

TRAVELLER

BOOK 4 : DEEP SPACE EXPLORATION HANDBOOK



SCIENCE FICTION ADVENTURE IN THE FAR FUTURE

TRAVELLER

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CREDITS

CLASSIC TRAVELLER

Marc Miller

Loren Wiseman, John Harshman, Frank Chadwick, Darryl Hany, Winston Hamilton, Tony Svajlenka, Scott Renner, Doug Poe, David MacDonald, Wayne Roth, Paul R. Banher.

MONGOOSE TRAVELLER

Author

Martin J. Dougherty

Editor

Matthew Sprange

Layout and Graphic Design

Amy Perrett, Sandrine Thirache

Interior Illustrations

Álvaro Nebot, Anderson Maia, Amy Perret, Vasburg, Michael Rookard, Sandrine Thirache, Jon Torres

TRAVELLER INNER CIRCLE

Andrew James Alan Welty, Colin Dunn, M. J. Dougherty, Rob Eaglestone, Sam Wissa, Joshua Bell, Maksim Smelchak

Special Thanks

Marc Miller, Loren Wiseman

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INTRODUCTION

The urge to venture into the unknown affects all sentient species. Without it, there would be no compulsion to investigate new lands in search of food or master the use of fire, metalworking or agriculture. Any species with the drive to develop a technological civilisation also has the urge to explore.

The exploration of deep space is necessary for any civilisation to spread throughout the stars. Most exploration takes a conventional form; identification of star systems from a distance using remote sensors, followed by a cursory survey. Exploration of promising worlds then takes place in increasing detail if results

merit it. Voyagers arrive and settle a world and soon it becomes familiar territory. Yet even in inhabited systems, there are often barely charted worlds where no-one has ever landed.

For those who venture off the edges of the map, there are fortunes to be made and wonders to be found but always at a price. Many of those who venture into deep space fail to return and those who find treasures may live to regret it. Exploding stars, black holes, alien races and artefacts of those long since extinct all present both excitement and danger for those willing to chance a trip into the void between known stars.



EXPLORING DEEP SPACE

Deep space exploration is a methodical business. It is simply not practical and safe to jump into deep space and take a look around; not if you plan on returning. An expedition normally takes the form of several distinct phases, not all of which need to be carried out by the same ship or crew.

Identification of Target: An exploration mission may be planned to follow up rumours or fragmentary data from earlier expeditions or simply to explore an unknown area. Most missions target star systems with planets and bypass sparse areas in favour of regions that have a greater chance of yielding a financial return.

Distant Reconnaissance: The distant reconnaissance phase can take the form of information gathering from databases, old star charts and other secondary sources but usually also includes some element of distant sensor operations. There is a limit to what can be determined about a star system or area of deep space from a parsec or more away, although good instruments can at least determine, in general terms, what the major characteristics will be. This is particularly important when attempting to find a potential fuel source in an 'empty' map hex on a sector map.

Preliminary Survey: A preliminary survey is carried out by sending a starship to collect data. A preliminary survey takes the form of a sensor sweep and collection of readily available data, such as the presence and type of stars, planetary bodies and the like.

Detailed Survey: Once preliminary data is obtained, resources can be allocated to investigating more thoroughly. In some cases, this is done by a follow-up mission, in others the exploration ship will remain on station and conduct a detailed survey of all promising targets. Typically, only the prospective mainworld of a system is subject to detailed survey, with other bodies ignored or given the most cursory of attention in the form of a quick fly-by or long-range probe.

Focussed Expedition: The final stage of exploration is a focussed expedition, which usually has a single primary goal. This may be a prospecting trip to find mineral resources or colonial proving mission to demonstrate the viability of the world as a prospect for settlement. A focussed expedition may also be scientific, sent to investigate ancient ruins or study a world's ecosystem.

Unless the Travellers are the sort who just blast off into the unknown and hope for the best, exploration will typically follow this model. The chances of finding anything (including fuel to allow a return to civilisation) are greatly increased by the availability of good information.

Data-gathering efforts will feed into a Survey Index. Travellers can have several Survey Indexes on the go at once, each connected with a different target. The greater the index value, the more the Travellers will know and the better their chances of finding something useful or interesting.

Unique Information

Sometimes, the Travellers may have information such as an ancient epic poem recovered from a crashed starship or map carved onto a rockface on some forgotten world. This kind of unique information will typically add DM+6 to the Survey Index for the target but can be worth more or less as the Referee deems appropriate.

THEORETICAL WORK

Preliminary theoretical work can contribute to a Survey Index, taking the form of listening to spacers' rumours in starport bars, a detailed scientific hypothesis or data-mining old charts and records. The Travellers may obtain information from various sources, with each valid source requiring a skill check to produce useful data. Only one set of useful data can be obtained from any given source, although different Travellers can try to obtain the same information.

Find useful rumours, folk tales, friend-of-a-friend stories and other vague but potentially useful information:

Average (8+) Carouse check (1D days, INT or SOC).

Look up all potentially relevant data from obscure databases and sources including old records, missing ship reports and historical accounts of events in the region: Average (8+) Investigate or Admin check (1D days, EDU).

Produce a scientific prediction of what might be found at a given location or predict where known phenomenon might occur: Average (8+) Science (cosmology or planetology) check (1D days, INT).

Other sources can be added at the referee's discretion.

Tying all this information together requires a Very Difficult (12+) Science (cosmology) check, (2D days, INT or EDU) to produce a theoretical analysis of the target. Each piece of useful information gained beforehand is worth DM+2 on this check.

Survey Index: The Effect of this check is added to the Survey Index.

DISTANT SENSOR OPERATIONS

Rather than jumping directly into an unknown area, many Travellers prefer to collect data from a distance. A typical starship's sensors are not well suited to this task but can still detect the most obvious of features. More specialised exploration and scientific packages can be used to collect very significant data from a distance of multiple parsecs.

Rather than making a skill check to determine the presence of any given object, an Electronics (sensors) check is made by the surveying vessel, with the level of success indicating what can be detected. The survey takes 2D days and can be repeated multiple times. However, only one result can be added to the Survey Index. The Travellers can thus spend months collecting data until they learn as much as they can.

This requires an Average (8+) Electronics (sensors) check (2D days, INT).

Survey Index: Twice the Effect of this check is added to the Survey Index.

PRELIMINARY SURVEY

A preliminary survey can only be carried out at the target location. The subject can be as large as a star system or small as a planetoid or comet. The amount of time required for the survey depends on the volume of space to be covered.

Surveying an object, such as a comet, takes 2D hours. A preliminary survey of a planet-sized object takes 6D hours, while 12D hours is required to survey a larger object such as a gas giant or brown dwarf.

A survey requires a Routine (6+) Electronics (sensors) check (INT).

Survey Index: The Effect of this check is added to the Survey Index, to a maximum value of 10.

Surveying a whole star system or hex on a sector map takes much longer; 3D days. The same Electronics (sensors) check is made as above but there is no maximum value applied to the Survey Index. A system survey of this sort can detect rogue objects associated with the system or hex.

The survey can be repeated but each survey after the first adds only half the Effect of the check, rounding down. In some special cases, the Referee may rule that a given object requires more than a score of 12 to detect (see page 5), which may reward persistence. Of course, there is no guarantee that there is anything present to be detected.

DETAILED SURVEY

A detailed survey includes mapping major surface features, collection of atmosphere, liquids and biological samples, and analysis work. A detailed survey of a planet-sized body takes 3D days; a planetoid belt takes 3D x 3 days, whilst a smaller body, such as a single comet, takes only 1D days.

Once the survey is completed, an Easy (4+) Science (planetology) check (INT) is made. If successful, the Survey Index is increased to 10. This does not mean that everything is known, nor that all data is 100% accurate, but Travellers will now be in possession of reasonably reliable information about their target.

FOCUSSED EXPEDITION

A focussed expedition does not add to the target's Survey Index, at least not as its primary goal. A focussed expedition is used to obtain specific information such as the presence of resources or what it is like to live on a given planet. At the Referee's discretion, this may fill in the blanks in earlier surveys and bring the Survey Index up to 10 but for the most part a focussed expedition should be the subject of one or more *Traveller* adventures rather than a single skill check.

SURVEY INDEX

The Survey Index indicates how much is known about the target of exploration. This data is not necessarily correct but errors will be within the bounds of possibility. For example, if the presence of a main-sequence star is indicated by the Survey Index then one will be there but it may not be of the expected type. A predicted yellow main sequence star might turn out instead to be an orange subgiant but it is very unlikely that a black hole will be found instead.

Note that rogue bodies (those with wildly eccentric orbits or located in deep space between star systems in empty hexes) require a very high Survey Index (11-12+) to detect at all. Once known, they can be visited and directly surveyed.

The Survey Index can be used by the Referee as an indicator of what is known about a distant star system. For example, it may be that the only available data on a given star system corresponds to Survey Index 4 – presence and type of stars. This would suggest there is no information in public databases about the inhabitants of the system, if any, or even if there are any planets.

A solid theoretical analysis with several avenues of data collection will typically yield a Survey Index of 2-4. Thoroughly conducted distant surveying by a properly equipped ship or observatory will produce a Survey Index of 4-6. Combining these two average values, it can be assumed that a Survey Index of around 7-9 is available for star systems close to major trade routes and inhabited worlds, even if the target system has not been visited. Full data (Survey Index 10) will be available on systems routinely visited by starships, although the presence of rogue bodies may not be known.

For more distant systems, only the most basic data may be available in public systems, if at all. If commercial starships do not travel to the target, it is unlikely there will be much information about it.

In a *Traveller* game focussing on exploration, the Referee can keep a record of the Survey Index of each map hex, which provides a quick indication of how much the Travellers will know about it.

Survey Index

Survey
Index Value Known Data

0	No data acquired
1	Presence of stars, if any. Presence of other major phenomena such as Black Holes
2	Presence of stars and general type (giant, main-sequence, etc)
3	Presence and type of stars
4	Presence and type of stars, presence of brown dwarf-sized bodies
5	Presence and type of stars, presence of gas giant-sized and larger bodies
6	Presence and type of stars, terrestrial (rocky) planets and larger bodies and planetoid belts
7	As 6, plus general planetary conditions such atmosphere and surface water
8	As 7, plus reasonably accurate estimate of first three planetary profile digits (Size, Hydrographics and Atmosphere)
9	As 8, plus correct first three planetary profile digits. Reasonable estimate of Population and Tech Level
10	Full planetary profile data
11	Detection of rogue planetary bodies
12+	Detection of rogue cometary bodies

STARS AND INTERSTELLAR PHENOMENA

Stars and interstellar phenomena are the objects that can be spotted from the greatest distance and which exert the greatest influence over what may be found within a hex on a sector map. If there is no star, there can be no star system, although this does not rule out the possibility of rogue planets or comets in deep space. If the star is of a type that cannot have life-bearing planets, this may influence the Travellers' decision to go there or investigate further. Very significant phenomena, such as a black hole, may influence many surrounding hexes and ultimately change the character of the region by being a major barrier to exploration.

BLACK HOLES

A black hole is not an object as such; it is a phenomenon caused by compression of matter into an infinitely small space termed a singularity. The 'hole' is in fact a region of such high gravitational attraction that even light cannot escape but this huge attraction does not reach as far as many might suppose. It is possible to send research starships into the same map hex as a black hole, although most commercial vessels will steer well clear. Since a star that collapses to become a black hole also generates a supernova, nearby star systems will have been affected by supernova effects in the distant past.

There are three general types of black hole:

- **Supermassive Black Holes** contain a mass equal to a small galaxy and are typically found at the core of galaxies.
- **Intermediate Black Holes** contain a mass significantly greater than that of the largest star but far less than that of a supermassive black hole. These objects are theorised to exist but have never been observed.
- **Stellar Black Holes** contain a mass equivalent to that of a star, in practice somewhere between 1-40 solar masses. They can be found wherever a large star has collapsed into a singularity.

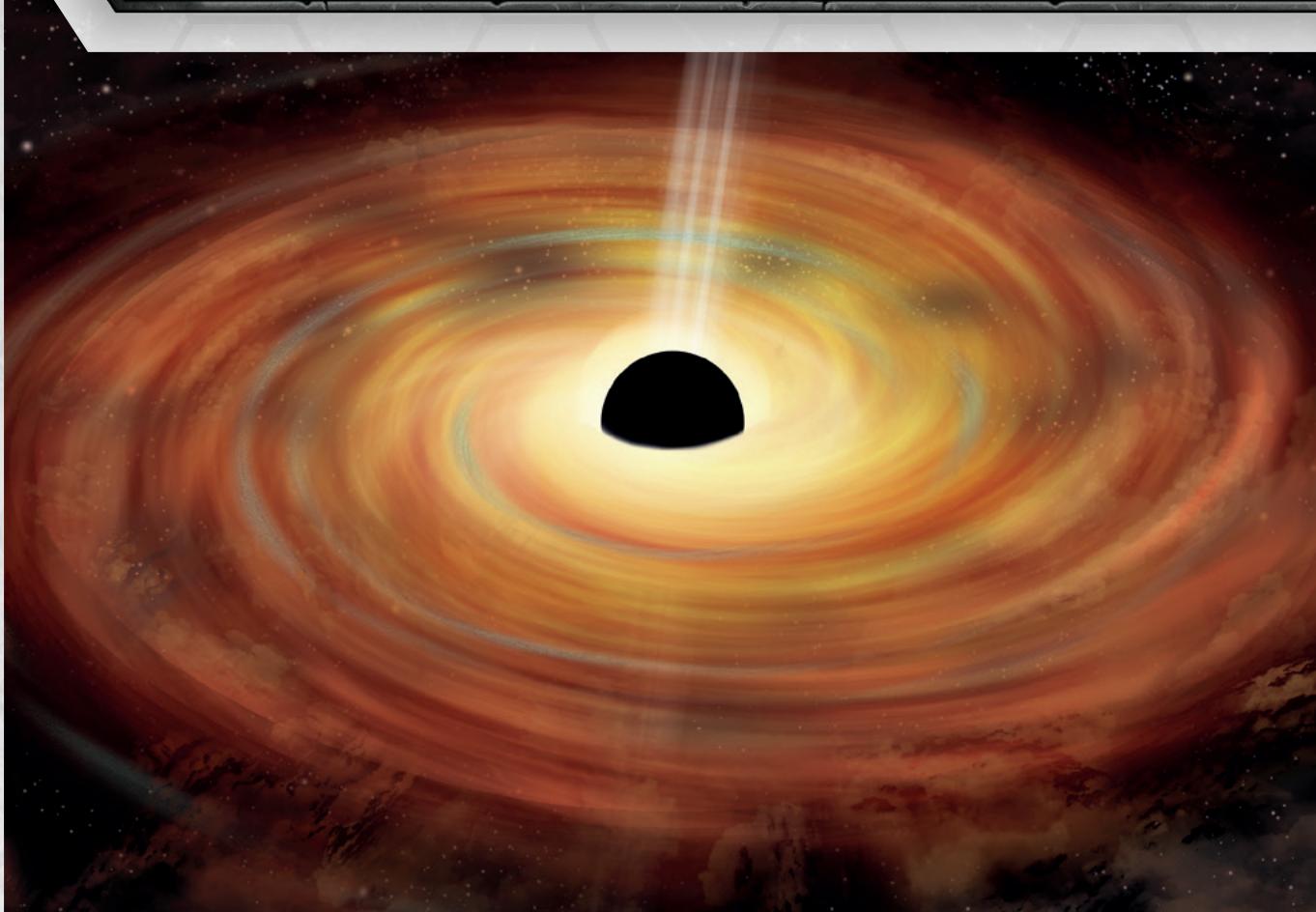
All black holes have a Schwarzschild Radius, which is the distance within which escape velocity exceeds the speed of light. Since nothing can travel faster than light without using a jump drive, anything within this radius is trapped inside the black hole. The Schwarzschild Radius also defines the event horizon of the black hole; anything occurring within the event horizon cannot affect the outside universe. For a non-rotating black hole, the event horizon is the same as the Schwarzschild Radius; there are some differences for a rotating black hole but the effect is similar enough in game terms.

The Schwarzschild Radius of a stellar mass black hole is typically around 3 kilometres. A supermassive black hole may have a mass anywhere from hundreds of thousands to several billion stellar masses, creating considerable variation in possible Schwarzschild Radii. The supermassive black hole at the centre of the Milky Way Galaxy has a mass of around 4.3 million solar masses and Schwarzschild Radius of 13.3 million kilometres, or about 0.9 Astronomical Units.

NEUTRON STARS

Neutron stars are the remnant of a star about twice as big as Sol, or larger, which has undergone a supernova explosion. The core of the star has collapsed into a very dense body composed of neutrons; one with the mass of Sol would be about 10 kilometres across. Neutron stars spin incredibly fast and are extremely hot, with a very strong magnetic field. Over time, neutron stars slow down and lose energy; very old Neutron stars are hard to detect as they produce low emissions.

A neutron star might have planets; either survivors of its own system or captured exoplanets. It is also possible for planets to have formed from material attracted by the neutron star; essentially this is a new planetary system most likely constructed (at least in part) from fragments of the original that was destroyed in the supernova event. These planets would receive little light but a great deal of harsh radiation and would be unlikely to support life.



Starship Operations

The 100-diameter limit for jump drive operations is a rule of thumb based upon objects of a standard density. Black holes and other high-gravity phenomena do not obey this rule.

A black hole of stellar mass (equivalent to the mass of Sol, Earth's star) has a jump shadow extending out to about 1.6 AU. This is vastly more than the 3 kilometre Schwarzschild Radius, so a jump drive could not be used within the event horizon. Indeed, it is not clear from the current understanding of jump physics whether a jump drive would work at all in this environment.

Ships attempting to jump into a black hole would be precipitated out of jump space around the 2AU-1.6AU distance. At this point, the vessel would be experiencing no more gravitational attraction than a ship the same distance from Earth's sun. A starship would be able to turn away and escape long before entering the event horizon but might encounter time dilation effects.

A supermassive black hole like that at the core of the Milky Way Galaxy would have a jump shadow extending out to around 10AU (gravitational forces obey an inverse square law and drop off very quickly as distance increases). Again, this is more than the Schwarzschild

Radius, so a jump drive would not permit escape. Ships approaching would be precipitated out of jump at around 10AU, where escape is entirely possible for a starship with a functioning manoeuvre drive.

The extreme gravitational effects encountered close to the event horizon can cause time dilation to occur. Essentially, as an object or starship gets closer to the event horizon, it appears to slow down as observed by someone aboard a distant ship. From the point of view of this distant observer, the ship will never cross the event horizon but would slow down until frozen forever. This is not a reduction in speed; it is an effect on the perceived passage of time. Thus, a ship at the event horizon could not communicate in real time with someone in a distant vessel.

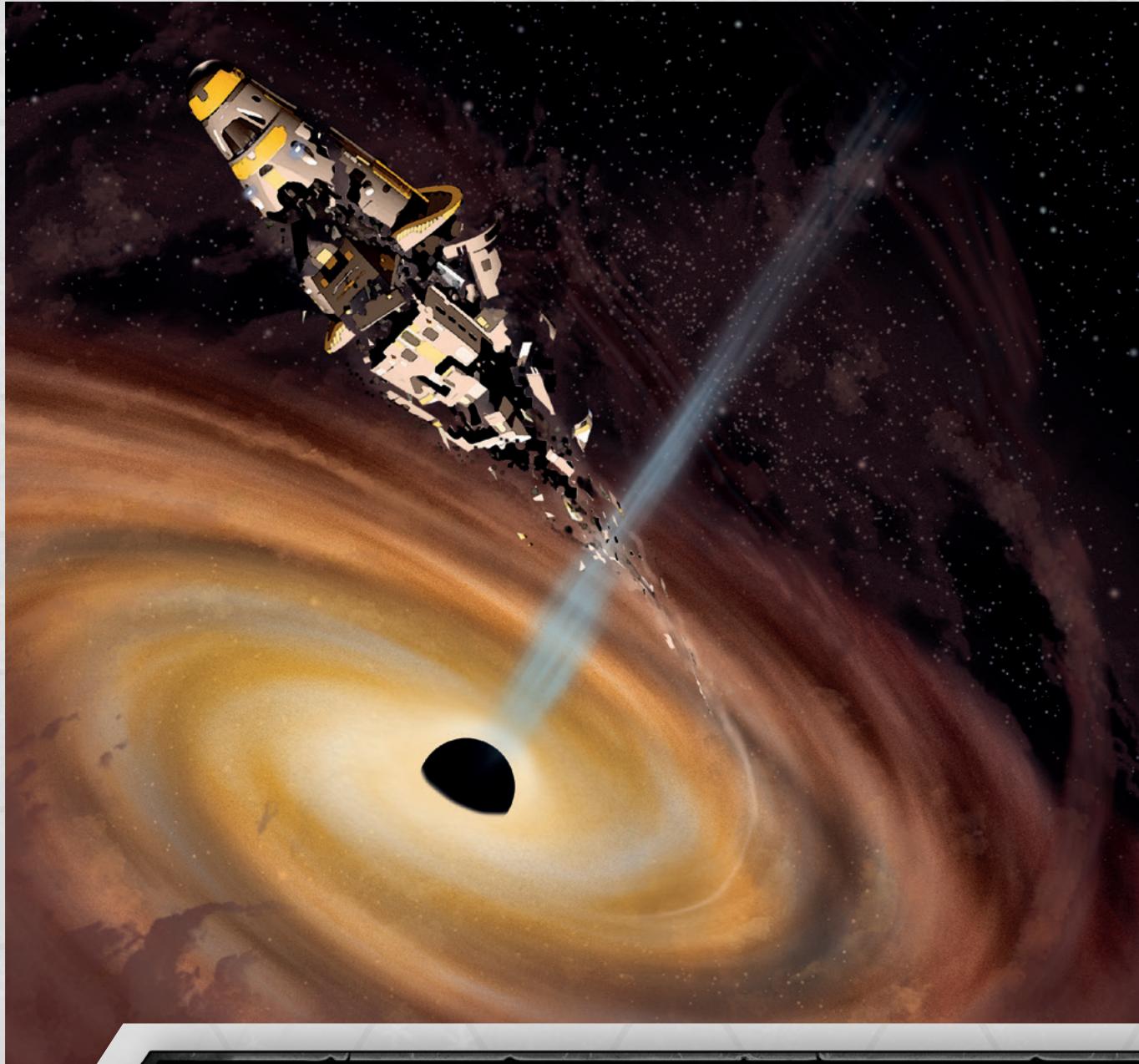
From the point of view of the vessel approaching the event horizon, time would pass normally aboard ship but the outside universe would appear to speed up. It might be possible to effectively travel into the future by passing close to an event horizon at high enough speed to escape again, using time dilation to cause a much longer time to pass in the outside universe. Objects and ships from the distant past might be preserved into the present era by this method.

A ship that passes the event horizon is lost to the outside universe, although there might be no immediate effects on the crew. Inside the event horizon is a high-energy environment where radiation and heat will likely destroy most vessels very quickly.

If the vessel survived long enough to experience gravitational effects, these would include severe stretching forces, which might result in 'spaghettification'. Rapidly increasing gravitational forces inside an event horizon will tear a ship apart – areas of the vessel even just a few metres closer to the singularity at the heart of the black hole experience much greater forces, resulting in a stretching effect that would rip a ship apart long before it reached the singularity.

This stress begins before the event horizon is reached but is more pronounced the smaller a black hole is. It is possible to pass through the event horizon of a supermassive black hole without being subjected to serious stresses but, for a black hole with a mass of Sol, a ship will suffer serious structural damage (equal to the tonnage of the ship, divided by 1D, per round) within 0.005 AU/750,000 km). By way of reference, this is close to the radius of a more typical stellar body of equivalent mass.

A neutron star or similar very dense object, that falls short of the concentration of mass required for a black hole, will create a jump shadow equivalent to a normal star of the same mass. For a typical neutron star, this is around 1.5-3 AU. Note that the supernova event that created the neutron star will have also destroyed the inner planets.



INTERSTELLAR CLOUDS, PROTOSTARS AND T TAURI STARS

A nebula is a cloud of interstellar dust or gas, appearing bright or dark depending on whether it is lit by stars within or behind it. Nebulae are very large, with the smallest being about a parsec (3.26 light-years) across and most nebulae being much larger. They are not normally dense; typically, a nebula would not conceal a luminous object like a star, although it would make it harder to detect a hiding starship, rogue planet or similar object (typically DM-2 to DM-6 on checks to locate the object, depending on the density of the nebula). Smaller interstellar dust or gas clouds can also exist.

A protostar is a cloud of interstellar gas that is beginning to coalesce into a star. The cloud is becoming denser at its centre but has not yet begun to undergo nuclear fusion in the core, so is thus not luminous. The only real difference between a protostar and a gas cloud is that there is enough mass present that someday the protostar will become a star and it has already begun this journey.

T Tauri stars are very young stellar objects, which will eventually become main sequence stars. The T Tauri object is farther along the path to becoming a star than a protostar but is still coalescing towards its main-sequence form. T Tauri objects have not yet begun to fuse hydrogen but are still very energetic as a result of gravitational energy released as the gas cloud coalesces. T Tauri stars are variable in the visible spectrum, with high X-ray and radio emissions. Although cooler than a main-sequence star, a T Tauri object appears brighter because it is larger.

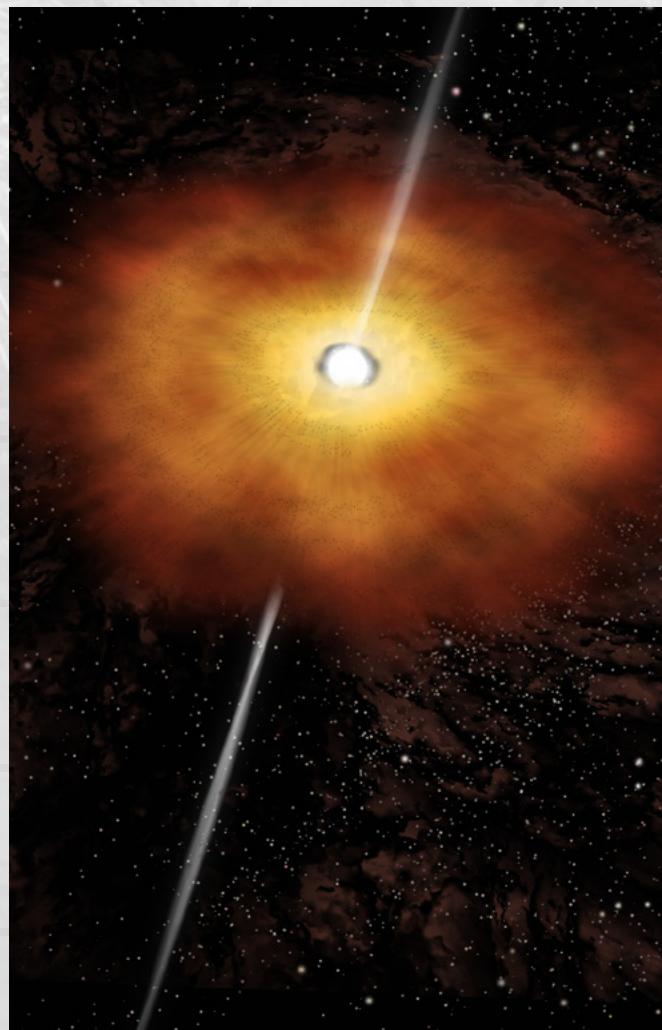
A T Tauri star is usually surrounded by a disc of gas and matter, which may include dense clumps, planetesimals and protoplanets. Planets may also have formed; gas giants and rocky planets are both possible. The disc may be agitated by emissions of gas from the star and there may also be collimated emissions from the star's poles.

Starship Operations

Nebulae and interstellar dust clouds can interfere with jump drive operations but are not dense enough to prevent interstellar travel entirely. Ships jumping into or out of a nebula (or from point-to-point within one) are more prone to misjumps, with DM-4 imposed on Engineer (j-drive) checks made to jump into or out of a nebula and DM-2 applied to jumps passing through one.

The denser gas of a protostar is not quite sufficient to prevent a jump through it but imposes DM-4 on attempts to jump through and DM-8 on attempts to jump into or out of the cloud. Ship movement within the coalescing gas cloud is as normal but sensor operations are subject to DM-4. Small clumps of rock, and the occasional planetesimal, might be encountered, but there is little solid matter within a protostar. A ship venturing towards the core of the forming star will be subject to increased heat and radiation (3D x 100 rads every hour) but will not suffer damage in the short term.

A T Tauri star is a physical object and may be orbited by rocky bodies and gas giants. Sensors and jump operations are affected in the same way as with a protostar, with a jump shadow exerted by the coalescing star out to around 7-10AU. Proceeding close to the forming star is as dangerous as approaching any other star, with the added complication that T Tauri stars are variable in their thermal energy and radiation output. The 'safe limit' can move by tens of millions of kilometres in mere seconds.



NOVA AND SUPERNOVA EVENTS

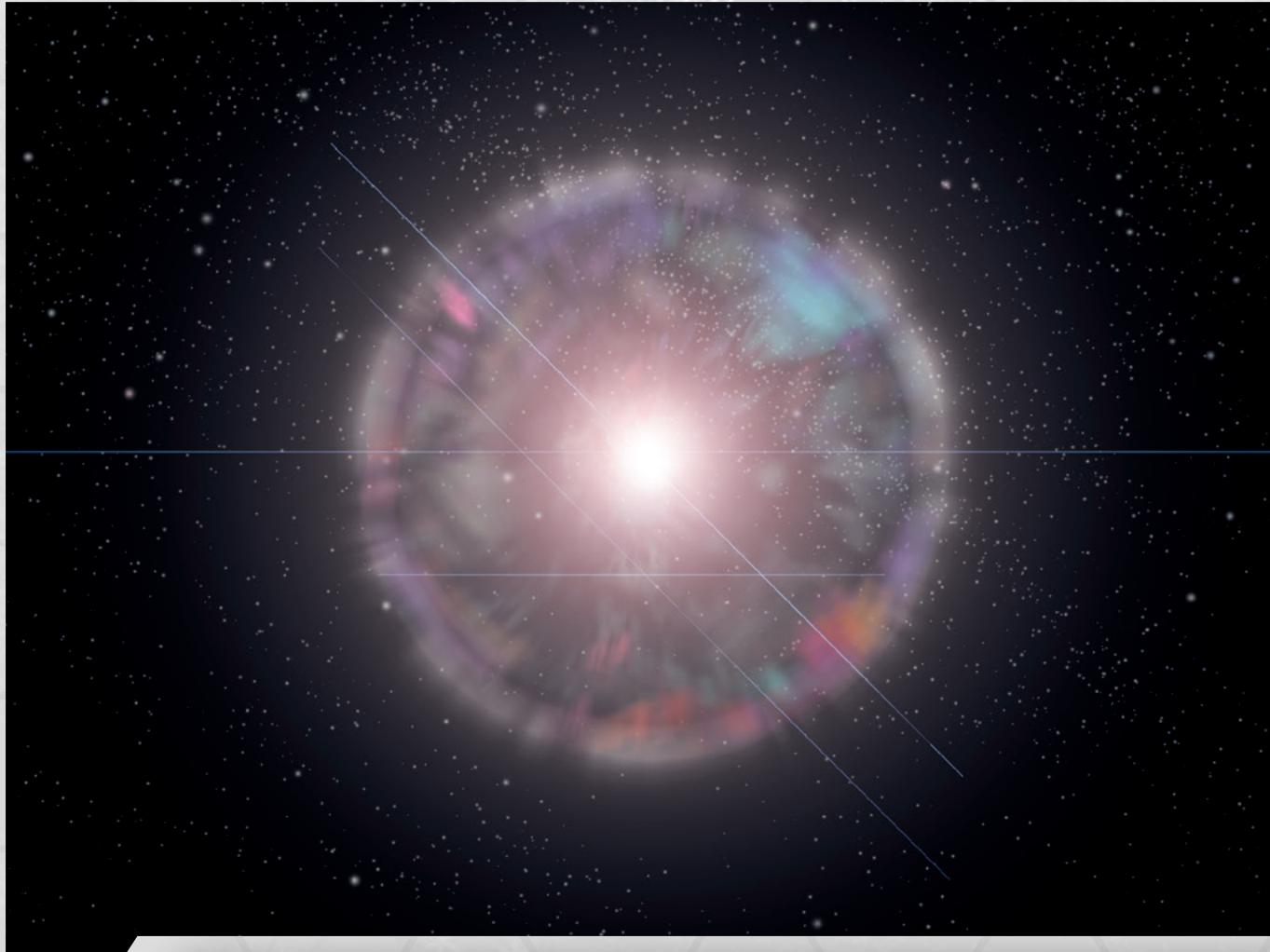
A nova is a sudden and massive increase in the luminosity of a star, fading soon after. The star may eject material at the time; a nova is unhealthy for anyone in the vicinity but will not destroy the star. Some stars 'go nova' on a frequent basis and planets in a nova system are likely to lose any atmosphere and surface water; life is unlikely to survive such conditions although an artificial colony could be built there.

A supernova is much more destructive and occurs when a high mass star dies, blasting out a cloud of radioactive gas and debris while briefly releasing vast quantities of energy (any ships in the system will be immediately destroyed, even if they are in the 'shadow' of a large planet). Depending on the size of the star, the remnant of the stellar core after a supernova may become an extremely dense neutron star or collapse further to create a black hole.

A supernova event will blast a 'shock wave' of debris out at about 10% of the speed of light, covering one parsec every 33 years or so, gradually dissipating as it expands. A huge pulse of radiation is also generated, potentially causing mass extinctions on nearby worlds. A particularly large event might destroy life for hundreds of light-years in every direction, although the gas ejected may eventually be responsible for the formation of new stars and worlds. Other stellar phenomena such as merging white dwarfs can result in equally powerful explosions also called supernova.

A hypernova is a theoretical version of the supernova where an extremely large star dies in the manner of a supernova, although is vastly more energetic. A hypernova will, for just a few seconds, put out more energy than everything in the rest of the observable universe combined. The effects will be obvious in any region where such an event has occurred; mass extinctions and major alterations to those biospheres that survive at all, along with heavy-element-rich planets and planetoids formed from the debris.

The gas and dust cloud created by a supernova may create nebula-like effects in systems as it passes through.



STARS AND SUB-STELLAR OBJECTS

Stars have a predictable life cycle, beginning as interstellar gas clouds. Internal gravitational forces cause the cloud to coalesce into a protostar. The centre of the protostar will gradually become hotter over millions of years, until the force of gravity initiates nuclear fusion.

If there is not enough matter to create a star, a quasi-stellar object (or brown dwarf) may be formed. Brown dwarfs are somewhere between extremely large gas giants and the smallest of stars. Assuming there is enough matter, a star eventually begins to undergo nuclear fusion while an accretion disc around it forms planets and moons, or even more stars.

Stars are classified by temperature and size. The majority are termed **main sequence stars** and are the most likely to have life-bearing planets. The life cycle of the star from this point on depends on its size and temperature; smaller stars may expand into red giants late in their life cycle before collapsing into a white dwarf, while larger and hotter stars burn through their fuel faster and may undergo runaway nuclear reactions towards the end of their life cycle. This will create a supernova event and leave behind a white dwarf, neutron star or even a black hole.

Giant stars destroy their inner planets as they expand. Most are red or red-orange in colour and relatively cool. When their hydrogen and then helium fuel runs out, the star will begin to collapse to become a white dwarf as it enters the final stage of its life. Planets in a system with a giant star are extremely unlikely to bear life.

Subgiants are hotter and brighter than main sequence stars but not large or bright enough to be classified as giants. The subgiant phase is a transitory one as the star expands to become a true giant. Subgiants start off more or less the same colour as the original main-sequence star and change colour as they become cooler, becoming orange or red just before becoming true giant stars.

A **white dwarf** is a small, dying star running out of fuel. A white dwarf will not have habitable planets around it, having destroyed the inner ones and scorched those farther out during its death throes.

A **brown dwarf** is essentially a very large gas giant, which almost acquired enough mass to ignite into a star but not quite. Brown dwarfs are massive and hot by planetary standards, although dim as stars go. They are difficult to detect and can be found in star systems as well as deep within interstellar space. In the latter case, they may be sometimes accompanied by the debris of a 'failed' star system that did not quite form. Brown dwarfs in a star system may have satellites (moons or planets) of their own.

STAR SIZES AND JUMP SHADOW

The size of a star is indicated by its Yerkes luminosity class. This does not give a complete picture of a star's characteristics but does give a general indication of conditions within the star system, if any, surrounding it. The Yerkes classification also indicates the effect a star will have upon jump drives.

The 100-diameter limit applies to stars and quasi-stellar bodies. Any vessel attempting to jump to a point within the 100-diameter limit will be precipitated out of jump close to this limit ('close to' in this case is in astronomical terms and can be several AU). Jumping from within the 100-diameter limit is hazardous. Jumping from within 10 diameters of any body is extremely dangerous.

Earth's sun is a typical main sequence star. Many measurements are based on its mass, referred to as 'one solar mass'. The diameter of Earth's sun is approximately 1,392,000 km, giving a 100-diameter jump limit of 139,200,000 km, or approximately 0.93 AU. This means that in the Sol system, Mercury and Venus lie within the sun's jump shadow and require a sublight transit to a suitable safe jump point.

The Jump Shadow table provides typical jump shadow regions for various stars. Brown dwarf quasi-stellar objects and gas giant planets are included for completeness but do not have a Yerkes luminosity class.

Jump Shadow

Type	Description	Typical 100D Limit (AU)
Ia	Very Luminous Supergiants	1,750
Ib	Less Luminous Supergiants	1,400
II	Luminous Giants	750
III	Giants	200
IV	Subgiants	100
V	Main Sequence (Dwarf) Stars	0.93
VI	Subdwarfs	0.15
VII	White Dwarfs	0.007
(N/A)	Large Brown Dwarfs	0.75
(N/A)	Small Brown Dwarfs	0.25
(N/A)	Large Gas Giant	0.095
(N/A)	Small Gas Giant	0.033

Spectral Class

Star Type	Colour	Surface Temperature	Average Mass	Average Radius	Average Luminosity
O	Blue	25,000K or more	60	15	1,400,000
B	Blue	11,000 – 25,000K	18	7	20,000
A	Blue	7,500 – 11,000K	3.2	2.5	80
F	Blue to White	6,000 – 7,500K	1.7	1.3	6
G	White to Yellow	5,000 – 6,000K	1.1	1.1	1.2
K	Orange to Red	3,500 – 5,000K	0.8	0.9	0.4
M	Red	Under 3,500K	0.3	0.4	0.04

SPECTRAL CLASS

Spectral class is indicated by the temperature of a star, which also determines its colour. Combining the Yerkes luminosity class and spectral class of a star creates a shorthand that can be used to describe the general characteristics of a star, which in turn indicates the conditions likely to be encountered in the star system.

Spectral class is indicated by a classification letter (O, B, A, F, G, K and M – you can remember this by the mnemonic Oh Boy An F Grade Kills Me) with a subtype of 0-9 indicating how far along the scale towards the next classification the star is. Thus, an F5 star would be average for its type, while an F9 and a G type are nearly the same temperature.

In the table below, temperatures are given in Kelvin (0 Kelvin is -273.16° Celsius and a temperature change of 1 Kelvin is equal to a change of 1° Celsius), Mass, Radius and Luminosity are relative to Sol (Earth's sun), which is given a nominal value of 1 for all three.

For example, Earth's Sun is a G2V under this classification system; a white-yellow (G2) main-sequence (V) star.



ANOMALIES, ROGUES AND OTHER' OBJECTS

The universe contains a great many objects that are not part of a solar system, along with others that do not fit into standard categories. For our purposes, anything that is not part of a solar system is termed rogue. For example, a planet hurtling through deep space would be known as a rogue planet. An object or phenomenon that is somewhere conventional science says is unlikely or that has very unusual properties, is termed an anomaly.

For a typical main sequence star, the planetary region extends about 30 AU out from the star, and it is highly likely that all planetary bodies in the system will be within this distance. Any that are not are possibly captured rogues or may be in the process of being ejected from the system. Very distant planets might not be part of the system at all but deep-space rogues passing by. This can cause perturbation of comets and moons in the system, sometimes with catastrophic results.

Beyond the planetary region is the Kupier belt, a disc-shaped region that stretches 30-50AU from the star and contains vast numbers of small rocky and ice bodies. These are dispersed over a wide area but a ship with good sensors should be able to find an icy planetoid to obtain fuel sooner or later. The Kupier belt may contain dwarf planets similar to Pluto or Ixion.

Beyond even the Kupier belt is the Oort cloud, a spherical region containing comets and small icy bodies. Although these exist in huge numbers they are small and widely dispersed in a shell reaching from 2,000AU to as far as 100,000AU (1.5 light-years) from a typical main-sequence star. Finding an object such as an ice comet for refuelling is far easier in the Oort cloud of a star system than in deep space.

Even in a map hex with a star system, there is still a huge volume that can be considered deep space since it lies outside the Oort cloud. This region may have a slightly higher distribution of rogue bodies than true interstellar space.

DETECTING ROGUE BODIES AND ANOMALIES

Detecting rogue objects in deep space is a difficult business. An object on the planetary scale (including gas giants) requires a Survey Index of 11 for it to be remotely detected. A smaller object such as a comet or small moon requires a Survey index of 12. Detecting a deep-space (rogue) brown dwarf by remote sensing requires a Survey Index of 4, plus one for every parsec the sensor platform is distant from the target map hex, to a maximum of 6.

This assumes the scanning is being done by a single exploration ship or observatory. A large-scale scientific operation involving radio telescopes and advanced sensor platforms across several systems can detect interstellar objects far more readily but such projects tend to be involved in wide-area scanning and may well be slower to pick up any given object than a dedicated small-scale project targeted on one map hex.

SHORT-RANGE DETECTION

The Survey Index for a given system can be used to predict and locate rogue objects at distances greater than one parsec. If a ship is in a given map hex and scanning for objects, the process is slightly different. This situation may arise when a survey ship deliberately jumps into an 'empty' map hex to conduct a short-range survey or set up a fuel cache, or can occur if a vessel misjumps into deep space and urgently needs to find a fuel source urgently.

The Referee should determine if any objects are within range of the scanning vessel. When jumping blindly into a hex, this is a matter of chance – a single map hex represents such a gigantic expanse of space that even a star system occupies only a small proportion of it.

The Detectable Objects table indicates how many objects, if any, exist within the scanning vessel's vicinity. The following DMs apply:

- +2 if the scanning vessel is in a map hex where an interstellar object such as a rogue planet is known to exist
- +4 if the scanning vessel is in the same map hex as a star system but not within that system (for example, in the Sol system a ship that has gone far out past Pluto and the Oort cloud but has not left Sol's map hex)
- +6 if the scanning vessel is within the Oort cloud
- +8 if the scanning vessel is within the Kuiper belt
- 1 per parsec to the nearest star system.

Detectable Objects

2D	Objects Within Range
7-	Nothing detected within range
8-9	One object within range
10-11	1D3 objects within range
12	1D objects within range
Each +1 above 12	One additional object within range.

The lack of any objects within range does not mean the hex is empty. There are limits to how far a ship's sensors can reach and still produce useful data in a reasonable time frame. A sweep of this sort takes 6D days and covers a volume of space equivalent to a typical star system's planetary zone and Kuiper belt. This is a spherical region of space around 50AU in radius.

A three-dimensional grid search of an entire map hex, constructed at 100AU intervals, could identify and map every single object within that hex. Such an undertaking is not feasible however; a 1-parsec map hex is over 200,000 AU across in each direction. Thus, 2,000 scans would be required just to map a 50AU wide strip across the hex.

Once the location of a rogue object is known, it is possible to jump directly to it, so a deep-space refuelling point or tanker rendezvous becomes possible. Of course, the slightest navigational error can strand a ship in deep space, in which case the above process is the only hope of finding a suitable body from which to obtain fuel.

NATURE OF OBJECTS FOUND

For each object detected, the Referee should roll 2D on the Primary Roll column of the Detected Objects table. Results of 2 or 12 require an additional 1D on the Extended Roll column.

Detected Objects

Extended Roll	Primary Roll	Result
1	2	Extremely unusual object
2	2	Drifting interstellar wreck
3	2	Dangerous object such as a relic from an ancient war or inhabited cometary body
4	2	Increased gravity or radiation with no obvious source
5	2	Planetoid or cometary body with signs of long-ago habitation
6	2	Unusually dense gas cloud
	3-4	Sensor glitch; nothing present
	5-9	Tiny ice-bearing comet suitable for one refuelling only
	10-11	Ice-bearing cometary body suitable for multiple refuellings
1	12	Large cometary body
2	12	Rogue dwarf planet
3	12	Rogue planetoid cluster
4	12	Rogue planet
5	12	Rogue gas giant
6	12	Highly unusual large rogue body

Highly unusual large rogue bodies might include dim brown dwarfs, perhaps with their own moon or planet system, pairs of large bodies orbiting one another as they voyage through deep space, or something even more unusual such as the burned-out shell of a dead star.

Extremely unusual objects should be treated with caution as they may be universe-changers. For example, if the Travellers find half a planet drifting in deep space with the shattered remnants of cities on its surface, then some cataclysmic event must have occurred. If the Travellers want to investigate, the Referee will need to have an explanation, which in turn may require introducing new themes to the game setting.

EXPANDED STAR SYSTEM CREATION



The following rules create a star system from scratch, in the order that information is most likely to become available to Travellers using their ship's sensors before moving in to conduct a full survey. The process can be halted at any point if sufficient detail has been generated or if the Travellers decide to go elsewhere.

STAGE 1

STARS & STELLAR OBJECTS

If random determination is desirable, the chance that there will be a star system present in a map hex is dependent upon the nature of its region of space:

Cluster: Star system is present on a roll of 2+ on 1D

Dense: Star system is present on a roll of 3+ on 1D

Average: Star system is present on a roll of 4+ on 1D

Sparse: Star system is present on a roll of 5+ on 1D

Very Sparse: Star system is present on a roll of 6+ on 1D

Rift: Star system is present on a roll of 12+ on 2D

Void: Star system is present on a roll of 18+ on 3D

The Referee can, of course, place a star system or stellar object anywhere he pleases rather than making random rolls.

Once the presence of a system has been indicated, its nature must be determined. This begins with the number and type of stars, as determined by the Star System table.

STAR SYSTEM

2D	System Type
2	Special (roll on the Special System table)
3-4	Trinary (close and distant companion)
5-6	Binary (close companion)
7-8	Solo star
9-10	Binary (distant companion)
11	Trinary (distant companion with close companion of its own)
12	Multiple star system (four or more stellar bodies)

SPECIAL SYSTEM

2D	System Type
2	Highly unusual body (roll on the Highly Unusual Body table)
3	Expanding pre-giant star
4-5	Brown dwarf system: Primary is a brown dwarf, as are all other stars
6-8	Empty system: No planetary bodies present
9-10	White dwarf star: Inner system destroyed
11	Giant star
12	Unstable star: Prone to nova events

STAGE 2

PLANETARY BODIES

The number of planetary bodies present in a star system can vary considerably. Some ‘systems’ have none at all, composed only of a lonely star and a few comets. The majority, however, have at least some bodies. In systems with a close companion star, the main planetary system orbits the stellar pair.

It is far less common to find planets orbiting a distant companion star than a system’s primary. The number of planetary bodies is generated separately for each distant companion star and may in rare cases be more than the main system. Roll 2D on the Planetary Bodies table for main system density and 2D-4 for the density of a planetary system orbiting a distant companion.

In the case where a planetary system has formed around a brown dwarf, it will be smaller than a normal planetary system in terms of volume, since the brown dwarf has far less mass than a true star and cannot hold objects in distant orbits. Roll 2D-2 for the density of a system orbiting a brown dwarf.

HIGHLY UNUSUAL BODY

2D	System Type
2	Black hole
3-4	Anomaly, e.g. white dwarf with life-bearing inner planets
5-9	Nebula or protostar
10-11	Highly complex multiple star system
12	Neutron star

Determining Star Type

A solo or multiple star system will normally contain a main-sequence star as its primary and main-sequence stars or possibly brown dwarfs as companions. If the Referee desires, a second roll can be made on the Main Sequence table to determine the nature of a system containing giant or pre-giant stars, although a close companion star is not likely to survive the primary’s giant phase. It may have already been destroyed or may be in the process of destruction, making the system extremely hazardous.

For most systems, roll 2D on the Main Sequence table for the primary’s star type, 2D-1 for a close companion and 2D-2 for a distant companion.

MAIN SEQUENCE

Result	Main Sequence (Dwarf) Star Type
0-2	Brown dwarf
3-6	Type M (Red)
7-8	Type K (Orange)
9-10	Type G (Yellow)
11	Type F (Yellow-White)
12	Type A (Blue-White), Type O (Blue) or Type B (Deep Blue-White)



If the result is ‘no significant bodies’ for any star, the system will contain little more than comets and rogue asteroids. These will be widely dispersed and may not have been mapped. Such a planetary system is unlikely to be inhabited.

PLANETARY BODIES

2D	System Type
1 >	No significant bodies
2	Single planetary body
3	Very sparse system; roll D3 for number of bodies
4-5	Sparse system; roll 1D+1 for number of bodies
6-8	Typical planetary system; roll 2D for number of planetary bodies
9-10	Dense planetary system; roll 2D+3 for number of bodies
11	Very dense planetary system; roll 3D for number of bodies
12	Crowded system; roll 4D for number of bodies

Once the number of planetary bodies is known, it is possible to determine the nature of each. Start with the innermost (closest to the star) and work outwards. It is possible for all types of planet to exist almost anywhere in a star system. For each planetary body, roll 2D on the Nature of Body table below to determine its general nature.

NATURE OF BODY

2D	Body Type
2	Unusual body
3-4	Planetoid belt
5-7	Terrestrial (rocky) planet
8-9	Small gas giant
10-11	Large gas giant
12	Anomalous body

Unusual Bodies differ slightly from the norm but occupy a fairly standard orbit. Roll 2D on the Unusual Body table.

UNUSUAL BODY

2D	Body Type
2-3	Low-density gas giant
4-5	Planetoid cluster
6	Low-density terrestrial
7	Super-Earth (diameter greater than 16,000km)
8	High-density terrestrial
9-10	Unstable terrestrial
11-12	Binary planet

Low-Density Gas Giants are simply gas giants comprising lighter elements and lacking a rocky core.

Planetoid Clusters are a group of planetoids, possibly including one or more dwarf planets, which orbit close together. A cluster contains far less bodies than a belt and is much more localised.

Low-Density Terrestrials are rocky planets comprising lighter elements and lacking in many useful mineral resources. The diameter of a low-density terrestrial is generated normally but its surface gravity is that of the next size smaller. This imposes DM-2 on rolls for Atmosphere codes.

Super-Earths are rocky planets much larger than Earth. One that has a diameter greater than ten times that of the Earth (i.e. greater than 127,000km) would be termed a Mega-Earth. Surface gravity is very high on such bodies and they are unlikely to be inhabited. A super-earth is likely to have a very dense atmosphere.

High-Density Terrestrials are rocky planets with an abundance of heavy elements. Diameter is determined normally but surface gravity is treated as one category higher (surface gravity for a Size code 10 high-density terrestrial is determined by rolling 2D and treating this result as the decimal added to base gravity of 1.4G).

Unstable Terrestrials are rocky planets in the process of forming or breaking up or 'lava planets' whose crust is molten.

Binary Planets are two planet-sized bodies orbiting one another. Determine the characteristics of each normally.

Anomalous Bodies are more or less standard in composition and characteristics but have something highly unusual about their orbit, or otherwise do not fit the norm. Roll 2D on the Anomalous Body table to.

ANOMALOUS BODY

2D	Body Type
2-3	Highly unusual composition
4-5	Retrograde orbit
6	Sharply inclined orbit
7	Highly eccentric orbit
8	Transient body
9-10	Trojan planet
11-12	Impossible characteristics

Highly unusual composition indicates the body contains elements in a very different proportion to the norm or that the materials comprising the body are organised in an unusual way. This may be shape, grouping or some other characteristic.

Retrograde orbit indicates the body orbits in the opposite direction to the rest of the system's bodies.

Sharply inclined orbit indicates the body's orbit is steeply inclined to the system's ecliptic plane.

STAGE
3

ASSIGN ORBITAL POSITIONS & ZONES

Typically, a mainworld will be in the system's 'warm' zone and thus having the potential for liquid water on its surface. If a mainworld exists, it will normally be placed within this region and it must be placed there if it is known to have water and/or life. A mainworld that does not have a breathable atmosphere can be placed anywhere in the system.

Once the position of the most habitable world is known, locations of other bodies can be assigned. Bodies around the system's primary should be allocated orbital positions in the order they were generated. Any worlds inwards of the mainworld (assuming it is in the warm zone) will be in the hot zone unless the Referee decides they orbit close enough to the mainworld to still lie within the warm zone. Worlds lying outward from the mainworld can be in the cold zone or outsystem.

It is possible for the inner system (the hot-warm-cold zones) to be very crowded, potentially with more than one body in the warm zone. All types of planetary bodies – terrestrials, gas giants and planetoid belts

Trojan planets are located at the Trojan point of another body, more than likely a gas giant or very large terrestrial. The larger world occupies the 'normal' orbital position for the system, with the Trojan planet located ahead of or behind the larger body. A Trojan planet could be a planetoid cluster or some other body.

Impossible characteristics indicates the body has some property that baffles science. This might be position, age, composition or an artificial nature.

– can exist in the inner system or outsystem. The order in which bodies were created indicates their order out from the star but not their exact position. For example, a system might have two worlds in the hot zone, nothing in the warm or cold zones and nine bodies in the outsystem. Exact locations of bodies are always a matter for Referee discretion.

**STAGE
4**

ASSIGN MAINWORLD & OTHER DESIGNATIONS

If the characteristics of the system's mainworld are already known, it can be added to the system listing at this point. If not, one of the bodies in the system can be designated the mainworld if the Referee so chooses but this is not absolutely necessary. If a system is unexplored and/or uninhabited, then each planetary body can be generated from scratch as necessary without any preference being given to any of them.

If the system does have a designated mainworld, it will usually be the most habitable body or the one with the best natural resources. If the Referee wants to designate a gas giant as the mainworld, this is perfectly acceptable – the actual mainworld will be a moon of the gas giant.

Assigning a mainworld biases the world generation system towards a populated planet or other body but

its nature can vary a lot. If the Referee wishes to create a particular type of world, its characteristics can be simply assigned or a designation used which will tailor the generation process towards a general outcome. Any of the designations in Stage 5 can be applied to any body, at the Referee's discretion.

**STAGE
5**

GENERATE WORLDS

The world creation system detailed in Chapter 12 of the *Traveller Core Rulebook* can be used to generate the worlds of a star system. If the Travellers are simply doing a distant survey, all that may be necessary is Size and perhaps Atmosphere codes, with other details filled in as the Travellers get closer. Alternatively, the Referee may prefer to generate the mainworld fully and leave other bodies for the time being or generate all bodies if this seems appropriate.

The *Traveller* world creation system is geared towards generating mainworlds and can be used unchanged for this purpose. However, it is possible that a world already indicated as being a terrestrial might have Size code 0 when fully generated; in this case, the Referee can assume the world is a solo dwarf planet

or large asteroid that happened to be in the right orbital position or may amend the Size code to at least 1. Gas giants do not require generation under this system unless they have inhabited moons.

The following modifiers are used when generating worlds:

Planetoid cluster or belt: Size code is automatically 0.

Super-Earth: Size code S is used. Apply DM+4 on Atmosphere code generation.

If located in Hot Zone: Generate Temperature on 1D+6.

If located in Warm Zone: Generate Temperature by rolling 2D, treating 1s as 2s and 6s as 5s (giving a result of 4-10).

If located in Cold Zone: Generate Temperature on 1D.

STAGE
6

GENERATE MOONS

It is not usually necessary to generate the number and nature of moons a world has but if it becomes relevant (such as when exploring a gas giant's moon system), the following process can be used:

Bodies with Size code 2 or less will have no significant moons.

Bodies of Size code 3-10 will have D3-1 moons.

Super-earths (Size code S) will have D3-1 groups of moons each containing D3 moons.

Small Gas Giants have D3 groups of moons, each containing 1D-1 moons.

Large Gas Giants and **Brown Dwarfs** have D3+1 groups of moons, each containing 2D-2 moons.

If located in Outsystem: Temperature is automatically Frozen.

Uninhabited: The Referee may choose to assume that any or all bodies in the system are uninhabited. Population code will automatically be 0 and no social data need be generated. This does not necessarily mean that a population cannot be discovered later; small bases are often missed in surveys or overlooked in databases.

Outpost: A body designated as an outpost generates Population code on D3. Government type is typically 1 or 6; a freeport or independent spacer base (pirate haven, to some) might have a Government type of 0 or 5.

Colony: A colony generates Population code on D3+3 and will usually have a Government type of 6 or the same as the parent world.

Independent Population a body with an independent population generates Population code on 1D.

Freeports, i.e. independent starports, require a population to support them. Population code is generated on D3+2 and Starport Class is generated using 1D+4.

Major Worlds are the capitals of states or major players in the local political and economic scene. A major world's Population code is determined using 1D+6, and DM+2 applies to Starport Class determination.

Trade Ports are starports built to facilitate the movement of trade through an otherwise underdeveloped star systems. Starport Class is determined by rolling 1D+5, regardless of Population. Even if the body is officially uninhabited, the port will have a resident staff and small supporting population.

MOON TYPES

Roll 2D for each moon on the Moons table:

2D	Type
2-4	Asteroids
5-6	Dwarf gas giant moon; Size code 1
7-8	Small gas giant moon; Size code D3
9-10	Planet-sized gas giant moon; Size code 1D+1
11	Large gas giant moon; Size code 2D-2
12	Huge moon, equivalent to a super-earth

Asteroids indicates a group of asteroid-sized objects orbiting close together. Gas Giants can have dozens or even hundreds of asteroid-sized moons. These clusters are hazardous to navigate but sometimes rich in minerals, attracting miners or those looking for somewhere to hide.

HIGH GUARD: DEEP SPACE EXPLORATION

This section provides new entries to the Spacecraft Options chapter in High Guard, giving naval architects tools to equip ships for deep space exploration.

BASE MODULE (TL12)

A base module is designed to be landed on a planetary surface (or moon, asteroid or other suitable body) and anchored in place with piles driven into rock. A base module consumes 20 tons if fitted as a detachable shipboard component and 28 tons if carried as cargo. The unit provides living and work space for four Travellers planetside, with a small fusion plant, recycling of water and air, and fuel reserves to last a year. One personnel airlock leads directly outside; a second into a small vehicle garage, capable of holding a vehicle of up to 5 Shipping Tons.

The module includes a compact laboratory area, which can conduct various forms of research but is typically geared to analysis of mineral and organic matter collected by the field team. The module costs MCr3.

CHART ROOM

A chart room is sometimes termed an astrographic plotting and analysis chamber, and provides DM+2 to Astrogation checks and Science checks related to astrographical matters. DM+1 applies to Tactics (naval) checks when planning multi-ship operations. Up to four personnel can work in a chart room, which consumes 16 tons and 2 Power, and costs MCr1.25.

FUEL/CARGO CONTAINERS

It is possible to extend the range of a standard starship by temporarily installing demountable or collapsible fuel tanks. The downside of this arrangement is the time required to swap between fuel and cargo carrying. In some configurations, the tanks may block access to some parts of the ship – certain vessels use the cargo area as a thoroughfare, which can be a problem if it is full of liquid hydrogen.

Dedicated fuel/cargo containers present an alternative, allowing space to be switched between uses without a lengthy remodelling of the ship's interior. Containers can also be built in such a manner as to retain accessibility, including accessways, hatches and heavy-duty partitions that make them part of the ship rather than a component that must be added or removed as necessary. Swapping from fuel tankage to cargo space requires little more than flushing the tanks, then loading with cargo as needed.

Containers of this sort are sometimes used aboard converted merchant craft to support other exploration ships by acting as tankers or long-range supply ships. They also increase the capabilities of an ordinary merchant, permitting extended transits between mains and clusters when necessary, yet retaining almost all capacity for day-to-day freighting operations.

Each ton of capacity in a cargo/fuel container requires 0.05 tons of additional equipment and costs Cr5000 per ton of capacity. For example, a fuel/cargo container capable of carrying 100 tons consumes 105 tons and costs Cr 500,000.

GRAVITATIONAL ANALYSIS SUITE (TL13)

A gravitational analysis suite permits the detection and analysis of extremely weak gravitic phenomena. It can be used to predict the presence of objects in deep space or track gravity waves caused by jump entry and breakout. Of course, since gravity waves propagate at the speed of light, a jump emergence detected in a system one parsec away will have occurred over three years previously, however this can still be useful in predicting traffic patterns, naval movements or the presence of a starfaring culture.

The suite requires a combined total of five levels of the Science skill to operate it, which can be supplied by one scientist or a group of up to four – the maximum accommodated in a single suite. For each class of object there is an Automatic Detection Range; beyond this distance, detection requires a Difficult (10+) Electronics (sensors) check, applying DM-1 for each multiple of the Automatic Detection Range.

Object or Occurrence	Automatic Detection Range
Supermassive object, such as a black hole	300 parsecs
Stellar object, such as a star	30 parsecs
Planetary scale object, such as a gas giant or terrestrial planet	3 parsecs
Jump emergence or entry	1 parsec
Cometary object	1/10th of a parsec

A search and plot requires a number of hours equal to $1D \times 10$, multiplied by the distance, in parsecs, being searched.

For example, a ship with a gravitational analysis suite can plot the gravitational signature of every star within 30 parsecs, requiring $1D \times 10 \times 30$ hours. The ship will also automatically detect any jump emergence within 1 parsec at the time the gravity waves reach the analysis suite.

Beyond the Automatic Detection Range, an Electronic (sensors) check is required. Failure indicates little useful data has been obtained and for each multiple of the Automatic Detection Range, DM-1 is applied, so attempting to detect planets at 8 parsecs is subject to DM-2.

Adding a gravitational analysis suite to a ship's sensor system consumes 5 tons, uses 6 Power and costs MCr12.

GRAVITATIONAL SHIELD (THE MARCELCRU DEVICE)

At high Tech Levels it is possible to create a shielding device that permits a vessel to survive areas of extreme gravitational forces. The Marcelcru Device, found aboard a derelict starship of great age by the crew of RSS *Marcelcru*, is postulated to have such a function – although it is not clear whether this was its primary or only purpose.

The Marcelcru Device is estimated to have been constructed at TL22 and cannot be duplicated with existing technology. It has a central nexus, connected to filaments of exotic construction running through the parent vessel's decks and hull. The nexus, in the case of the original Marcelcru Device, displaced just over four hundred tons and contained several sub-chambers. Some could be entered safely, others were lethal and some changed state without warning.

The location of the original Marcelcru Device is highly classified, although it is supposed that it was fitted to a research ship, which may or may not remain in service. Attempts to duplicate the device, or create crude versions of it, met with mixed success but it is now possible to create a partial shield at TL15.

A Marcelcru Device, or gravitational shield, consumes 12% of a ship's tonnage, of which 3% is dedicated to the central nexus and the rest distributed throughout the vessel. It provides protection from gravitational forces but requires power only to activate or deactivate – when active, the device appears to generate its own operating power by gravitational induction. There is no known way to tap this power but it is possible the original creators of the device were able to do so.

Protection from gravitational force is partial, with an upper limit. If this is exceeded, the device fails and the protected vessel will be destroyed by gravitational shear. The original device was thought to offer infinite protection, in theory allowing a vessel to survive inside the event horizon of a black hole.

Gravitational shielding does not negate mass, so this device will not allow a craft to exceed the speed of light in the normal universe. It does – again, in theory – permit navigation using a standard m-drive in areas of extreme gravitational forces. The degree of shielding possible is based on a percentage reduction in perceived gravitational forces, so a ship with 90% protection in a



40G field would be affected by 4G. This is insufficient to damage a vessel and, just as importantly, a ship with a good m-drive could escape – no known vessel would be able to escape a 40G well otherwise!

System	TL	Reduction in Perceived Gravity	Upper Limit
Crude Gravity Shield	15	10-25%	20G
Early Gravity Shield	17	90%	50G
Basic Gravity Shield	19	99%	100G
Advanced Gravity Shield	21	99.9%	250G
The Marcelcru Device (Full Gravity Shield)	22+?	100%	Infinite?

It is not possible to put a price on such a device; the processes required to make the necessary materials are barely understood at TL15 and the materials themselves essentially priceless. Any constructed devices are one-off prototypes and may not perform exactly as described. Indeed, there are rumours of high-gravity research craft built using materials salvaged from derelict vessels, whose performance would be impossible to predict without trial and – probably fatal – error.

HOSTILE ENVIRONMENT OPERATIONS PACKAGE

A Hostile Environment Operations Package is a conversion applied to a spacecraft that allows it to operate for extended periods in corrosive, insidious, or otherwise hazardous environments. In addition to improved seals and bracing, the vessel is also fitted with a self-decontamination facility and can decontaminate personnel within its airlocks.

If built into the design from the outset, the package takes up 5% of the hull's tonnage. Retrofitting consumes 10%. Either way, the package costs MCr0.1 per ton of the vessel.

HOSTILE ENVIRONMENT OPERATIONS SUPPORT SUITE (HEOSS)

A HEOSS is a bulky component intended for use aboard larger starships. It contains a specialist airlock with extensive decontamination facilities, equipment ready and maintenance areas, and a set of heavy-duty hostile environment suits plus accessories such as thrust packs and equipment-transport drones. It can support a four-person team outside the ship plus additional personnel working on equipment maintenance or undergoing training within the facility.

A HEOSS consumes 32 tons and costs MCr24.

OBSERVATORY

Starships and space stations may install an observatory for the purposes of navigation, exploration and research. A basic observatory contains only optical telescopes and infra-red detection equipment, while a standard observatory also features radio telescopes, interferometry and refractometry equipment, alongside extensive systems equipment to allow collection of composite data. An advanced observatory also has extremely sensitive gravitic sensors and other exotic instruments.

An observatory grants all personnel working within it a DM on Astrogation checks, as well as any attempt to discover distant objects (see page 4). The size of the observatory limits the number of scientists who can work at once, which in turn impacts time taken to carry out a given task.

A given astronomy, cosmology or space science related task can be performed quicker in a dedicated observatory. The total Effect of any observatory-related skill check made by a scientist in the observatory, multiplied by the combined Effect Multiplier of the observatory itself, produces a percentage reduction to the time required on a given task, to a minimum of 10% of the normal time requirement.



PRESSURE HULL

Intended primarily for gas giant research vessels, a pressure hull is designed to withstand incredibly high pressures. Components within the pressure hull are protected from damage, as is the hull itself, to a far greater depth than normal when skimming fuel.

If the gas giant operations rules from the *Traveller Companion* are being used, the ship suffers no ill effects when operating in the Extreme Deeps zone. If the vessel

Observatory Type

Size	Tonnage Consumed	Personnel	Type	TL	Cost	DM	Effect Multiplier
Small Observatory	100	2	Basic	7	MCr25	+1	x0.5
			Standard	9	MCr50	+2	x1
			Advanced	13	MCr125	+3	x1.5
Medium Observatory	400	8	Basic	7	MCr100	+1	x1
			Standard	9	MCr200	+2	x2
			Advanced	13	MCr500	+3	x3
Large Observatory	1,000	20	Basic	7	MCr250	+1	x1.5
			Standard	9	MCr500	+2	x3
			Advanced	13	MCr1,250	+3	x4.5

enters the Depths zone, it will be unharmed for 2D hours, after which the pressure hull will begin to fail on a roll of 8+ on 2D, made every 1D hours. Once the pressure hull has begun to fail, the ship takes normal damage (2D per round) and the pressure hull will need extensive repair work if the ship survives.

If these rules are not in effect, assume the ship can descend to a level in a gas giant that makes it undetectable to ships in orbit. A vessel with a pressure hull can also operate at depths of 50 kilometres underwater; far deeper than the oceans of most worlds.

A pressure hull consumes 25% of the vessel's tonnage and costs ten times the normal hull cost. It is considered to have an intrinsic armour Protection 4.

RAMSCOOP

A ramscoop is a device for sweeping up interstellar gas and dust particles using a large electromagnetic field to guide them into a collector. It only works when a vessel is moving in normal space – not while jumping – and typically collects only a few molecules every hour. It would take many months to fill a fuel tank in this manner, so typically a ramscoop is used to collect gas and dust for scientific analysis. It is possible to discover much from the composition of interstellar gas, such as the nature of stars in the very distant past. It might also be possible to sustain an extremely long duration mission (such as a ‘sleeper’ colony ship) by using collected hydrogen to replenish powerplant fuel.

A ramscoop must be tailored to the tonnage of the parent vessel to be effective, consuming 1 ton of equipment per 200 tons of the vessel, plus an additional 40 tons for the central capture and field generation unit. It requires 1 Power to operate per ton, costing Cr50,000 per ton.

SCIENTIFIC OPERATIONS SUITE

Designed to be installed aboard very large starships and space stations, a scientific operations suite is a large-scale laboratory complex supported by conference rooms, specialist data processing and storage facilities, in addition to larger instruments than can be fitted in a shipboard laboratory. A ship or station can carry

multiple suites but each must be optimised for one field of research. This is reasonably general, such as physical sciences, life sciences or archaeology. A suite provides all scientists working within it with DM+1 on all tasks associated with their field of scientific endeavour.

A scientific operations suite has a minimum size of 48 tons and can accommodate 16 scientists. Each additional three tons allows one more scientist to work in the suite.

The suite costs MCr0.8 per ton, making it slightly more cost efficient than a standard laboratory, as well as more effective but it will consume 1 Power for every 10 tons or part of.

SOFTWARE

This section provides new entries to the Ship’s Computer chapter in High Guard, giving naval programmers tools to configure computers for deep space exploration.

Science

Whilst a Library package contains a wide store of knowledge it must be manually accessed by the user, who needs to know what to look for. The Science package is vastly more capable and designed to support working scientists on a pseudo-intelligent and interactive basis. A Science package will compare findings and ideas against all known theories and hypotheses, allowing a basic peer review of ideas to take place in moments. This occasionally results in someone having a blazing row with the ship’s computer but, overall, the ability to quickly find supporting or countervailing theories is extremely useful to researchers.

A Science (general) package is useful across the whole range of scientific endeavour, granting DM+1 to all tasks associated with research or development of ideas. A specific package, such as Science (cosmology), grants DM+2 only within its area of expertise. The Advanced variant of this package increases the DM by +1.

Software	Bandwidth	TL	Cost
Science (any)	6	11	MCr20
Science (general)	9	12	MCr25
Advanced Science (any)	12	13	MCr30

Mentor

A Mentor package is designed to train personnel in basic functions that support research staff; essentially it guides the user through a set of exercises and tests to ensure they can function within a laboratory without putting the experiment or staff at risk. Once basic training has been completed, the package monitors the assistants and warns them if they are about to do something hazardous or perform a task incorrectly. Mentor cannot stop a clumsy lab-monkey from dropping a beaker but it can remind him of decontamination protocols or where to find the neutralising agent he needs in a hurry. Mentor can support up to 12 personnel per instance running on the ship's computer. It does not provide bonuses to complete scientific tasks but does give a positive DM on any check needed to avoid a problem or deal with a mishap. Mentor also shaves time off scientific tasks by providing guidance on the most efficient way to carry out experiments and research.

Software	Bandwidth	TL	Cost	DM	Time Reduction
Mentor/1	3	8	MCr2	+2	-10%
Mentor/2	5	10	MCr3	+3	-20%
Mentor/3	7	12	MCr4	+4	-30%

Research Assist

A Research Assist package automates many functions required in scientific research. Instruments are automatically calibrated to the requirements of the scientist, telescopes aligned and data is neatly tabulated just how the user likes it. It takes 4D hours of operation to 'train' the Research Assist package to meet a user's needs, during which it is an aggravating nuisance that keeps getting everything just wrong enough to be infuriating. Once properly set up, Research Assist provides a DM to all science and research related tasks carried out by that user. One instance of Research Assist can support twelve users.

Software	Bandwidth	TL	Cost	DM
Research Assist/1	4	9	MCr2	+1
Research Assist/2	6	11	MCr3	+2
Research Assist/3	8	13	MCr5	+3

Flight Operations

A Flight Operations package helps coordinate spacecraft, drones and other traffic around the parent vessel or installation, automatically generating safe courses and advising crews of hazards ahead of time.

It tends to err heavily on the side of caution, gaining it the nickname of Old Lady. If allowed to operate autonomously, Flight Operations reduces the chances of a collision or close encounter to virtually nothing, although at the cost of making operations such as approach to docking take much longer. More advanced versions of the package can control more craft with greater efficiency.

Software	Bandwidth	TL	Cost	DM	Craft or Vehicles Controlled
Flight Operations/1	4	9	MCr6	+1	8
Flight Operations/2	8	11	MCr10	+2	16
Flight Operations/3	12	12	MCr15	+3	32

If used with personnel interaction, Flight Operations provides a DM to all tasks associated with craft or traffic control. This can be quite mundane, such as guiding a drone to intercept an asteroid or critical to survival – such as advising a stranded Traveller on how to use the last propellant in their craft to get back to the ship with seconds of air left.

Planetology

A Planetology package is tailored to interpret survey data and create a working hypothesis of a body's characteristics. The more data available, the better the model; a cursory radar map of the surface allows the package to take an educated guess at the composition of a world, whereas data on its magnetic field, atmosphere composition and gravity conditions permits an accurate estimate of internal configuration (such as the depth of layers in the crust, mantle and core), tectonic and volcanic activity and the presence of minerals in the crust.

Analysis of a small object such as a comet takes 1D hours. A planet requires 3D hours, although a quick-and-dirty estimate is typically available in minutes. In addition, a Planetology package grants a DM to related tasks such as prospecting for minerals or predicting weather patterns.

Software	Bandwidth	TL	Cost	DM
Planetology/1	2	9	MCr1	+1
Planetology/2	3	11	MCr3	+2
Planetology/3	5	13	MCr7	+3

The Travellers Aid Society presents

JAYNE'S GUIDE

TO STARSHIPS OF EXPLORATION



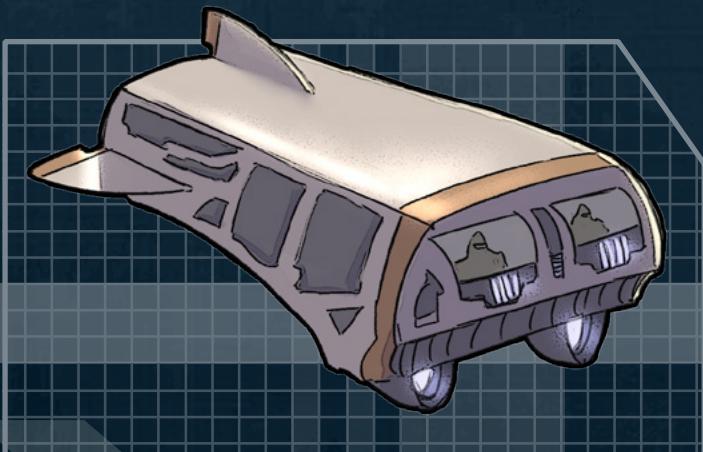
UTILITY BOAT

TL12

TONS COST (MCr)

Hull	60 tons, Standard	-	3
Armour	None	-	-
Reaction Drive	Thrust 2	2.4	0.48
Power Plant	Fusion, Power 15	1	1
Fuel Tanks	6 hours at Thrust 2, 40 weeks of operation	28	-
Bridge	Dual Cockpit	2.5	0.15
Computer	Computer/5	-	0.03
Sensors	Civilian	1	3
Cabin Space	Passengers x4	6	0.3
Software	Manoeuvre/O Library	-	-
Cargo		19.1	-

TOTAL: MCr12.28



24

HULL POINTS

ARLAUDU-CLASS

CREW

PILOT,
CO-PILOT/MECHANIC

RUNNING COSTS

MAINTENANCE COST:
Cr1023.33/month

PURCHASE COST:
MCr12.28

POWER REQUIREMENTS

0

12

MANOEUVRE DRIVE

BASIC SHIP SYSTEMS

1

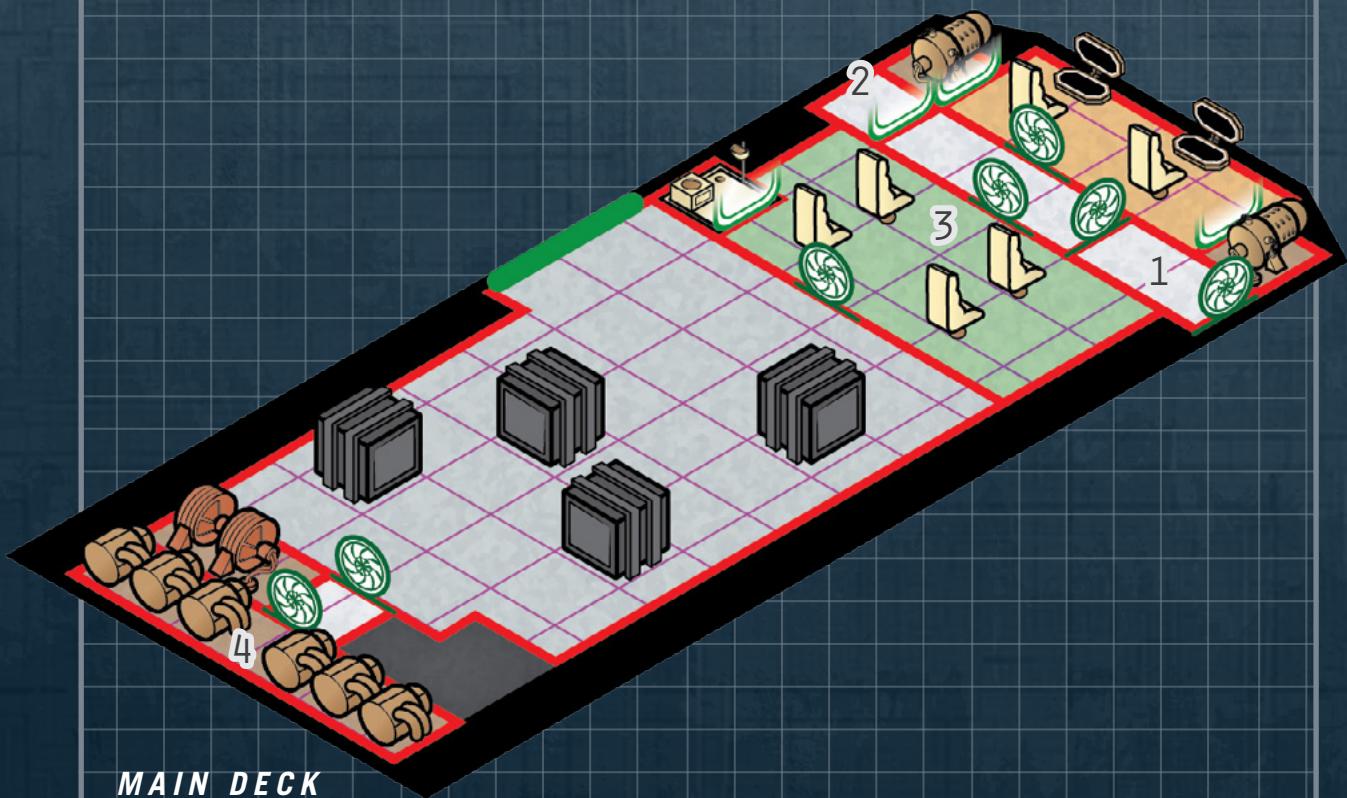
SENSORS

The Arladu-class is designated a 'utility boat' and can be encountered in a variety of roles. Its reaction drive and generous fuel allocation makes it useful for deep space operations and although it is possible to thrust for six hours at a constant 2G acceleration, few operators are likely to do so. More commonly, pilots are positively stingy with fuel and fret constantly about reserves on a long mission. The craft is normally operated by a crew of two, with cabin space for four additional personnel. The 16 tons of available cargo space can be reconfigured as additional cabins, fuel tanks, or almost any other application.

One common configuration is as a rescue tug or module-handling craft for deep-space operations.

In this role, a boat might be fitted with a manipulator arm or attachments allowing it to clamp itself to another craft (or detached module). It is not uncommon to find boats of this sort at deep space refuelling caches or installations, sometimes acting as pilot craft or tugs to bring larger vessels in to a docking position.

LOWER DECK
FUEL ONLY



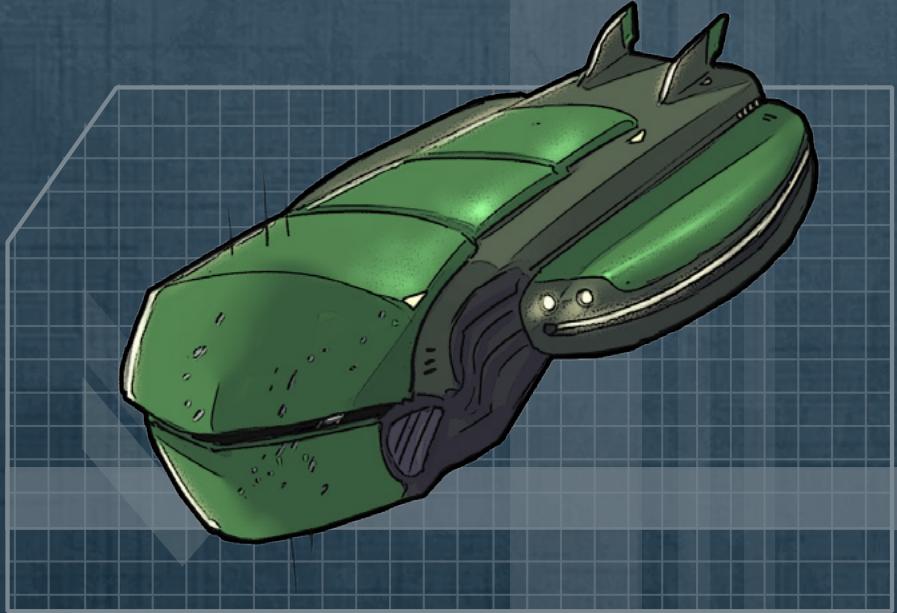
1. AIRLOCK
2. SHIP'S LOCKER
3. CABIN SPACE
4. REACTION DRIVE

HOSTILE ENVIRONMENT EXPLORATION VESSEL

RANDALL-CLASS

TL15		TONS	COST (MCR)
Hull	200 tons, Streamlined Hostile Environment Operations Package Heat Shielding	- 10 -	12 20 20
Armour	Bonded Superdense, Armour: 4	6.4	3.84
M-Drive	Thrust 4	8	16
J-Drive	Jump-2	15	22.5
Power Plant	Fusion, Power 200	111	111
Fuel Tanks	J-2, 40 weeks of operation	50	-
Bridge		10	1
Computer	Computer/25	-	10
Sensors	Advanced Sensor Stations x 2	5 2	5.3 1
Weapons	Dual Turrets (beam lasers) x 2	2	3
Systems	Fuel Scoops Fuel Processor (20 tons per day) Hostile Operations Support Suite Advanced Probe Drones Mineral Detection Suite Laboratory	- 1 32 2 - 8	. 0.05 24 1.6 5 2
Staterooms	Standard x6 Emergency Low Berths x 2	24 2	3 2
Software	Manoeuvre/0 Jump Control/2 Library Advanced Science (general) Planetology/3	- - - - -	- 0.2 - 25 7
Common Areas		6	1.2
Cargo		6	-

TOTAL: MCR 844.7787



80

HULL POINTS

CREW

PILOT, ASTROGATOR, ENGINEER,
EXPLORATION CREW X 5

RUNNING COSTS

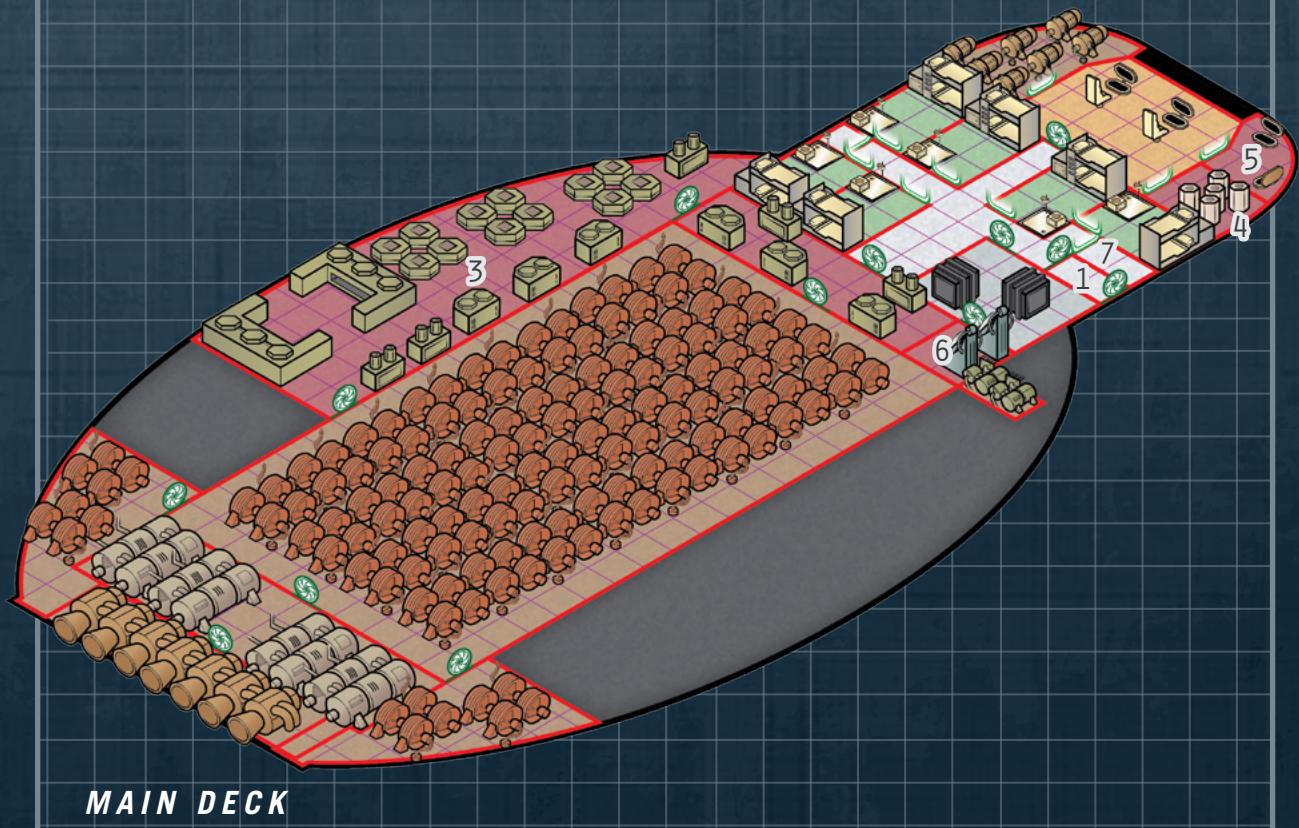
MAINTENANCE COST
Cr17142/month

PURCHASE COST
MCr205.69

POWER REQUIREMENTS

80	40
MANOEUVRE DRIVE	BASIC SHIP SYSTEMS
40	6
JUMP DRIVE	FUEL PROCESSOR
	SENSORS

The *Randall*-class is a survey and research vessel intended to land on hostile worlds and carry out a detailed investigation of threats and potential for development. The hull resists extended exposure to corrosive and other harmful atmospheres, with personnel exiting the vessel via decontamination-capable airlocks. The vessel's laboratories and software are geared to planetological research and investigation of local conditions. It is typically used by mining and colony-preparation companies, although examples are in use with the Scout Service and some exploration corporations. In the latter case, the *Randall* is often carried to the vicinity of the target by a larger ship, or supported by other vessels that remain safely in orbit whilst the *Randall* ventures into the hazard zone.



MAIN DECK

1. AIRLOCK
2. LABORATORY
3. HOSTILE OPERATIONS SUPPORT SUITE
4. PROBE DRONES
5. SENSOR STATION
6. LOW BERTHS
7. SHIP'S LOCKER

LONG RANGE SCOUT/MESSAGE BOAT

WAKA AMA-CLASS

TL15

TONS COST (MCR)

Hull	300 tons, Standard	-	15
Armour	None	-	-
M-Drive	Thrust 2	6	12
J-Drive	Jump 6	50	75
Power Plant	Fusion (TL15), Power 320	16	32
Fuel Tanks	J-6, 10 weeks of operation	184	-
Bridge	Small (DM-1)	10	1
Computer	Computer/25 bis	-	15
Sensors	Improved Sensors	3	4.3
Weapons	Double Turret (empty)	1	0.5
Systems	Fuel Processor (40 tons/day)	2	0.1
	Fuel Scoops	-	1
Staterooms	Standard x 2	8	1
	Emergency Low Berths x 2	2	2
Software	Library	-	-
	Manoeuvre/O	-	-
	Jump Control/6	-	0.6
Common Areas		4	0.4
Cargo		15	-

TOTAL: MCR 126.4

CREW

PILOT/ASTROGATOR,
ENGINEER X 2

RUNNING COSTS

MAINTENANCE COST:
Cr10560/month

PURCHASE COST:
MCR126.4

POWER REQUIREMENTS

60

MANOEUVRE
DRIVE

60

BASIC SHIP
SYSTEMS

180

JUMP DRIVE

4

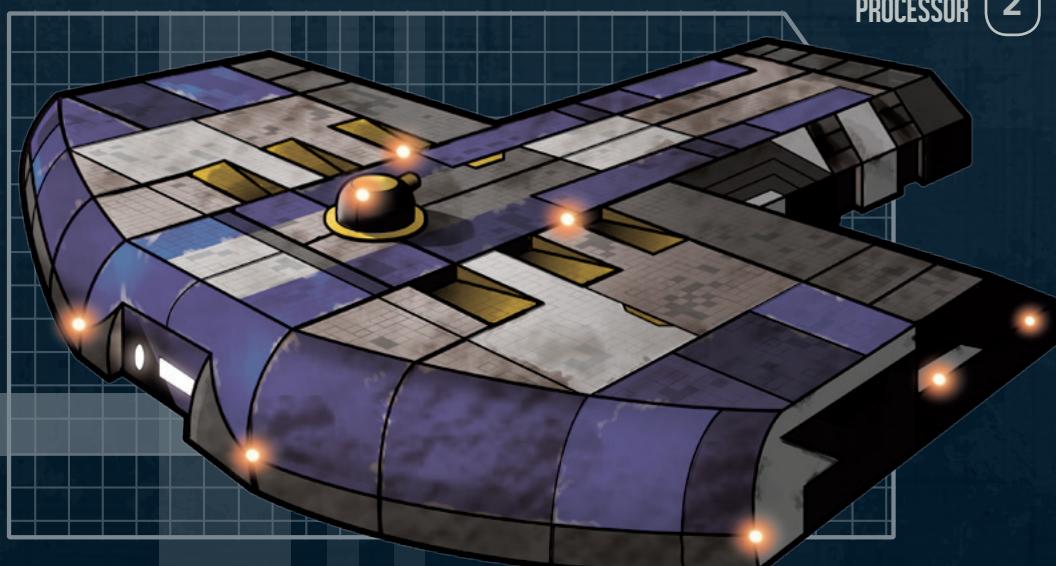
SENSORS

FUEL
PROCESSOR

2

1

WEAPONS



120

HULL POINTS

The *Waka Ama*-class is named for a type of ocean-going canoe, which perhaps sums up the nature of this ship. Although capable of crossing immense distances in a relatively short time, the *Waka Ama*-class is officially designated a boat by its manufacturers, since it is intended to operate from a base or parent ship rather than as a starship in its own right. It is tiring and stressful to operate, with crewmembers confined to a small area for extended periods. Indeed, this class of ship has been connected with long-term psychological damage to crewmembers. This stress is greatly reduced if the crew can escape their tiny world at opposite ends of a trip.

The *Waka Ama*-class is a horribly cramped design, little more than a jump drive and fuel tank with a crew compartment attached. Just two cabins accommodate a crew of three or four, with a small common area providing the only relief from confinement.

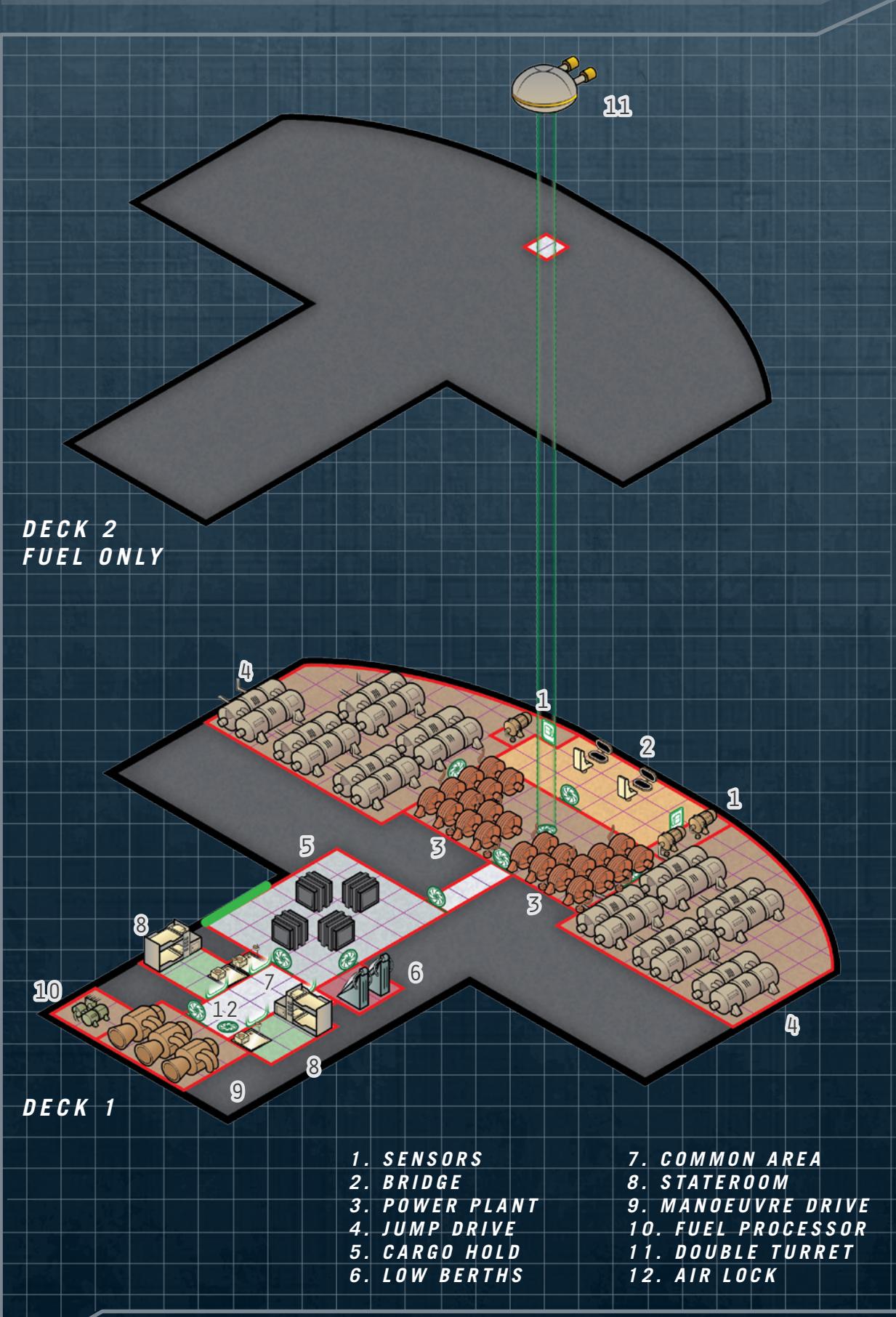
Many crews use odd corners of the bridge and the relatively large engineering room as personal spaces. As a result, it is not uncommon to find engineering access ways constricted by a hammock and improvised nightstand, or a hobby desk set up over the top of rarely used controls. Most operators turn a blind eye to this activity as it makes service aboard a *Waka Ama*-class scout a little more bearable, reducing the chances of crewmembers making a fatal mistake.

The *Waka Ama*-class fulfils two main functions for exploration missions; scout and messenger. In the latter capacity, it can serve as a link back to civilisation, carrying messages or rotating crewmembers home. In this role, a *Waka Ama* might make several jumps between prepositioned fuel caches and gas giant refuellings, spending as much as two to three months in transit. It is common practice to give crews downtime or reassign them to more spacious craft after missions. Communications between an exploration flotilla dispersed over several star systems can also be maintained, even in areas where standard scout/couriers lack sufficient jump capability.

The *Waka Ama*'s high jump capability also allows it to function as a scout for a slower exploration vessel or flotilla. Ranging ahead and to the sides of an exploration mission, these long-range scouts can undertake preliminary surveys or investigate discoveries without diverting the main mission. When acting as a flotilla messenger or scout, it is customary for a *Waka Ama* to spend time docked to a larger craft, essentially acting as a jump-capable ship's boat rather than an independent vessel.

The *Waka Ama*-class is often pressed into service as a utility vessel, fulfilling a variety of roles to which it is not very well suited. As a supply vessel, supporting an expedition planetside, it is extremely inefficient but often the only ship that can reach the site. Vessels are sometimes assigned to skim and process fuel for other ships, acting as small (and again, inefficient) tankers. This activity is a necessary part of exploration operations, where mission leaders must work with what they have rather than bringing along a perfect selection of ships.

The *Waka Ama*-class has one other application, which is rarely discussed. Using its own emergency low berths, it can rescue a handful of survivors from a distressed survey or exploration ship, and in some cases vessels are fitted with additional low berths in the cargo hold. Few expeditions set out with a ship expressly set up as a lifeboat but can be improvised using low berths from other ships or dispatched from a mission base after hasty retrofitting. Nobody likes to talk about the possibility of rescue from dozens of parsecs away but the presence of an escape vessel is reassuring to explorers. For this reason, whilst the *Waka Ama*-class is almost universally hated by its own crews, its presence at an exploration base or within a flotilla is considered to bring good luck.



EXPLORATION VESSEL

ARMSTRONG-CLASS

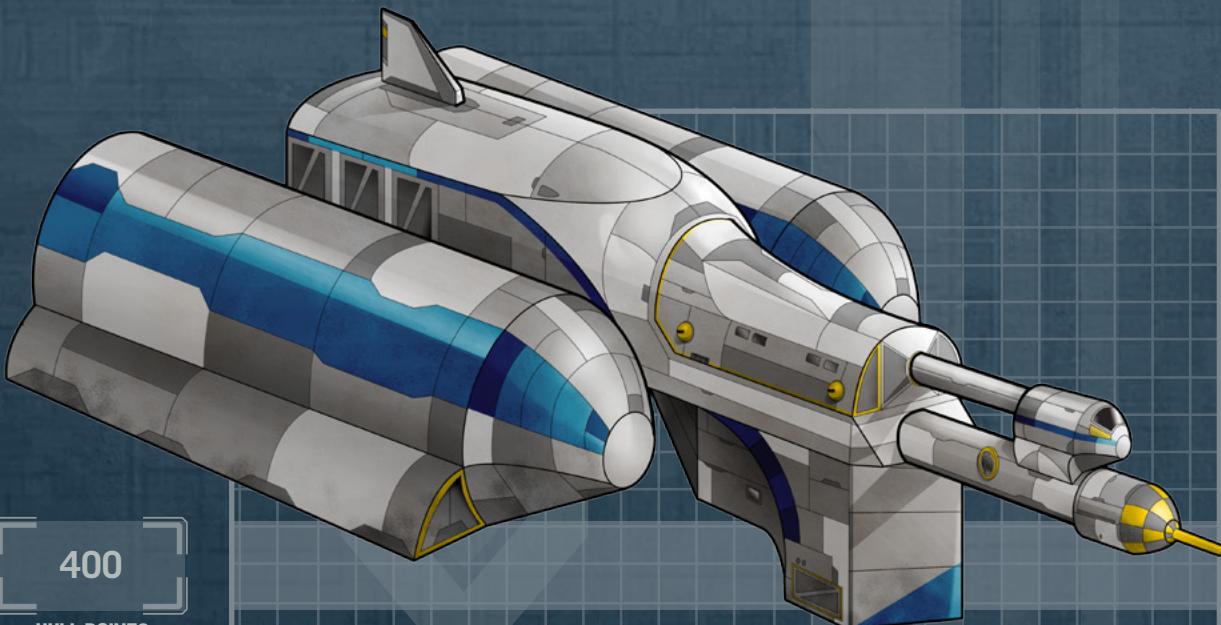
TL15

TONS

COST (MCR)

Hull	1,000 tons, Streamlined	-	60
M-Drive	Thrust 1, Energy Efficient x 3	10	20
J-Drive	Jump 3, Decreased Fuel x 3	80	180
Power Plant	Fusion (TL15), Power 600	30	60
Fuel Tanks	2 Jump-3, 32 weeks of operation	534	-
Bridge		20	5
Computer	Computer/35	-	30
Sensors	Advanced with Extended Arrays	15	15.9
	Deep Penetration Scanners	1	1
	Life Scanner Analysis Suite	1	4
Weapons	Double Turrets (pulse lasers) x 4	4	10
	Missile Barbette	5	4
Ammunition	Missile Storage (120 missiles)	10	-
Systems	Fuel Processor (100 tons/day)	5	0.25
	Fuel Scoops		-
	Advanced Probe Drones	2	1.6
	Docking Space (30 tons) x 2	66	16.5
	Ship's Boat x 2	-	14.544
	Laboratory	8	2
	Workshop	6	0.9
	Medical Bay	4	2
Staterooms	Standard x 12	48	6
	Emergency Low Berths x 4	4	4
	Brig	4	0.25
Software	Jump Control/3	-	0.3
	Library	-	-
	Manoeuvre/O	-	-
Common Areas		48	4.8
Cargo		95	-

TOTAL: MCR 443.044



400

HULL POINTS

CREW

CAPTAIN, PILOT, ASTROGATOR,
ENGINEERS X 4, MAINTENANCE,
MEDIC, GUNNERS X 4, SHIP'S
BOAT PILOTS X 2

RUNNING COSTS

MAINTENANCE COST

Cr36920/month



PURCHASE COST

MCr443.044

POWER REQUIREMENTS

25

MANOEUVRE
DRIVE

200

BASIC SHIP
SYSTEMS

300

JUMP DRIVE

20

SENSORS

5

FUEL PROCESSOR

32

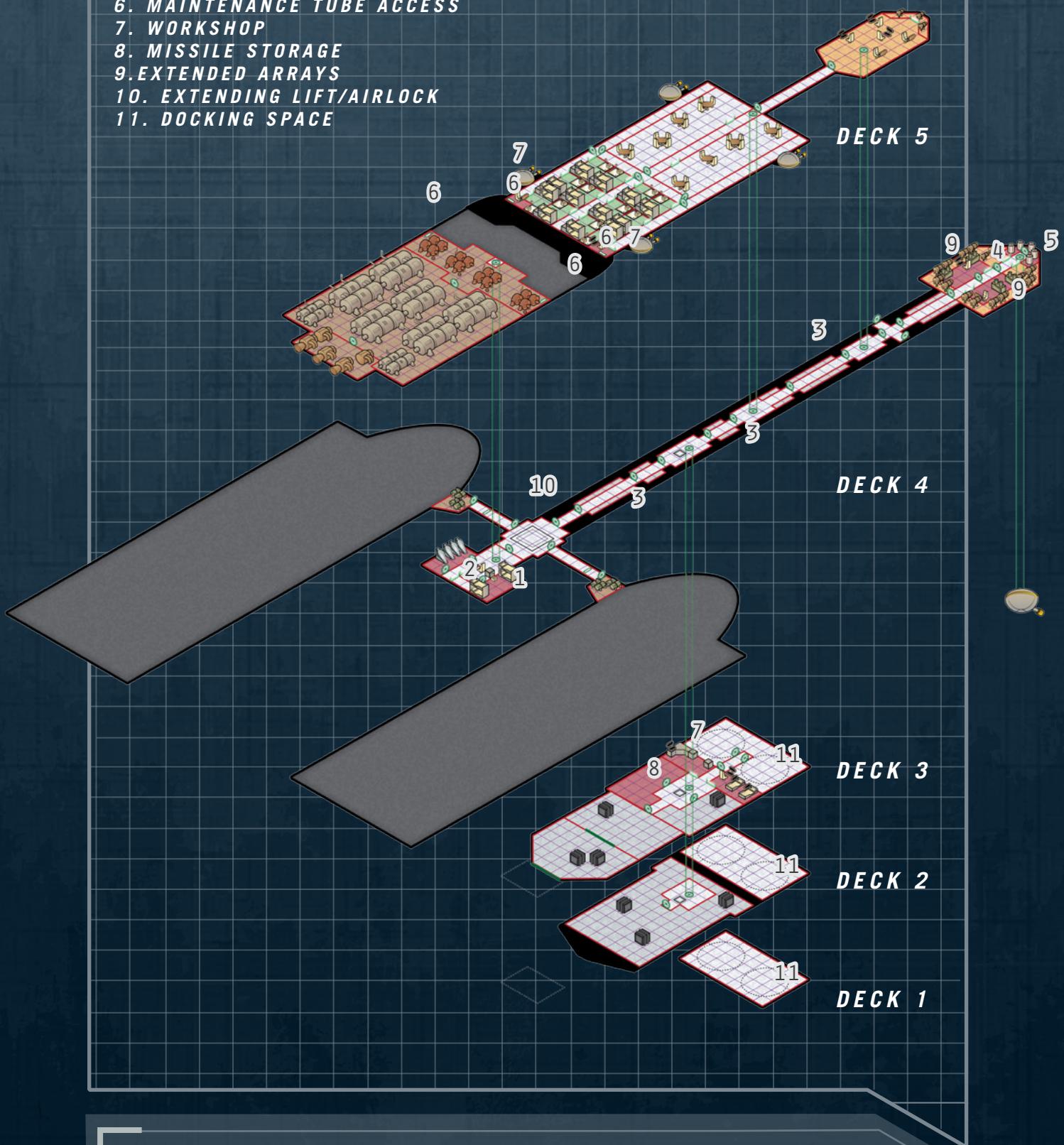
WEAPONS

Named for famous space explores, the *Armstrong*-class is designed for long-range deep space exploration either solo or with the support of tankers and supply vessels. Its two-jump-3 capability allows the crossing of a large rift or a there-and-back mission to a target up to three parsecs away, even if fuel is not likely to be available. Although a jump-6 drive would allow the crossing of similar distances, the decision to fit a lower capacity drive actually enhances the capabilities of this vessel.

Not only is the jump-3 drive significantly smaller, the mature technology of jump-3 capability allowed an extremely fuel-efficient design to be developed. The *Armstrong*-class takes twice as long to cross a 6-parsec distance as a jump-6 vessel but can do so using 85% of the fuel. This had the effect of saving around 90 displacement tons for other purposes. Whilst the idea of a relatively low-jump exploration ship remains controversial, many operators are satisfied with the cost and tonnage savings, since exploration missions tend to be of long duration anyway.

The manoeuvre drive is similarly a very energy-efficient design, enabling a slightly smaller powerplant to be carried. This saving is not as significant as the jump-fuel consideration and has led to an undeserved reputation for the *Armstrong*-class being underpowered. The rumour is untrue, although with only 1G acceleration available, an Armstrong cannot dash around a target system and requires time to reach gas giants for fuel skimming operations. The limited thrust has been criticised for situations in which the vessel ventures close to a high-gravity mass, although these are rare and usually handled with careful use of the ship's boats.

1. BRIG
2. SECURITY OFFICE
3. LOCKERS AND STOWAGE
4. LABORATORY
5. PROBES
6. MAINTENANCE TUBE ACCESS
7. WORKSHOP
8. MISSILE STORAGE
9. EXTENDED ARRAYS
10. EXTENDING LIFT/AIRLOCK
11. DOCKING SPACE



The Gantry

The vessel is built around a central structure variously referred to as the gantry or spine, running the length of the ship and carrying circuitry, piping and other connecting components, as well as a wide personnel corridor. Although it looks somewhat fragile, the spine is heavily overbuilt and designed to withstand forces encountered in vastly harder manoeuvring than the Armstrong is capable of.

Tool and storage lockers line the sides of the corridor, which is subdivided in case of a breach, and contains access points to component modules. There is a chamber slung under the gantry (between the front ends of the fuel modules) and when the vessel is landed, an extending framework drops to the ground allowing this chamber to be used as a lift/airlock giving direct access to the ship. It also has access hatches that can be used to enter the fuel processor chambers.

The ship's primary personnel airlock is located near the fore end of the gantry, as a through-section, which allows access from either side (most starports have mobile steps or boarding tubes permitting entry at this level). The airlock is a large chamber, the width of the spine, and if necessary the doors can be opened on both sides at once to allow access between craft docked on both sides of the ship. This lock also permits access to the science module from the main gantry section and not coincidentally, allows any contamination of that area to be contained.

Right aft in the gantry is a flared section that contains the ship's security equipment – the ship's locker, personal armament racks and a small security office where incidents can be logged or a duty officer can drink coffee and watch the monitors. In practice, this area tends to collect a lot of objects that do not belong anywhere else and often ends up as a messy close-the-door-and-forget-about-it facility. There is a tiny containment cell, which is more commonly used to hold beer than a prisoner. The emergency low berths are also located here.

Fuel Modules

The largest components attached to the gantry are the two fuel modules, roughly 260 tons displacement each. These take the form of rounded cylinders or cones, flaring aft, and flattened off at the ventral surface. The Armstrong-class is a belly-lander when it does touchdown on a planet, with the base of the fuel modules providing a large contact surface to reduce ground pressure.

On the front underside of the cones are the ship's fuel scoops, leading into processing chambers that occasionally require crew access. For the most part, however, the fuel modules are visited only by maintenance personnel. They carry the ship's jump fuel, enough for a jump-3 in each tank. To reduce rotational stresses on the vessel, fuel is normally drawn equally from each tank but in theory a distressed Armstrong could jettison one of its tanks to reduce mass and crawl home using the other.

Operations Module

The day-to-day heart of the vessel is the operations module. This is located on the underside of the gantry, forward of the fuel tanks, and is two decks high. It is rounded off at the front for streamlining purposes, with a large cargo airlock at the lower forward end. This gives access to the main operations and storage space, which contains most of the vessel's cargo capacity and bulk mission stores as well as a 20-ton space used as a hangar for planetary vehicles. Two berthing areas capable of containing 30-ton ship's boats are located at the sides of this area, with the small craft exiting through doors in the outer surfaces of the module.

The exact nature of vehicles carried can vary considerably. Some ships may carry none at all and use the space for other purposes. Vehicles can exit through the forward cargo airlock or be loaded into the ship's boats for delivery to a planetary surface. The operations deck also contains a small workshop for maintenance of vehicles and other planetside equipment.

Like the fuel modules, the operations module has a flattened underside and acts as a third point of contact when the ship is on the ground. The two ship's boats cannot be launched when on the ground; they exit the ship to the sides and downwards. The vessel has to hover a few metres to facilitate this but launch operations are rarely a problem as the parent vessel most commonly remains in orbit rather than landing directly.

Science Module

At the fore end of the spine, and projecting ahead of the flight and operations modules, is a smaller cylindrical variously referred to as the nose or science beak. It contains two laboratories, housings for various electronic devices such as the ship's life sensors and deep penetration suite, much of the extended arrays and control room for the ship's drones, which are also launched from here. Forward-right is a missile barbette, which many ships use to launch long-range probes but which can fire combat missiles at need.

Flight Module

The flight module sits atop the forward end of the gantry, partially above the science module. It contains the bridge, main computers, some electronics and other critical systems. Access is normally by way of a lift from the main gantry, just aft of the primary personnel airlock. However, a narrow emergency corridor runs aft to the accommodation module; in theory, it is used when personnel are called to the bridge in a hurry but in practice few crewmembers take the lift down to the gantry then up again to the bridge.

Accommodation Module

The accommodation module takes the form of a rounded cylinder, lying atop the gantry and hanging over its sides in the manner of a saddle. This module contains living quarters, common areas, the galley and a fair amount of general storage space. The ship's four dual pulse laser turrets are located on the outer corners of the accommodation module and can be manned directly but more commonly operated from the bridge.

There is an emergency corridor to the flight module but no direct access to the drives. It is possible to transit between the drive and accommodation modules by way of maintenance access tunnels that lead to the front of the fuel modules. These are concealed within the ship's outer hull and are generally forgotten about other than by those who must crawl through them from time-to-time.

Drive Module

The drive module is another rounded cylinder, sitting atop the aft of the gantry. It contains the powerplant, jump and manoeuvre drives, and fuel normally reserved for the powerplant. In reality, fuel is pumped from one tank to another as needed but many crews like to consider the three tank areas separate as this helps visualise range and duration.

In theory, it is possible for a crippled vessel to crawl home by jettisoning the fuel and science modules, before rigging fuel tanks in the cargo hold. It might be possible to further reduce mass by cutting away the accommodation module and living in the engineering and flight chambers. Shedding modules in this manner would cause a lot of structural damage but could be accomplished cleanly in a few days or rather more quickly if the ship was not intended to be

repaired. Jump performance and amount of fuel per parsec would depend on the volume of ship left but an emergency measure such as this was considered by the designers and guidelines for drive recalibration are incorporated into the engineering software.

Operations

Docking to small craft or externally docking with a station is by way of the main airlock at the fore end of the spine. This chamber is large enough to allow cargo to be easily brought in but is normally used as a personnel access lock. When the ship is grounded, the belly lock (located two-thirds of the way along the spine, between the nose ends of the fuel modules) is extended to the ground and provides personnel access. This has the advantage of being close to the security station.

For the most part, however, access is by way of the operations module. Most personnel transfers use the two ship's boats and when the ship is landed on a planetary surface the main cargo lock can be used for vehicles and personnel. Standard practice is for vehicles, personnel and supplies to be landed from orbit using the small craft, with the parent vessel remaining in orbit as a scientific and support base or conducting a survey of the rest of a star system. The parent ship may also land an expedition then take off to obtain fuel.

Crew

The Armstrong-class has a nominal crew of seven – four engineers, a pilot, astrogator and captain who could in theory double up one of the other posts. However, this is a dangerously small crew to operate an exploration vessel and makes no provision for small craft operations, gunnery or any sort of emergency. The vessel has 12 crew staterooms, giving a maximum complement of 24 personnel. Arrangements vary from mission-to-mission but a typical crew will include multi-skilled personnel who can handle different roles. One possible arrangement is as follows:

Captain

Executive Officer/Gunnery Officer

Flight Crew	Engineering Crew	Operations Crew	Mission Personnel
Flight Operations Officer/Astrogator	Chief Engineer	Operations Officer/ Administration Officer	4-6 personnel as per mission.
Chief Pilot	3 x Assistant Engineer	3x Deck Crew	
2x Ship's Boat Pilots			

Typically, the four most senior personnel have their own stateroom, with all others living in double-occupancy. This is a little cramped but offset by the generous amount of common space aboard the vessel. Some of this is used for workspace or storage on a typical ship but overall the Armstrong-class is large enough for crewmembers to avoid undue fatigue during a long mission.

Deck crew are expected to be multiskilled. Typically, each has a secondary role such as medical technician, gunner, missile/probe handler and so forth. In practice on a vessel like this, there will always be some job-sharing – personnel who expect to do only their own job are not suitable for long-range missions.

FAR COURIER

GURMASHMAR NUUR-CLASS

TL15

		TONS	COST (MCR)
Hull	1,000 tons, Close Structure	-	45
Armour	None	-	-
M-Drive	Thrust 2 (energy efficient x 3)	20	60
J-Drive	Jump-6	155	232.5
Power Plant	Fusion, Power 760	38	76
Fuel Tanks	J-6, 8 weeks of operation	608	-
Bridge		20	5
Computer	Computer/35	-	30
Sensors	Advanced	5	5.3
Weapons	Dual Turrets (beam lasers) x 4	4	6
Systems	Fuel Scoops	-	1
	Fuel Processors (100 tons per day)	5	0.25
Staterooms	Standard x/8	32	4
	Emergency Low Berths x 2	2	2
Software	Manoeuvre/0	-	-
	Jump Control/6	-	0.6
	Library	-	-
Common Areas		16	1.6
Cargo		95	-

TOTAL: MCR 422.325



80

HULL POINTS**CREW****CAPTAIN/ASTROGATOR, PILOT,
ENGINEERS X 6, GUNNERS X 4****RUNNING COSTS****MAINTENANCE COST**
Cr35194/month

• • • •

PURCHASE COST
MCr422.325**POWER REQUIREMENTS**

50

**MANOEUVRE
DRIVE**

600

JUMP DRIVE

200

**BASIC SHIP
SYSTEMS**

6

SENSORS

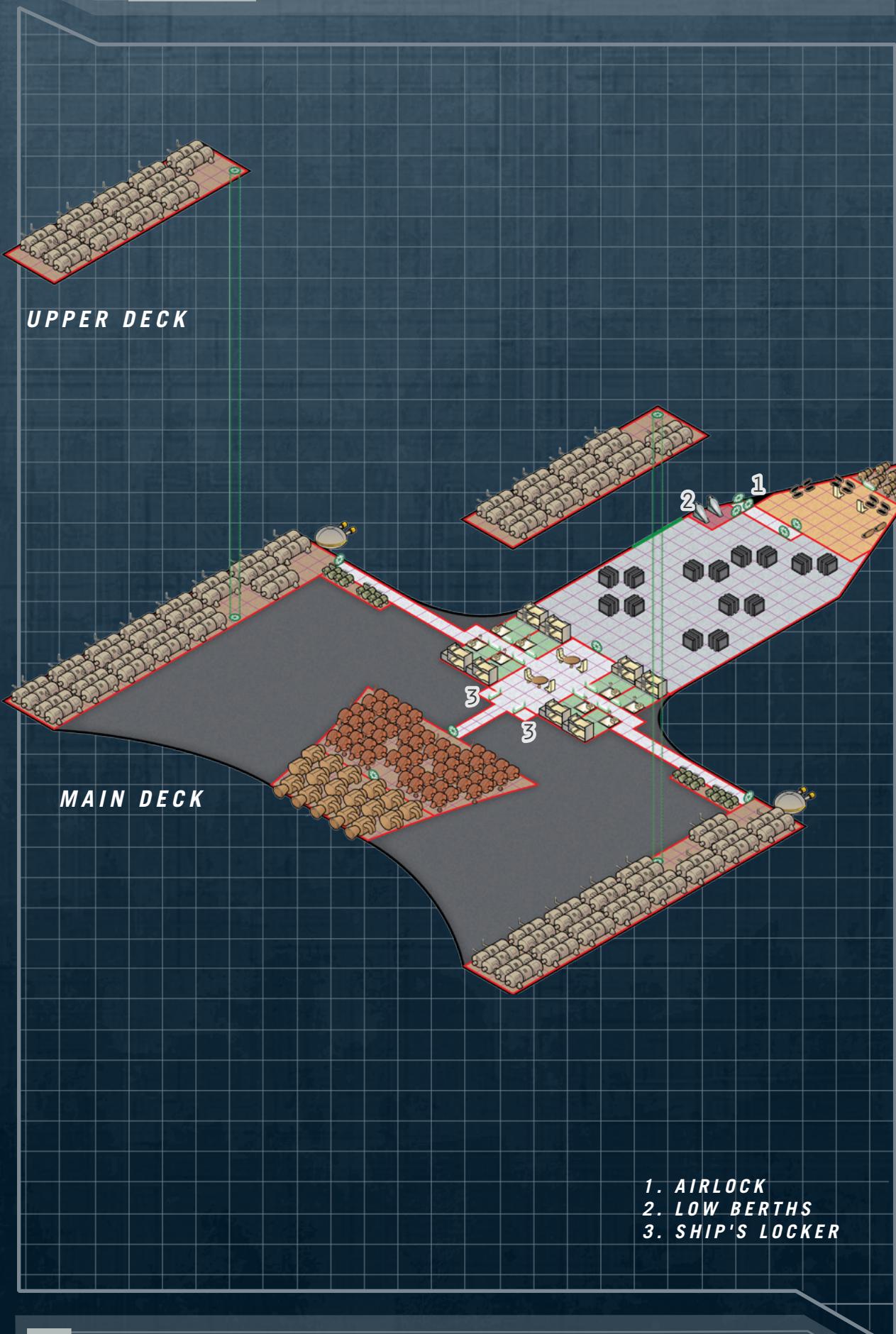
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**FUEL
PROCESSOR**

The *Gurmashmar Nuur* is not an exploration ship as such, instead used to maintain communications across rifts. Examples are in service with the Imperial Navy as well as Scout Service and some world governments operate these vessels as fast couriers. It is possible that the *Gurmashmar Nuur* is secretly used to maintain a 'faster-than-express boat' network in strategically critical regions.

The design has been criticised for being bigger and more expensive than necessary but even so there is little spare space aboard. Crew accommodation is cramped, making these vessels tiring to operate and unpopular with crews.

What space remains after drives and fuel tanks is mostly taken up with cargo space but can be reconfigured for other uses. *Gurmashmar Nuur*-class ships are sometimes outfitted with a laboratory for exploration or scientific support work or additional accommodation to allow personnel to be transferred to and from remote expeditions.



INTERSTELLAR VESSEL

ZARELINUNG-CLASS

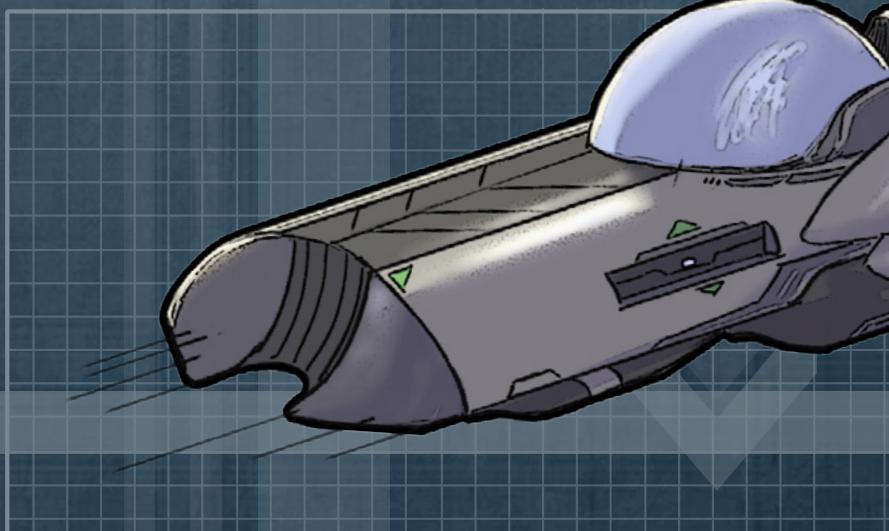
TL15

TONS

COST (MCR)

Hull	1,500 tons, Close Structure	-	67.5
Armour	None	-	-
M-Drive	Thrust 2	30	60
J-Drive	Jump-3	117.5	176.25
Power Plant	Fusion, Power 1200	60	120
Fuel Tanks	28 weeks of operation	42	-
Bridge		40	7.5
Computer	Core/40	-	45
Sensors	Advanced	5	5.3
Weapons	Small Missile Bay	50	12
	Dual Turrets (sandcasters) x 8	8	8
	Dual Turrets (pulse lasers) x 2	2	5
Systems	Collectors	50	25
	Scientific Operations Suite (16 personnel)	48	38.4
	Laboratory	8	2
	Library	4	4
	Biosphere	24	4.8
	Gaming Space	40	0.24
	Additional Airlocks x 2	4	0.4
Staterooms	Full Hangar (80 tons)		
	Standard x8	32	4
	Emergency Low Berths x 2	2	2
Software	Manoeuvre/0	-	-
	Jump Control/3	-	0.3
	Library	-	-
	Advanced Science (general)	-	30
Common Areas		256	25.6
Cargo		391	-

TOTAL: MCR 696.49



660

HULL POINTS

CREW

CAPTAIN, ASTROGATOR, PILOT, ENGINEERS X 6,
MAINTENANCE, STEWARDS X 2, GUNNERS X 11

RUNNING COSTS

MAINTENANCE COST
Cr58040/month

PURCHASE COST
MCr696.49

POWER REQUIREMENTS

300

MANOEUVRE
DRIVE

450

JUMP DRIVE

300

BASIC SHIP
SYSTEMS

6

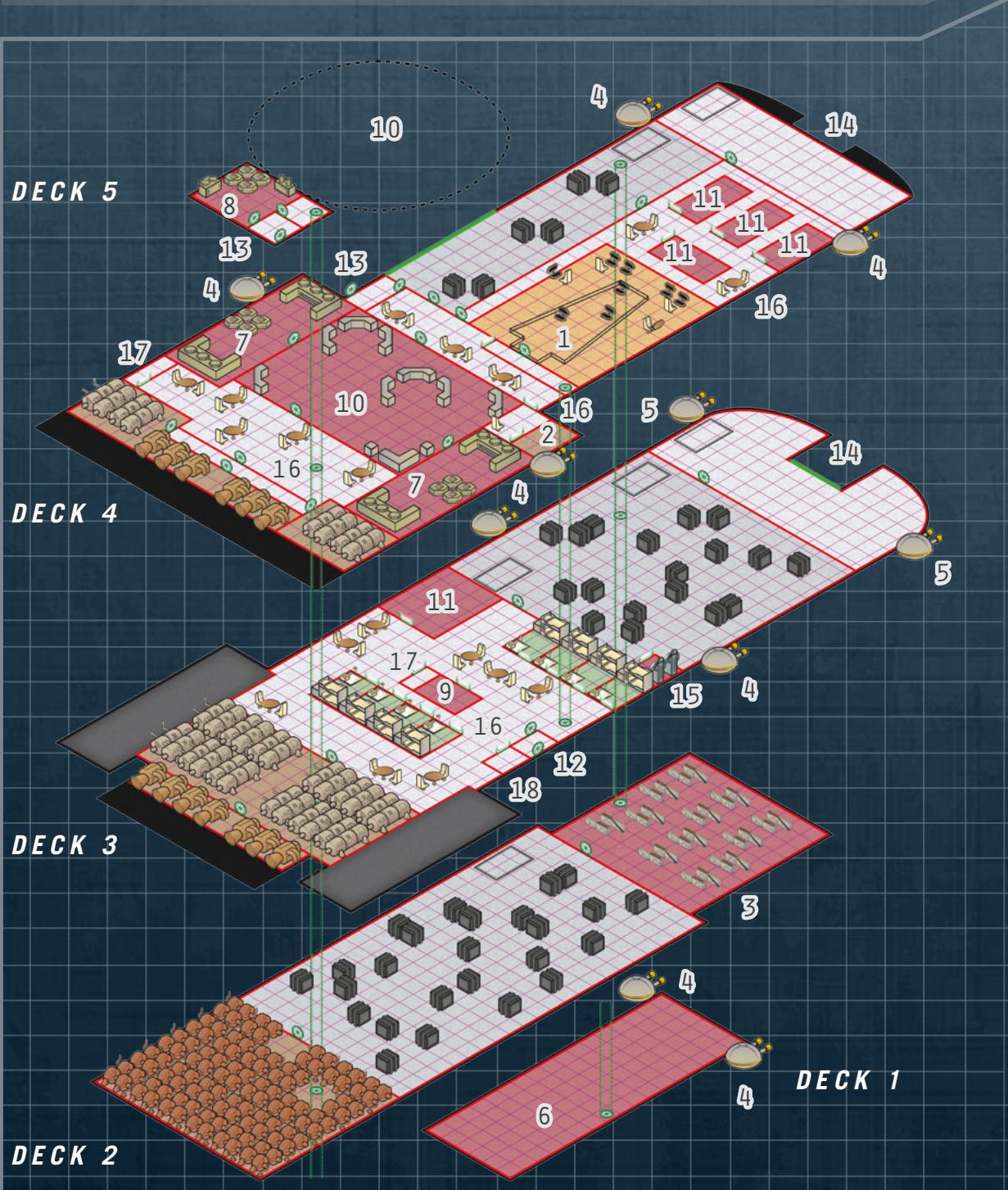
BIOSPHERE

SENSORS

The *Zarelinung* is something of an oddity. Its name comes from a Te-Zlodh (Darrian) word translating roughly as 'slow moving but it gets there vessel'. Only a handful were ever built, most for private clients who put their ships to a variety of uses. In concept, the *Zarelinung* is a luxurious scientific vessel intended for long-duration missions and a media-friendly science ship serving foundations and projects whose public face is important to funding. Equipment tends to be showy as much as functional, although the *Zarelinung* is more than capable of carrying out real scientific work.

The heart of the design is a collector-based jump system, which harvests exotic particles to power the jump drive rather than consuming fuel. The ship's range is thus limited only by powerplant endurance and shipboard stores.

The *Zarelinung* class has a well-equipped scientific suite as designed and can be configured to the client's wishes. It is armed for self-defence, mounting a small missile bay as a deterrent, while the hangar is intended to hold four launches but can accommodate any mix of small craft up to 80 tons.



1. BRIDGE & RAISED PLATFORM

2. SENSORS

3. SMALL MISSILE BAY

4. TURRET (SANDCASTERS)

5. TURRET (PULSE LASERS)

6. COLLECTORS

7. SCIENTIFIC OPERATIONS SUITE

8. LABORATORY

9. LIBRARY

10. BIOSPHERE

11. GAMING SPACE

12. AIR LOCK

13. ADDITIONAL AIR LOCK

14. HANGAR

15. LOW BERTHS

16. COMMON AREAS

17. FRESHER

18. SHIP'S LOCKER

DECKPLANS LEGEND

ISOMETRIC DECKPLAN KEY

	BUNK		HATCH		FUEL PROCESSOR
	FRESHER		Iris Valve (Wall)		POWER PLANT
	WORKSTATION		Iris Valve (Floor/Ceiling)		JUMP DRIVE
	G-CHAIR		INTERNAL WALL		MANOEUVRE DRIVE
	LOW BERTH		HULL		1.5M 3M
	CRATE				

ISOMETRIC FLOORPLAN

