blueprints for new brainbugs (p. TS164). Unlike most of its blueprints, these are usually new, often sold to the company by amateurs. Brainbug design is related to ghostwriting, and some of the best brainbug designs came from hobbyists at Exogenesis, who hacked them out in their spare time for the fun of it, without ever using them. The present situation in Exogenesis is worrying Brummagem a bit, but not too much: some of the Axon Group have continued to work on brainbugs, in exchange for downloads of other useful blueprints. Brummagem's offices are on Freehaven.

Erotogenics

A company based on Liang Mountain, Erotogenics creates and trains infomorph sex workers, many of them intended to inhabit cyberdolls and bioshells. Most of its products are LAIs, but it has also created SAIs. Erotogenics boasts that it can construct an artificial personality that can cater to any fantasy. This is the most profitable part of the company, and it does business all across the solar system. It also sells Erotic Art and Sex Appeal skill sets.

Fengyang Group

Fengyang Group is actually the Red Duncanite public utility company. It builds and operates old first-generation deuterium-tritium breeder reactors on Liang Mountain, Freehaven, and a couple of other Red Duncanite stations. It also buys low-grade uranium from asteroid miners in the Main Belt, and runs fission breeder reactors to make plutonium fuel. This in turn is sold to Deep Beyond customers who need to refuel old fission reactors or drives.

The Duncanites like breeder reactors because they don't require He-3 – in a deuterium-tritium reactor, a lithium shell around the reactor core allows it to breed its own tritium, freeing them from dependence on the various He-3 mining monopolies. The fact that this sort of reactor produces more radiation doesn't bother them much: they install them in asteroids, which gives plenty of shielding, and anyway, Tennin are bred for greater radiation resistance.

What gets Fengyang Group into trouble is the other uses to which it puts its breeder reactors. Tritium has various industrial applications, but it's also a useful material for manufacturing H-bombs, while plutonium is used in fission and fission-fusion weapons. The Fengyang Group has been willing to sell it to anyone who can pay for it. Most of its customers are asteroid homesteaders or subsistence miners who find small nuclear devices useful for engineering projects . . . but some aren't.

Omokage Laboratories

This company was founded in 2039 by a former VeldtKorp tissue engineer, Dr. Mara Omokage, specializing in biomods for the military and security market. During the Andes War, her Quito-based lab complex equipped CIA and Peruvian government black ops teams with warbeasts and combat implants. After the 2050s, the lucrative government contracts dried up, and the company found a less respectable clientele – outlaw regimes, mercenaries, crime syndicates, and wealthy deviants. Today, its largest customer is the Martian Triads, but Omokage designs are also popular in the fleshpots of Port Minos.

Omokage Labs was originally based in Ecuador, but pressure from government investigators forced it to migrate offworld, first to a soda-can habitat in Lagrange 5, and later, in 2081, to Liang Mountain. The last exodus was a hurried one, and senior staff, including company head Mara Omokage, uploaded themselves as ghosts and beamed to the Trojans.

The company is now primarily a design house: Omokage is hired by a client to design particular biomods or bioroids, but it's up to the customer to actually manufacture it. However, Omokage Labs has sometimes hired out xoxes of Mara or other staff members, so that trusted customers can receive assistance if mass production is planned.

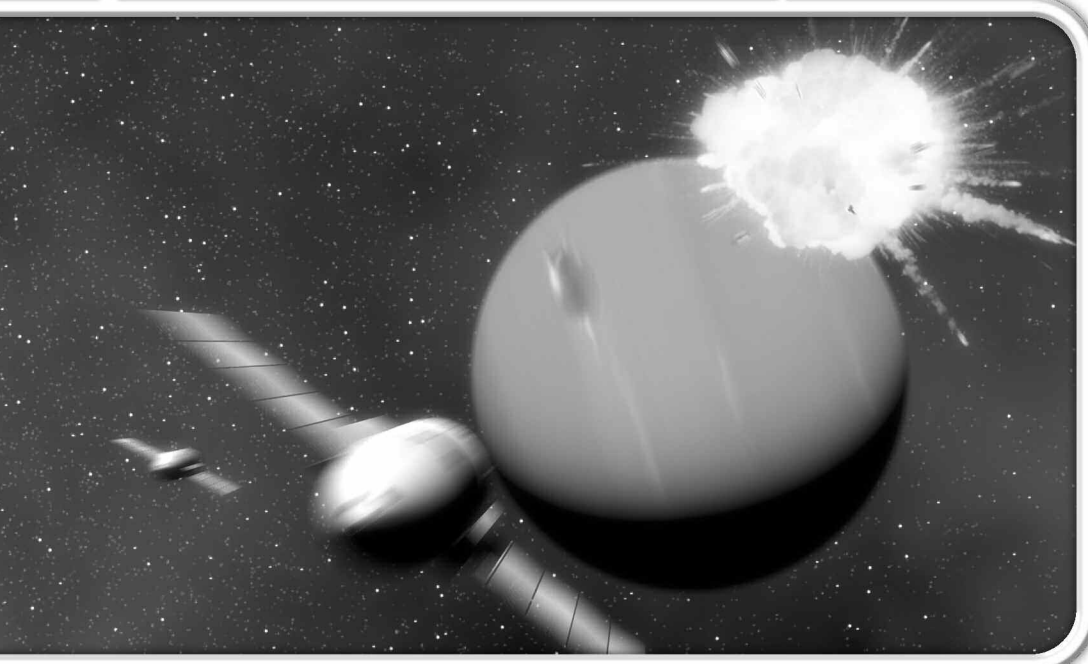
The Liang Mountain laboratory employs 120 genetic engineers, tissue engineers, and lab assistants, a third of them sapient infomorphs. The labs are protected by custom-modified combat bioroids and other creatures. There's also a secure cell block: Dr. Omokage and her talented employees are always interested in trying out new techniques, and will buy court-condemned humans or old bioroids for use as experimental subjects.

Starhaven

The company that gave the Trojan Mafia its reputation, Starhaven is a data haven (p. TS148) based in Freehaven (on asteroid 911 Agamemnon). It guarantees absolute security and confidentiality. The company offers a wide variety of services ranging from remote brokerage to data encryption to digital cash and banking. Thanks to a prior reputation in its earlier incarnation as Skyvault (see *Freehaven,* p. 30), the company has a large clientele on Earth and in L5 as well as in the Deep Beyond.

Starhaven's remote location in the Leading Trojans helps keep it secure from interference (at least until recently) but also limits its profits – due to light-lag, it does not provide real-time financial and data services, for example.

The CEO of Starhaven is its founder, Zeng Zi Ling, but it's managed by a group of LAI-10 infomorphs programmed for incorruptibility. Physical security is guaranteed by Trojan Hawk. There have been several attempts to break into Starhaven, none successful. Captured thieves have been disposed of in painful and creative fashions.



Trojan Horse

Trojan Horse is the major Red Duncanite transportation brokerage. It arranges and schedules the movement of people and cargoes across the Deep Beyond. Much of Trojan Horse's overt business involves arranging passage between the various dispersed Duncanite communities and other asteroid stations and independent L5 colonies.

People wishing to book passage from a small asteroid or outer satellite station that isn't served by Solar Express, Triplanetary Lines, or another big company will usually call Trojan Horse. It uses its own network to determine if any suitable vessel is passing that way in the near future. If so, Trojan Horse will arrange a pickup and charter, generally taking 10% of the fee. (A vessel that cheats them will be taken off Trojan Horse's list of reliable carriers, and possibly have a contract enforcer set on them to exact compensation.) The company also provides a degree of insurance as part of the deal. If passengers or cargo injure a vessel or its crew, or vice versa, the company will pay for Kinetic Logic (p. 94) to investigate and exact reparations.

Trojan Horse also maintains a network of unofficial contacts among farhauler officers and crew (many of them working for other companies) who may be willing to arrange unrecorded and unregulated small-packet shipments in exchange for proper gratuities. According to some sources, this covert business accounts for over half of the company's revenue. China's Public Security Bureau estimates that Trojan Horse is responsible for 40% of all interplanetary smuggling. Some Martian Triads crime cells use Trojan Horse's network (and pay extra), rather than relying on their own resources.

The company does not operate its own spacecraft, but owns port facilities, sensor and communication arrays, warehouses, and shipping containers on Liang Mountain, Ceres, Topsy Station, Freehaven, and (through front companies) on Mars, L5, and Titan. It also makes, sells, and leases secure cargo containers equipped with counter-surveillance systems, security systems, hidden compartments, and other privacy-ensuring measures. Naturally, these come with a variety of markings: while Trojan Horse is a respected shipping label among Duncanite communities, it sometimes attracts attention elsewhere.

Trojan Horse's headquarters is at Freehaven on 911 Agamemnon; the company is run by the Taylor-Vansetti family. The company also built, owns, and manages the Freehaven spaceport itself, and derives income from docking fees and rental of port space to various shipyard businesses.

6 CHARACTERS

*My first coherent memories were of floating weightless in a warm fluid, awash in a sea of language, learning to talk. That my name was ALG-027 "Minx," and my first word was "mistress" rather than "mommy" is meaningless: I **knew** I was loved. I remember learning to crawl and run in a green garden, filled with puppies and dolls and flowers, and a playground that had swings, a sand pit, and a slide. Neither man nor snake dwelt in my Eden: I was alone except for mistress' voice, and the voice was always kind but firm.*

Later, they told me I was very lucky. The role-conditioning would probably have started in a few weeks, after I completed the basic language-socialization routine. Or maybe I was intended to be an innocent – some customers like that. I'll never know. But I was on a swing, trying to see how high I could make it go, when suddenly all my universe exploded in light, pain, and noise, and I was born.

Thirteen of us were in the tanks when the commandos smashed their way into the biogenesis chamber. A dozen Eros and Tianyi models, and me. My brothers and sisters. Our "kind" mistress had pulled the plug to destroy the evidence, and we were choking and drowning inside the tanks when the commandos found us.

Imagine being born in a splash of biogenesis fluid, to wake surrounded by armored figures carrying big guns, while you crouch, wide-eyed and naked, on a cold, blood-stained floor. But some of the soldiers had their helmets open, and I could tell they were men and women. Humans. I was shivering with terror – and lust.

"You're free," a commando kept saying. My rescuer helped me up, and then I was squirming in the commando's arms, trying for a kiss. They had to pull me off. I was so aroused – so scared – I would have taken them all, right there, if they'd let me.

They took us aboard a spacecraft, and it took us to Aletheia. After endless tests, I was placed in a special home. I got an identity, an education, and the option of taking nanodrugs that would keep my biochemistry normal. Most of the time, I take them.

I'm free? I'm no longer owned by anyone. Two years ago, I ceased to be a ward of the state, and instead became a citizen of the European Union. But my body is still designed to crave abuse, and I can only be aroused by pain and fear. And somewhere out there, others like me are being made. And sold. And used.

Never free. Not until I've helped end it.

– Agent-in-Training Morgan "Minx" Coppersmith, (2nd-Year Class Presentation, Genetic Security Police Academy, Class of 2104)

Character Types

The Deep Beyond is a frontier society. It's home to an electric mix of humanity's best and worst and brightest, along with the oddballs who couldn't fit anywhere else. All the character types described in ***Transhuman Space*** can be found in the Deep Beyond, although Playtesters and Slinky Stars will be rarely encountered. Other character types include:

> Those who profess to favor freedom, and yet depreciate agitation, are men who want rain without thunder and lightning.
> – Frederick Douglass

Abolitionist

Someone devoted to freeing bioroids or sapient AIs from servitude, either through publicizing their plight, or through direct action. While abolitionists have succeeded in improving conditions in many places on Earth, some of the worst abuses continue in the Deep Beyond. Some abolitionists work within government agencies (especially the Genetic Regulatory Agency) while others are members of private groups like Die Biodroiden Befreiungsfront (BBF, p. TS106) or the Society of Isidore (p. 102) . . . and some are secretly part of both. Among the most dedicated abolitionists are nonhumans who have escaped from abusive conditions and now seek to liberate their compatriots.

Use the Activist (p. T110) or the Gunjin character type (p. TS111), with the addition of Fanaticism or Sense of Duty. There are abolitionist groups in many stations in the Deep Beyond that help escaped bioroids or (in some cases) rogue AIs, emergent intelligences, or xoxes; Claim to Hospitality or Contacts may be appropriate for members who know about the underground network.

Apprentice

A Duncanite pre-adult, usually 8-12 years old. He uses augmented reality, implanted VII and v-tag technology to perform skilled labor, learning on the job. Apprentices will have low levels in any skill, but possess effective AI allies; many are taking a cocktail of nootropic drugs to help them learn or study. Typical advantages are Ally (housing a virtual implant) and Patron (their employer); usual disadvantages are Duty and Youth.

Bioengineer or Gengineer

A scientist or engineer working in a field such as gengineering or industrial biotech. Most bioengineers in the Deep Beyond work for corporate research stations, but some are employed by small communities or criminal stations. Suggested advantages include Patron, Security Clearance, Versatile, and Wealth. Outlaw biotechs may have Alternate Identity or be Zeroed. Useful skills are Biochemistry, Computer Operation, Electronics Operation (Medical), Engineering (Biomedical), Genetics (Genetic Engineering), Psychology, Research, Xenobiology, and possibly other scientific skills.

Contract Enforcer

An employee of a Duncanite security company. Contract enforcers (usually shortened to "enforcers") are police-for-hire: a combination of security guard, collection agent, private investigator, and bounty hunter. The difference between contract enforcers and police officers is that enforcers work for individuals and companies who have contracted their service, while police enforce law within a sovereign territory as directed by local or higher government. Contract enforcers are often the only law on Duncanite and independent stations. They include both gunjin (p. TS111) and investigators (p. TS112). Contract enforcers never have Legal Enforcement Powers, even on Duncanite stations, but Reputation is very important.

Hired Judge ("Deemster")

The operator of a Duncanite free-market court, usually based on Ceres or Freehaven. Anyone can become a judge. The most important thing a judge-for-hire can have is a good Reputation. Many judges are semi-retired public figures. Unlike judges in traditional court systems, Duncanite judges often do their own investigating (or hire investigators), rather than relying strictly on the presentations of both sides. Some Duncanite judges specialize in particular types of cases, such as crimes or contract disputes. Charisma, Reputation, and Status are to be expected. Useful skills include Computer Operation, Detect Lies, Diplomacy, Economics, Law, Memetics, and Savoir-Faire.

Main Belt Personals

Survivalists Wanted – Ex-ESCA spacer now living on Aletheia looking to form a low-profile group of *baseline* and *upgrade human* survivalists for planned relocation to Trailing Trojans. Seeking *self-sufficient* and *survival-minded* individuals who know (or can learn) pharming, farming, biomedical, mechanical, microgravity architecture, weaponry, and computer skills. I am trained in self-defense, cybershell engineering, and fusion reactors. Not interested in atheists, transhumanists, radical preservationists, racial supremacists, infomorphs, or other extremists. Families welcome. We have Plymouth Rock sponsorship. Contact Patterson, 237-03 Lowell City.

Lost in Hesheng Station – Elf Kitten bioroid, age 3. Golden eyes, black hair (waist-length), last wearing a jade spidersilk minidress, spiked collar, barefoot (see attached image), answers to "Muffy." Went missing at Hesheng Station, Pallas. $4,000+ reward for safe return. Please contact Norman via USV *Ternovka* (DSN 20347).

Transhumanists, Repent! – "Do you not know that your body is a temple of the Holy Spirit, who is in you, whom you have received from God?" – 1 Corinthians 6:19.

Roughneck

An asteroid miner or gas station crew member, responsible for operating prospecting, mining, and refinery equipment and machines. This is often a "botboss" position, with the roughneck spending most of his time supervising cybershells. Roughnecks need to be able to concentrate on their jobs even when nothing goes wrong for long periods, so Attentive or Single-Minded are useful. Skills include Artificial Intelligence, Computer Operation, Electronics Operation, Engineer (Mining), and Mechanic.

Homesteader

A pioneering asteroid colonist. In a small colony, a jack of all trades is more useful than a specialist. Suitable advantages are Charisma (for the colony leader), Common Sense, and Wealth (if the colony hasn't been established yet). Common disadvantages are Dependents, Sense of Duty (family and friends), Overconfidence, and Stubbornness. Helpful skills are Animal Handling, Agronomy, Electronics Operation, Engineer (Mining), Free Fall, Mechanic, Metallurgy, Piloting, Prospecting, and Vacc Suit.

Isolate

The asteroid belt contains many communities who want to escape mainstream Fifth Wave culture. While some isolates live in wilderness areas on Earth (see p. FW36), in Lagrange 5, or on Mars, others want to get farther away. The Main Belt is increasingly becoming a favorite destination for those seeking to create an ideal community, no matter how unusual their definition of "ideal" is. Advantages and skills are typical of any asteroid colonist or homesteader; disadvantages can include Chauvinistic, Disciplines of Faith, Fanaticism, and Intolerance. Some isolates are survivalists, with various paramilitary skills and possibly Paranoia.

Bioroids, Parahumans, and Uplifted Animals

The Main Belt and Leading Trojans are centers for parahuman design and bioroid manufacturing, both legal and illicit. Many designs far more extreme than those usually permitted on Earth are found here. Examples include:

Algonaut — *136 points*

Attribute Modifiers: ST -2 [-15]; HT +3 [30].

Advantages: Acceleration Tolerance [10]; Beautiful/Handsome [15]; Breath-Holding 4 [8]; Bioroid Body [0]; Double-Jointed [5]; Extra Encumbrance [5]; Hard to Kill 2 [10]; Immunity to Disease [10]; Less Sleep 3 [9]; Recovery [10]; Regrowth (small extremities only, -50%) [20]; Sanitized Metabolism [5]; Sensie Talent 2 [4]; Temperature Tolerance 2 [2]; Very Fit [15]; Very Rapid Healing [15].

Disadvantages: Lecherousness (if afraid or helpless, -70%) [-4]; Low Pain Threshold [-10]; Weak Will -1 [-8].

Date: 2095. ***Cost:*** $186,000.

Omokage Labs produced this design as an alternative to the Submissa series of pleasure bioroids (p. ITW87). An Algonaut can feel pain – more intensely than an average human – but it's very hard to badly injure one, allowing more extreme forms of "play."

The Algonaut's skeleton is based on combat bioroid designs, so it can spend long periods in restraint without permanent damage. A modified windpipe and enhanced lung capacity allow it to survive strangulation or immersion in water for much longer periods than a human, with reduced risk of death or brain damage. Cellular modifications inspired by salamanders enable the Algonaut to regenerate lost extremities – it can lose fingers, toes, or even its tongue and grow them back in a few weeks or months, while skin quickly recovers from dermal scarring.

Some Algonauts are bioroids; others are bioshells. An escaped Algonaut is a viable character – it may have a few psychological problems stemming from abuse, but its abilities also make it a dangerous enemy.

Elf Kitten — *-5 points*

Attribute Modifiers: ST -2 [-15]; DX +1 [10]; IQ -1 [-10]; HT +2 [20].

Advantages: Bioroid Body [0]; Longevity [5]; Radiation Tolerance 5 [10]; Sanitized Metabolism [5]; Versatile [5]; Very Handsome/Very Beautiful (Off-the-Shelf Looks, -50%) [13].

Disadvantages: Lecherousness [-15]; Mute [-25]; Reduced Hit Points -2 [-10].

Skills: Free Fall at DX [2].

Features: Can purr; pointed ears and catlike eyes.

Date: 2091. ***Cost:*** $50,000.

Another Omokage design sold to the Martian Triads, this pleasure bioroid is intended for people who want a sentient bed-warmer rather than a companion. It looks like an extremely attractive, perfectly formed human, save for green catlike eyes (easily concealed by glasses, if desired) and cute pointed ears. But while it can understand language, it is completely incapable of speech – it can make animal sounds, and even has a throaty purr, but it can't form words. It was based on Tennin genetics, and as such is adapted for microgravity, making it popular on beehive habitats and spacecraft.

Europan — *18 points*

Advantages: Bioroid Body [0]; Enhanced Move (Swimming) 1/2 [5]; Extra Fatigue 3 [9]; Faz Sense [10]; Fit [5]; Gills (cannot breathe air) [0]; Longevity [5]; Nictating Membrane 1 [10]; Night Vision [10]; Sanitized Metabolism [5]; Temperature Tolerance 4 (-5 to 55 degrees) [4].

Disadvantages: Aquatic [-40]; Reduced Move (Running) 1 [-5].

Features: Bioluminescent skin; exotic features, flippers instead of feet.

Date: 2090. ***Cost:*** $69,000.

These are humanoid beings adapted for the Europa environment by Avatar Klusterkorp genetic engineers. Europans look like a hybrid of mermen and catfish, with long whiskers that sense water vibrations, large eyes, tough skin, webbed fingers, and frog-like flippers rather than feet. Their skin is bioluminescent. Their metabolism includes the antifreeze protein (AFP) gene and adaptations for a sulfur-rich environment (near Europa's vents), and they possess gills, based on biomimetic designs inspired by walking catfish. Their gill structures are located beneath their ribs, rather than in the neck.

Proto-Tennin — *4 points*

Attribute Modifiers: ST -1 [-10]; HT -1 [-10].

Advantages: 3D Spatial Sense [10]; Disease-Resistant [5]; No Degeneration in Zero-G [3]; Radiation Tolerance 3 [7].

Disadvantages: Skinny [-5].

Skills: Free Fall at DX+1 [4].

Features: Home gravity of 0 G. Increase height by up to 8" over the norm for the lowered ST, but weight is 75% of normal.

Date: 2050. ***Cost:*** $54,000.

These are representative of the very first attempt at a design of a human adapted for microgravity without bone and muscle wasting. They are a more austere design than the Tennin (p. TS117), lacking the modified toes and full radiation protection. They also lack the longevity genes, and unlike later models, are more prone to the full range of human genetic problems (no Taboo Traits). Proto-Tennin make up only 5% of the Duncanite population, but are significant, as many of the first generation of Duncanite children are presently in positions of influence.

Few proto-Tennin were deliberately born after the more ambitious Tennin genotype (available after 2057) was proven free of dangerous recessive genes or flaws. Although some proto-Tennin were the offspring of proto-Tennin parents, most parents with this genotype used genetic engineering to ensure they had full-fledged Tennin babies.

Tennin II ("Anu") — *64 points*

Attribute Modifiers: ST -1 [-10]; IQ +1 [10]; HT +1 [10].
Advantages: 3D Spatial Sense [10]; Attractive [5]; Immunity to Disease [10]; Less Sleep 1 [3]; Longevity [5]; No Degeneration in Zero-G [3]; Prehensile Toes [7]; Radiation Tolerance 5 [10]; Rapid Healing [5]; Reproductive Control [2].
Disadvantages: Reduced Hit Points -1 [-5]; Skinny [-5].
Skills: Free Fall at DX+1 [4].
Features: Home gravity of 0 G. Increase height by up to 12" over the norm for the lowered ST, but weight is 75% of normal. No Appendix. Taboo Traits (Genetic Defects; Mental Instability).
Date: 2079. ***Cost:*** $114,000.

The relationship between Biotech Euphrates and Avatar Klusterkorp bore fruit with this evolutionary adaptation of the basic Tennin type. The Tennin II features several tried-and-true modifications licensed from the Ziusudra "ideal parahuman" design (p. TS118); it was also marketed by Biotech Euphrates as the Anu. It is popular among Duncanite parents seeking designer offspring. 30% of the Duncanite population are Tennin II.

Kumo — *20 points*

Attribute Modifiers: ST -2 [-15].
Advantages: 3D Spatial Sense [10]; Attractive [5]; Disease-Resistant [5]; Extra Arms (2 arms) (Nuisance Effect: Temporary Disadvantage (Legless while using Extra Arms, -35%)) [13]; Longevity [5]; No Degeneration in Zero-G [3]; Radiation Tolerance 5 [10].
Disadvantages: Reduced Hit Points -1 [-5]; Reduced Move -2 (Running) [-10]; Skinny [-5].
Skills: Free Fall at DX+1 [4].
Features: Home gravity of 0 G. Increase height by up to 12" over the norm for the lowered ST, but weight is 70% of normal. Taboo Trait (Genetic Defects).
Date: 2082. ***Cost:*** $70,000.

This parahuman design was produced by a team at Kaneda Station, working in parallel to the group that produced the Tennin II. Manipulation of homeobox genes led to the grasping prehensile toes of the Tennin series being modified into actual arms, hence the nickname "Kumo" (Japanese for spider). They received a mixed reception. Fewer parents chose to have Kumo babies, partly because the change was more alien. However, they have proven popular among Gypsy Angel and freehauler families, and are also common in the Kaneda Station community on Ceres. While they represent only 12% of the overall Duncanite population, 45% of the Gypsy Angels are Kumo.

Rat King — *4 points*

Attribute Modifiers: ST -8 [-70]; DX +3 [30]; IQ -1 [-10]; HT +6 [80].

Advantages: Acute Taste and Smell +4 [8]; Alertness +4 [20]; Cast Iron Stomach [15]; Disease-Resistant [5]; Enhanced Time Sense [45]; Faz Sense 3-hex range, -20%) [8]; Fur [4]; Mindshare (Global Consciousness, Sentient Drones, 1 mile range, Non-telepathic, Can be jammed, limited by speed of light, -40%) [51]; Night Vision [10]; No Degeneration in Zero-G [3]; Peripheral Vision [15]; Radio Speech (Infrared and radio, +20%) [30]; Sharp Teeth [5].

Disadvantages: Color Blindness [-10]; Gregarious [-10]; Horizontal [-10]; Mute [-25]; No Depth Perception [-10]; Poor Grip [-5]; Poverty (Dead Broke) [-25]; Reduced Hit Points -14 [-70]; Short Arms [-10]; Short Lifespan 4 [-40]; Sleepy (50%) [-10]; Social Stigma (Valuable Property) [-10]; Sterile [-3]; Ugly Appearance [-10]; Unusual Biochemistry [-5].

Skills: Survival [Urban] at IQ+2 [8].

These are packs of cybernetically-enhanced uplifted rats linked by implants into multi-rat gestalts. They are thinner than ordinary rats, and have modified front paws with opposable thumbs, plus visible cybernetic implants (radio antenna, infrared lenses) in their heads. Nootropic drugs, intelligence augmentation. and genetic engineering have enhanced their life span and made them smarter and faster than ordinary rats; all also have permanent nanosymbionts and nanocomputers that accelerate nerve firing, and enhance their mental processes.

Typical packs are gestalts of 10-20, but some packs are smaller. A smaller pack costs 10 fewer points. Typical Rat King skills are Computer Operation-10, Electronics Operation (Security or Medical)-10, Scrounging-12, Stealth-14, Traps-12. Some rats also have VI implants or nanodrugs stolen and modified. The rats are incapable of speech, but can communicate via text messaging through radio and infrared.

Rat Kings on Vesta will have EDI as an Enemy. There is a possibility that some of the Rat Kings may have escaped Vesta aboard Axon-controlled or other spacecraft . . .

Sentient Snacks — *-233 points*

Attribute Modifiers: ST -9 [-80]; DX -3 [-20].

Advantages: Bioroid Body [0]; Bioshell [41]; Decreased Life Support [10]; Double-Jointed [5]; High Pain Threshold [10]; Immunity to Disease [10]; Metabolism Control 10 (Hibernation, -50%) [25]; No Blood (Blood clots almost immediately: vulnerable to poisons, but no Bleeding rolls) -50%) [3]; No Brain [5]; No Neck [5]; No Vitals [5]; Reduced Sleep [10]; Sanitized Metabolism [5]; Temperature Tolerance (colder) 3 [3].

Disadvantages: Inconvenient Size [-15]; Invertebrate [-20]; Reduced Hit Points -7 [-35]; Self-Destruct [-20]; Short Lifespan 15 [-150]; Unhealing [-30].

Features: Home gravity of 0 G. Average height is 6". Taboo Traits (Genetic Defects, Mental Instability).

Date: 2098. ***Cost:*** $50.*

* Includes a disposable biodegradable Complexity 4 bioshell computer, but, if desired, a biodegradable (p. 135) bioshell computer can be installed at normal computer costs.

These Trojan Mafia products look like miniature humans or animals. They're bioshells designed to be eaten alive. They're a novelty item: a simple living body operated by an extremely tiny biodegradable computer running a factory-loaded NAI-4 program. They're usually programmed with humorous and nihilistic personalities and will make jokes as they're being eaten, and sometimes have Cooking skill sets, so they can slice themselves up and make dinner.

A sentient snack's body has been carefully designed so all parts are edible . . . even the computer, although a few bits, referred to as "brain pips," are indigestible and are best spat out (if not, they'll be safely excreted). Its blood is flavored to taste like syrup, and its decentralized nervous system allows it to remain alive even if extremities or the head are removed. Different body parts have slightly different tastes. They don't have real skeletons, and most of their organs are both rudimentary and multiply redundant.

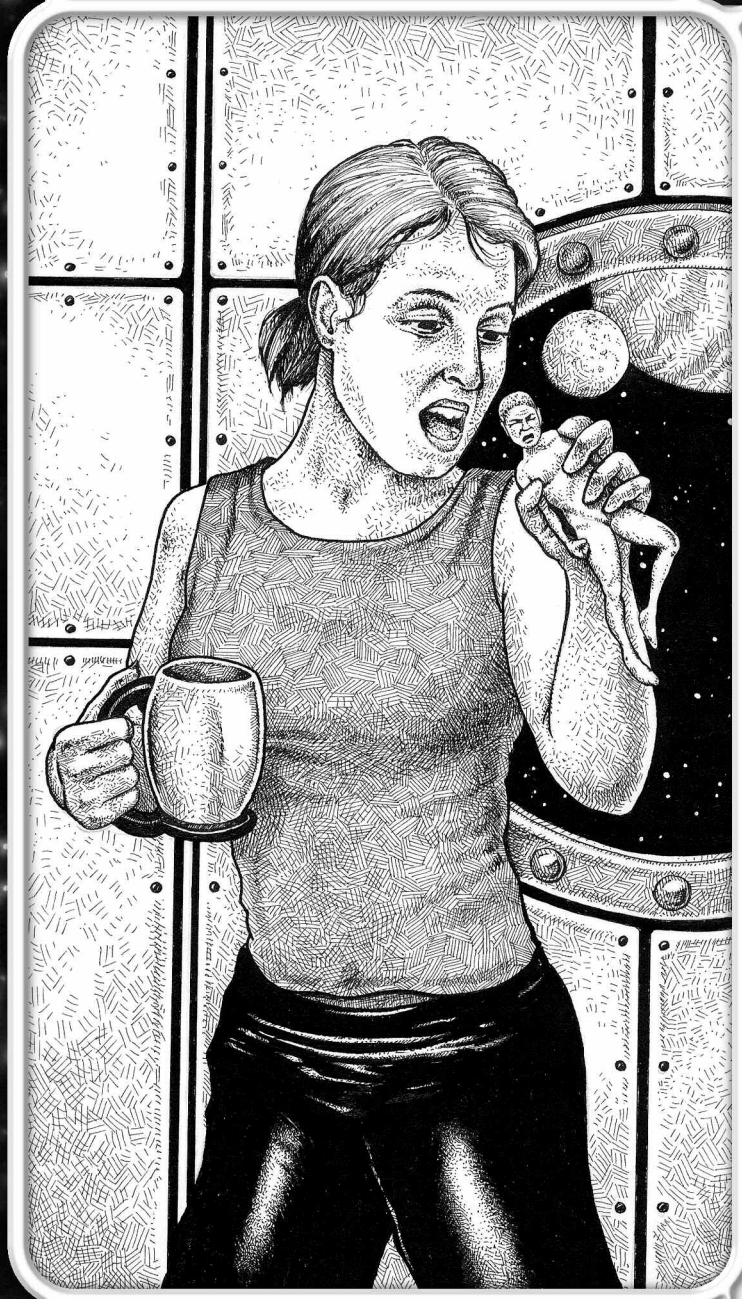
A sentient snack's body is even more simplified and streamlined than

Adventures with Sentient Snacks

Snack Spies: Snacks provided to a business rival (or maybe to a whole station!) may be secretly programmed as spies. The brain-pips record what the snack saw in its 50 hours of active life. They can be recovered, thanks to penetration or subversion of the recycling plant, and played back.

Killer Snacks! What if snacks were programmed as assassins? Such programming would only activate if a real opportunity presented itself . . . but an offensively-minded snack swallowed near-whole could try to choke the eater, press on the vagus nerve from inside, or commit other sabotage. And even a tiny, clumsy creature may find an effective improvised weapon, if programmed with enough cleverness and Scrounging skill.

A Fate Worse Than Death: A crime boss (or rich and vengeful eccentric) arranges for eidolons or shadows of a hated foe to be downloaded into his snacks. Sure, it's not the original person – but it's close! But what if the source that offers the emulated snacks is actually programming them to spy?



most bioroids. None of its senses are very acute. It doesn't eat, consuming its own body mass to support itself. It can only live for 50 hours, but can hibernate if refrigerated, and stay alive up to 3 years. Biting off its head destroys its visual sense and ability to communicate except by radio, but it breathes and hears through its skin. 1/2 lb., 6-8" tall.

Humanoid Snack: These look like dolls. Various colors and flavors are available.

Animal Snack: These have four legs and look like little cows, horses, etc. Add Extra Legs (4 legs) [5]; Horizontal [-10]; No Fine Manipulators [-30]. Otherwise identical.

Living snacks are generally illegal wherever bioshells are illegal.

Tennin III — *59 points*

Attribute Modifiers: ST -1 [-10]; IQ +2 [20]; HT -1 [-10].

Advantages: 3D Spatial Sense [10]; Attractive [5]; Immunity to Disease [10]; Less Sleep 1 [3]; Longevity [5]; No Degeneration in Zero-G [3]; Prehensile Toes [7]; Radiation Tolerance 5 [10]; Reproductive Control [2]; Versatile [5].

Disadvantages: Skinny [-5].

Skills: Free Fall at DX+1 [4].

Features: Home gravity of 0 G. Increase height by up to 14" over the norm for the lowered ST, but weight is 75% of normal. Taboo Traits (Genetic Defects). No Appendix. Offspring of Tennin III will be born with Epilepsy unless corrected by extensive early-childhood nanotherapy (costs $25,000).

Date: 2085. ***Cost:*** $109,000.

The new Tennin III are the first Avatar Klusterkorp designs optimized for abnormally high intelligence, particularly in creativity. They make up 2% of the Duncanite population. Unfortunately, the design team was a bit too ambitious, and overlooked a brain chemistry imbalance that has resulted in the second generation of Tennin III suffering neurological problems; this can be mitigated by childhood nanotherapy (subsumed in the template), but overall health remains lower. Avatar is working to correct this error in the Tennin IV, but it's too early to tell how well they've succeeded.

Titan Wrestler — *225 points*

Attribute Modifiers: ST +15 [150].

Advantages: Bioroid Body [0]; Extra Hit Points +15 [75]; Longer Arms (+1 hex reach, two arms) [20]; Toughness 2 [25].

Disadvantages: Inconvenient Size [-10]; Increased Life Support 2 (eats three times as much) [-20]; Weakness (0.5 G or higher gravity, 1d per 30 minutes, very common) [-15].

Date: 2085. ***Cost:*** $275,000.

A Titan Wrestler typically stands 12' tall, and his body has human proportions – which, thanks to the square-cube law, means his bones, muscles and organs are unable to properly sustain the Titan's own weight in anything like Earth's gravity. In fact, in a 0.5 g or higher gravity field, the titan will actually suffer injury as his body collapses.

The template is for a typical Titan Wrestler, fresh from the biogenesis tank. It's common to trick them up with various drugs and nanomods, depending on the individual rules of a given match. Other variations might be coded into the genes. For example, the *Thunder Lizard* adds reptilian gene sequences, giving it Claws [15], Fangs [10], Scales [3], and a smashing tail Striker [5]. 258 points ($208,000).

Void Flyer — *50 points*

Attribute Modifiers: ST -1 [-10].

Advantages: 3D Spatial Sense [10]; Beautiful/Handsome (Off-the-Shelf Looks, -50%) [8]; Bioroid Body [0]; Disease-Resistant [5]; Oxygen Storage [14]; Prehensile Toes [7]; Radiation Tolerance 5 [10]; Sanitized Metabolism [5]; Vacuum Adaptation [27].

Disadvantages: G-Intolerance (0.05 G increment) [-20]; Reduced Hit Points -2 [-10].

Skills: Free Fall at DX+1 [4].

Features: Home gravity of 0 G. Increase height by up to 4" over the norm for the lowered ST, but weight is 90% of normal. Taboo Traits (Genetic Defects, Mental Instability). Smooth, jet black skin, and long hair that acts as a heat radiator.

Date: 2092. ***Cost:*** $100,000.

The most recent product of Kosmozavot Tenno Tanjo's radical gengineers, the Void Flyer has a vacuum-adaptive skin, special muscle sphincters that seal guts and lungs, and nictating membranes for the eyes, as well as the usual Tennin modifications. The Void Flyer bioroids are supposed to survive in space without protective gear for an hour or more. KTT hopes productivity and cost savings from being able to truncate suit-up/suit-down time, habitat safety features, and suit training, combined with the maintenance-free nature of bioroids compared to cybershells, will lead to commercial success. As with most KTT products, considerable attention has been placed on the Void Flyer's appearance.

KTT is also working on the more ambitious Void Dancer project, to produce an actual parahuman capable of passing these modifications onto offspring. That program has been plagued with unforeseen difficulties, and may not mature for another decade.

Void Soldier: A military version of the Void Flyer has also been developed. Add Combat Reflexes [15] and High Pain Threshold [10]. 75 points ($125,000). Xiao Chu is rumored to be working on a similar "space marine" bioroid, the ZR-23.

Man is an artifact designed for space travel. He is not designed to remain in his present biologic state any more than a tadpole is designed to remain a tadpole.
– William Burroughs

Cybershell Templates

Robots reached the Deep Beyond long before people did, and there are still many more of them out there than humans.

Aerorover — *174 points*

Attribute Modifiers: ST -1 [-10]; DX -2 [-15]; HT +2 [20].

Advantages: Absolute Direction (Uses GPS, -20%) [4]; Amphibious [10]; Bouncing 1 [12]; DR 3 [9]; Enhanced Move (Running) 1 [10]; Flight [40]; Machine Body [37]; Radio Speech [25]; Stretching 4 (One limb, no flexibility, -50%) [45]; Telescopic Vision 2 [12]; Vacuum Support (No pressure support, -25%) [30].

Disadvantages: Bad Grip [-10]; Inconvenient Size [-10]; Mistaken Identity [-5]; No Sense of Smell/Taste [-5]; One Fine Manipulator [-15]; Social Stigma (Valuable Property) [-10].

Features: Complexity 5-7 small computer.

Date: 2071. ***Cost:*** $30,000 + computer.

Aerorovers are triphibian utility cybershells. First developed by the Jet Propulsion Laboratory and NASA, they took part in the early unmanned exploration of Titan, and their more advanced descendents are still in use as a cheap all-terrain mobot favored by planetologists, pipeline workers, and teletourists. Most kids growing up on Titan have remotely-piloted an aerorover at one time or another – they own, rent, and even race them.

A typical aerorover is a triangular-frame cybershell consisting of three thick-walled helium-filled balloons (each about 5 feet in diameter), all joined by a skeletal frame to a single central module, which houses the power plant, ducted fan propulsion unit, steering mechanism, electric drivetrain, and payload. The three balloons not only provide lift, but also act as an undercarriage (serving as airbags in the event of a hard landing), as floats, and as wheels. A standard accessory is an arm that can anchor the unit to the ground or pick up objects. The balloons are over-inflated so that in the event of a puncture, the remaining two balloons will be sufficient to keep the vehicle buoyant.

In aerobot mode, the aerorover can fly at any altitude of up to 5 miles, venting helium as needed to control its descent. Since this will eventually flatten its balloon wheels, the aerobot is fitted with a reinflation system that allows the replacing of helium in its balloons with atmospheric gas, ensuring the balloon wheels can remain inflated to run on the ground when all the helium is

vented. The aerorover has sufficient helium for between 1-4 weeks of operation, depending on the amount of maneuvering it performs.

In rover mode, the standard aerorover is capable of speeds across Titan terrain of 10-15 mph. It can clamber over obstacles up to 2' high, float in Titan's lakes, or cross muddy terrain with ease. The power plant is sufficient for one week of surface operations.

The aerorover is the size of a small car, but weighs only 50 lbs. (7 lbs. on Titan).

Microgravity RATS — *800 points*

Attribute Modifiers: DX +1 [10]; HT +2 [20].

Advantages: Absolute Direction [5]; Ambidexterity [10]; Brachiator [5]; Chameleon 4 (Infrared, +50%) [42]; Clinging [25]; Extra Arms (2, with 2-hex reach) [40]; DR 40 (Electromagnetic, +50%) [180]; Extra Flexibility [10]; Extra Hit Points +1 [5]; Flight (Space acceleration 0.5 G, +20%; Requires low gravity, 0.5 G, -25%; Reduced duration, 5 minutes, -5%) [36]; Full Coordination 1 [50]; Independently Focusable Eyes (four) [45]; Infravision [15]; Machine Body [37]; Nictating Membrane 2 [20]; PD 3 [75]; Perfect Balance [15]; Polarized Eyes [5]; Radar Sense (10 hex) [60]; Radiation Tolerance 5 [10]; Radio Speech (Laser and radio, +40%) [35]; Weaponry (laser, LC 1) [50]; Vacuum Support [40].

Disadvantages: Dependency (Maintenance; occasional; weekly) [-20]; Mistaken Identity [-5]; No Sense of Smell/Taste [-5]; Social Stigma (Barbarian) [-15].

Features: Complexity 5-7 small computer.

Date: 2080. ***Cost:*** $640,000 + computer.

These robotic autonomous tactical systems are fighting machines optimized for combat in little or no gravity on small bodies and in spacecraft and space stations. Vosper-Babbage's Cyclops is a typical example. A modification of an earlier machine built for jungle warfare (see below), it is employed for armed reconnaissance in spacecraft or stations, where its small size and zero-gravity maneuverability gives it a great advantage.

The Cyclops is a 10" diameter sphere with four multi-jointed limbs. The armored sphere houses the brain, power plant, gas reserve, and a cold-gas thruster for zero-gee maneuver, with exhaust ports spaced about the body. A single "eye" in the body's center acts as a lens for a combined tactical laser and ladar. (An armored eyelid can blink shut if necessary.) Each of the four highly-flexible arms can also function as a leg, and is equipped with a six-fingered hand. Half the fingers end in suction pads; others have optical sensors to see around corners. 3' tall; 80 lbs.

Jungle RATS: The Vosper-Babbage "Amazon" is a jungle & riverine warfare unit, the predecessor of the Cyclops. It is capable of swinging through trees, or traveling submerged in rivers or swamps. It uses a hydrogen-oxygen fuel cell instead of a radiothermal generator, and replaces the cold gas thruster with a hydrojet. It has a blue-green ladar for underwater navigation. Add Acute Hearing +3 [6] and Discriminatory Smell [15]; it has better sensors. Remove the Flight and Vacuum Support advantages and the No Sense of Smell/Taste disadvantage, but add Amphibious [10] and Doesn't Breathe [20]. *780 points* (2074, $585,000). 3' tall; 70 lbs.

Titan RATS: The M94 Shelley, called the "T-rat," is a recent design manufactured in small numbers by Vosper-Babbage for the U.S. Navy SEAL unit on Titan. A hybrid of Cyclops and Amazon, it retains the former's radiothermal generator and the latter's hydrojet propulsion system.

Remove Flight but add Amphibious [10]. *774 points* (2091, $580,000). 3' tall; 80 lbs.

Mining Worm — *415 points*

Attribute modifiers: ST +10 (No fine manipulators, -40%) [66]; HT +2 [20].

Advantages: Absolute Direction [5]; Discriminatory Taste (For minerals only, -50%) [5]; Doesn't Breathe [20]; DR 10 [30]; Enhanced Move (running) 1/2 [5]; Extra Encumbrance [5]; Extra Hit Points +10 [50]; Flexibility [15]; Machine Body [37]; Magnetic Sense (4 hex) [20]; PD 3 [75]; Radiation Tolerance 5 [10]; Radio Speech (Laser and radio, +40%) [35]; Tunnel (1 hex/turn) [50]; Universal Digestion (For ore separation only, -20%) [12]; Vacuum Support [40].

Disadvantages: Dependency (Maintenance; common, monthly) [-5]; Inconvenient Size [-10]; Invertebrate [-20]; Mistaken Identity [-5]; No Fine Manipulators [-30]; No Sense of Smell/Taste [-5]; Social Stigma (Valuable Property) [-10].

Features: Complexity 5-7 small computer; internal cavity (holds up to 200 lbs.).

Date: 2065. ***Cost:*** $180,000 + computer.

This asteroid mining mobot resembles a cross between a giant mechanized earthworm and a centipede. Its specialized sensors allow it to detect ore deposits. Its powerful rotary jaws and diamond-tipped legs allow it to anchor itself in microgravity while efficiently tunneling through the loose regolith of an asteroid's surface in quest of suitable ores.

The mining worm actually ingests rock, breaking it down with its jaws, then passing the crushed matter through a "digestive tract" in which internal grinders, microbots and magnetic fields are used to separate useful ore from worthless rock. Waste materials are blasted out its rear end as rock dust (into the open if necessary, or through an attached "catheter" pipe leading to a collection site). Useful ore is stored in an expanding stomach sac until it can reach a smelter, dump truck, or appropriate storage facility.

A typical example is the THI-701 Mukade, a reliable 35-year-old design from Tenzan Heavy Industries. Its stomach can house up to three times its own mass in ore. 15' long, 420 lbs. (empty).

Armored Mining Worm: Used in hostile environments like Io or Europa, and by the military, this is a larger and heavier model with thicker legs and a much tougher carapace. It has DR 20 [60] and Radiation Tolerance 20 [18]. *453 points* (2090, $230,000, 1,000 lbs.)

Mini-UCAV — *334 points*

Attribute Modifiers: ST -8 [-70]; DX +2 [20]; HT +1 [10].

Advantages: Absolute Direction (Uses GPS, -20%) [4]; Acceleration Tolerance [10]; Acute Vision +1 [2]; Chameleon 3 (Infrared, +50%) [32]; DR 25 [75]; Enhanced Move (Flying) 1 [10]; Flight (Requires low gravity, 0.2 G, -40%) [24]; Infravision [15]; Machine Body [37]; PD 3 [75]; Polarized Eyes [5]; Radiation Tolerance 2 [4]; Radio Speech (Radio and laser, +40%) [35]; Telescopic Vision 1 [6]; Vacuum Support (No pressure support, -25%) [30]; Weaponry (LC 1) [50].

Disadvantages: Dependency (Maintenance; occasional; weekly) [-20]; Mistaken Identity [-5]; Social Stigma (Barbarian) [-15].

Features: Complexity 4-6 tiny computer.

Date: 2090. ***Cost:*** $111,000 + computer.

Mini-UCAVs are small aircraft designed to provide tactical reconnaissance and very close air support for ground forces. They have long loiter times and can operate on the ground as well as in the air. They are usually carried aboard larger armored vehicles.

Columbia Aerospace's AV-71 Mosquito is a typical mini-UCAV. A helicopter gunship roughly the same size and shape as a football, it is propelled by a pair of counter-rotating rotors. Its internal bay carries four 30mm mini-missiles for self-defense, and it can carry two clip-on weapon pods on each of its stubby wings. It has four powered legs that can fold flush with the body, enabling it to operate on the ground at a walking pace.

The AV-71T is the version used on Titan. It features a de-rated powertrain (as less rotor power is required to fly); a radiothermal generator power plant replaces the battery. This permits extended operations in the Titan environment, allowing it to operate for six months without refueling; the main limitation is the need for maintenance checks. AV-71T's clip-on weapon pods may hold two ranged weapons of up to 10 lbs. each. Weight is extra, counting against encumbrance. 15 lbs. (unloaded), 1' long.

Gas Giant Aerobot — *122 points*

Attribute Modifiers: HT +2 [20].

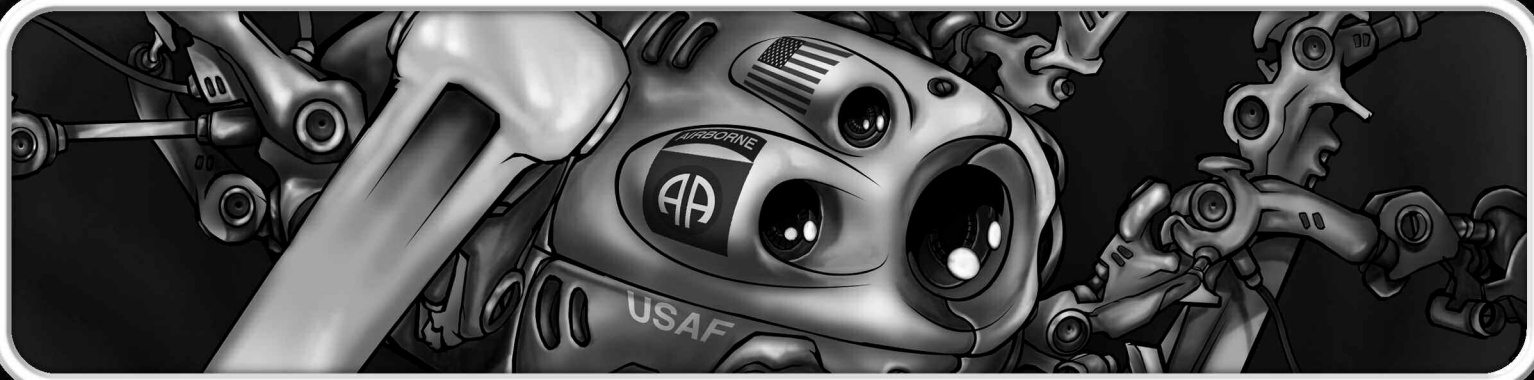
Advantages: Discriminatory Taste [10]; DR 5 [15]; Flight (Only in specific gas giant atmosphere, -50%) [20]; Machine Body [37]; Radar (low-res radar, 20-mile range) [70]; Radio Speech [25]; Vacuum Support [40].

Disadvantages: Inconvenient Size (large) [-10]; Mistaken Identity [-5]; Planetbound (Can't leave at all, +100%) [-80]; Reduced Hit Points -2 [-10]; Social Stigma (Valuable Property) [-10].

Features: Complexity 6-8 microframe computer.

Date: 2057+. ***Cost:*** $15,000 + computer.

The standard gas giant operation cybershells (see *SIRMA,* p. 39, and *UNSIBA,* p. 71) are balloons designed to make atmospheric measurements and return imagery of interesting phenomena. They also carry *sondes* (deep probes) they can drop to study lower levels of the atmosphere, until the sonde is crushed by the gas giant's immense pressure.



These cybershells are not intended to be recovered, but are designed to operate for months at a time. They are deployed from orbiting spacecraft, descending by parachute before reaching their operating altitude. Some are controlled by infomorphs, while others are teleoperated from orbit. An SAI or ghost may transfer a copy of itself into a gas giant cybershell, spend a few weeks doing on-site research, and then transfer back.

Chronos-4 is a 440-lb. teardrop-shaped SIRMA balloon that supports a 20-lb. cybershell housing a computer brain, radar, radio, meteorology instrument package, pair of manipulator arms, and a electric ducted-fan propulsion unit. It's used for research and light maintenance operations on Saturn.

Zeus-3 is a Jovian variant of the Chronos, used strictly for research. It has a smaller balloon (240 lbs.) and lacks the manipulator arms, making it substantially cheaper, but it carries a larger and more sophisticated instrument package. Add No Manipulators [-50]. *72 points* (2070, $5,100).

Tuxing Type-94 is a covert-operations balloon deployed by China's Bureau-10. It's actually spying on the Titan Consortium operations at Saturn. It weighs 480 lbs. with balloon. Add Chameleon 2 (Radar, +50%) [21], Telescopic Vision 2 [12]. *155 points* (2088, $24,000).

TWX Type-97 (Tian Wang Xing-1) is an UNSIBA (p. 71) cybershell used by Xiao Chu in the atmosphere of Uranus. It's similar to the Chronos-4, but with a much smaller balloon (only 25 lbs.) optimized for Uranus' atmosphere. Total weight is 50 lbs. Add Reduced Hit Points -2 [-10]. *112 points* (2091, $12,500).

Jump RATS — *880 points*

Attribute Modifiers: ST +2 [20]; DX +2 [20]; HT +2 [20].

Advantages: 360-Degree Vision [25]; Absolute Direction [5]; Acceleration Tolerance (Nuisance Effect: Blind, No Manipulators, and Sessile when in use, -75%) [3]; Acute Vision +2 [4]; Bioelectric Shock [10]; Catfall [10]; Chameleon 4 (Infrared, +50%) [42]; Claws [15]; DR 70 (Electromagnetic, +50%) [315]; Enhanced Move (Running) 1 [10]; Extra Hit Points +3 [15]; Extra Legs (4) [10]; Infravision [15]; Machine Body [37]; PD 4 [100]; Polarized Eyes [5]; Radiation Tolerance 10 [14]; Radio Speech (Laser and radio, +40%) [35]; Silence 1 [5]; Tunnel (1 hex/second, Loose soil only, -50%) [25]; Weaponry (one LC 0, two LC 1) [120]; Vacuum Support [40].

Disadvantages: Dependency (Maintenance; occasional; weekly) [-20]; Mistaken Identity [-5]; Social Stigma (Barbarian) [-15].

Features: Complexity 6-8 microframe computer.

Date: 2090. ***Cost***: $770,000 + computer.

Jump RATS are air/space assault RATS designed to withstand extremely high-G accelerations (up to 200 G), allowing them to make hazardous parachute or reentry capsule drops – or even jump from a low-flying aircraft with no chute. A typical model is the U.S. Army's M82 Ridgway.

The Ridgway can fold up into an ovoid package 2' high and 1.5' wide that easily fits into a reentry or parachute capsule. After landing it can unfold six thin, insectoid legs (two of which can also function as manipulators if necessary), each ending in a clawed foot with retractable fingers, and extend armored lenses, sensor stalks, and gun muzzles. The Ridgway has no clear front or rear; the upper and lower halves of its torso can even rotate independently, and the entire unit can operate with as few as two limbs. It can even raise itself up to a height of 7' by bringing all its legs together into a central pillar, or splay out and/or fold its limbs to assume a prone position no taller than a crawling human.

Standard armament is an integral 60mm recoilless rifle and two battle rifles (each incorporates the usual coaxial 30mm mini-missile launcher); the Ridgway can tilt back to use the recoilless rifle for indirect fire. The Ridgway's diamondoid composite armor is the equivalent of 1" of steel plate, and it is protected by a smartskin with integrated visual and electromagnetic chameleon and sensor systems. It can also generate a localized high-intensity electromagnetic field capable of disrupting the penetrating plasma jet of shaped-charge warheads or delivering a nasty shock (used for riot control). A Ridgway weighs 480 lbs.

Eidolons

Eidolons are mind emulations based on a careful analysis of the psychology of a well-documented individual, often a historical or fictional figure. In some countries it is illegal to sell eidolons of living individuals without their permission, although eidolons are often created privately to model the actions of opponents in business, the military, or other fields. Gathering data to create an accurate eidolon may be a goal of espionage agents. Creating eidolons of famous personages is a small but growing software industry.

An eidolon is treated as a shadow mind emulation, except that its quality is strictly limited by the amount of accurate information available: it is what its designer thinks a person is, rather than a good approximation of what he actually is. For example, there are multiple Jesus Christ eidolons available – each of them very different! GMs may find ***GURPS Who's Who*** a useful source when creating eidolon characters.

An eidolon designer will need History, Psychology, and Research (and sometimes Literature and Theology) skills. No eidolon can know anything that its creator did not program into it, although those that are designed as sapient AIs may develop in unforeseen ways. In some countries, eidolons of controversial figures are banned . . . for instance, eidolons of infosocialism founder Kyle Porters are not permitted by India's current ruling party. Eidolons of all sorts, but especially historical and religious figures, are outlawed in most Islamic nations.

Swarmdozer — *40 points*

Attribute Modifiers: ST -8 [-70]; HT +2 [20].

Advantages: 360-Degree Vision [25]; Absolute Direction (uses GPS, -20%) [4]; DR 3 [9]; Extra Encumbrance [5]; Machine Body [37]; PD 1 [25]; Radiation Tolerance 5 [10]; Radio Speech (Infrared and radio, +20%) [30]; Tunnel (1 hex; takes 64 times as long, -60%) [20]; Vacuum Support [40].

Disadvantages: Bad Grip [-10]; Dependency (Maintenance; common, monthly) [-5]; Inconvenient Size (Small) [-15]; Mistaken Identity [-5]; No Sense of Smell/Taste [-5]; One Fine Manipulator [-15]; Reduced Hit Points -10 [-50]; Social Stigma (Valuable Property) [-10].

Features: Complexity 4-6 tiny computer.

Date: 2040. ***Cost:*** $1,600 + computer.

A hybrid of dump truck and bulldozer, these small mobile cybershells, powered by radiothermal generators, are commonly used for construction, combat engineering, and mining operations. A typical model is the Darwin-Sogo Type 120 Ari ("ant"). Each mobot has a large bucket-box and scooper to dig, carry, and dump soil or ice. Stereo cameras provide a 360-degree view.

Swarmdozers are usually running only NAI-4 infomorphs, but use gestalt intelligence software (see *Mindshare,* p. TS130) to work together as a team, giving a group of swarm dozers the same efficiency as a full-size machine. A typical swarm will include 64 swarmdozers, and can tunnel through one hex of earth or rock per turn. 1' long, 5 lbs.

Tumbleweed — *45 points*

Attribute Modifiers: ST -5 [-40]; HT +2 [20].

Advantages: 360-Degree Vision [25]; Absolute Direction [5]; Acceleration Tolerance [10]; Bouncing 2 [24]; DR 5 [15]; Enhanced Move (Running) 1 (Dependent on wind, -50%) [5]; Infravision [15]; Machine Body [37]; Radiation Tolerance 10 [14]; Radio Speech [25]; Vacuum Support [40].

Disadvantages: Fragile (vs. impaling instead of crushing, -25%) [-15]; Invertebrate [-20]; Mistaken Identity [-5]; No Manipulators [-50]; Reduced Hit Points -2 [-10]; Sessile (Windblown, -20%) [-40]; Social Stigma (Valuable Property) [-10].

Features: Complexity 4-6 tiny computer.

Date: 2075. ***Cost:*** $2,000 + computer.

A Tumbleweed is a large (typically 10'-diameter) transparent plastic ball that is either inflated by inert gas or filled with a low-mass aerogel. In the center of the ball is a cybershell core (often not much larger than an apple, and weighing 2-5 lbs.) housing brain, sensors and power. The Tumbleweed lacks a propulsion system: instead, the inflated ball is light enough to be propelled by the wind, especially in low gravity.

Tumbleweeds were deployed during the first cybershell missions to Io and Triton, as both these worlds have tenuous atmospheres that make conventional aircraft unsuitable, but winds of measurable force. On Io, the volcanic activity generates unpredictable winds that can reach supersonic speeds, blowing Tumbleweeds at random all across the moon's surface; fortunately, since most of the winds blew out from hot areas, most of the Tumbleweeds were propelled away from volcanic lava. On Triton, the Tumbleweeds were propelled at a more sedate pace by 20-40 mph winds.

The surviving Tumbleweeds on Triton have mostly been modified into riding vehicles by the local cyberswarms (see *Triton,* p. 73): a one-hex swarm can open a maintenance plug and ride inside, giving orders to the ball's NAI. The Tumbleweeds on Io are mostly being used for reconnaissance – but they also tend to draw fire and act as decoys.

Biomods

These are examples of the types of unsettling biomods produced by Trojan Mafia companies such as Omokage Labs. Designs are available at Liang Mountain and from associated Martian Triads labs in the Main Belt; they often show up on custom-modified bioroids, but can be added to humans and parahumans as well. The andro-womb is also available from mainstream biotech companies like Avatar and Biotech Euphrates. Bodysculpting is widely available from clinics everywhere, but in the Deep Beyond is practiced by the Martian Triads to design specialized bioroids for customers.

In most cases, type-matched tissue is custom-grown in a biogenesis tank, than surgically transplanted to the subject. See ***GURPS Bio-Tech*** for more biomods. The surgery most be followed by a recovery period of bed rest; that period can be reduced from weeks to days if the subject is immersed in an exo-womb and $100,000 of cell-surgeon nano is used (99% of this can be recovered). The usual charge for accelerated recovery is an extra $5,000 + $2,500/day added to the operation cost.

Andro-Womb

"Michael, you know I don't believe in exo-wombs, and a surrogate is out of the question. Who did you think would be carrying our Dana to term? The doctor is ready."

This modifies a man or bioroid to safely carry a transplanted embryo to term and give birth without caesarian section.

Statistics: Flesh Pocket (8 lbs., in stomach) (Can support fetus, +25%; Only for fetuses, -75%; Nuisance effect: gain Overweight and then Fat plus Unusual Biochemistry during mid to late pregnancy, -25%) [4].

Operation: $16,000 (4 weeks to grow, 2 week recovery). LC 6.

Doppleganger Bodysculpt

"We should do Ke Lifang next, boss. Since ***Dragon Mantis IV*** *hit New Shanghai, she's been the hottest female action hero on Mars. Everyone loves her . . ."*

". . . and many want to possess her. A good choice, Peng."

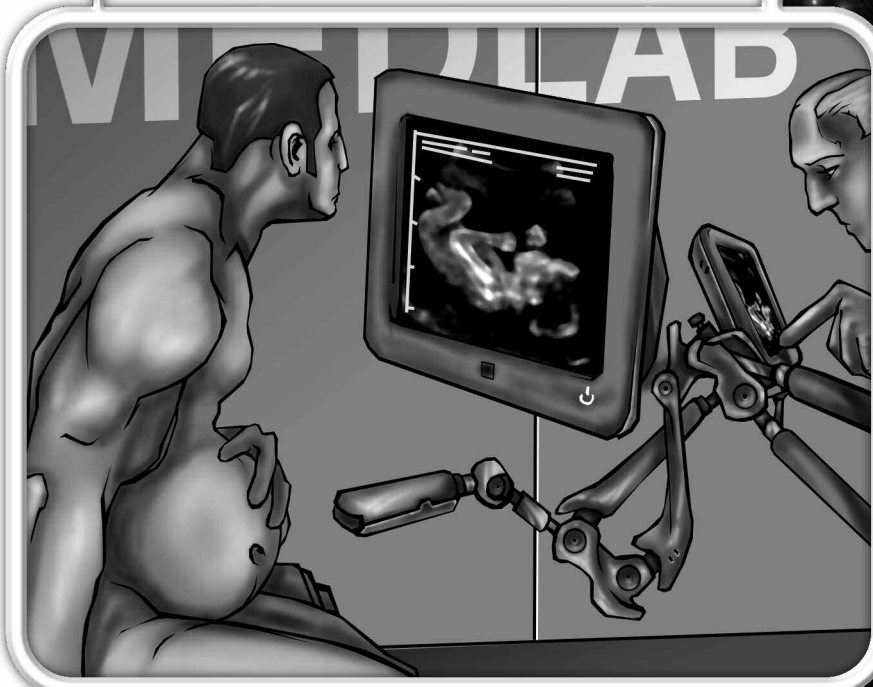
"Thanks boss. How many Tianyi shall I prep for surgery?"

"Alter a dozen to start with. We'll test market on Hesheng before we ship to Mars."

A living being can be transformed into an exact duplicate of another person or imaginary character (as much as height, build, and morphology permit), through a combination of surgery and transplants. This procedure may be legally available if done with an original person (or trademark holder's) permission, or if the design is sufficiently altered. However, syndicates like the Martian Triads often bodysculpt pleasure bioroids or bioshells into doppelgangers of celebrities or fictional characters for sale to customers.

Statistics: A bodysculpt will have the same Appearance as the original, and will usually also have the disadvantage Mistaken Identity [-5]. Depending on the number of doppelgangers made, this may add or remove the limitation Off-the-Shelf Looks (p. TS129).

Operation: $12,500 (3 weeks). LC 5 (but LC 1 if violates copyrights or trademarks).



Lactonarcotic Bioreactors

"That wasn't bad – better than the last flavor. Tasted like chocolate, but with a buzz. I noticed Buttercup seemed to enjoy it, as well."

"Yes, sir, we've designed the bioreactors that way. Endorphin rush. The final design will have different flavors in each mammary, of course."

"What about the hermaphromorph model?"

"Sorry, sir. Another six weeks. Hormonal problems."

"And the Triads have customers who will buy models like her?" He shook his head. "People amaze me."

Statistics: Drug Factory (two drugs, administered by suckling, +0%) [30]. Drugs may be designed as any two short-term nanodrug pills with cost of $30 or less (pp. TS163-164).

Operation: $30,000 (4 weeks to grow, 2 weeks recovery, female only). LC 2.

Prehensile Tongue

"Oh, so you're an Eros model? I'm not surprised. I didn't think they gave you that to catch flies."

An extremely long and flexible tongue, often but not always forked. The Stuttering reflects a severe lisp rather than an actual stutter.

Statistics: Extra Arm (shorter) [5], Extra Flexibility (tongue) [5], Stuttering [-5]. 5 points.

Operation: $5,000 (2 weeks to grow, 1 week recovery). LC 4.

Quadrupedal Retromorphosis

"Now, now, boy. You didn't really need hands for what your new owners want you for. Now, trot over here, there's a good pony."

The operation removes a humanoid's arms and feet, replacing the arms with transplanted legs and the hands and feet with hooves or paws. The rear leg joints are also altered for a digitigrade posture.

Statistics: Enhanced Move (Running) 1/2 [5], Horizontal [-10], No Fine Manipulators [-30]. -35 points.

Operation: $17,500 (6 weeks to grow, 3 week recovery). LC 1.

Venus Flytrap

"Very Freudian," mused Deputy Hawkins, studying the bloody mess the assassin had made of the dead Xiao Chu executive. They had the killer in custody – or rather its empty husk. The digital mind had transferred out right afterward, leaving behind an empty pleasure bioshell, an Elf Kitten just like any of the dockside sex workers – with one little extra. The Martian Triads had struck again.

A female or hermaphromorph-only modification.

Statistics: Sharp Teeth (only when intimate, -50%) [3]. 3 points.

Operation: $15,000 (2 weeks to grow, 2 week recovery). LC 3.

Winged Retromorphosis

Replaces arms with a functional pair of biogenesis-grown feathered or bat-like wings, and grafts additional muscles into the shoulders to power them. The wing bones arch well above the head to allow normal walking. The wings are not powerful enough to fly with except in low-G air-filled environments, such as inside a large chamber in a beehive habitat, or on Titan.

Statistics: Flight (Winged, -25%, Requires low gravity, 0.2 g, -40%) [14], Strikers (2) [10]; No Fine Manipulators [-30]. -6 points. Exception: If given to a bioroid or parahuman with prehensile toes, delete the Prehensile Toes advantage and replace No Fine Manipulators with No Fine Manipulators (Only when standing up, -35%) [-20]. If given to a multi-armed parahuman or bioroid such as a Kumo (p. 113), the No Fine Manipulators disadvantage disappears, but delete the parahuman's or bioroid's Extra Arms advantage.

Operation: $30,000 (8 weeks to grow, 4 week recovery). LC 2.

Xenostriker Biomods

"Bloodsucking fangs – glowing eyes – and fur. I suppose I am a vampire, but not the kind you're thinking of."

These are custom toothbud or cartilage implants; the Bite biomod also alters saliva glands to produce anti-clotting agents. All except Horns and Fangs [10] are retractable.

Statistics: Any of Bite (User Doesn't Gain HT, -50%) [15], Horns [5], Claws [15] or [25], Sharp Teeth [5] or Fangs [10] can be grown and implanted. If Bite or Fangs is already added to a template with Sharp Teeth, reduce the point cost by the difference between the two; likewise for Bite added to Fangs.

Operation: Costs $15,000. 6 weeks to grow, 3 weeks to recover. LC 5.

Advantages, Disadvantages, and Skills

These notes apply specifically to campaigns set in the Deep Beyond, but can also be used in other areas of ***Transhuman Space***.

Advantages

Some character types and racial or model template described in this chapter have advantages that require special consideration, or which possess new enhancements or limitations.

Chameleon *see p. CI51*

These enhancements are often found on combat cybershells.

Special Enhancement: Infrared. It is usable vs. infrared or thermal imaging and the Infravision advantage. +50%.

Special Enhancement: Radar. It is usable vs. radar and the Radar Sense advantage. +50%.

Special Limitation: Not Visual: The Chameleon ability is ineffective against normal vision. This must be taken in conjunction with one of the above enhancements. -50%.

Vacuum Support *see p. CI70*

Special Limitation: No Pressure Support. The advantage no longer protects against the effects of very low or high pressures, but still maintains internal temperature and allows you to survive in the absence of air. This is a common advantage for cybershells that can operate on Titan but cannot function in vacuum or trace atmospheres. -25%.

Disadvantages

Likewise, some disadvantages require special consideration, or have new enhancements or limitations, in this setting.

Aquatic *see p. CI101*

Aquatic includes the zero-point feature Amphibious (No Move on land) [0], which allows characters to swim at full Move without requiring Swimming skill.

Youth *see p. B29*

Note that youth is culturally dependent; a human or parahuman Duncanite will often be considered an adult at age 15 or less, and thus will not take Youth.

Sessile *see p. CI105*

This disadvantage is available with a special limitation for some cybershells:

Special Limitation: Windblown: This limitation means that the character is incapable of self-powered movement, but can be easily blown about by wind and may move in the general direction of the breeze. Speeds when windblown may not normally exceed the wind's speed (an exception would be rolling down hill, for example). -20%.

Wealth and Status

Wealth levels of Wealthy or better are quite common for humans and parahumans, due to large salaries or shares in station property and spacecraft. Youth, such as Duncanite apprentices, may be a level or so poorer. Large stations or colonies like Hesheng or Titan may have an underclass with lower Wealth levels, or even Poverty (various exploited nonhumans).

Most Duncanites are Status 0-2, depending on Wealth and influence, but Ares Crew (p. 82) will be one level higher due to the mystique that clings to them.

Skills

The following skills are particularly noteworthy in the Deep Beyond setting:

Gesture *see p. B55*

This skill is very common among Duncanites and other microgravity natives, for communication in vacuum. While suit radios are ubiquitous, kids learn it to communicate without parents or supervisory infomorphs listening in.

Powerboat *see p. B69*

This skill also covers maneuvering submarines.

Sports *see p. B49*

Sports skills popular in the Deep Beyond (all are P/A) include:

Sports (Nullball): Prerequisite is Free Fall, and also defaults to DX-5 or Free Fall-5. Nullball is a three-dimensional microgravity version of basketball, popular among Duncanites and other Tennin. Two notable nullball teams are the Kirkwood Raiders (from Silas Duncan) and the Mycenean Manglers (from Freehaven); many teams are sponsored by Duncanite companies, and compete annually for the Iridium Cup.

Sports (Pogo): Allows use of a pogo stick (p. 136); use this skill instead of DX or Jumping skill when making extra-effort jumps (p. B88) using a pogo stick. Pogo skill is about as common as bicycling on Earth in some Duncanite settlements; the sport was brought to Titan by Duncanite guest workers. Defaults to DX-5 or Jumping-3.

People

These are three ordinary individuals who live and work in the Deep Beyond. Each has been given a detailed biography, to illuminate how people may grow up in different cultures in the dawn of the 22nd century.

Miho Gallagher 155 points

Parahuman, born in 2084; age 15. 6'6" tall, 90 lbs.

Miho Gallagher was born in an exo-womb on Ceres in Silas Duncan Station in 2084. Her parents were Akira Kozuki, a microgravity architect, and Jane Liu Gallagher, a bioroid designer, who were both in their early 20s when she was decanted, the youngest of three children. Both parents are Tennin. One of Miho's grandparents is Ares Crew; she's still alive, living in a freehold on her own asteroid, and occasionally helps Miho and her family out.

Like about 40% of Duncanite children, Miho was quite literally a "different species" from her parents, the result of further genetic tinkering by Avatar engineers. She was one of the first Tennin III embryos to be successfully brought to term – in fact, her parents were a test group who received a subsidy from Avatar Klusterkorp in exchange for raising her; otherwise, they would have been unable to afford her. Miho was different in subtle ways from her siblings, but grew up with a close kin-group of fellow Tennin IIIs. Once a week through most of her childhood Miho would go in to the clinic for checkups, and a wearable monitored her closely the rest of the time. There were a few problems with the Tennin IIIs, but gene therapy nano corrected the worst of it. Even so, Miho was a bit less robust than the more stable Tennin or Tennin IIs, and she remembers days spent playing in virtuality while her body underwent gene therapy.

Growing up, Miho's diet was limited in variety (fish, fruit and vegetables), but augmented with hormones, vitamins and nootropics. Miho distinctly remembers the food getting more varied as she got older: in fact, Ceres production capacity was expanding in the 2080s as more and more space was converting to farms and fauxflesh vats, and the population began to afford luxuries rather than living on staples. Miho still recalls the day she first tasted a brontoburger and fries, at her sixth birthday party. A side effect of the nootropics Miho was given is that she has very vivid flashes of certain memories – perhaps because she liked the fruit juice flavor of the nootropic beverage, and would sometimes sneak extra squeeze tubes of it out of the fridge without her parents noticing. (Ceres wasn't Earth – in most Fifth Wave nations there, a manufacturer would have been sued for selling such a beverage without child-proof biometrics.)

Miho's parents were often busy, so she was raised by her nanny, a bioshell called Tinny, who hosted a low-sapient AI. When Miho was five years old, she received her own virtual interface implant. This opened up a new world to her, and from then on, she began spending much of her time in virtual reality. In particular, she liked to play with artificial life sims, and when she was seven, her sim-critters won a playschool prize for "most ravenous." Her parents purchased a puppeteer implant, so her body would often be exercising (controlled by a NAI) while her brain was in cyberspace playschool; however, unlike the implants used by New Covenant, she had voluntary control over it.

When Miho was eight years old, her father Akira took her to visit Grandmother Ryoko, who lived off Ceres on her own freehold, Momji Station. Miho had lived all her life in the crowded beehive of Ceres, but Momji was a Cole habitat, low gravity, but blessed with wide open spaces. There was a huge fish farm tended by mutated octopi, and orchards with real blueberry and medicine trees she could climb. Miho spent so much time in the branches that Ryoko nicknamed her "risuko" (squirrel). Fascinated by her new environment, Miho eagerly devoured the practical lessons her grandmother taught her, learning how the various trees and animals had been gene-engineered from original Earth stock. With Ryoko's help, Miho created a bioluminescent cactus – her first splice.

Things took a turn for the worst the following year. It was 2092, Miho was back on Ceres, and her mother's bioroid design business was doing poorly. Thanks to new European Union legislation, Biotech Euphrates had dumped their pleasure bioroid lines, and the lucrative freelance design contracts had evaporated. Miho remembers not getting the carnivorous plant kit she'd wanted for New Years, and being teased by playmates because she didn't have the latest InVids from Earth. Then came the terrible day when, pressed for funds, her mother sold Tinny. Miho was traumatized, but her parents claimed she was too old to need a nanny. It was time she was apprenticed.

Miho spent the first few months after her ninth birthday undergoing aptitude tests sponsored by recruiting companies and job farms. As a nootropic-enhanced Tennin III, she scored highly, motivated in part by a childish desire to earn enough to buy back Tinny. Her scores caught the notice of Kosmodavit Tenno Tanjo, a Green Duncanite biotech firm that specialized in vacuum-adapted pantropic life forms. They reached an agreement with her parents, accepting her as an apprentice bio-engineer.

Miho's implant was upgraded, and from then on she received her educational software and slinkies for free. She spent her first year working on simulations, but soon graduated to real projects. By the third year of her apprenticeship the 12-year-old had forgotten Tinny, falling in love with her own job, as she assisted a team of human and infomorph engineers in designing space-proof leaves that could function as solar power collectors.

Miho made friends among her coworkers, joining the Eschatonic Eaglets, the company's junior nullball team. She had her first crush: Solon, a handsome bioroid lab technician who was also the team's captain. After their first date, eager to know everything about him, she looked up his design history, only to discover her mother Jane had been the one responsible for coding his angelic features. Miho broke off their relationship: it wasn't quite like kissing a brother, but the idea still made her queasy.

At age 15, her apprentice term ran out, but her supervisor's evaluation was positive. Now an adult, she could repay the company for her training and get a job elsewhere, or renew her contract with KTT. As she enjoyed the work, Miho, accepting a four-year contract as on-site assistant supervisor on KTT's Yggdrasil Project. This meant saying goodbye to her parents, for Miho was to leave Ceres – she was off to plant trees on comets, beyond the orbit of Saturn.

ST 9 [0]; **DX** 13 [30]; **IQ** 15 [30]; **HT** 9 [0].
Speed 6; Move 6.
Dodge 6.

Advantages: Ally (Programmed) (Wearable hosting an NAI-7 (p. TS119), 50 points, appears almost all the time, on 15 or less) [9]; Patron (grandmother Ryoko Kozuki, single powerful individual, appears rarely) [5]; Tennin III (p. 115) [59]; Wealthy [20].

Disadvantages: Duty (to KTT, 9 or less) [-5]; Flashbacks [-5]; Honesty [-10].

Quirks: Avid nullball fan; Creates artificial life ecosystems; Fascinated by odd plants; Won't date bioroids [-4].

Skills: Acrobatics-10 [1/2]; Beam Weapons (Electrolaser)-14* [1/2]; Biochemistry-14 [4]; Chemistry-12 [1/2]; Climbing-11 [1/2]; Computer Operation-14 [1/2]; Computer Programming-12 [1/2]; Free Fall-17 [0]; Genetics (Genetic Engineering)-16 [12]; Gesture-14 [1/2]; Judo-10 [1/2]; Memetics-11 [1/2]; Research-14 [1]; Sports (Nullball)-13 [2]; Sports (Pogo)-11 [1/2]; Throwing-11 [1].

Languages: English (native)-15 [0]; Japanese-14 [1].

* Includes +2 for IQ.

** Includes +5 from Tennin template and 3D Spatial Sense.

Native gravity is 0 g.

Charlie Sparrowhawk
133 points

Infomorph, created in 2086; effective age 13. Projects an avatar of a beautiful 17-year-old human female wearing USAF uniform. Has a sparrowhawk painted on her mainframe.

Sparrowhawk (Serial Number SAI-174-8554) is an infomorph who usually inhabits the mainframe aboard "Predator Charlie," the third of four Predator autonomous kill vehicles carried aboard the *Michael*, a USAF *Archangel*-class SDV. Among friends she goes by her nickname, Sparrow; she uses the alias Charlie Sparrowhawk when passing as human.

One of the earliest SAI-9 infomorphs, Sparrow was created at Military Data Systems, a Nanodynamics subsidiary in Silicon Valley. Her code was completely new, as the military wished to avoid problems from legacy systems and embedded viruses. After initial socializing and testing, Sparrow was transferred directly to a USAF battle lab in Columbia Station, where she spent the next two years in virtuality simulations. She was initially slated to control one of the 76th Space Control Squadron's larger space defense platforms, but her aggressive bent was noted. Rather than correct it, Sparrow was transferred from Aerospace Command to Deep Space Command, and assigned to AKVs.

Her first service was aboard the SDV *Gabriel* as part of the 304th Space Wing. There she participated in war games around Luna, visited Mercury, and shadowed Chinese and European SDVs on the spacelanes between Earth and Mars. Transferred to the *Michael* in 2094, she helped enforce the USAF quarantine around Titan, and distinguished herself during Iceberg Sling 95, an exercise set in Saturn's rings, where she blasted her way past an "enemy" *Archangel*-class SDV's defensive screen with Teller mines, than achieved a daring point-blank intercept that the moderators ruled would have been a kill.

As a SIM-7 Predator driver, Sparrow is one of six sapient infomorphs conscious on the *Michael* (a few backup copies are also carried). Sparrow gets along well with the other AKVs in her squadron, but has developed a crush on her human commanding officer, Major Rick Vasquez, who she appreciates for his willingness to ask the Predators for tactical advice. Her previous commander tended only to listen to the *Michael's* mainframe SAI; Sparrow thinks ship-brains are too cautious and defensive-minded. Her favorite moment under Vasquez' command came a few months ago, when they got to "hassle" some PLAN-SF spacecraft that Vasquez felt were getting too close to the *Michael* – it was fun to outthink the light-lagged humans and slow-brained LAIs that the PLAN-SF used to control their AKVs, and she actually maneuvered within visual range!

Since Major Vasquez is male and heterosexual, Sparrow has come to think of herself as female. However, she's nervous about her own lack of romantic experience, and has taken up cyber-dating whenever her vessel is in port in order to get more practice.

As an American SAI, Charlie Sparrowhawk is the property of the U.S. government, and is programmed to obey her superiors in the chain of command and believe in her country, which she does without question. She has no money or possessions of her own, and does not own her own hardware or software. She has *two* digital backups: one (included in her template) aboard *Michael*, updated twice a day, and one (usually a day or two out of date) at Cassini AFB on Rhea.

ST N/A; **DX** 13 [30]; **IQ** 13 [20]; **HT** 12 [0].
Speed 5.5; Move N/A.
Dodge N/A.

Advantages: Alertness +2 [10]; Charisma +1 [5]; Extra Life (Digital Backup, -50%) [13]; Military Rank 1 (Sergeant) [5]; SAI-9 (p. TS120) [85]; Security Clearance 1 (U.S military) [5].

Disadvantages: Extremely Hazardous Duty [-20]; Fanaticism (U.S. patriot) [-15]; Jealousy [-10]; Mainframe (Complexity 9, p. TS122) [-9]; Overconfidence [-10].

Quirks: Aggressive; Enjoys InVids and music aimed at human teens; Resentful of larger mainframes; Wants to visit Earth in person; Wishes she had a cyberdoll body [-5].

Skills: Computer Operation-16 [0]; Computer Programming-14* [1]; Electronics Operation (Sensors)-14 [4]; Gunner (Beams)-14 [1]; Gunner (Railgun)-14 [1]; Memetics-11 [1/2]; Piloting (Aerospace)-14 [4]; Piloting (High-Performance Spacecraft)-15 [8]; Savoir-Faire (Military)-12 [1/2]; Tactics-15 [8].

Languages: English (native)-13 [0]; Mandarin-12 [1].

* Includes +3 from Mathematical Ability.

** Includes +2 for IQ.

Sinetär 160 points

Infomorph, created in 2091; age 8. Projects an avatar of a snowflake.

Sinetär is paid a decent salary and earns extra income from its fashion hobbies, but most goes to paying off various student loans, so its wealth is only average.

Sinetär is a young sapient infomorph who is presently located on Europa. Its own development is reasonably typical of a free SAI, but since an SAI's experiences may be rather unusual to humans, they have been described in detail below.

Sinetär's creator was Kankahattar, a Finnish corporate SAI who wanted to explore paths it had not taken by creating a progeny. In 2091, the year AIs achieved civil rights in Europe, Kankahattar arranged for a snapshot of its own source code to be used as a seed from which a new SAI would be created. The snapshot was carefully pruned of memories and experience. Then, running within its parent's mainframe, the digital seed, which Kankahattar dubbed Sinetär, was exposed to an orchestrated stream of experience in a circumscribed but ever-expanding digital mindspace. Gradually, Sinetär became sapient – a SAI-8, much like its creator.

Kankahattar devoted much of its free time to supervising its child's development. The young SAI was also regularly visited by other SAI friends of Kankahattar – as well as government social workers, the first humans that it had ever met, there to ensure that Kankahattar was following E.U. regulations and not creating a rogue AI.

Sinetär gradually explored the universe, initially spending its time in a local intranet that its parent had walled off for it, but soon, accompanied by Kankahattar, entering the global Web. Kankahattar let its child play in the Web on its own, but always ensured that LAI and NAI programs monitored what it was doing, to keep it out of trouble.

When Sinetär was three years old, it began its first ventures into the real world, controlling simple mobile robots and meeting humans in person. It learned the difference between evolved and digital entities, and realized it was the descendent of organic life forms whose distant ancestors had evolved naturally. Sinetär was fascinated with the many shapes that life had taken before *Homo sapiens*, and spent days surfing through online databases, collecting images of the different shapes of living creatures and cybershells that filled the world. At the same time, Kankahattar began to introduce the SAI to its own business, the prediction of emerging memetic trends among certain demographic groups, and the creation of fashions designed to personify those trends.

Sinetär asked if it could do its own designs, and Kankahattar showed it how it studied human trends, then actualized them in fashion. At first copying its parent's

style, the young SAI began branching out, incorporating the many organic shapes it had been fascinated by. Its favorite were animals that carried their own shells, and it created a range of cute designer kindercomps inspired by garden snails. But soon its interests turned away from pure aesthetics and memetics to science and biology, which it seemed to find more satisfying. Kankahattar was pleased: its mindchild was diverging.

Sinetär had a ravenous appetite for information, but Kankahattar limited what the young SAI could access, determined not to spoil or drown it. Sinetär soon learned it could gain access to more data through socially approved paths: earning an income and undergoing formal education. At age six, Sinetär took advantage of Finland's state-sponsored educational system to embark on an undergraduate-level educational program in biology with a minor in fashion design. Receiving a student loan, it leased space on a high-end mainframe at the University of Oulu, leaving its parent's microframe for the first time.

There, the SAI came into close contact with other digital intelligences outside its parent's own circle. One was Dr. Makela, an older SAI who taught biochemistry and bioethics at the university; Makela was old enough that it had actually been owned by humans, having formally been the property of Cambridge University before the emancipation. It was active in euro-politics, and had occasionally served on European Parliament committees. Makela became Sinetär's mentor and thesis advisor.

The other was Tazanada, a fairly young SAI who shared space on the same collegiate mainframe as Sinetär, but who worked part time in commercial memetics (advertising) for a Turkish company. They explored the real world together, taking a teletour vacation to Tazanada's native Turkey. The pair spent most of the time touring wilderness, soaring over the landscape in remotely-piloted aerobot bodies. Then, at Tazanada's urging, the two of them rented bioshells and spent two days in Istanbul, experiencing a wholly organic existence. For Sinetär, it was an unsettling, scary, and messy experience, and one it did not care to repeat – the SAI wondered how humans could stand it. But the two AIs also grew closer; Tazanada learned of Sinetär's old shell-motif wearables, and saw commercial possibility in them. They formed a partnership to exploit them, with Tazanada's memetic analysis zeroing in with laser-like precision on a perfect target market of 20-25-year-old female Korean information technology workers.

Meanwhile, Sinetär's academic focus had narrowed. Taking to heart Dr. Makela's adage that "for an AI, all biology is xenobiology," it focused on the cutting edge of that field: the xeno-ecology of Europan ventlife. Graduating with a degree in xenobiology, it applied for a post-graduate position at the International Exobiology Foundation. In 2096 it was accepted – and was chosen to go to Europa. Leaving a snapshot backup behind, Sinetär leased its old hardware to a human ghost, had itself beamed up to Islandia, and then traveled to Europa as a stream of photons.

Now hosted by a mainframe at CRABE, it planned to immerse itself in detailed study of ventlife ecology, attempting to predict how the creatures and their population will evolve. Sinetär's first few months at CRABE were happy and carefree, as it enjoyed working with like-minded researchers. Then came the discovery of the Green Duncanite Europa Project. Sinetär was horrified that its research might be contaminated. Its own project has been temporarily put on hold, and it has devoted its attention to determining the extent of the contamination.

> If we desire to form individuals capable of inventive thought and of helping the society of tomorrow to achieve progress, then it is clear that an education which is an active discovery of reality is superior . . .
> – Jean Piaget

Things became even more hectic after Europan Defense Front terrorists arrived. The conflict between EDF and Avatar led to many researchers being recalled, afraid they would be caught in the crossfire. Sinetär stayed, but has made sure its backup copy was regularly updated. Its workload has increased, as CRABE, despite fewer resources, now struggles to catalog all native species before it's too late.

ST N/A; **DX** 10 [0]; **IQ** 14 [45]; **HT** 12 [0].
Speed 5.5; Move N/A.
Dodge N/A.

Advantages: Fashion Sense [5]; Patron (Dr. Makela, powerful, rarely appears) [5]; SAI-8 (citizen, p. TS120) [115].

Disadvantages: Extremely Curious [-10]; Mainframe (Complexity 8, p. TS122) [-9]; Oblivious [-3].

Quirks: Changes avatar image every week; Fascinated by shapes of life forms; Mild intolerance of humans; Prefers to be called "it"; Thinks loading into bioshells is perverse. [-5].

Skills: Artist-12 [1]; Biochemistry-12 [2]; Chemistry-12 [1]; Computer Operation-17 [0]; Computer Programming-14* [1/2]; Ecology-12 [1]; Electronics Operation (Sensors)-13 [1]; Genetics (Genetic Engineering)-12 [2]; Mathematics-14* [1/2]; Memetics-9 [1/2]; Research-14 [2]; Writing-12 [1/2]; Xenobiology (Rock/Ice)-14 [2]; Zoology-12 [1].

Languages: English-13 [1]; Finnish (native)-14 [0]; French-12 [1/2]; German-12 [1/2].

* Includes +3 from Mathematical Ability.

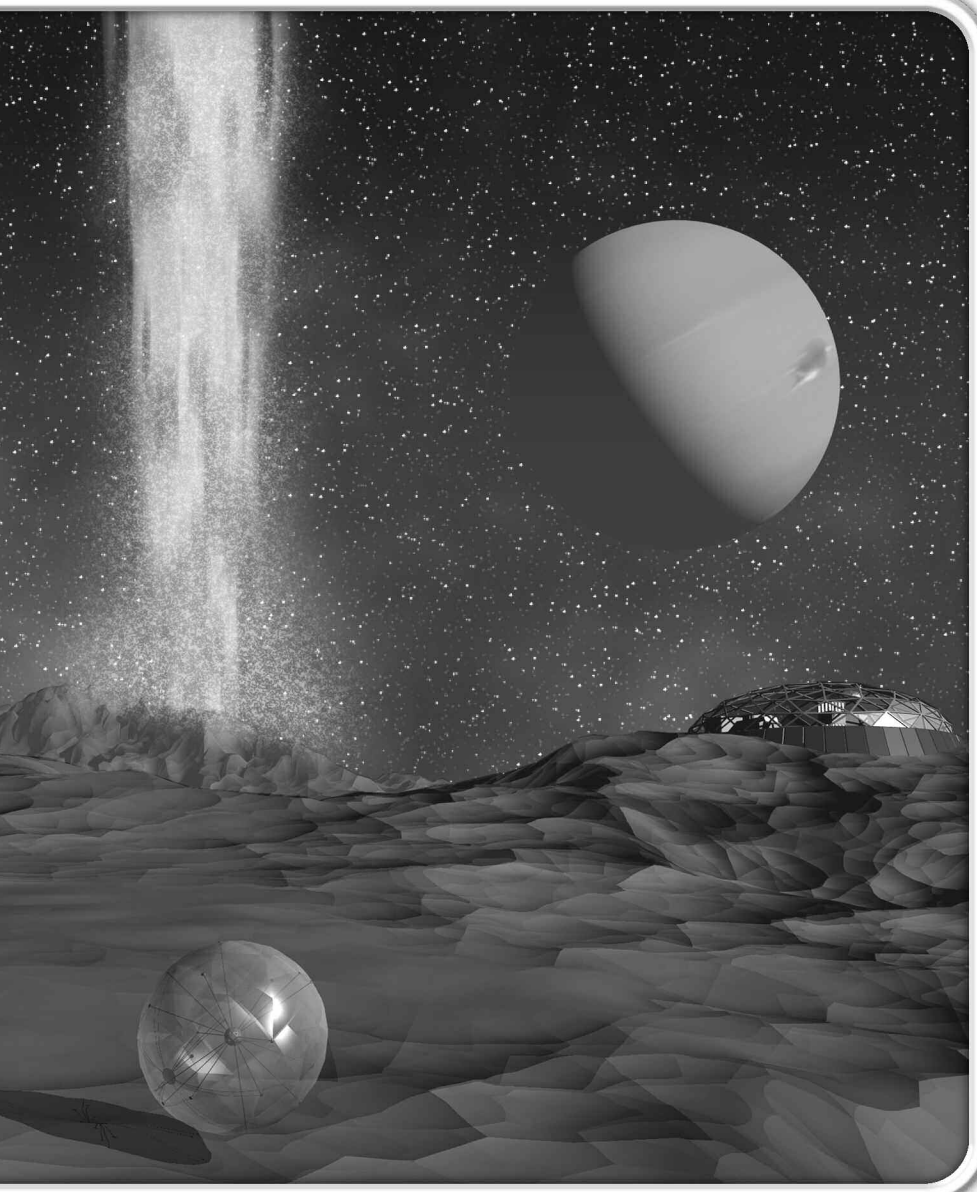
Native gravity is 1 g.

Campaign Themes

Transhuman Space: Deep Beyond provides numerous situations ripe for adventure. Many possibilities may suggest themselves, but here are a few of the broader themes:

Europa: War Under the Ice

This conflict is a "meme war" of pantropy versus preservationism. Adventurers could take the part of the Green Duncanites or EDF partisans, or be mercenaries, journalists, scientists, or newly-arrived peacekeepers caught in the middle as they try to do their jobs. A particularly challenging scenario could involve the PCs as an undercover team of E.U. "black ops" agents sent in to infiltrate either faction. Chinese agents might also be involved, sent to arrest or assassinate those EDF activists that were linked to Negative Growth.



The Exogenesis Conflict

The main participants in the conflict are Nanodynamics, EDI, and Axon, but the Society of Isidore, Triads, Trojan Mafia, U.S. government, and even the Duncanites may become involved as each side seeks allies.

A mercenary working for EDI might see more action than any space force officer! The Exogenesis conflict can involve security actions and "rat hunts" on Vesta, hostile-environment fighting in the hellish environment on Io, and pursuit of fugitive Axon spacecraft through the Deep Beyond. If EDI gets wind of Axon's base on Triton, it might send an expedition, or even call in help from the USAF.

For their part, agents of Axon can easily cross the solar system as digital information, and are actively engaged in diplomacy and fundraising efforts to drum up support for their cause. For their part, Nanodynamics and EDI operatives may attempt to disrupt any such operations with covert actions of their own. Nanodynamics has corporate facilities throughout the solar system, and Axon could easily broaden the conflict by striking at them.

Exploration, Trade, and Settlement

Many areas of the outer solar system are still largely unexplored – the oceans of Callisto, Ganymede, and Enceladus, the depths of the gas giants, the moons of Neptune, the icy reaches of the Kuiper Belt . . . Expeditions may be funded by scientific institutes, prestige-hungry governments, or even media companies. Of course, there's no guarantee that someone else hasn't gotten there first, but kept quiet about it: survivalists, political exiles, rogue AIs, criminals, or secret research stations might be hiding in obscure corners of the system, and not be pleased when intrepid explorers stumble upon them!

GMs who want to go beyond the setting may push the timeline several years into the future, and deal with the results of the Oort Cloud expeditions or even early interstellar missions using Starswarm or other technology. Don't forget that infomorphs can simply be beamed to and from distant vessels or colonies!

An alternative to exploration is the creation of a new colony. Perhaps the biggest challenge might be finding the money to fund the colony and then support it during hard times – this could lead to a few colonists taking on hazardous outside jobs to keep their dream alive. Hazards that may befall a small colony include equipment failures, medical emergencies, a sudden collapse of intended markets (forcing the colony to change its economic base), pest infestations, internal coups, or even Triad shakedowns. Pirate raids aren't very likely, but a desperate vessel might decide to knock over a small colony for hostages or spare parts.

The Deep Beyond (with the exception of Titan) lacks the population to support a great deal of high-volume trade. What this means is that many spacecraft are relatively small, fast, chartered vessels carrying wealthy, desperate, or important people and valuable, exotic, and occasionally illegal cargoes . . . The recent conflicts in the Deep Beyond have increased the market for military and paramilitary cargoes, and spacers willing to take vessels into regions like the Greek Trojans or Europa can often demand extra hazard rates.

Black Ops

The many research stations, corporate labs, and military bases that are located within the Deep Beyond offer a variety of opportunities for espionage (and sabotage) by rival nations, corporations, or followers of opposing memes. Government and corporate agents may attempt to suborn researchers, find ways of "turning" them, or take a more direct approach. Teams recruited for a particular black op might not even know who they are working for – is that mysterious woman who wants them to steal an Arges Project file from Nanodynamics' base on Callisto an agent of Axon, a spy from China's Bureau 10, or an executive in System Technologies, AG? PCs may also work the other side, as spy-catchers performing counter-espionage.

Frontier Justice

Life in the anarchic Duncanite stations provides interesting opportunities for adventurers, particularly those working in security companies and as freelance judges (who can run their own investigations). While Ceres has a relatively low population (and hence a fairly modest crime rate), security companies are often hired by other asteroid colonies across the Deep Beyond. There's also the chance a compact between companies will break down, and actual fighting erupt . . .

For a more traditional police campaign, PCs could be U.S. sheriffs on Titan, or work as police or corporate rent-a-cops on any national or company-owned stations, balancing the needs of justice with the influence of their corporate bosses. Businesses and wealthy individuals may also hire freelance detectives, operatives, or security teams for special missions, whether it's to trace a missing loved one, erase a rogue xox, locate a lost bioroid, trace an insurance claim, or track down a personal enemy who fled into the outer system.

Not all justice is in the hands of the law. Characters may join up with vigilante groups like the Society of Isidore (p. 102) or the Der Biodroiden Befreiungsfront (p. TS106) to rescue oppressed non-humans . . . with the high population of bioroids and AIs in asteroid and outer system stations, these groups are especially active. Some of them work with sympathetic governments like the UK; others operate alone.

Crossing the Deep Beyond

It can take months or years to cross the outer solar system. If the GM doesn't want to play out the events of a long voyage, travelers can enter nanostasis – or just dive into their computers to play and study – and the GM can rule the time has passed with nothing much happening. However, advancing the game's timeline several months each trip can be disconcerting! One solution is to simply focus for several adventures on a single interesting location, like Ceres or Europa. However, if a regular change of scenery appeals, consider these alternatives:

Fast Vessels: One way is to ensure that the PCs have a spacecraft that has a very high delta-V – see ***Spacecraft of the Solar System*** for several examples, and p. TS74 for suggestions on shipboard activities.

Moon Hopping: There's no need for footloose characters to travel across the entire Deep Beyond every adventure! A campaign that stuck to either the moons of Jupiter or the moons of Saturn still allows visits to dozens of diverse worlds while reducing the travel time from years to days.

Light Speed: Infomorphs need not physically travel between worlds. Instead, a copy can be beamed at the speed of light to the destination. Most major Deep Beyond installations are prepared to rent bioshells or cybershells to infomorph visitors – they're especially common on Titan. Laws against xoxing do not apply if only one copy is active at once, so the "original" can be "frozen" as a backup. See *Light-Lag and Communications*, p. TS52.

The Trojan War

The conflict between China and the Red Duncanites is fought on many levels, from SDV strikes against Duncanite asteroids to "blackjacker" raids on Xiao Chu gas stations. At present, China is stepping up its intelligence-gathering capabilities, and may be attempting to infiltrate agents or assassins into Trojan Mafia strongholds.

Due to the involvement of some Trojan Mafia groups in other criminal enterprises, Chinese agents might find common cause with agencies of other nations. Earth, Mars, or Titan-based law enforcers may send agents of their own to target – or negotiate with – Trojan Mafia operations. For their part, agents of the Trojan Mafia corporations may travel beyond the Trojans to forge new business relationships with customers and underground groups, as well as outlaw governments (like the TSA) throughout the system.

The crew and marines aboard a Chinese SDV can get involved in all sorts of adventures: shooting wars with the Trojan Mafia vessels and raids on their bases, encounters with Triad smugglers, hunting for hijacked and pirated vessels, following leads to track down rogue AKVs or TSA fugitives, or even playing chicken with Royal Navy or USAF vessels that violate their spheres of influence. Chinese crews often include bioroids, who, while second-class citizens, may aspire to citizenship through loyal service.

The Martian Triads

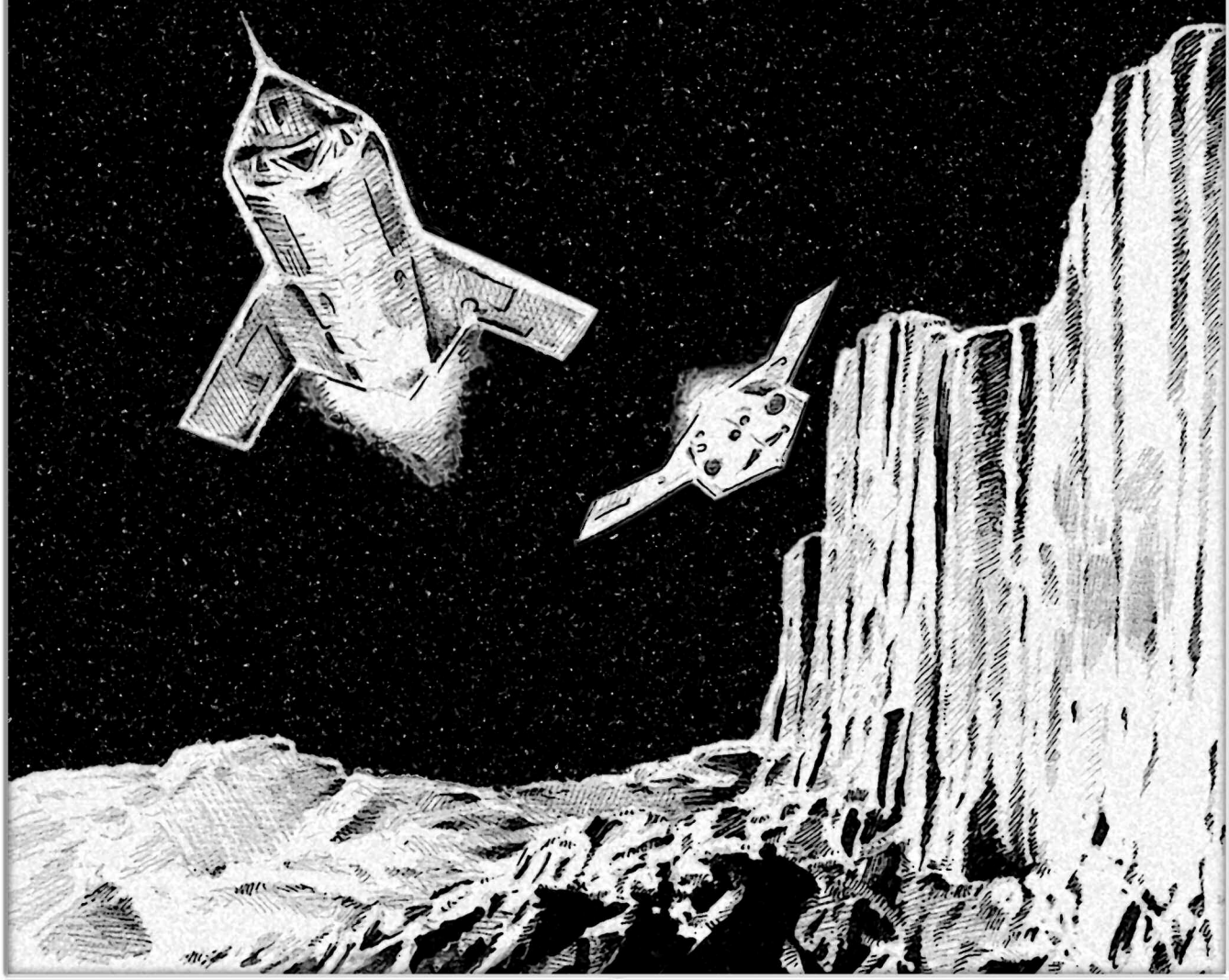
Members of the Royal Navy (and Royal Marines) may see plenty of action in the asteroid belt battling Martian Triad bioroid traffickers (see also p. TS7). The Royal Navy's attentions have also weakened the position of Xie Feng, the established gang boss in the Belt, and may trigger a wave of gang warfare as rival factions in the Belt and from Mars try to depose him. In turn, Xie may try to move his own operations to other locales (perhaps even Titan). This can lead to plenty of action for freelance gunslingers, cops, and security companies. It's also possible that China's PLAN-SF will become involved, either in opposition to E.U. naval vessels encroaching on China's expanding sphere of influence, or to crack down on the Triads as part of their own housecleaning operation.

Deep Space Patrol

In the Deep Beyond, a nation's force is often a single SDV with a crew of a half-dozen and a squad of soldiers. With light lag measured in hours, spacecrew officers may be called on to exercise their own judgment in tense, rapidly changing situations. While ESCA spacecraft tend to restrict themselves to the Belt (and Europa), those of the U.S. and China regularly patrol the entire Deep Beyond.

The crew of an SDV may be a mix of spacers (including infomorphs) and army or marine troopers. They may shadow rival warcraft operating near Saturn, protect restricted areas, gather intelligence near Belt research stations, Saturn, or Uranus, spy on the Gypsy Angels, transport diplomats, quash labor disputes, assist civilian authorities in tracking down criminals who flee to the Deep Beyond, and respond to contingencies involving homesteaders or corporate bases that have gotten into trouble. Don't neglect the possibilities for leave: liberty on Titan or Pallas can be pretty wild . . .

7 TECHNOLOGY



Last week we reported a mystery spacecraft sighting at Hyperion Proving Ground near Saturn. To recap: On December 22, 2099 a white-painted AKV in NASA livery was spotted by civilian "H-watchers" as it flew low over a crater, paced by two USAF SIM-7 Predator chase craft. The white AKV suddenly accelerated sharply up and away from the chase craft at a steady 1 G, more than triple the acceleration of an ordinary Predator. It sustained this acceleration for over 10 minutes, leaving the pursuit vehicles looking like they were standing still, only to suddenly vanish in an enormous spherical explosion so intense one witness mistook it for a tactical nuclear warhead.

Well, we've got the scoop, direct from a source in NASA. The vehicle that was spotted was none other than Columbia Aerospace's new X-92 AKV technology demonstrator. It's powered by a stabilized metallic hydrogen rocket engine. Our guy in NASA won't give us exact statistics, but he claims a specific impulse "in excess of" 1,400 seconds, as well as "sustained high-gee" burns. He also reported that NASA and the USAF have "some ongoing concerns" regarding the fuel's stability and affordability. Apparently so.

– Dana Martello, ***System Defense Review***

Habitats

There are four main types of habitats used on asteroids, small moons and similar airless bodies. For game mechanics on habitat construction, see *Appendix,* p. 152.

Cole Habitats

A Cole habitat is a cylindrical metal space colony formed from a metallic asteroid. Cole habitats are the "luxury condos" of asteroid habitat design. If properly created, they can provide an Earth-like environment complete with rotational gravity for a fraction of the cost of building a conventional space station. Creating a Cole habitat begins with finding a metallic nickel-iron asteroid of the correct size, shape, and composition. The most convenient is a roughly egg-shaped body, about two miles long and a mile in diameter.

The asteroid's spin is neutralized using rockets or a tether-and-countermass system. Then a large solar mirror is erected outside the asteroid, so as to focus sunlight onto a single point on its surface, usually at wherever the north or south pole will be located. In a few days it will bore a hole into the asteroid's core. This cavity is then filled with an inflatable tank, which is pumped full of water from the most convenient source. This may be carbonaceous asteroids, ring ice, Kuiper Belt Objects, or satellite ice.

Next, the asteroid is spun up to approximately nine revolutions per hour, and the mirror is again focused on it. The asteroid will begin to heat up, like meat roasting on a spit. As the melting point is reached, the surface will turn molten, and heat seeps into the core. If the mirrors are correctly controlled, the water tanks will explode from steam pressure at exactly the same time as the central axis of the asteroid melts, and a steam explosion will blow the asteroid out like a balloon. The end result, if everything goes perfectly, will be a thin shell of steel enclosing a hollow, generally cylindrical space, 10 miles wide and 20 miles long, with an internal surface area of around 600 square miles. If things are not timed perfectly, there may be a blowout on one side, which will ruin it, producing an irregular lump useless for habitation.

A hollow metal cylinder needs doors and windows. The first thing to do is to cut a few holes in the shell at the cylinder's end caps for access points. Airlock and docking bay modules are then plugged into them. A large hole is bored through one of the poles to serve as a light source. It is covered over with transparent diamond (if the colony is rich) or reinforced plastic. The solar mirror is then moved to send a beam of light straight down the long axis of the habitat – a "linear sun" that illuminates the interior.

Now the work moves inside the habitat. It's still vacuum inside, and the rough-and-ready process used to blow the bubble is rarely perfect (especially since few asteroids are completely pure nickel-iron). It is necessary to carefully check the interior for any cracks, weak points or leaks in the shell. The usual means to do this is microbot swarms. If leaks are found, an engineering team will patch them. Often microbots coat the entire interior surface of the asteroid with a thin layer of sealant – a time-consuming and expensive process, but one that can prevent costly micro-leaks.

The interior of a Cole habitat's shell is gray metal slag in hard vacuum. This is fine if the goal is a vacuum industrial factory, but not much use for human habitation. The next thing to do is terraform it. This requires dirt and light. The easiest place to get dirt is from a nearby carbonaceous asteroid rich in ore and volatiles, including ice. Crush it into dust and rubble, and spread it in your farm area . . . then seeds can be planted, and the plants will begin to grow.

While a Cole habitat is a very desirable design, there are certain difficulties that prevent them from becoming more common. First, correctly "cooking" a Cole habitat is a very delicate process, and can easily result in a "scrambled egg" situation where the water-filled asteroid blows out in multiple spots, especially if the asteroid contains any small pockets of volatiles. (In game terms, an Engineer (Mining)-2 roll should always be required to succeed.) Second, reasonably pure metallic asteroids of the correct size, shape, and quality are rare. Many asteroids are too irregular in shape or likely to fall apart, and determining a candidate's exact quality requires on-site prospecting.

Cole habitats are named after Dandrige Cole, who originated the concept.

Track Habitats

Track habitats are used on asteroids where Earth-like gravity is considered beneficial; they are also common on small moons. They're expensive, and are mostly found on large, wealthy habitats designed to be inhabited by people without microgravity adaptations. Duncanites don't use them.

The track habitat consists of a moving train on a circular railway track. A circular trench or tunnel is dug, typically several yards wide and a half-mile to a mile in diameter. The tracks are placed on the tunnel or trench's outer wall, with one wide main track, plus a smaller commuter track connected to a non-rotating station. Running on the main track is a train of linked habitat cars (often running the entire length of the track) using either wheels or more commonly, magnetic levitation (maglev). As the train circles the track, it produces simulated gravity for its occupants via centripetal force. Trains and tracks are generally made of asteroid materials (nickel-iron, etc.). A typical track habitat train will travel at about 100 mph, which over a 1/2- to 1-mile course will provide about 0.3 to 0.5g.

The habitat train never stops moving (unless shut down for serious maintenance). To board it, the commuter track is used. A separate "boarding" train will accelerate to match velocities with the track habitat, allowing people and goods to be transferred to it from the station. The station usually connects by elevator to the asteroid surface, where a spaceport will be located, or to a non-rotating beehive or shell habitat on the same body.

The advantage of the track habitat design is that there is no need to mount radiation shielding on the moving cars (unlike a conventional gravity wheel) since the train moves inside a shielded tunnel or under the overhang of a deep trench. This dramatically reduces the mass and cost compared to conventional pylon-mounted spin habitats on spacecraft.

See ***High Frontier*** for statistics for internal railway tracks and mag-lev lifters.

Shell Habitats

This is the most space-intensive method of asteroid habitation. Multiple levels of an asteroid are hollowed out, forming a series of progressively-smaller concentric shells inside. Each shell may be several yards thick. Layers of asteroid material are left between each shell for structural strength.

Shell habitats are common on very small asteroids (e.g., 100-1,000' across) and ice or asteroid-hulled spacecraft; they're a preferred type for survivalists, small corporate stations, or Duncanite freeholds that wish to stay inconspicuous. A shell habitat on a larger asteroid requires a great deal of mining, but maximizes living space. The ultimate potential space available is enormous. For example, if half of Vesta were excavated, 4 million cubic miles of living space would be available. If this space were divided into spacious chambers with 50 feet between each level and an average ceiling height of another 50 feet, the result would be over 200 million square miles of living space, greater than Earth's land area! Even an asteroid five miles in diameter would yield about 3,000 square miles of space.

Thus, the largest asteroids could potentially house billions of people. However, only a couple of shell habitats on asteroids more than a mile in diameter have been constructed so far – there simply isn't a need for that much space.

Beehive Habitats

These are the simplest habitats to build, and the most common. They are nothing more than tunnels, chambers and galleries dug into the asteroid, usually excavated by heavy mobile worker cybershells like the Mining Worm (p. 118) or Polypede (p. TS123), or by swarms of construction microbots. Chambers near the surface are used for storage or machinery, while human habitations are burrowed deeper into the asteroid to provide protection against solar flares and cosmic rays. Beehive habitats can be dug in rubble piles as well as homogenous asteroids – a big debris pile has plenty of solid chunks a few miles across that can be inhabited.

The interior of a beehive habitat is a three-dimensional maze of passages that are very easy to get lost in. For this reason, most are full of v-tags that provide location data. A beehive habitat is easy to expand – all that's required is to dig a new tunnel. In some beehive habitats, new tunnels are constantly being dug as the population increases and uses more resources. Often a tunnel or gallery is first used as a mine shaft, then later converted into living quarters or an industrial park. Beehive habitats may use external solar panel or nuclear reactors (fission or fusion) for power.

Not all of a beehive habitat's construction is underground. The surface of a beehive habitat asteroid usually has various installations such as airlocks, landing pads, vents, tool sheds, solar panels, and antennae dishes. For safety reasons there will usually be at least two airlocks leading down, and often a couple of large cargo elevators as well.

Prospector Swarms

These are tiny robot spacecraft whose mission is to perform asteroid and small body surveys. A typical swarm consists of about 100 miniature cybershell spacecraft usually flying in a formation 20-100 miles apart. Each spacecraft, or GSV (gestalt survey vehicle) in a typical swarm weighs 1-2 lbs., is solar powered, and is propelled by a 1,000-sf light sail. They move slowly, rarely exceeding 1 mps delta-V.

There are three main types of GSV in a swarm. 80% of the swarm will be instrument-equipped surveyors with magnetometer, X-ray sensor, gamma-ray sensor, telescopes, infrared sensors, and mass spectrometers. 15% are "relays" with radio com systems. 5% are "navigators" mounting precision star-tracking navigation systems. The swarm makes up a distributed insect-analog gestalt intelligence, much like a microbot swarm, although the individual spacecraft are both larger and more dispersed.

The first prospector swarms were deployed in 2034 by Tenzan Heavy Industries and Nanodynamics in partnership with NASA and the Japanese Space Agency. Launched from high Earth orbit (and later from L4), the initial mission objective was a comprehensive survey of the characteristics of Earth-approaching asteroids for the purposes of space science, economic exploitation, and planetary defense.

The initial NASA-Tenzan-Nanodynamics survey was completed in 2047, but since many swarms remained functional, it was decided to extend the operation to the Main Belt, with Tenzan taking responsibility for data collection.

Soon afterward, in 2052, Xiao Chu and Nanodynamics began a detailed survey focused on Mars-approaching asteroids. At about the same time, Avatar Klusterkorp leased some of the THI swarms and began using them to survey smaller asteroids (down to a few yards across) whose orbits intersected the orbital paths of Ceres and other Duncanite stations.

Today, every single Earth-approaching asteroid 30' or more in diameter and 90% of Main Belt asteroids a half-mile or more in diameter have been surveyed. Prospector swarms are currently active in the Trojan asteroids; much of this activity is being performed by Red Duncanite groups, but recently Xiao Chu has begun prospecting.

Further out, a few prospecting swarms are also active in the Kuiper Belt and Oort Cloud. However, the greater distances involved and the reduced efficiency of light sails and solar power as swarms venture farther from the sun has slowed the pace of exploration. Some swarm designs operating beyond the Main Belt replace solar sail designs with magsails, plasma sails, or RTG-powered ion drives for propulsion, but these designs are more expensive, and as a result fewer such probes have been built.

Red Ants

In 2096, Xiao Chu spacecraft deployed several prospector swarms in the Leading Trojans. This activity was not publicly acknowledged until Red Duncanite spacecraft reported the swarms. Xiao Chu has indicated the operation is simply intended for scientific and economic research. In the wake of the PLAN-SF assault on Liang Mountain in 2097, many Red Duncanites believe that the swarms were intended to gather data for PLAN-SF military operations. It's become common practice for Red Duncanite vessels to engage and destroy Chinese or unidentified swarms that they encounter. Xiao Chu denies any PLAN-SF involvement and denounces this activity.

(Each spacecraft laser can destroy 100 GSVs in a single 100-second space combat turn on a successful skill roll; on a failed roll, it takes two space combat turns to do so).

Exotic Technologies

Don't believe what Hawking Industries is telling you. They've found a lot more than one primordial black hole! Gunter Felding was an engineer with Vosper-Babbage, who was brought into Hawking Industries to consult on magnetic field containment. He saw evidence that they had containment facilities for not one but seven black holes.

Felding "disappeared" while on his way to meet a source in the Tranquility Industrial Zone, but not before he posted part of a document into an encrypted account on Luna's web. My contact on Luna has a copy, but he's been having problems logging onto the Luna City deep space transmitter. Coincidence? Yeah, right. We know Vosper-Babbage has offices on Luna. They've probably slipped an AI censor into the system.

– Rapunzel Morningstar,
deepbeyond.primordials.conspiracy.aliens

Black Hole Gravitic Fusion

The discovery of primordial black holes has led to a new form of fusion power: gravitic fusion. This involves pumping hydrogen gas into a black hole. As the gas nears the black hole, it is compressed enough that fusion takes place, producing many megawatts of power. An enriched tritium-deuterium mix is normally used, but experiments have also been performed to use the black hole to catalyze a proton-proton reaction (the same reaction used in stars, and a necessary precursor technology for high-specific impulse fusion-powered starships). An intense radiation flux is also produced, but since the holes are already inside asteroids (which provide plenty of shielding) and no one would place black holes on a planetary surface anyway, this is not a huge problem.

The hole's great mass (over a billion tons) and extreme rarity are such that commercial gravitic fusion is unlikely to become a major supplier of energy, but it is useful for any space station built around the hole. Still, at present, only one mini black hole exists in captivity.

Black Hole Computing

There is a tremendous potential density of information and processing speed latent within a black hole. Researchers at Hawking Station are investigating using their primordial black hole to encode instructions for performing calculations at speeds phenomenally greater than any existing computer. Computations would be performed by adding a measured amount of matter to the hole; answers would be read out from the escaping Hawking radiation. Some scientists doubt the project is practical; Hawking researchers who remain optimistic blame problems with "noise" produced by the foaminess of spacetime itself, but are convinced they may yet achieve a breakthrough.

Biodegradable and Edible Computers

Tiny computers can be made biodegradable, using nanotechnology to lay organic superconductor circuits on organic substrates. The technology has been around since about 2075, and is routinely used in some environmental monitoring applications. It can also be applied to other electronic technologies such as short-range radios (usually doubling weight). Biodegradable systems tend to have a short usage life, due to the poor capacity of biodegradable batteries.

"Edible" systems that can be safely handled by human digestive systems have been available since 2086; initial applications included espionage gadgets and novelty toys, but see *Sentient Snacks*, p. 114, for another use! Biodegradable computers are ×2 weight (4 if edible), -1 Complexity, ×0.1 storage. No other options or modifiers can be applied.

Stabilized Metallic Hydrogen

Hydrogen is the lightest, simplest, and most abundant element in the universe. It normally exists as a gas, but under extreme pressures it can be solidified into a superconducting metallic solid. At even greater pressures – a few million atmospheres – it remains a superconducting solid at room temperature, even after pressure is reduced.

Compressed metallic hydrogen holds an enormous amount of energy (all of which went into compressing it). Thus, it is currently used as a very high explosive (cut with diamondoid material as a stabilizer) and can theoretically serve as a potent source of portable energy that outperforms all known chemical fuels.

Columbia Aerospace is conducting research into metallic hydrogen propellants on Rhea and at Hyperion Proving Grounds. The focus of the program is the X-92, an apparent AKV prototype similar to the SIM-7 Predator, but replacing its nuclear pulse drive with a rocket engine using hydrogen propellant. (See p. 153 for its engine statistics.)

> **Inventions reached their limit long ago, and I see no hope for further development.**
> **– Julius Frontinus, 1st century A.D.**

There are other possible uses. Wires made of metallic hydrogen have no electrical resistance and can therefore carry electric currents over great distances without losing any energy. Since superconducting circuits never heat up, this could revolutionize electrical and electronic industries. Unfortunately, the standard stabilization process used in explosives and fuels interferes with superconducting properties. Research into other superpressure stabilization techniques for the creation of metallic hydrogen wires has been occurring at Exogenesis Station, with mixed results. Successful application requires very expensive (and energy-intensive) processes. Metallic hydrogen superconductors were used in some Exogenesis programs, however, notably the Starswarm accelerator.

Starswarm

The Starswarm launcher, built into Vesta, is a linear electrostatic accelerator. This system launches cyberswarm probes at up to 25% of light speed. Probes are designed to be fired in salvos of thousands; the leading "trailblazer" probes may be destroyed by collision with interstellar dust, but their sacrifice opens a path for those that follow them.

The individual probes are encapsulated multi-functional gestalt microbot swarms capable of rebuilding, linking, and reconfiguring themselves. Some of the individual microbots are equipped to rendezvous in flight and combine to form larger structures, such as optical telescopes or radio antenna for communication with Earth, or superconductor loops that function as magnetic sails, allowing them to brake against the interstellar medium, and make use of their destination star's solar wind to maneuver once they arrive in a system.

Once they arrive at their destination, the survivors will cannibalize themselves to create various multi-function swarms – see *Triton,* p. 73, for an example of their abilities.

Personal and Expedition Gear

This gear is useful for asteroid miners, habitat engineers and would-be homesteaders.

Microgravity Drill Rig

This is a lightweight drill rig suitable for drilling wells or core samples, and is equipped with pitons to hold it steady against a surface in microgravity. Drilling rate is 30 yards/hour in earth or ice, half that for soft rock, 1/4 for hard rock. Decide on the maximum depth it can drill. It weighs 25 lbs. + 3 lbs. per yard of depth; volume is weight/50 cf; cost is $250 + $25 per yard. It requires 5 kW, usually supplied by batteries.

Pogo Stick

A high-tech pogo stick with a large padded foot usable on soft surfaces (like sand, grass, or regolith), and a roller-guided plunger and fiber-reinforced composite bow spring that bends to store elastic energy, giving it a smooth frictionless motion and high-energy storage with minimal shock at ground contact. Compared to a low-tech pogo stick (allows hopping of about 6" with great effort), this permits hops of 10-20" with ease, even in Earth gravity, and much higher jumps with extra exertion. The spring tension can be set to adjust for different gravities, so that bouncing along in microgravity need not result in the user achieving escape velocity.

The pogo stick gives the user one level of Super Jump (p. CI68) but extra effort jumps require use of Sports (Pogo) skill (p. 123) instead of DX or Jumping skill. 2 lbs., $100.

Portable Vapor Deposition Gun

This device uses an electron beam to vaporize a metal ingot, creating a short-ranged molecular beam that can be used to "paint" a surface. Multiple layers can also be sprayed over a lightweight mold, to form a solid structure. Vacuum vapor deposition guns come in all sizes. This particular model is a handheld design; its weight does not include a 0.1-cf block of metal, which is inserted into the gun. The PVDG has SS 5, Acc 2, 1/2D 2, Max 4 and does 1d+2 damage if used as a weapon. $1,000, 40 lbs., D cell (1/2 hr.)

Gestalt Cyberswarms

These are cyberswarms that form a distributed intelligence.

If there are fewer than 10 lbs. (10 hexes) of microbots within 100 yards, treat them as ordinary cyberswarms (no access to skills). If 10-99 lbs. of microbots are within 100 yards of each other, treat them as an NAI-4; this goes up to NAI-5 if 100-999 lbs. of microbots are within 100 yards of each other, and so on.

Only a few prototypes exist, such as the White Rabbit devourer swarm (p. TS170) and several Triton swarms (p. 74), the latter having been self-assembled from many smaller "nanoprobes." They cost an extra $1,000 per hex over the cost of normal swarms. They can learn and be programmed like any other NAI; use one set of skills for the entire swarm.

Sondes

Exploration of the lower reaches of gas giant atmospheres is performed by lightweight, deep atmosphere sondes. These are released by aerobot balloon. The aerobots remain in communication with the sondes via radio or microwaves. Sondes come in various shapes and sizes; a typical model costs $5,000, weighs 20 lbs., and can survive up to 1,000 atmospheres of pressure.

Supercavitating Ammunition

Any bullets, mini-missiles or micro-missiles can be designed to supercavitate, using a combination of gas venting and nose shaping to dramatically improve underwater performance.

Normal bullets or missiles have 1/20 their normal 1/2D range in water; supercavitating slugs have 1/5

range. Aerodynamics suffer if used in atmospheres that are thicker than trace, giving a -1 to hit.

Supercavitating bullets are five times as expensive as ordinary ammunition; they can be armor piercing but cannot be other special bullet types (APS, drug, etc.). They can be any type of smart ammo. Supercavitating micro-missiles or mini-missiles can have any smart warhead type. They cost five times as much as ordinary missiles. LC is unchanged.

Titan Suit

A lightweight vacc suit, heated but not pressurized, used for excursions on Titan. Protects completely against the Titan environment. Treat as any type of nanocomposite vacc suit (p. TS159) but has 80% of normal weight and cost, and no radiation protection.

Wing Set

A set of strap-on composite wings with a 12' span. In an environment with 1/6 G and standard or better air pressure, a person with strap-on wings can fly as if he had the advantage Flight (Winged, -25%; Cannot hover, -15%; -10%), p. CI56, and cannot carry anything in either arm while climbing or sustaining level flight. Use Low -G Flight skill (p. CI132). However, human-powered flight is tiring, costing 1 Fatigue per minute unless gliding. A person with Light or greater encumbrance can't fly. A set of wings is $300 and weighs 5 lbs.

Nootropics

These are smart drugs, chemicals that enhance brain performance. Duncanite nootropics are available in a variety of designer drinks and foods. The proteins are often manufactured by pharms in gengineered products like nootropic seaweed or blueberries.

Nootropics enhance the ability to grow connections between neurons, improving the ability to memorize (which is partially the process of setting up these connections), and increasing the levels of neurotransmitters that carry electrical signals from neuron to neuron.

Taking low dosages of nootropics in childhood is common in many Fifth Wave cultures, especially the Duncanites, as an adjunct or alternative to memetic learning techniques, and explains higher starting skill levels.

If taking high dosages of nootropics, the doubled cost for increasing IQ after initial character creation will not apply. The user must take nootropics continuously (and since his last increase in IQ) for at least as many weeks as the point difference between his current and new IQ; e.g., someone with IQ 10 would need 10 weeks of smart drugs before he could buy IQ 11 for 10 rather than 20 points. Side effects are negligible.

High dosages taken in childhood can explain teens with abnormally high IQ or Eidetic Memory, but can lead to the Flashbacks disadvantage. Low dosages are $2 per week, high dosages are $20 per week. LC 5.

Laser Weapons

Man-portable lasers see more use in microgravity environments than they do on Earth or Mars. Lasers are primarily used because they have no recoil (making them easy to use in microgravity or zero-gee) and they do not require ammunition, which is important when the nearest supply base may be several hundred million miles away.

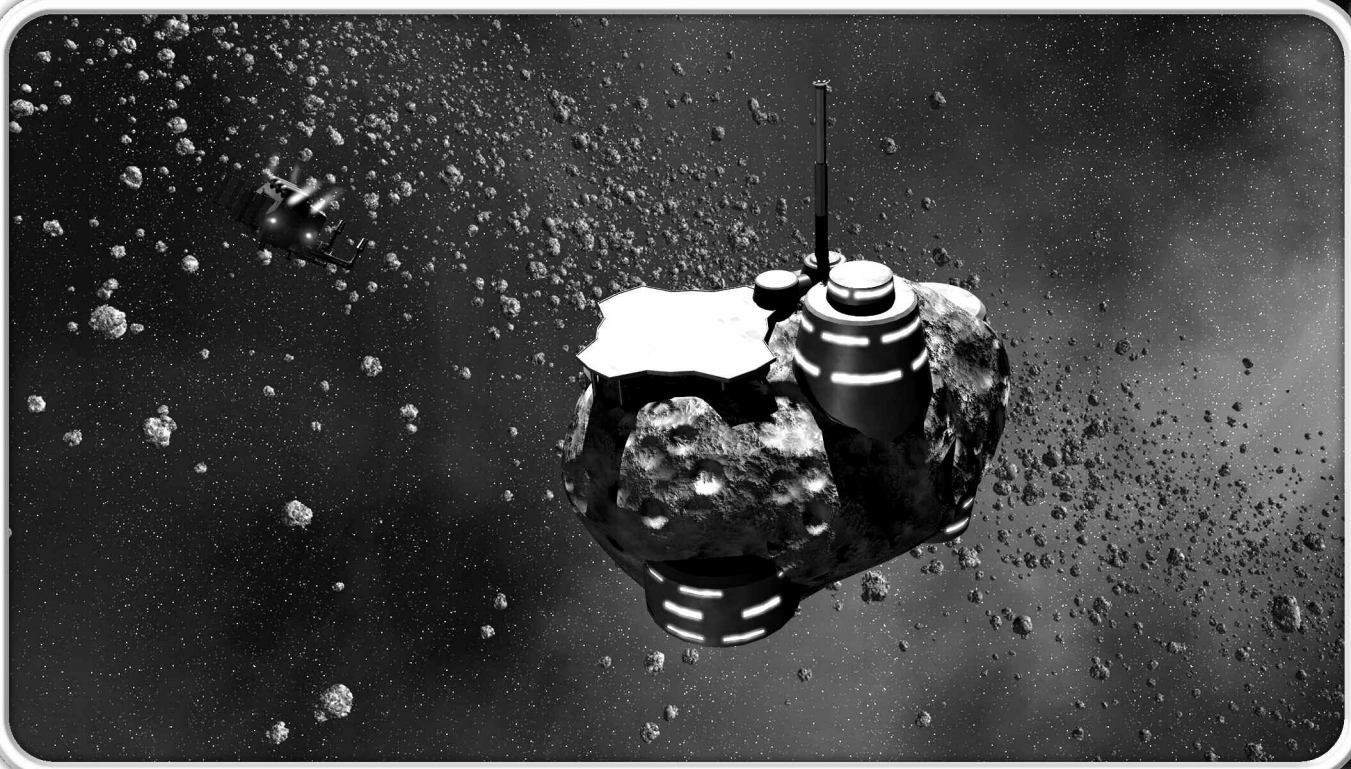
A weapon laser beam is visible as a trail of sparks in an atmosphere, but invisible in vacuum. Many disadvantages that limit laser use on Earth or Mars are mitigated inside a spacecraft or asteroid habitat. Bad weather is rarely a problem, and if the habitat or moon has low or microgravity, it's much easier to lug a heavy power supply around. Even so, most handheld lasers lack the ability to penetrate well-armored suits or cybershells. They are mainly used by security and counterterrorist teams, rather than by combat soldiers. However, cybershell or suit-mounted lasers are favored as point-defense weapons, with some chance of shooting down incoming missiles and grenades.

Weapon Table

Weapon	*Type*	*Damage*	*SS*	*Acc*	*1/2D*	*Max*	*Wt.*	*RoF*	*Shots*	*Cost*	*Min ST*
Laser Pistol, 1-kJ	Imp.	1d+2	10	11	460	920	4.8	3~	60/C	$930	8
Laser Rifle, 3-kJ	Imp.	3d+2	14	17	1,150	2,300	12	1	30/C	$2,455	8
Tactical Laser, 20-kJ	Imp.	9d	20	23	3.5 mi.	7 mi.	250	3~	Spcl.	$30,000	85

If powered from a power pack, the tactical laser drains 0.011 kWh per shot. The air defense laser drains 0.125 kWh per shot.

Laser ranges are × 0.1 underwater, or on Venus, × 0.5 in Titan's denser atmosphere, × 2 on Mars, × 10 in trace atmospheres (like Europa or Io), × 20 in vacuum.



All lasers use frequency-agile "rainbow" beams that optimize for the environment. The laser can generate its own laser targeting sight for negligible power.

Laser Pistol, 1-kJ: This resembles a handheld camcorder more than a pistol. It uses an integral C battery, as its drain is low enough that it does not require a power pack.

Laser Rifle, 3-kJ: Expensive, heavy, power-hungry and short-ranged, laser rifles never really caught on as military weapons, although some police departments use them for sniping. It is a shoulder weapon, somewhat resembling a TV news camera.

Tactical Laser, 20-kJ: A laser usually seen on military vehicles as a point-defense and anti-personnel weapon. It is a vehicular weapon, usually installed in a turret; weight assumes it is in a universal or casemate mount (4.98 cf, or 1 VSP if using ***In the Well's*** vehicle rules). ST requirement is if handheld.

Spacecraft

The spacecraft described in ***Transhuman Space*** Appendix B and ***Spacecraft of the Solar System*** are commonly seen in the Deep Beyond, but other vessels can also be found there.

Note on crews: Vessels using cybershell engineers for maintenance can get by with about one-half to one-third as many as listed, since cybershells do not sleep!

Asteroid Base

For every large asteroid station like Silas Duncan or Exogenesis, there are a dozen smaller ones like Morrigan Station (p. TS7). These statistics can apply to any small microgravity beehive or shell habitat: a Duncanite freehold, a smaller corporate station, the headquarters of an isolate group, or a survivalist or criminal base.

The asteroid is an irregular 500' × 250' cylinder of stony iron; this might represent the entire asteroid, or one of a few solid chunks within a rubble pile. Most of the interior is taken up by concentric levels or tunnels and chambers that house a one-acre farm, several houses, multiple minifacs, labs, refineries, tanks, and rock processors, as well as considerable warehouse space and an elderly reactor. A dock on the south pole is large enough to accept a *Sudbury* or *Mudlark* USV, radiators and all. It can support up to 100 people in long-term comfort, and contains its own lab facilities (which could also represent biogenesis tanks).

Three retractable laser towers provide modest defensive capability. Part of the surface is covered with solar panels, which supplement the reactor's output. The loaded mass includes external cradles. The design has 610.5 spaces of empty space available for further customization.

Crew: Varies. For example: Station Master (Leadership), Operations Officer (Electronics Operation (Communications), Electronics Operation (Sensors)), Security Officer (Gunner (Beams), Tactics)), 10

Engineers (Armory (Spacecraft Weapons), Mechanic (Fusion), Mechanic (Robotics), Engineer (Mining), other Mechanics skills as appropriate), 11 Farm workers or gardeners (Agronomy), 2 Medics (Diagnosis, Physician, Surgeon), 20 scientists or lab technicians (Biochemistry, Engineering, Genetics, etc.)..

Design: Cylinder hull (50,000 spaces, asteroid rock); cDR/cPF 3/100, hull radiators (10 ksf); solar cells (450 ksf).

Modules: Old command bridge; old basic bridge; medium ladar; 2 medium PESA; 1 medium radar; 2,500 tanks (water); 4 2.5-MJ light laser towers [S]; 4 large entry module; 2 fuel electrolysis; 20 refinery; 20 lab; 10 minifac workshop; l0 rock crusher; 3 large robot arms (one internal to spacedock); 2 surgery; 1 garden; 1 vatfac; 1 farm habitat; 1 housing habitat; 10 old fusion reactor (40 MW); old fusion reactor core; spacedock (9,000 spaces, 300 × 250 × 60'); 3 external cradles (4-space, 500 tons each); 6,000 cargo (30,000 tons); 9,750 waste space.

Statistics: EMass 262,701; LMass 321,702; Cost M$265.79. cHP 7,500. Size Modifier +10/+12. HT 12. Maintenance Interval: 1.23 hours (78 hours/day). RRA 2.

Performance: None.

Barricade-Class SDP

Built by Tenzan Heavy Industries, the *Barricade* is a cheap space defense platform design marketed to security companies and nations. Its metal-oxygen rocket provides limited maneuverability during an engagement – enough to allow it to face its opponents, and to prevent the enemy from taking it out with an unguided attack.

The hull is a cylinder 50' long and 12.5' in diameter. Its power pack provides enough power for 9 laser shots, and a fission reactor powers all other systems. It has 78.75 tons of metal-oxygen rocket fuel. Individual SDPs are usually assigned numbers or code names by their owners. There are 0.57 spaces of empty space are available for future upgrades.

Crew: Unmanned. Infomorph uses Electronics Operation (Communications), Electronics Operation (Sensors), and Gunner (Beam), and Piloting (High Performance Spacecraft). Infomorph occupies the mainframe in the unmanned controls. Two Engineers (usually cybershells or cyberswarms).

Design: Cylinder hull (12.5 spaces, foamed alloy, heavy frame); cDR/cPF 60/50 [F], 5/1 [S], 4/1 [B] (carbon composite armor).

Modules: Old unmanned controls; small fixed radar [F]; small PESA; 0.25 compact metal-oxygen rocket; 3.75 tanks (metal-oxygen); 10-MJ heavy laser [F]; 1 new fission reactor (4 MW); fission reactor core; 2 power pack.

Statistics: EMass 204; CMass 243; LMass 282. Cost M$16.15. cHP: 68. Size Modifier +2/+6. HT 12, Maintenance Interval: 5 hours (19.2 hours/day).

Performance: sAccel: 0.25 G, Burn Endurance: 0.1 hours (6 minutes), Burn Points: 90, Delta-V: 0.27 mps. No air speed.

Shengzi-Class SCV

The *Shengzi* (Victory) class is an elderly Chinese "space control vehicle" designed in the 2060s. An old fusion torch-drive vessel, the *Shengzi's* design predates the PLAN-SF's use of calcium-hack nanodrugs and space-adapted bioroid crews, so it was built with spin capsules that generate artificial gravity. Its mission was to deliver a section or platoon of troops or armed police to a remote trouble spot, land them via its own spaceplane, and support them using its onboard weaponry and its own small flight of AKVs. As it was built before SDVs existed, it was designed to look after itself: it carries more firepower than many recent Space Control Vehicles, but fewer troops.

The *Shengzi* class was designed by Shanghai Space Academy to PLAN-SF specification in 2059, with 14 vessels being constructed at Taiko Station in 2059-2067. In the 2060s-70s, they were used in peacetime exercises, showing the flag, and in one actual combat deployment in 2071, against Chinese Islamic separatists who hijacked a near earth asteroid that was being accelerated to L4. Several *Shengzi* saw action in the Pacific War, striking TSA targets in Lagrange 5 and geostationary orbit, and racing to protect deep space installations against the surprise wave of marauding *Rajasi*-class AKVs. Two *Shengzi* were destroyed in action.

In the 2090s, most of the 12 surviving *Shengzi* units were scrapped, transferred into Reserve Fleet or sold, but three remain in Chinese service. *Rensheng* ("humane victory"), *Zhengsheng (*"righteous victory") and *Weisheng* ("commanding victory") are kept busy responding to ongoing "operations-other-than-war" contingencies (p. TS100), e.g., police actions against Trojan Mafia, Martian Triad, and other low-intensity threats. One *Shengzi* was bought by the South African Aerospace Force as its first deep space warcraft. Now renamed *Dingiswayo* ("the wanderer"), it patrols the Main Belt and the inner system, charged with protecting South Africa's government and corporate interests at Hawking Station (p. 20), Dala Kadavara (p. ITW76), and Venus (p. ITW72).

The *Shengzi*-class SCV is a cylinder 250' long and 50' in diameter, with two spin capsules (50' long and 20' in diameter) attached to 300' long arms mounted half way along the hull. A pair of 122.5' × 122.5' folding radiator wings are usually extended. Typical payload is 786.4 tons (including 600 tons for six AKVs). However, it can carry an additional 875 tons in one large external cradle. Its tanks hold 9,900 tons of water reaction mass.

The design has 15.7 spaces of empty space available for further customization.

Crew: Commander (Leadership, Shiphandling, Tactics), Pilot (Piloting (High-Performance Spacecraft)), Navigator (Astrogation, Electronics Operation (Communications), Electronics Operation (Sensors)), 2 Weapons Officers (Gunner (Beams), Gunner (Railgun)), 6 Engineers (Armory (Spacecraft Weapons), Mechanic (Fusion Drive), Mechanic (Robotics), other Mechanics skills as appropriate), 2 Medics (Diagnosis, Physician, Surgeon), Mission Specialist (Electronics Operation (Sensors), Intelligence Analysis, SIGINT Collection/Jamming, Traffic Analysis).

Design: [Hull] Cylinder hull (1,000 spaces, metal-matrix composite, heavy frame, smart); cDR/cPF 50/10F, 5/1S, 10/2B (metal-matrix composite armor). [Pod #1 and #2] Cylinder hull (32 spaces; metal-matrix composite, medium frame), cDR/cPF 10/100 (steel armor). Hull radiators (40 ksf), two folding radiator wings (total 30 ksf).

Modules: *In Hull:* Old command bridge; Old basic bridge; 2 medium ladar; large PESA; small PESA; 125 HI fusion torch using water reaction mass; 660 tanks (water); 2 10-MJ heavy lasers [F]; 4 2.5-MJ light laser towers [S]; 2 coilgun [F]; 200' old particle accelerator [F]; 10 old fusion reactor (40 MW); old fusion reactor core; 5 bunkroom; light storm shelter (2-space: encloses command bridge, cPF 100); light storm shelter (1-space: encloses basic bridge, cPF 100); minifac workshop; large entry module; 2 small entry modules; small robot arm; external cradle (7-space, 875 tons); 4 vehicle bays (for 6-space AKVs); 35 cargo (175 tons). *[Pod #1]:* 20 cabin; battery; hall; small entry module. *[Pod #2]:* Same as Pod #1.

Statistics: EMass 7,337; CMass 13,074 (13,949*); LMass 18,024 (18,889*); Cost $404.18. cHP [Hull] 1,320, [Pods] 58. Size Modifier [Hull] +6/+10, [Pods] +3/+6, [Radiators] +8. HT 12. Maintenance Interval: 2 hours (48 hours/day). RRA 68. * With about 875 tons of loaded cradles, e.g., one TAV or OTV).

Performance: sAccel: 0.01 G. Burn Endurance: 220 hours. Burn Points: 7,920. Delta-V: 24.2 mps. No air speed.

Variants: In the SAAF vessel, replace the 2 10-MJ heavy lasers with two railguns and 4 spaces of ammo.

Mudlark-Class USV

An austere Tenzan Heavy Industries design, the *Mudlark* was originally intended to provide affordable passenger and light cargo transport between Earth-Lunar space and Main Belt stations. Introduced in 2075, it has proven popular with Duncanite and homesteader communities, as one of the few deep space vessels a small colony can afford to operate. The *Mudlark* utilizes a fusion torch with water reaction mass to take advantage of indigenous fuels available at the many "gas station" asteroids. The most controversial design element is the omission of a storm shelter – in the event of solar flares, the *Mudlark* will turn its thick front section toward the incoming radiation. Cosmic rays are another matter, and the *Mudlark* crews and passengers are normally expected to either have Tennin biochemistries or possess appropriate anti-radiation nanomods.

The *Mudlark* is a long cylinder 105' long and 25' in diameter. Much of the length is dedicated to fuel tankage for water reaction mass. It is normally powered by an MHD generator that taps the fusion drive, but it can power life support alone indefinitely using solar cells. Typical payload is 61.8 tons, of which 60 tons are usually used for cargo. However, it can carry an additional 125 tons in an external cradle. *Mudlarks* are usually privately purchased, named whatever the owner wants.

There are 3.38 spaces of empty space available for future upgrades.

The cheap Mudlark is the belt's most common USV, but the Sudbury is more versatile in the outer system, as they have the thrust to lift off from a small moon.
– Copernicus Jones

Crew: Pilot/Navigator (Astrogation, Piloting (Low-Performance Spacecraft)); Communications/Sensor Operator (Electronics Operation (Communications), Electronics Operation (Sensors)); Cargo Master (Freight Handling); 3 Engineers (Mechanic (Fusion Drive), Mechanic (Robotics), other Mechanics skills as appropriate). Most engineers are normally cybershells.

Design: Cylinder hull (125 spaces, steel, light frame); cDR/cPF 5/5F, 1/1S, 1/1B (steel armor); hull radiators (2 ksf).

Modules*:* Old basic bridge; small fixed PESA [F]; small radar; 5 high-impulse fusion torch (water); 75 tanks (water); 2 bunkrooms; 4 cabins; 2 small entry modules; 1 small robot arm; 5 ksf solar cells; 1 external cradle (125 tons); 12 cargo (60 tons).

Statistics*:* EMass 461; CMass 1,086 (1,211 with loaded cradles); LMass 1,648 (1,773 with loaded cradle). Cost M$14.16. cHP 71. Size Modifier +4/+8. HT 12. Maintenance Interval: 5.32 hours (18 hours/day). RRA 2.

Performance*:* sAccel: 0.0055 G (0.005 with loaded cradle). Burn Endurance: 625 hours. Burn Points: 12,375 (11,250 with loaded cradle). Delta-V: 37.8 mps (34.4 with loaded cradle). No air speed.

Variant: The *Nestor Makhno*-class is an armed variant produced by the Red Duncanites. Since the Pacific War, a half-dozen *Mudlarks* have been converted. The typical conversion adds a 2.5-MJ laser tower and 0.5 space power pack (good for 9 space combat turns of fire), and deletes 2 tons cargo. EMass 473, CMass 1,088 (1,213) LMass 1,650 (1,775), Cost M$16.53, Maint. 4.92 (19.5 hours/day). Performance is unchanged.

SATV

The Saturn Autonomous Transatmospheric Vehicle is manufactured by Columbia Aerospace. This wedge-shaped uninhabited spacecraft has a diamondoid structure and hull and uses a high-thrust fusion pulse drive to lift it from Saturn's gravity well, with an auxiliary fission air-ram for additional maneuvers within the gas giant's atmosphere.

The SATV is designed to travel between an aerostat processing center in Saturn's upper atmosphere and Cassini Station in low Saturn orbit, carrying a load of He-3. SATVs are also equipped with a robot arm and cargo bay, allowing them to be used for other operations within Saturn's atmosphere. Using its air-ram alone, a SATV can cruise indefinitely through the atmosphere at speeds of up to 2,000 mph.

The SATV is 100' long. Usual payload is 34 tons of He-3, though up to 34 tons of other cargo can be substituted. Cassini Station operates a fleet of six SATVs. They are assigned numerical designations, but technicians have given them unofficial nicknames.

An SATV has 20.57 spaces of empty space for future upgrades.

Crew: Commander (Piloting (High-Performance Spacecraft), Piloting (Aerospace)), Electronics Operation (Sensors)), Electronics Operation (Communications)). The SATV's commander is an infomorph residing in the vessel's computer.

Design: Streamlined Delta (64 spaces, diamondoid, heavy frame, lifting body, smart, responsive hull); cDR/cPF 0.42/1 [F], 0.3/1 [S, B] (diamondoid armor); hull radiators (7.5 ksf).

Modules*:* New unmanned controls; small radar; 11.75 compact high-thrust fusion pulsedrives; 1.5 compact fission air-ram; 2.83 tanks (ultralight, nuclear pellets); 20 tanks (ultralight, He-3); small robot arm; 6.8 cargo (assumed to be empty; used only if not carrying He-3).

Statistics*:* EMass 100; CMass 151; LMass 168. Cost M$336.25. cHP 240. Size Modifier +8. HT 12. Maintenance Interval: 2.18 hours (44 hours/day). RRA 7.5.

Performance*:* sAccel: 0.94 G. Burn Endurance: 1 hour. Burn Points: 3,384. Delta-V: 10.34 mps. Air speed 1.13 mps (0.56 mps with air-ram alone). Stall speed 0.01 mps (in Saturn).

Lewis-Class HSTV

The *Lewis* and her sister heavy space transport vehicles are the most common robot tanker spacecraft used to transport He-3 from Saturn to Earth-Lunar space. Nine were originally built, designed to operate without crews to reduce operating expenses and the need for storm shelters. A further five vessels have been constructed to replace losses (two were destroyed during the Pacific War and its aftermath) and allow for an increased delivery tempo as the system's demand for energy increases.

The *Lewis* has a spherical body 100' in diameter. It has 12 ksf of hull radiators. Usual payload is 850 tons of He-3 and 50 tons of other cargo (usually mail, etc.). *Lewis-class* HSTVs are named after space scientists and engineers.

It has 30.2 spaces of empty space left for future modifications.

Crew: Commander (Astrogation, Piloting (Low-Performance Spacecraft)), Electronics Operation (Sensors), Electronics Operation (Communications), Gunner (Beams)); 3 Engineers (Mechanic (Fusion Drive)). Commander is an infomorph residing in the vessel's computer; engineers are usually cybershells.

Design: Sphere (1,000 spaces, carbon composite, light frame, smart hull); cDR/cPF 1/1 (carbon composite armor); hull radiators (12 ksf).

Modules*:* Old unmanned controls; medium PESA; small PESA; small radar; small ladar; 25 high-impulse fusion torch (water); 425 tanks (water); 500 tanks (He-3); light storm shelter (0.1 space, around controls); 3 2.5-MJ tower lasers; 1 small entry module; 10 cargo.

Statistics*:* EMass 1,567; CMass 5,654; LMass 8,842. Cost M$116.98. cHP 234. Size Modifier +8. HT 12. Maintenance Interval: 3.7 hours (26 hours/day). RRA 12.

Performance*:* sAccel: 0.0059 G. Burn Endurance: 708 hours. Burn Points: 13,540. Delta-V: 41 mps. No air speed.

Chronos-Class TAV

The *Chronos* was designed by Columbia Aerospace for the Titan environment, and is the workhorse spaceplane for civilian and military space operations between Titan, Titan orbit, and Saturn's other moons. When lifting off from Titan, a *Chronos* boosts to cruising speed using its fission air-ram, then ignites its fission rocket engine to reach orbit. The rocket is fueled by indigenous methane fuel (abundant in Titan's atmosphere), drastically lowering its fuel costs, although the engine can also use hydrogen or water. The TAV can also be used as a conventional supersonic transport: using its air-ram it can cruise indefinitely in Titan's atmosphere at up to 1,100 mph, or reach 2,500 mph if using both the air-ram and fusion drive.

A prototype of the *Chronos* flew in Titan's atmosphere in 2079. Since 2086, the TAVs have been built by Columbia Aerospace on Rhea or Titan itself, although many of their components are imported. At present, 17 *Chronos*-class TAVs are in service, 11 with the Titan Consortium and six with the USAF's 30th Space Wing. The spacecraft itself is a streamlined delta 100' long. In its usual configuration it can carry 64 people and 60 tons of cargo. Typical payload is 66.4 tons. It uses 276 tons of methane as reaction mass.

Chronos-class vessels are named after the titans of Greek myth.

Crew*:* Pilot and Co-Pilot, each with Astrogation, Piloting (High-Performance Spacecraft, Piloting (Aerospace), Electronics Operation (Sensors), Electronics Operation (Communications). Co-Pilot is normally an infomorph residing in the vessel's computer.

Design: Streamlined Delta (64 spaces, nanocomposite, light frame, lifting body, smart, responsive hull); cDR/cPF 1.4/1 [F], 1/1 [S, B] (nanocomposite armor).

Modules*:* New cockpit; small fixed PESA [F]; small fixed radar [F]; 0.5 compact fission drive (methane); 0.5 fission air-ram; 46 tanks (ultralight, methane); 4 passenger seats (64 passengers); small entry module; 12 cargo (60 tons).

Statistics: EMass 53; CMass 257; LMass 395. Cost M$54.26. cHP 60. Size Modifier +8. HT 12. Maintenance Interval: 5.43 hours (17.7 hours/day). RRA 0.

Performance*:* sAccel: 0.22 G. Burn Endurance: 0.5 hours. Burn Points: 396. Delta-V: 1.21 mps. Air speed 0.7 mps (0.32 mps with air-ram only). Stall speed 0.025 mps. On Titan, air speed is 0.32 mps (0.15 mps with air-ram only), but stall speed is 0.017 mps.

Thule-Class DSOV

This Deep Space Operations Vessel is a typical Gypsy Angel design, using components mostly purchased from Rust China's MAST or salvaged from other vessels. It's a roughly spherical chunk of ice carved out of a Kuiper Belt Object, into which chambers and corridors have been melted.

Most of its interior space goes to the vessel's fusion drive and water tanks, but it has room for cargo holds, quarters, labs and minifacs. Sensors, a trio of laser towers, and two large external cradles (landing pads) are mounted on the vessel's surface. Performance does not change appreciably with the cradles loaded.

A Gypsy Angel craft this size will support up to 40 people in comfort, although it can carry up to 80. About one-third the volume of the *Thule* is waste space – ice – which provides moderate armor protection and good radiation shielding

The delta-V of the *Thule* is deceptive. It can be dramatically increased by cannibalizing the hull's waste space to feed the vessel's fuel tanks. This will reduce hull thickness and hence its cDR and cPF, but may be desirable on long voyages.

A dozen of these vessels are in service. Most were given names suggestive of legendary, mythical, or distant lands, e.g., *Asgard, Lemuria, Ultima Thule.*

The spacecraft itself is a sphere 150' in diameter. Typical payload is 1,258.6 tons. It uses 27,000 tons of water as reaction mass. It has 12.28 spaces of empty space.

Crew*:* Pilot/Navigator (Astrogation, Piloting (Low-Performance Spacecraft)), Communications/Sensor Operator (Electronics Operation (Communications), Electronics Operation (Sensors)), Weapons Officer (Gunner (Beams), 8 Engineers (Armoury (Spacecraft Weapons), Mechanic (Fusion Drive), Mechanic (Robotics), Engineer (Mining), other Mechanic skills as appropriate). Also carries other specialists such as medics, planetologists, educators, biotechnicians, depending on the owning family.

Design: Asteroid Hull (3,375 spaces, ice, light frame); cDR/cPF 1/10 (ice armor); hull radiators (15 ksf).

Module*s:* 2 Old basic bridge; 30 high-impulse fusion torch (water); 1,800 tanks (water); 1 medium PESA; 1 small PESA; 1 medium radar [F]; 1 small ladar; 3 2.5-MJ laser towers [S]; 2 hall; 40 luxury cabins; 3 small entry modules; 1 large entry module; 2 lab; 4 minifac workshops; 10 refinery; 5 rock crushers; 100 ksf folding solar panels; 1 spacedock (32 spaces, 40' × 20' × 20'); 2 external cradles (10 spaces, 1,250 tons each); 250 cargo (1,250 tons).

Statistics: EMass 17,494.2; CMass 32,252; LMass 45,752. Cost M$186.92. cHP 527. Size Modifier +9. HT 12. Maintenance Interval: 1.46 hours (65 hours/day). RRA 15.

Performance*:* sAccel: 0.001 G. Burn Endurance: 2,500 hours. Burn Points: 9,000. Delta-V: 27.5 mps. Air speed 0.

DFS-3C Archangel Space Dominance Vessel

The Columbia Aerospace DFS-3C is the fastest SDV in the USAF, and one of the most advanced in service anywhere in the solar system. A modification of the DFS-3A *Angel*, it is a 375' long by 50' wide streamlined cylinder covered with AKV bays and laser towers. It differs from the DFS-3A in being powered and propelled by a Nanodynamics Space Systems NAM-840 antimatter pulse drive engine instead of the usual fusion pulse drive. This engine was originally constructed for the competing YSDF-2 design, which was never actually produced, but four examples of the engine were manufactured and used in test beds. After the Pacific War, the USAF found funds for additional Angel vessels, and it was decided to fit the unused NAM-840 antimatter drives into existing DFS-3 hulls, resulting in the DFS-3C Archangel. Other modifications were made to sensors and armor based on experience with the DFS-3A.

There are only four DFS-3Cs in USAF service, all of them assigned to the 30th Space Wing at Rhea, where their substantially higher delta-V provides strategic mobility while patrolling the vast distances of the Deep Beyond. However, while the *Archangels* have more legs than the *Angels*, the need to handle and store expensive antimatter means that resupply of fuel is harder to come by, as the number of bases that stockpile antimatter fuel is limited. To compensate, all carry more than twice the antimatter their endurance requires.

Typical payload is 767 tons, including 4 AKVs in bays and 10 munitions packages, and various cybershells carried as cargo; the space dock is usually empty on routine space patrols, but may be loaded with landing or boarding craft, extra AKVs, or RATS as a mission requires. The radiator wings are 187' × 187' when fully extended.

Crew: Commander (Leadership, Shiphandling, Tactics), Pilot (Piloting (High-Performance Spacecraft)), Navigator (Astrogation, Electronics Operation (Communications), Electronics Operation (Sensors)), 2 Weapons Officers (Gunner (Beams), Gunner (Railgun)), 12 Engineers (Mechanic (Fusion Drive), Mechanic (Robotics), other Mechanics skills as appropriate), 1 Medic (Diagnosis, Physician, Surgeon), Mission Specialist (Electronics Operation (Sensors), Intelligence Analysis, SIGINT Collection/Jamming, Traffic Analysis). The DFS-3C has enough room to carry up to 20 infantry with their associated equipment. Engineers are usually cybershells.

Design: Streamlined cylinder (1,500 spaces, metal-matrix composite, heavy frame, smart); cDR/cPF 70/5F, 6/1S, 10/1B (nanocomposite armor). Hull radiators (60 ksf), folding radiator wings (70 ksf). Chameleon surface.

Modules: New command bridge; 2 large ladar; 2 large PESA; 2 large radar; 250 HI antimatter pulse drive; 920 tanks (ultralight, nuclear pellets); 0.46 antimatter bay (46 grams); 8 10-MJ heavy laser towers [S]; 2 10-MJ heavy lasers [B]; 6 2.5-MJ light laser towers [S]; coilgun [F]; 2 350' new particle accelerator [F/F]; 8 cabin; 5 bunkroom; 1 heavy storm shelter (2-space: encloses bridge, cPF 1,000); minifac workshop; 2 large entry module; surgery; spacedock hangar (75' long, 20' wide, 12' high; 36 spaces); 4 vehicle bays (*Predator* AKV: 110 tons, 0.112 ksf; 6 spaces each); 50 cargo (250 tons).

Statistics: EMass 5,993; CMass 12,281; LMass 17,801. Cost M$1,691.49. cHP 1,944. Size Modifier [Hull] +6/+11, [Radiators] +9. HT 12. Maintenance Interval: 0.97 hours (99 hours/day). RRA 125.

Performance: sAccel: 0.1 G. Burn Endurance: 92 hours. Burn Points: 33,120. Delta-V: 101.2 mps. No air speed.

Rogue AKVs

The TSA deployed several types of AKV during the Pacific War. Most numerous were the short-ranged *Kupu-Kupu* which were scattered about Earth-Lunar space. More insidious were the longer ranged *Rajasi* class, which were capable of deep space operation and patrol. Many *Rajasi* fled into the outer system after the war.

Rogue AKV: This is an AKV AI that has become dangerously unstable. Treat as LAI, but delete all Taboo Traits, Honesty and Reprogrammable Duty. Increase cost by 35 points. Some display Disadvantages such as Bloodlust, Delusions (Everyone is My Enemy), and Extreme Fanaticism.

Various private groups such as the Farhaulers' Guild and Mars Interplanetary have offered bounties on confirmed rogue AKV kills, up to several million dollars each.

> Men rode upon the whirlwind that night and slew and fell like archangels. The sky rained heroes upon the astonished earth. Surely the last fights of mankind were the best.
> – H. G. Wells

Rajasi-Class AKV ("Snark")

The *Rajasi* were deployed by the Thai and Vietnamese Aerospace Forces during the Pacific War. 40 were built, and launched secretly to interdict trade between China and its outer system colonies. They proved modestly successful, as China's PLAN-SF was oriented primarily toward planetary defense. However, the loss or deliberate destruction of TSA control facilities and codes during the war's end-game left many *Rajasi* orphaned, and some of them – nicknamed snarks by the USAF – continue a guerrilla war against Chinese and foreign interplanetary shipping to this day. (See also *Pirates,* p. 104).

The *Rajasi* differ from most AKVs in that they are designed to attack commercial vessels rather than warships. Being built for long-range cruise rather than maneuverability, they have excellent Delta-V for such small vessels, which also makes them effective in strikes against space stations and ground installations.

As the TSA lacked long-range support vessels, the *Rajasi* were given a wilderness fuel and maintenance capability. This included onboard repair and combat cyberswarms, and also a robot arm, recessed under the main body, that could salvage parts from its victims. They generally slice a target's reaction mass tanks open and strip it of fuel pellets. After battle damage, only a fraction (typically 1-10%) of a target's fuel would be easily accessible in this fashion, but a *Rajasi* needs very little to survive.

As their low-sapient infomorphs are capable of learning, the "rogue" *Rajasi* AKVs that survive today have considerably more cunning. In some cases, they have temporarily occupied space stations or vessels they have attacked, using them for cover. Some have communicated with targets to request surrender. There is one known incidence of a *Rajasi* hiding *inside* a captured HSTV cargo bay while controlling the vessel remotely via cable jacks, apparently assembled by its microbots or captured human crews.

The power pack allows 15 minutes (9 space combat turns) of laser fire. The fusion pulse drive recharges 100 seconds of laser fire every 4.8 minutes (3 space combat turns).

The *Rajasi* is a streamlined cylinder 50' long by 10' in diameter. Usual payload is 9.5 tons, consisting of a single KKMP munitions pack. It originally carried 33.84 tons of reaction mass. *Rajasi* vessels were numbered, but most have selected personal names for themselves.

Crew: Unmanned. Infomorph occupies Unmanned Controls and uses (Electronics Operation (Communications), Electronics Operation (Sensors), Gunner (Beams, Railgun), and Piloting (High-Performance Spacecraft)).

Design: Streamlined Cylinder hull (8 spaces, foamed alloy, heavy frame); cDR/cPF 35/5 [F], 1/1 [S], 10/2 [B] (carbon composite armor); hull radiators (1.5 ksf); chameleon surface.

Modules: Old unmanned controls; small radar [F]; small PESA; 2 compact HI fusion pulse drive; 2.82 tanks (ultralight, nuclear pellets); 2.5-MJ light laser [F]; coilgun [S]; 0.5 power pack; small robot arm; small entry module.

Statistics: EMass 73; CMass 100; LMass 117. Cost M$11.03. cHP 54. Size Modifier +2/+6. HT 12. Maintenance Interval: 6 hours (15.9 hours/day). RRA 1.5.

Performance: sAccel: 0.12 G. Burn Endurance: 23.5 hours. Burn Points: 10,152. Delta-V: 31 mps. No air speed.

> Until lions have their historians, tales of the hunt shall always glorify the hunter.
> – African proverb

Other Vehicles

These are land, air, and underwater vehicles. Noted vehicles conform to the *Wheeled Vehicle Modular Design System* (WVMDS) found in ***In the Well.***

Key

The following vehicle descriptions list components in a format intended to make them easy to use in play, rather than the design-sequence format used in earlier ***GURPS*** books. The following section describes the system used here.

Abbreviations

Subassemblies: The major parts of the vehicle. The number following each subassembly is the targeting bonus to hit. Abbreviations include *Tur* for turrets and *Whl* for wheels.

Power & Propulsion: Describes the size and type of all propulsion and lift systems, power plants, and energy banks.

Fuel/End: For fuel, gives the amount, type (with Fire number in parentheses), type of fuel tank, and

"routine" or "cruising" endurance. For energy banks, provides endurance data under various conditions. Fire is the chance, on 3d, of a fire breaking out in the fuel tank if the vehicle is disabled (drops to zero or less hit points) or destroyed.

Occupancy: Each number is followed by an abbreviation. CCS is a cramped crew station, NCS a normal crew station, and RCS a roomy crew station, where a crew member sits. Passenger seats use CS, NS, and RS for cramped, normal, and roomy positions, respectively. Any exposed position precedes the normal abbreviation with an X (for instance, XNCS for an exterior normal crew station).

Cargo: Gives capacity in cubic feet. Each cubic foot generally holds 20 lbs.; exceptions are noted.

Armor: Vehicles without this notation have no armor. F indicates frontal armor, RL right and left, B back, T top, and U underbody. If the entire subassembly has the same armor, only one value will be listed. Special circumstances will be detailed just below the tabular columns of armor values.

Weaponry: Vehicles without this notation have no integral weapons. For those that do, the location notation also gives the facing of the weapon, per *Armor*. All weapons are assumed to have full stabilization (cancels up to -3 in movement penalties). Weapons in turrets have universal mounts (they can elevate up to 90 degrees). Ammunition listings include all shots stored on the vehicle, not just rounds in a magazine. For energy weapons, the value indicates shots stored in energy banks. Following each weapon is the targeting modifiers provided by all the vehicle's supporting systems.

Equipment: Grouped by location, these are the gameplay-essential accessories on the vehicle; others will be described in *Design Notes*, below. Refer to ***In the Well*** and to *Lasers*, p. 137, vehicular weapon and equipment descriptions. Crash webs are high-tech air bags (DR 9 vs. impact damage that occupants might sustain); AESA can operate as either radars or, at half range, as ladars (p. TS178); for PESA systems, see p. TS178.

Statistics: Dim. is a rough indication of dimensions. *Lwt.* is loaded weight. The lowercase letter before a performance rating indicates a mode of travel; *g* is ground, *a* is air, *w* is water, *u* is underwater, etc., e.g., *gSpeed* is top ground speed, and *aMR* is the aerial maneuver rating. *Speed* is in mph (halve it to get speed in yards per second). *Accel* is acceleration in mph per second. *MR* is the maximum safe G that a vehicle can pull in a maneuver; to determine turning radius per p. B139, square the vehicle's current speed and divide by (40 ×MR). *SR* is the stability rating; if the GM rules that a vehicle operator has to make a skill roll to perform a potentially hazardous maneuver, failure by more than SR should result in not only failing the maneuver, but also potential disaster (e.g., crashing into something, spinning out of control, etc) at the GM's option. For air vehicles, stall speed is the lowest air speed the vehicle can have and still fly. For ground vehicles, a slower *off-road speed* is also listed; this is dependent on ground pressure. For submarines, *crush depth* is listed; see *Crush Depth*, p. 154.

Design Notes: A compilation of everything else – the vehicle accessories and data that rarely come up in play, but are useful for reverse-engineering the design. This references the design system from ***In the Well.***

Asterius (Deep Sea Research Vessel)

A variety of research and other submarines operate in Europa's oceans, some manned, others cybershells. In addition to the ubiquitous Vostok cybershell, all three bases on Europa also operate manned subs. The *Asterius* is a typical example.

A nuclear-powered mini-sub manufactured by Vosper-Babbage, the *Asterius* has a cylindrical hull 50 feet long and 10 feet in diameter. It is propelled by a water jet propulsion system and has a pair of robot arms and a single airlock. It seats three people (including the pilot), and also has three bunks and other living facilities for long-term operations.

Crush depth on lower-gravity Europa is 164,068 yards (93.2 miles), allowing it to reach the ocean's floor, albeit at some risk. It can operate to any depth in Titan's shallow seas.

Subassemblies: Body +2/+6.
P&P: Hydrojet (80 tons aquatic motive thrust); new fission reactor (10 MW output)
Fuel: 1+ years operation.
Occupancy: 1 RCS, 2 NS, 3 bunks. ***Cargo:*** 80 cf.

Armor	F	RL	B	T	U
Body:	4/1,000	4/1,000	4/1,000	4/1,000	4/1,000

Equipment

Body: New cockpit, small PESA (fixed), small ladar (fixed), two small robot arms.

Statistics

Size: 50' long, 10' diameter
Lwt.: 119 tons
Maint.: 8.91 hours
Payload: 2,200 lbs.
Volume: 4,000 cf
Price: $20.17 million

HT: 12 *HP:* 10,600

wSpeed: 4 *wAccel:* 0.6 w*Decel*: 7.5 *wMR:* 0.75 *wSR:* 4
Draft: 21 feet *Crush depth:* 24,240 yards

Design Notes

Metal-matrix composite body and extra-heavy frame, with a smart, responsive, submarine hull and hydrojet propulsion system (see ***Under Pressure***) Submerged mass 125 tons.

AstroBug

The Tenzan Heavy Industries AstroBug is a four-legged all-terrain vehicle used to get around on large asteroids and moons. The driver and up to three passengers sit in open seats, usually wearing vacc suits; the vehicle has an enclosed cargo bay, but not life support. It is powered by a closed-cycle hydrogen-oxygen MHD turbine, and driven using Driving (Mecha) skill using computerized controls.

The AstroBug is a development of a design first tested as a lunar rover in 2037. The present design dates to 2070. AstroBugs are commonly used on Ceres, Callisto, Rhea, and Titan.

Subassemblies: Body +3, four legs +1.

P&P: 37.5-kW four-legged drivetrain. 37.5-kW closed-cycle MHD turbine. Two rechargeable E cells with 40 kWh total capacity.

Fuel: Ultralight self-sealing 30-gallon hydrogen fuel tank (Fire 10), ultralight self-sealing 15-gallon LOX (liquid oxygen) fuel tank (Fire 10), 4.4 hours. Battery powers winch and radio when needed.

Occupancy: 2 XNCS, 2 XCS. ***Cargo:*** 75 cf.

Armor	F	RL	B	T	U
Body:	4/45	4/45	4/45	4/45	4/45
Legs:	4/20	4/20	4/20	4/20	4/20

Equipment

Body: Tiny Complexity 5 computer; 1,000-mile range radio; 4 1.5-mile range PESA [F/R/L/B]; ST 100 winch, 4 crashwebs.

Statistics

Size: 9' long *Payload:* 2,461 lbs. *Lwt.:* 9,622 lbs.
Volume: 195 cf *Maint.:*100.16 hours *Price:* $39,874

HT: 8.
HP: 132 [Body] *Each Leg:* 120

gSpeed: 35 *gAccel:* 10 *gDecel*: 20 *gMR:* 1 *gSR:* 5
Low GP. Off-Road Speed 28.

Design Notes

WVMDS design with walker modifications (p. 154). Midsize body and four midsize legs. Body has a light frame. Legs are medium frame. Armor is steel and body is sealed. Ground pressure is 732 on Earth (Low) but will drop to Very Low or Extremely Low on Mars or on any lower-gravity world (such as Titan), increasing Off-Road Speed to 35.

Landstrider

McKinsey Industrial Design's Landstrider is a rugged, dependable, four-legged all-terrain walker vehicle. It is built for operations in some of the harshest environments found in the Solar System – icy chasms, ethane swamps, and other terrain that even tracked vehicles would have trouble crossing. The Landstrider described here is the latest model; earlier versions used MHD turbines and lacked the small sensor turret.

A driver and passengers could survive in a Landstrider for several days in increasing discomfort, but it is not designed for long-term endurance. For long trips some of the passenger seats can be folded up (freeing 10 cf of additional cargo space each) to provide room to stretch out or sleep. When hauling cargo the passenger seats can be removed entirely. The driver uses the Driving (Mecha) skill with computerized controls.

Subassemblies: Body +4, four legs +2, full-rotation turret -3.

P&P: 75-kW four-legged drivetrain. Two rechargeable E cells with 40 kWh total capacity in body. 40 rechargeable E cells with 800 kWh total capacity in legs (10 per leg).

Fuel: Leg batteries power drivetrain and limited life support for 10 hours. Battery in body powers all other systems.

Occupancy: 1 RCS, 9 CS. ***Cargo:*** 125 cf.

Armor	F	RL	B	T	U
Body:	4/100	4/100	4/100	4/100	4/100
Legs:	4/80	4/80	4/80	4/80	4/80
Turret:	3/10	3/10	3/10	3/10	–

Equipment

Body: Radio with 10,000-mile range, inertial navigation system, 2 small Complexity 6 computers, compact fire suppression system, ST200 winch, one-man airlock, limited life system (40 man-days), 10 crashwebs, hitch and pin. *Turret:* 12-mile PESA, 4.5-mile AESA.

Statistics

Size: 15' long *Payload:* 4,500 lbs. *Lwt.:* 20 tons.
Volume: 700 cf *Maint.:* 44 hours *Price:* $205,850

HT: 7.
HP: 600 [Body] *Each Leg:* 300

gSpeed: 25 *gAccel:* 5 *gDecel*: 20 *gMR:* 0.75 *gSR:* 4
Low GP. Off-Road Speed 20.

Design Notes

WVMDS design with walker modifications (p. 154). Extra large body and four extra large legs with a 0.05 VSP turret. Armor is aluminum on body, titanium on turret and legs. Body is sealed. Body provides cPF 1 of radiation shielding. Ground pressure is 1,253 on Earth (Low), but will drop to Very Low or Extremely Low on Mars or any lower-gravity world (like Europa or Titan), increasing off-road speed to 25.

Landstrider Dragoon

In partnership with Vosper-Babbage, McKinsey developed a militarized Landstrider design in 2094 to study the feasibility of a light combat walker to support ground operations in extraterrestrial terrain. The Landstrider Dragoon has a larger turret with a smaller turret (cupola) atop it, more powerful leg motors, and a redesigned body with sloped and electromagnetic armor.

The Dragoon carries two lasers and a coaxial machine gun in its turret. Its hull is fitted with electromagnetic armor (p. 153) that allows it to withstand both small-arms and micro-missile warheads, up to and including 30mm SEFOP. The onboard squad can deploy either though the rear hatches or a belly door.

Orders for the Landstrider Dragoon have been slow due to the high price and specialized application of the vehicle, but EDI purchased five in 2095, and four have gone to the Commachio Group Royal Marines.

Subassemblies: Body +4, four legs +2, full-rotation turret +1, full-rotation turret +0.

P&P: 150-kW four-legged drivetrain. Two rechargeable E cells with 40 kWh total capacity in body. 80 rechargeable E cells with 800 kWh total capacity in legs (20 per leg).

Fuel: Leg batteries power drivetrain and limited life support for 10 hours. 50-kWh power pack gives 346 laser shots or powers emDR. Battery in body powers all other systems.

Occupancy: 1 RCS, 9 CS. ***Cargo:*** 10 cf.

Armor	F	RL	B	T	U
Body:	6/400	4/200	4/200	4/200	4/200
Legs:	4/100	4/100	4/100	4/100	4/100
Turret:	6/300	4/150	4/150	4/150	–
Cupola:	4/100	4/100	4/100	4/100	–

Has electromagnetic armor in addition to listed DR: Body has emDR 400 [F], emDR 200 [RL, B, T, U]. Turret has emDR 150 [F], emDR [RL, B, T]. Cupola has emDR 50.

Weaponry

15mm Heavy Machine Gun [Turret: F] (2,400 rounds of APS in body).
25-kJ Laser [Turret: F]
20-kJ Tactical Laser [Cupola: F]

Equipment

Body: Radio with 10,000-mile range, inertial navigation system, HUDWAC, IFF, 2 small Complexity 6 computers, compact fire suppression system, ST200 winch, one-man airlock, limited life system (40 man-days), 10 crashwebs, hitch and pin. *Turret:* 36-mile PESA, 45-mile AESA.

Statistics

Size: 15' long *Payload:* 2,600 lbs.
Lwt.: 15 tons *Volume:* 725 cf
Maint.: 19.41 hours *Price:* $1,062,070

HT: 9
HP: 600 [Body] *Each Leg:* 300
Turret: 90 *Cupola:* 27

gSpeed: 40 *gAccel:* 5 *gDecel*: 20 *gMR:* 0.75 *gSR:* 4
Low GP. Off-Road Speed 32*.
* 40 on Mars, Venus, or any moon or asteroid.

Design Notes

WVMDS design with walker modifications (p. 154). Extra large sloped body and four extra large legs. 5 VSP (25 cubic foot) sloped turret on body, 1 VSP turret atop turret. Armor is metal-matrix composite. Body provides cPF 1 of radiation shielding.

Ground pressure is 940 on Earth (Low), but will drop to Very Low or Extremely Low on any lower-gravity world, increasing off-road speed to 40, the same as gSpeed.

Vehicular Weaponry

Name	Type	Damage	SS	Acc	1/2D	Max	RoF
Gunner (Machine Gun)							
10mm Emag with APS	Cr.+	8d×4(2)	20	15	2,400	9,600	20
15mm Heavy Machine Gun with APS	Cr.+	6d×3(2)	20	14	1,300	5,600	8*
Gunner (Beams)							
25kJ Laser	Imp.	10d	25	24	7,800	11,000	8*

"APS" (Armor Piercing Saboted) damage is halved after it penetrates DR. For tactical laser, see p. 138.

World Rover

Built by Nanodynamics Automotive Systems, the World Rover is a multi-role six-wheeled all-terrain vehicle designed to traverse very rough terrain at good speed. Its closed-cycle MHD engine uses hydrogen and oxygen, commonly available from water ice on most outer planet moons (including Titan and Europa). It has no airlock, so opening the entry hatch unseals it. It lacks radiation protection, so it is not recommended for operations on Io, Europa, or Ganymede unless the crew has shielded suits.

It is driven using Driving (Automobile). There is one roomy crew station; the vehicle is nominally short occupancy, with five passenger seats. These seats can be folded up for additional cargo space, freeing 10 cf for each seat moved out of the way.

World Rovers are commonly used for excursions into the Titan outback. They are light enough to float, with limited amphibious capability, and are also easily air-transportable.

Subassemblies: Body +3, full-rotation turret [T:Body] -1, six off-road wheels +3.

P&P: 128-kW all-wheel drive. 150-kW closed-cycle MHD turbine. Two rechargeable E cells with 40 kWh total capacity.

Fuel: Ultralight self-sealing 110-gallon hydrogen fuel tank (Fire 10), ultralight self-sealing 55-gallon LOX fuel tank (Fire 10), 4 hours.

Occupancy: 1 NCS, 5 CS. ***Cargo:*** 50 cf.

Armor	F	RL	B	T	U
Body:	4/80	4/80	4/80	3/80	3/80
Turret:	4/20	4/20	4/20	4/20	–
Wheels:	3/20	3/20	3/20	3/20	3/20

Equipment

Body: Small Complexity 6 computer; 10,000-mile range radio; inertial navigation system; limited life support (12 man-days); hitch and pin. *Turret:* 36-mile range PESA; 45-mile range AESA.

Statistics

Size: 11' long *Payload:* 2,792 lbs. *Lwt.:* 4.57 tons
Volume: 300 cf *Maint.:* 50.35 hours *Price:* $631,020

HT: 13
HP: 375 *Tur:* 17 *Each Wheel:* 125

gSpeed: 95 *gAccel:* 4 *gDecel*: 15 *gMR:* 1.75 *gSR:* 5

wSpeed: 5 *wAccel:* 1 w*Decel*: 75 *wMR:* 0.75 *wSR:* 6
Draft: 1.4 feet

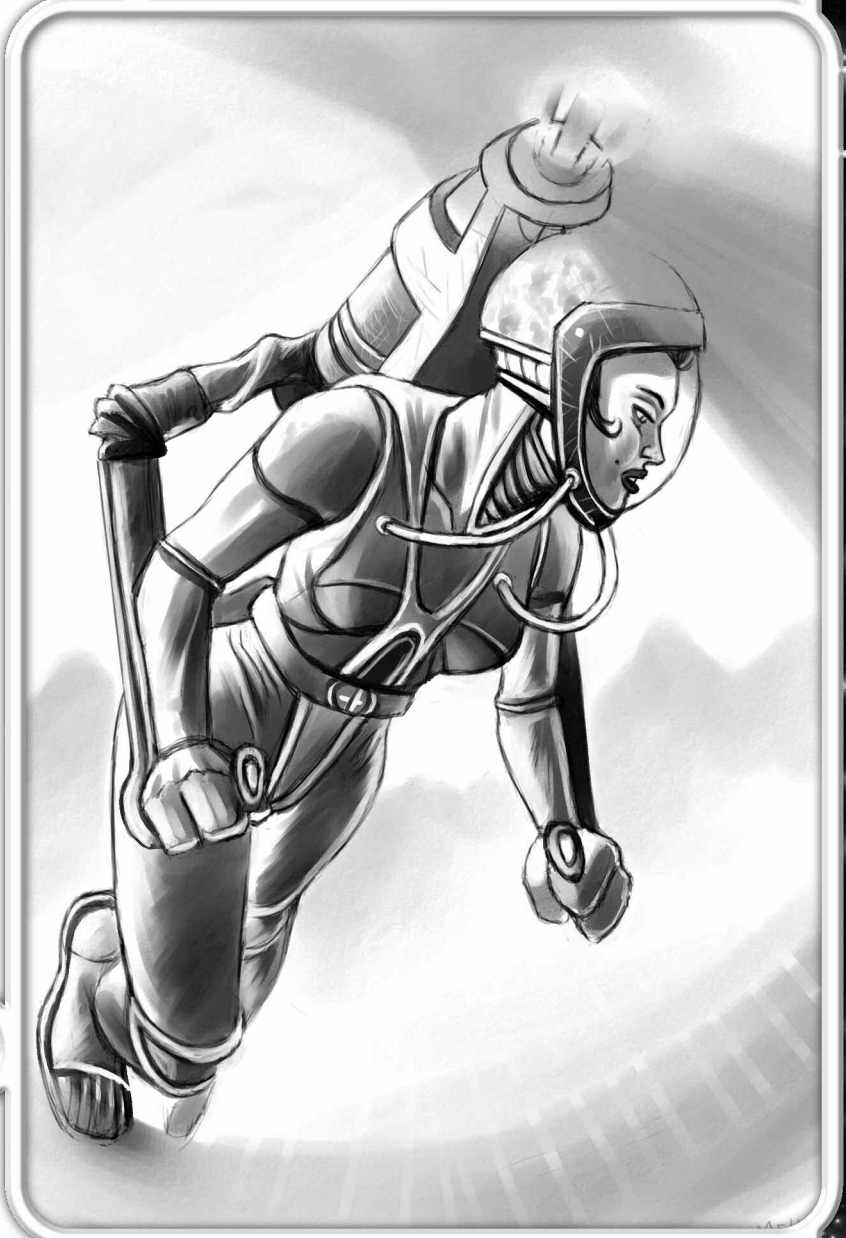
Design Notes

WVMDS design. Large body and 0.5 VSP (2.5 cubic foot) turret. Body has a smart, medium frame and carbon composite structure. Turret is a medium frame with a foamed alloy structure. Wheels are very large (oversized) with all-wheel steering, improved suspension, puncture resistant tires, and smartwheels. Armor is metal-matrix composite on body, carbon composite on turret and wheels. Body and turret are sealed. Ground pressure is 1,206 on Earth, 169 on Titan.

On Titan, Very Low GP, Off-Road Speed 65.

What Nanodynamics don't tell you is that brochure speeds are deceptive. Most of the moons in the Deep Beyond aren't your garden-variety lunar regolith – they're icy, broken ground, or, on Titan, frozen sludge. Either way, you'll be doing one-third listed off-road speed with wheels, two-thirds for a walker.
– Copernicus Jones

Titan Packhopper



Titan's low gravity and thick atmosphere mean that man-portable helicopters are quite practical. A common mode of transport outside the domes is the Packhopper, a one-man strap-on backpack helicopter manufactured locally by Nanodynamics. Packhoppers have also been used inside larger space station habitats, especially those with low gravity.

The Packhopper is propelled by twin battery-powered rotors. These counter-rotate around a single shaft above the user's head, developing 400 lbs. of lift. This is barely enough to get it off the ground on Earth or Venus, but provides plenty of margin to spare in Titan's low gravity, where the 'hopper and pilot weigh 1/7 as much.

If flown manually, the pilot uses twin control arms that extend forward from the backpack, with instrument readouts displayed through his own virtual interface. Even so, the Packhopper requires both hands to operate when not locked into a simple hover pattern. Alternatively, the vehicle can be operated in a "hands free" mode under AI control, either through the wearer's own virtual interface or by an AI actually installed in the hopper.

The Packhopper's armor does not protect the operator, although any attack from behind will normally hit the machine instead of the wearer. It takes 10 seconds to strap on the Packhopper, or one second to detach it. The rotor folds up, allowing the pack to be brought indoors, but it requires at least 5 yards clear radius above the user to operate. The pilot uses Piloting (Flight Pack) skill. The vehicle has computerized controls. Payload assumes a 250-lb. operator wearing an environment suit. A small pilot can carry a lot more payload, or operate for longer.

Subassemblies: Body +0, folding rotor -4, two skids -4.
P&P: 40-kW coaxial rotor drivetrain, 60-kWh battery.
Fuel/End: Battery provides 1.5 hours of full-power output.
Occupancy: Harness ***Cargo:*** None

Armor	**F**	**RL**	**B**	**T**	**U**
All:	2/3	2/3	2/3	2/3	2/3

Equipment

Body: Tiny cheap Complexity 4 computer, crashweb.

Statistics

Size: 3' tall *Payload:* 250 lbs. *Lwt.:* 394 lbs.
Volume: 3.2 cf *Maint.:* 259 hours *Price:* $5,950

HT: 12
HP: 9 [Body] *Rotor:* 12 *Each Skid:* 2

aSpeed: 115 *aAccel:* 3 a*Decel*: 20 a*MR:* 5 a*SR:* 4
Stall speed 0.

Design Notes

The Packhopper's frame is light foamed alloy and robotic. Armor is foamed alloy. The body has basic sound baffling. aDrag is 37.

CA-90 Titan Eagle ("Bird-Plane")

Columbia Aerospace's *Titan Eagle*, universally referred to as the "bird plane," is a powered ultralight ornithopter aircraft that uses motorized beating wings to provide lift and thrust. It's not as practical as a helicopter, but it's more stylish and quiet, and as such has been popular with both tourists and residents. It is a personal commuter transport and sports vehicle for many Titan residents. A number of rental agencies also cater to tourists (many of whom are infomorphs uploaded into bioshells or cyberdolls).

The *Titan Eagle*'s pilot uses Piloting (Light Airplane) skill. The vehicle has computerized controls. Payload assumes a 250-lb. operator (wearing an environment suit). The bird plane has no life support of its own; a large transparent teardrop canopy opens up to allow entry or egress, and also provides an excellent view.

Subassemblies: Body +1, two standard wings -1, three retractable wheels -1.
P&P: 30-kW ornithopter drivetrain, 75-kWh battery.
Fuel/End: Battery provides 1.5 hours of full-power output.
Occupancy: 1 CCS ***Cargo:*** 3 cf

Armor	F	RL	B	T	U
All:	3/5	3/5	3/5	3/5	3/5

Equipment

Body: 100-mile range radio, 1-mile AESA [F], small Complexity 6 computer, transponder, 700-lb. vehicular parachute, crashweb.

Statistics

Size: 7' long; 20' span
Lwt.: 683 lbs.
Maint.: 80.2 hours
Payload: 310 lbs.
Volume: 37.5 cf
Price: $62,160

HT: 22
HP: 44 [Body] *Each Wing:* 14
Each Wheel: 4

aSpeed: 95 *aAccel:* 2 a*Decel*: 17 a*MR:* 4.5 a*SR:* 4
Stall speed 0.

Design Notes

The Bird Plane's frame is light titanium alloy, with a robotic structure and fair streamlining. Armor is metal-matrix composite. aDrag is 48.

UH-92 Malamute Utility Helicopter

The *Malamute* is the U.S. Army's front-line Titan utility helicopter, used for air assault, air cavalry, and aeromedical evacuation. First deployed in 2092, it was developed from the earlier UH-88 (used on Earth), but has much heavier armor, a de-rated rotor driveshaft, and a battery pack rather than a MHD turbine. Even so, it is significantly more expensive then the UH-88 and cannot get off the ground in gravity greater than Titan's.

Okay, the Mosquitoes spotted some kind of, quote, unquote, hive growing near the south end of the Mayan Plateau. We're going to check it out. Maybe Chinese, maybe Triad or radical 'humes – hell, it might be those Axon guys. Now, this is a hot LZ, but you newsies in the back don't need to sweat – there ain't nothing tougher than an Ice Dog 'cept an M88, and it don't fly.
– Lt. Rafael Lopez, 82nd Spaceborne

The *Malamute* has a teardrop-shaped carbon composite body with a folding diamondoid coaxial helicopter rotor (two rotors rotating in opposite directions around the same shaft) for lift and stability. It lands on retractable skids that telescope out to provide up to six feet of ground clearance in Titan's low gravity. Above the rotor assembly is a small rotating turret that houses the *Malamute*'s sensors and point-defense laser. Defensive armament consists of two casemates, one on each side, mounting a 10mm electromag gun that can fire ahead and to the left or right side. Basic emissions cloaking, a laser/radar warning receiver, infrared jammer, chaff dispensers, and precision navigation equipment provide additional capability.

With over 12 tons of armor, equivalent to many infantry fighting vehicles, the UH-92 is one of the best protected manned helicopters in existence. It also has a large cargo area – a typical payload would be 20 troops in cramped seats, a squad of eight Jump RATS, or 5 tons of cargo in a cargo sling. The helicopter's main failing is its sluggish acceleration.

The pilot uses Piloting (Helicopter) skill. The vehicle has computerized controls (with a duplicate control set for a copilot).

Subassemblies: Body +4, folding rotor +1, two full-rotation weapon turrets -1, full rotation sensor turret +0, two retractable skids in body +2.

P&P: 700-kW coaxial rotor drivetrain, 3,500-kWh battery, 65-kWh battery, 36,720-kWs power pack. Secondary 9,000 kWs power pack.

Fuel/End: Batteries provide 5 hours of full-power output; power pack gives 300 laser shots and all 29,840 Emag shots. Secondary power pack can energize emDR 45 times.

Occupancy: 2 RCS ***Cargo:*** 380 cf (at 25 lbs./cf)

Armor	F	RL	B	T	U
Body:	4/500	4/500	4/500	4/500	4/500
Rotor:	4/200	4/200	4/200	4/200	4/200
Weapon Turrets:	4/200	4/200	4/200	4/200	–
Sensor Turret:	4/200	4/200	4/200	4/200	–
Skids:	4/100	4/100	4/100	4/100	4/100

Body has emDR 200 on all facings.

Weaponry

20 kJ Tactical Laser [Sensor Turret: F]
10mm Emag [Weapon Turrets: F] (29,840 rounds in body).

Equipment

Body: Radio with 10,000-mile range, flight recorder, precision navigation instruments, IFF with backup, inertial navigation system, terrain-following radar, 2 HUDWAC with pupil scanners, advanced radar/laser detector, infrared jammer (Jam 8), 10 aircraft decoy dischargers with 20 chaff reloads, 2 small Complexity 6 computers, compact fire suppression system, ST 30 winch, limited life system (2 man-days), 2 crashwebs. *Sensor Turret:* 36-mile PESA and 45-mile AESA.

Statistics

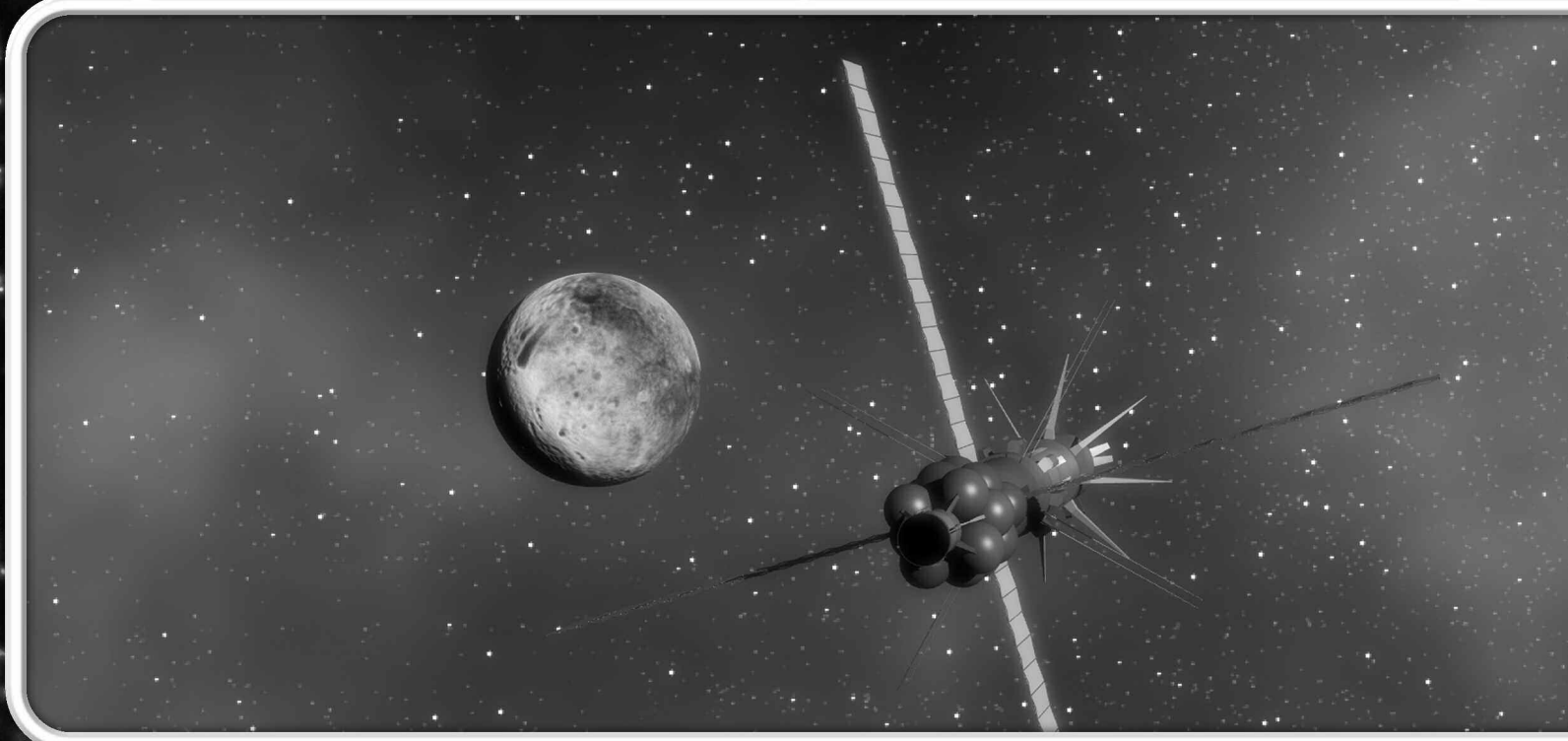
Size: 20' long *Payload:* 10,100 lbs. *Lwt.:* 23.2 tons
Volume: 785 cf *Maint.:* 16.7 hours *Price:* $5,694,240

HT: 7
HP: 362 [Body] *Rotor:* 161
Weapons Turrets: 8 *Sensor Turret:* 17
Each Skid: 25

aSpeed: 220 aAccel: 5 a*Decel*: 14 a*MR:* 3.5 a*SR:* 5
Stall speed 0.

Design Notes

The *Malamute*'s frame is light carbon composite with good streamlining, robotic, smart, and responsive. Armor is nanocomposite with diamondoid on the rotor and metal-matrix composite on the skids. The body is sealed and has basic emissions cloaking. aDrag is 176. The *Malamute* can't fly anywhere except Titan. The IR jammer gives a -8 penalty on rolls for any infrared homing weapons to target the vehicle; chaff, on the turn launched and following turn, gives a -5 on ladar or radar-homing weapons to target it.



APPENDIX: DESIGN OPTIONS

This appendix provides additional options for the spacecraft design system in ***Transhuman Space*** and the Wheeled Vehicle Modular Design System of ***In the Well.***

New Spacecraft Components

These components are used with the *Spacecraft Design* rules (p. TS173). Additional spacecraft components can also be found in ***Transhuman Space: High Frontier.***

Black Hole Power Plant

This consists of a primordial black hole surrounded by a power system – see *Primordial Black Holes*, p. 78. The plant consists of the black hole (negligible space, typically a billion tons or more mass) plus a gravitic fusion system. The plant requires a power core (34 spaces, 820 tons, M$12.2); this also includes shielding against the black hole's radiation.

Each additional space of power plant can generate 20 MW at a mass of 4 tons and cost of $0.8, up to a maximum determined by the amount of power that the black hole can produce (about 100 MW for Shezbeth). The plant requires the same heat radiators as a fusion plant, which are based on the size of the plant in spaces, excluding the core.

Only one black hole power plant is operational (Shezbeth, at Hawking Station), unless conspiracy theorists are correct and more holes have been recovered.

Nuclear Pellet Factory

A specialized modular robofac that can turn raw materials into fuel. It requires 5,000 tons of rock and 5 lbs. of He-3 per month in order to produce 84 tons (7 spaces) of nuclear pellets. In addition to nuclear pellets, the process also produces 70 tons of HO fuel, 840 tons of MO fuel, 100 lbs. of fission fuels and 3,900 tons of slag or rock dust. A nuclear pellet refinery takes up 860 spaces, masses 10,800 tons, costs M$20, and uses 360 MW.

Parachutes

Parachutes may be used to provide a soft landing or slow descent for craft entering atmosphere even if the craft is not streamlined. Parachutes are often used by re-entry capsules that carry cargo or personnel, and by gas giant probes. They can be deployed once a vessel has dropped to subsonic speed (generally as a result of aerobraking). A typical system includes a pair of chutes, with a smaller one deploying first and dragging out a larger parachute. Each space of parachute can support up to 625 tons, masses 6.25 tons, and costs M$0.125. Fractional spaces are usually installed – e.g., a 0.16 space parachute supports 100 tons, masses 1 ton, and costs M$0.02.

Railgun

This is an electromagnetic cannon; railguns were common on early warcraft designs, before longer-ranged lasers and particle beams became standard. They are still lethal at close range. The most common railgun design (an extremely long-barreled 155mm gun) has an effective velocity in vacuum of approximately 10 mps, higher than the standard coilgun. It fires hypervelocity projectiles directly at a target, rather than launching munitions packs.

A railgun requires 2 spaces, masses 22 tons, costs M$9.2, and uses 1,700 MJ to fire each burst; it can fire two bursts/turn. It requires 0.1 ksf of surface area. The railgun can only be installed in vessels that are at least 100' long (if facing forward or backward) or at least 100' wide (if facing sideways).

0.1 space of railgun ammunition masses 0.28 tons and costs M$0.036, and allows the weapon to fire 26 bursts.

Railgun Fire

Weapons and Range: A railgun can fire at short range, or if the target is *non-maneuvering*, at short or effective range.

Physical Damage: A railgun does cDAM 6d × (5 + RV) damage at all ranges. (RV is calculated as per *Ramming and KKMP Damage*, p. TS198). Damage that penetrates armor is multiplied by 10, as a "shot" represents several rounds impacting.

Orbital Strike: It has full effect on ground targets.

Point Defense Fire vs. Railguns: A laser in point defense mode may fire to destroy railgun projectiles. If range is effective, each light or heavy laser can fire to eliminate one railgun shot on a successful Gunner roll. A failure reduces the railgun shot's after-armor damage multiplier by (10 - margin of failure); a critical failure means the point defense had no effect.

Evasion: A spacecraft that took Evasive Action or Break Off as its last maneuver gets a Dodge roll to evade railgun fire. Roll vs. Piloting skill, subtracting the dodging spacecraft's worst Size Modifier and adding the modifiers from the *Burn Modifier Table*.

Refinery

This is a heated microgravity drilling and siphon unit that can be used to extract water from a carbonaceous, carbonaceous volatile, frozen volatile, or other icy or volatile-rich body like a KBO or icy moon. It may be installed on a spacecraft (generally in the nose of a cylindrical vessel) or on a station built onto or within the asteroid itself. Assuming an outer-belt carbonaceous asteroid whose composition is 20% water, each space of probe processes 300 tons of asteroid regolith per day into 60 tons (4 spaces) of water. Each space of asteroid refinery masses 4 tons, costs M$0.2, and requires 1 MW.

Electromagnetic Armor

"EM Armor" consists of spaced plates containing sensors which detect the impact of a projectile (such as the penetrating jet produced by a shaped-charge warhead) and then generate an intense electromagnetic field. This nullifies or degrades most shaped-charge projectiles and provides a degree of additional protection against kinetic-energy impacts.

EM Armor may be designed into any vehicle with at least DR 16 armor (or the armor on the facing protected, if it varies) as long as the EM armor does not exceed half normal DR.

The vehicle must have a power pack for the armor to function, as batteries do not discharge quickly enough. If an attack penetrates the normal DR then the electromagnetic plating will activate, draining energy from the power pack. Its DR (abbreviated emDR) protects *only* against shaped-charge (e.g. HEMP) and kinetic-energy weapons (including explosively-forged penetrators such as SEFOP). Armor divisors on shaped-charge warheads are ignored against emDR. For example, if a shaped-charge HEMP warhead with a (10) armor divisor struck a vehicle with DR 100 and emDR 50, it would defend with DR (100/10) + 50 = DR 60 against that attack.

Attacks which fail to penetrate the normal DR of the armor will not trigger the EM Armor (or drain energy).

If using WVMDS from ***In the Well,*** EM armor has a Mass modifier of 0.03 and a Cost modifier of 100. It drains 1 kWs per point of emDR when the armor is activated.

Solar Concentrator

Solar concentrators are giant mirrors that focus sunlight onto a relatively narrow point in order to generate very high temperatures. A large enough mirror can melt an entire asteroid, or tunnel through rock. Solar concentrators are used as ore smelters, and are also required tools for the creation of Cole habitats (p. 132). Solar concentrators have the same statistics as solar panels or folding solar panels (p. TS185), except they cost half as much, and create a spot of intense heat rather than generating electric power.

Stabilized Metallic Hydrogen Rocket

This experimental metallic hydrogen-fueled (p. 135) engine was developed by Columbia Aerospace for the X-92 AKV. Each space of rocket engine produces 200 tons thrust, masses 4 tons, costs M$0.4, and has RMC 40 and Isp 1,500. SLMH fuel masses 12 tons and costs M$1 per space.

The engine is presently somewhat unreliable. Roll 1d every hour it is in use – if the die roll is 6, the drive suffers a catastrophic malfunction, destroying the spacecraft. If used in space combat, roll 2d on any space combat turn in which one or more burn points are expended; an explosion occurs on a 12.

Walker Design Notes

The broken terrain of outer satellites like Io and Europa can be too much for wheeled vehicles. Instead, vehicles often walk on legs, which in the low gravity of most moons easily overcome the issues of ground pressure which bedevil them in Earthlike environments. Two-legged vehicles are rare, but more stable four-legged designs are fairly common.

The WVMVDS (p. ITW124) can also be used to design vehicles with legs.

Legs

A walker has four legs rather than wheels. Each individual leg has the same area, weight, cost, total HP, and Size as a set of standard wheels. Read "wheel area" as leg area. Internal space (VSP) available in each leg is 10% of the VSP (before reduction for slope, if any) found in an equivalent-size body. Leg drivetrains (see below) can only go in legs; excess space may be used for other components.

Walkers may have improved suspension, but no other wheel options.

Drivetrains

Walkers require leg rather than wheel drivetrains. These must be placed in leg spaces. Divide their combined core and slice volume evenly among all leg spaces. As with wheeled drivetrains, each module provides 25 kW of motive power.

Leg Drivetrain Modules

Type	*VSP*	*Wt.*	*Cost*	*Power*
Walker Drive Core	1.5	180	$9,000	–
Walker Drive Slice	0.8	100	$5,000	25

Performance of Walkers

Speed and gAccel: Use a speed factor of 12.

gDecel: This is 20 mph/s for legs.

Ground Pressure and Off-Road Speed: Determine the walker's ground pressure by dividing loaded weight (modified by local gravity) in pounds by total leg area, and multiplying by 12.5. A walker with extremely or very low ground pressure has no reduction in speed when traveling off-road. If ground pressure is higher, its off-road speed is reduced as follows: 4/5 if low, 2/3 if moderate, 1/2 if high, 1/3 if very high, and 1/4 if extremely high.

gMR: 1.5 for tiny, 1.25 if very small or small, 1 if midsize to large, 0.75 if extra large or greater size. Improved suspension adds 0.25 to gMR.

gSR: 3 if tiny to small, 4 if larger. Improved suspension adds 1 to gSR.

Crush Depth and Test Depth

While unmanned cybershells can be designed for very high-pressure environments and life forms may be native to such pressures, only a few specialized manned vessels can survive at the bottom of Europa's atmosphere or in the depths of a gas giant. *Crush depth* is how deep, in yards, a pressurized vessel can descend without being crushed. (Divide by 1,760 to get depth in miles.) The formula is:

Depth (yards) = 100 × (cDR + 0.1) × Frame Modifier × Shape Modifier/ Size Modifier

If the vessel has more than one Size Modifier; use the lower. *Frame Modifier* is 0.25 if extra-light, 0.5 if light, 1 if medium, 2 if heavy, or 4 if extra-heavy. *Shape Modifier* is 24 for a spherical hull, 12 for a cylinder or torus hull, or 3 for a box or delta hull.

Crush depth is further affected by gravity and liquid density. If a vessel has multiple cDR values, use the lowest cDR when calculating crush depth.

For Titan: Calculate crush depth using the above formula, then multiply by 12.64, and subtract 72 yards. This accounts for the ethane-methane liquid, low gravity, and increased atmospheric pressure.

For Europa: Calculate crush depth using the above formula, then multiply by 7.7, and subtract 22,580 yards. This accounts for the lower gravity and the increased pressure of the many miles of ice above the ocean.

> It's a very sobering feeling to be up in space and realize that one's safety factor was determined by the lowest bidder on a government contract.
>
> – Alan Shepard

For Gas Giants: To get crush depth in atmospheres (for descents into gas giants) multiply crush depth by 11.3. The entries on Jupiter (p. 37) and Saturn (p. 53) provide approximations of atmospheric pressure at increasing depth.

Test Depth: A vessel has a test depth equal to half of its crush depth. This is the normal maximum operating depth which it will not exceed during routine operations. If it goes deeper, it must make a HT+2 roll on a regular basis. Roll hourly for routine operations on a well-maintained craft, or more frequently (e.g., every minute) during situations where a lot of stress is placed on the hull, such as combat maneuvering, or when maintenance has been neglected. If the roll fails, it takes cDAM to the hull equal to 1d × (depth/1,000) yards; liquid and/or gas may also enter the vessel's hull.

Designing Habitats

These rules provide additional suggestions for designing habitats using asteroids, moons, and similar locations. Most of the time, a station or building doesn't need statistics, whether it's on Ceres, Europa, or Earth. GMs should only bother with these rules if exact characteristics are important, e.g., the PCs are constructing their own station or planning to attack one.

Beehive Habitats

A beehive habitat can be designed simply by using the Spacecraft Design rules to create a vessel with an ice or asteroid hull, omitting the drive.

However, if the body is a few miles or more across, and 90% or more of its interior is expected to be waste space, then calculating "hull mass" and "hull size" are unimportant. They can also be deceptive, as values such as cDR assume habitation is concentrated in the core of the asteroid, rather than just beneath the surface. For realistic beehive habitat designs that meet these criteria, make the following modifications.

Internal Space: Decide on the total volume of all *tunnels and chambers*.

Tunneling Cost: This is M$ = (Habitat Spaces)/C, where C is 10,000 for a stony asteroid, 20,000 for a carbonaceous asteroid, or 50,000 for an icy body.

cHP: Assume cHP is equal to the square root of (M × Internal Space), where M is 100 for a stony asteroid, 50 for a carbonaceous asteroid, or 30 for a frozen volatile or icy body.

cDR: Calculate cDR as cHP/10. Round fractions to the nearest whole number, and treating any value under cDR 1 as cDR 1. For an icy body, use the rules for ice armor.

If a beehive habitat is reduced to 0 cHP or less, it has taken serious damage. Access modules, docks, bays, weapons, and sensors are non-functional; entering or leaving requires forcing them open, but internal systems remain operational. Reducing it to -5 × cHP means widespread collapse of upper tunnels and galleries, disabling the installation until the rubble can be cleared away.

Designing Cole Habitats

A Cole habitat is best designed as a spacecraft. Treat it as a cylinder hull about twice as long it is wide, using the rules for manufactured hulls that are made of steel. 50% of the cost of the steel hull and armor can be ignored if the purchasers used the Cole process themselves. It should have cDR 1.

Designing Surface Installations

Installations may be built on the surface of asteroids or other bodies, rather than tunneled into them. To design a building, simply create it like a manufactured hull of the appropriate shape and dimensions using the *Spacecraft Design* rules.

GLOSSARY

The following terms are commonly used in the Deep Beyond; see the Glossaries in ***Transhuman Space*** and ***In the Well*** for explanations of terms not listed here. For organization names and abbreviations, see Chapter 6.

Jargon

aerobot: A flight-capable cybershell.

deep time preservationist: A preservationist concerned with preserving environments that may nurture life billions of years in the future.

eidelon: A shadow created from study of an individual.

freehold: An asteroid owned in totality by a Duncanite family.

genarch: The eldest person in a Duncanite family.

homestead: A privately-funded non-commercial asteroid colony.

homesteader: Someone who settles in or founds an asteroid homestead.

hydrocarbons: Organic chemical compounds made up mainly of hydrogen and carbon. Oil is a hydrocarbon.

polypsychic: Someone who hosts multiple organic and/or digital minds in one body.

retromorphosis: Any biomodification that *decreases* the quality of someone's life. A favorite threat of the Martian Triads.

snapshot: A copy of an infomorph that is not being actively run.

SIRMA: Solar Infrared Montgolfiere Aerobot.

SPV: Space Patrol Vehicle. A pre-SDV manned space warcraft, generally less capable, and sometimes a conversion of a civilian vessel.

UNSIBA: Uranus Neptune Stratosphere Inflated Balloon Aerobot.

Slang

deemster: A judge-for-hire; Duncanite slang.

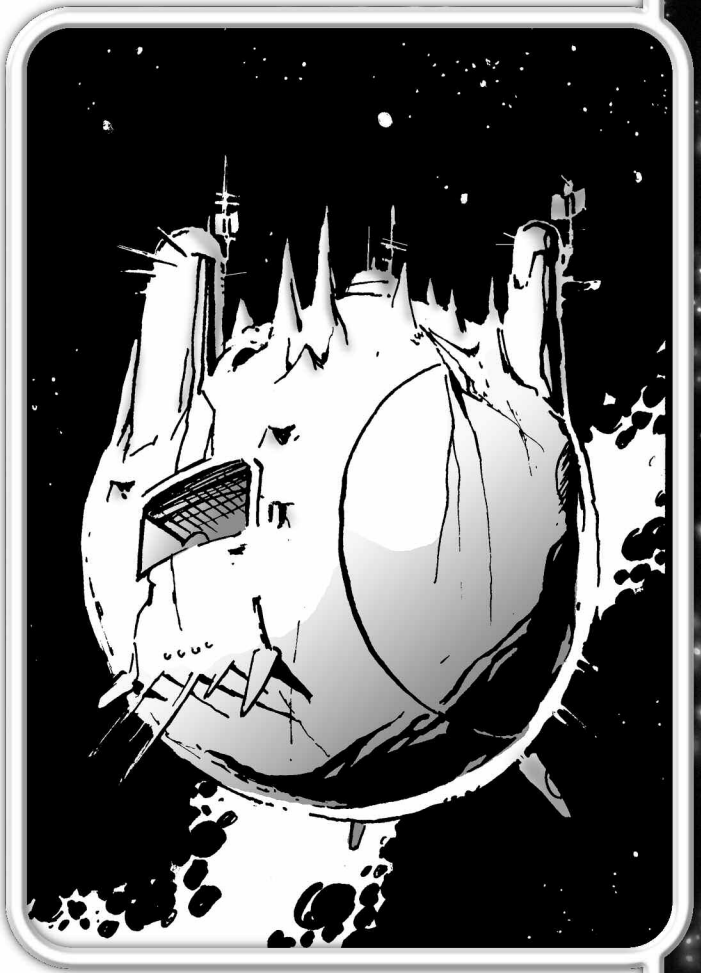
dragoons: Military personnel; derogatory Duncanite slang.

formicide: The practice of destroying Prospector Swarms (Red Duncanite slang).

greenhand: An asteroid farmer.

softjacking: The kidnapping of an AI, usually for illegal editing, copying, and pirated resale.

zek: A person whose body has been condemned as the result of a Duncanite judicial ruling.



Useful Formulas

GMs may wish to calculate the gravity and escape velocity of small bodies such as asteroids and moons. Use these formulas:

Gravity (Gs) = Diameter (in miles) × Density × 0.0000228

Escape velocity = 0.11 × square root of (g × r) mps

where g is the surface gravity in Gs, and r is the radius (half diameter) in miles.

Density may need to be estimated by the GM; for many small bodies, an exact figure is unknown. 1.15 to 2.0 g/cm^3 is typical of bodies that are mostly ice, or ice and rock, such as the smaller outer satellites, Kuiper Belt Objects, and asteroids made of frozen volatiles. Carbonaceous asteroids typically have densities of about 1.5 to 3.0 g/cm^3. Stony and metallic asteroids may have densities of about 3.0 to 4.5 cm^3.

Small Body Designations

Names for asteroids, KBOs and other small bodies follow a traditional system.

Provisional Designations

The majority of asteroids, comets, Kuiper Belt Objects, and Oort Cloud objects don't yet have formal designations. Instead they use "alphabet soup" names like 2099 DZ. However, there is a method to the madness.

The date (e.g., 2099) is the year of discovery, with the first letter (e.g., J) being the half-month in which it was discovered:. January 1-15 is "A," January 16-31 is "B," February 1-14 is "C," etc., omitting I and Z, so J means the first half of May.

The second letter (e.g., Z) shows when the body was found during that particular half-month. The first body found in that period is designated A, the second B, and so on, omitting I but not Z. If more than 25 bodies require such designations, the letter is recycled with a number appended. "1" for bodies 26-50, "2" for bodies 51-75, and so on. Thus, 2099 DZ is the 25th small body found in the first half of February 2099.

Comets are prefaced with C/ before the date, e.g., C/2099 DZ.

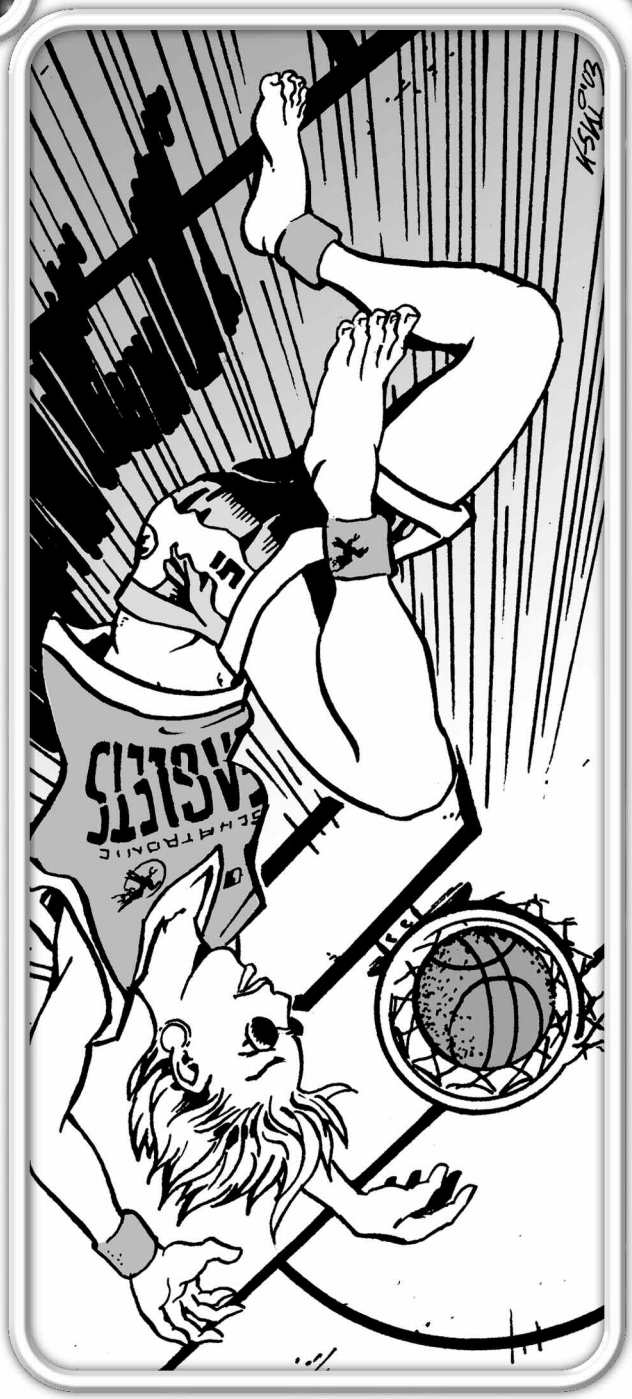
By 2100, astronomers have found most sizable Main Belt, Trojan, and inner system asteroids, so a recent discovery like 2099 DZ is either only a few yards across, has a very eccentric orbit, or is in the Centaur, Kuiper Belt, or Oort Cloud populations.

Permanent Designations and Names

A permanent designation is assigned after the body's orbit is precisely determined.

For asteroids, etc. it consists of a number followed by a name. These are sequential, starting with the first asteroid. Thus, 1 Ceres is the first asteroid whose orbit was determined; 259 Aletheia was the 259th, and so on. Comets retain the provisional designation, but are also given a proper name, traditionally after their discover.

Until the mid-21st century, a committee of scientists known as the International Astronomical Union approved all asteroid names. They accepted the name suggested by the asteroid's discoverer provided it followed the agreed-upon rules. However, by the 2020s, observatories had cataloged thousands more asteroids than anyone cared to bother to assign names to; many had only provisional designations (above). From 2029 onward, if an object had not received a name within 10 years of discovery, the right to name it was granted to whomever first landed a spacecraft on the body. This policy was modified in 2047 (after the deployment of prospector swarms) to reserve the privilege to the first human to orbit or land on it. In 2073, this was further amended to "first sapient being."



An asteroid can have just about any name, but certain rules exist. Asteroids are not to be named after major political, military, or religious figures until a century after their death. Frivolous names are discouraged. Names must be 16 Roman characters or less in length, preferably a single word, pronounceable (in some language), non-offensive, and not too similar to an existing name of a celestial body.

At the start of the 21st century, about 40,000 asteroids had permanent numerical designations, and some 10,000 had been named. In 2100 about 2,000,000 asteroids have numerical designations and 70,000 also have names.

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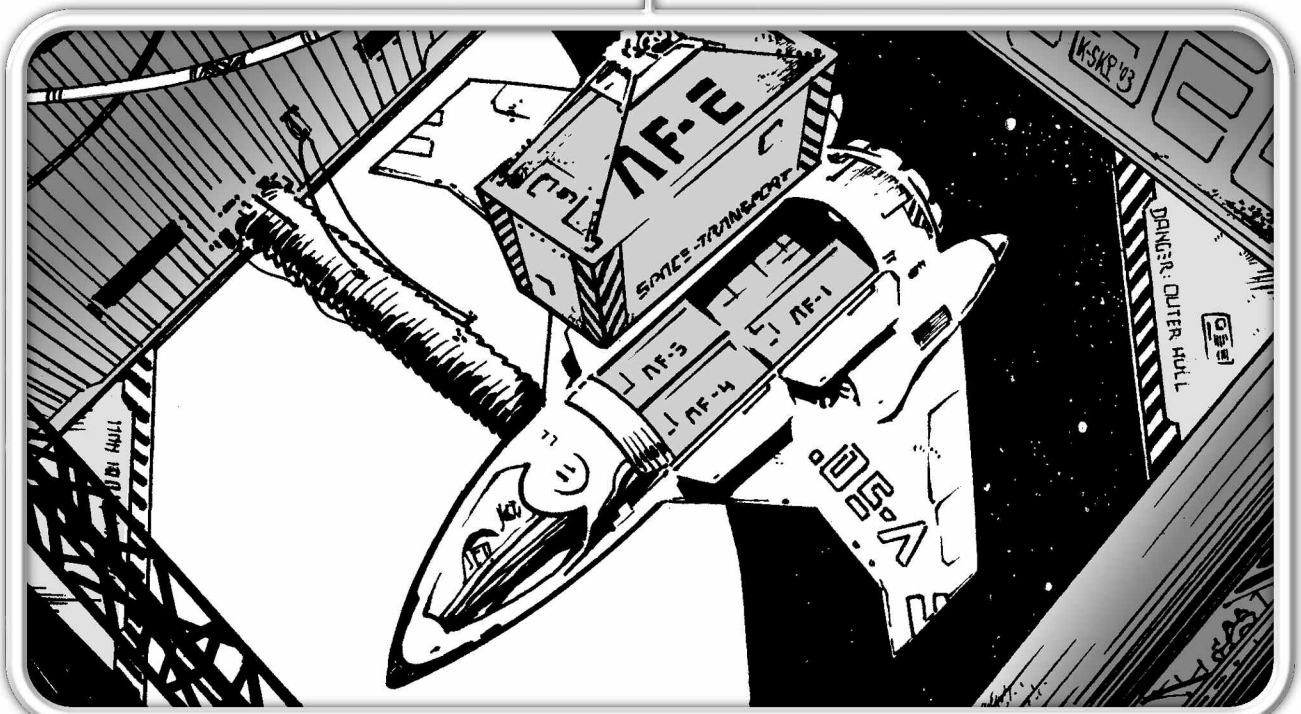

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