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Science-Based Starships And Colonies (And Aliens!)
By Raymond Towers

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Introduction

I loved Space 1999. This was a science fiction TV show from the 1970s that ran for 2 seasons with a total of 24 episodes per season. I loved this series about the same as I loved Star Trek, The Original Series, from the mid-sixties, and this was a lot more than TV shows that came later in the eighties, such as Battlestar Galactica, Buck Rogers In The 25th Century and the original V series.

I think part of the draw was that the fantasy world in Space 1999 was only a couple of steps more advanced than contemporary technology was back then, more in the realm of plausible sci-fi than other franchises in line with the first Star Wars movie, which was full of alien races, medieval fantasy weapons such as light sabers, and giant Death Stars

the size of moons. The characters in Space 1999 were regular people in my eyes, back when I was in elementary and junior high watching the reruns of those shows. Martin Landau was usually cool and collected, but if his tantrum buttons were pushed he'd bark at his crew and often make decisions against the consensus. Barbara Bain was a silver-haired fox for me, and still is as I watch the old shows when I can find them on Youtube (Or on the Tubi app!). The show was filmed on a low budget, but I wasn't too worried about plastic models being used for spaceships and temporary scenery backdrops. I was more interested in whatever new concept would be presented, and how the crew would get out of trouble during the hour-long program.

As a tribute to this TV show that helped stoke my love for science fiction, I wanted to go back and watch the old episodes and gain inspiration from them. There was a problem! A lot of the science was inaccurate back then, and is downright ridiculous in today's world. Just look at the premise of the show: an explosion of nuclear waste causes Luna to be propelled out of orbit, and now Luna and the colony on it are hurtling through space with no hope of rescue and no way to remedy the situation. Moon Base Alpha gets obliterated every other episode, and they lose half of their Eagle ships whenever they have a dogfight in space, but miraculously everything is renewed in time for the next episode. There are no issues with maintaining a breathable environment, replenishing food, water, electricity, fuel for the ships, etc. I know, I know, some of this stuff has to necessarily be simplified for a TV program, such as alien races speaking English for the benefit of the audience, and the ability for the cast to walk around on exotic new worlds without wearing spacesuits.

I can accept some of that stretching of the imagination, and I do similar things myself depending on the writing project I'm working on. However, as a writer trying to present a plausible space environment and ensuing adventure to a reader, I have to make sure that most of my science is grounded on actual facts, and is reasonably extrapolated from what is known today. For those reasons, I'm doing research on the practicality of interstellar ships, space colonies of various types, and a few other related topics. Space 1999 will still be my inspiration, but the web of fantasy I weave my stories around will have a much better real-world grounding. The information I've gathered is credible, fairly practical and can be backed up by science.

I'm showing this from a general, semi-detailed perspective, so if any of these ideas interests you, you can do more research on your own. The math on some of this stuff is very complex, and too meticulous for the depth of my project. Also, I've left out some of the more fanciful concepts, such as Larry Niven's Ringworld idea, where a giant human habitat is constructed around an entire planet. That's really not feasible or practical, as it would take the nickel and iron content of a dozen worlds or more to create. The concepts I'm presenting are much closer to home and could be possible as working models within our lifetimes. Most of the concepts are within our reach with the science and technology we have today, and that will make for a more credible story for you and I to write.

Types Of Interstellar Ships

1. Methuselah ships - The crew on these ships has extremely long life spans and can survive the voyage from start to finish.

2. Sleeper ships - These ships have hibernation areas and a small, active skeleton crew.

3. Generation ships - These ships are designed with the ideas of multiple generations of families living and breeding on board. To prevent genetic stagnation and inbreeding problems, human egg and sperm cells can be frozen for measured durations before they begin to deteriorate, or DNA printing can add new / diversified genetic code onto existing DNA strands.

4. Seed ships - This concept is for a very small and heavily automated ship that carries seeds of life or advanced printing technology. Humans, animals, vegetation and terraforming would be done mechanically upon arrival at a destination. Machines or robots would raise humans once the initial set-up work has been done.

5. Data ships - Another very small ship, this one would carry vast amounts of data that could unpack itself upon arrival, by using local material.

Types Of Interstellar Propulsion

1. Nuclear fusion - At present, these ships are very expensive. Small, controlled (and potentially very dangerous) nuclear explosions would propel a ship forward to approx. 10 percent of light speed. Estimated costs for building this type of ship are around $350 billion dollars. The advantage is they could potentially move huge amounts of cargo, but they would use a tremendous amount of power materials and be difficult to speed up and slow down. A hybrid ship type named the Bussard Ramjet would suck space material in and use that for additional power. The Star Trek ship Enterprise design has twin Bussard Ramscoops on the ends of its wings.

2. Anti-Matter - I'm going to skip this idea, because we can't make anti-matter, and even if we could, we have no way to safely store it. Basically, anti-matter would provide huge propulsion for a ship.

3. Black hole - This theory is beyond me. I don't understand the physics of *safely* using a black hole's gravity pull to move a ship between stars. Next!

4. Light sails - This concept I really like. Solar panels made of ultra-thin graphene absorb light energy and use it to propel a ship forward. The shape of the sail might be a problem. The further away from a star, the slower the sail would move. Also, the shape of the sail would create drag on the non-solar side. The sail would end up becoming more of a parachute. Lasers or microwaves could boost the sail's velocity. 1463 Gigawatts of laser power would accelerate the light sail by 1 Gee. A laser may be needed at the destination to slow the sail down.

Interstellar Highways

In the traditional rocket fuel model, Tsiolkovsky's Rocket Equation tells us that when a rocket-based ship launches, 63% of its weight will be fuel. For a rocket-based ship to land or slow down, 86% of its weight must be fuel. That is the amount of fuel needed to achieve Exhaust Velocity. To propel a ship at twice Exhaust Velocity, the percentages increase to 86% at launch and 98% for slow-down. This is about 400 pounds of fuel for every 1 pound of cargo at 1 times Exhaust Velocity.

Shooting light photon lasers at a graphene sail is more cost effective, but there are problems with making sure the laser hits the sail at just the right angle and also when the laser and sail are too far apart from each other. The proposed thickness for a graphene sail would be 1 micrometer thick. A galactic GPS network will be necessary to keep things in alignment and for course correction. A sister laser at the destination could help slow the sail down. Additional lasers can be spaced out along the travel route.

Alternatives to photon lasers are charged particles aimed at magnetic sails and also solar neutrinos, if a new material were invented capable of reflecting them.

A sample sail ship could weight 10 million kilograms (10,000 pounds) and have the shape of a cone to lessen drag and deflect incoming objects. The amount of laser power needed to push this size ship is tremendous, comparable to the noonday sun shining over an entire continent. The laser can also be used as a particle accelerator and for communications.

50 relays per light year at 2000 light years of highway equals 100,000 total relays. These relays would use about a trillion kilograms of hydrogen fuel per day to power the lasers. There are projections that such a system could power a ship fast enough to reach relativistic speeds, but for the purpose of my writing project, I'll probably set a more practical cap of 10% of light speed.

Propulsion Notes

Newton's First Law - Objects only change speed if force is exerted on them. This will play an important part in my sci-fi project based on the Space 1999 TV series. In that scenario, Luna was wrenched off its orbit by exploding nuclear waste. The human colony on Luna had no way to slow the moon down, which made up the basic premise of the series; a runaway moon with people on it.

Asteroids could serve as way stations to replenish fuel supplies.

If a ship travels at 10% of light speed, one year on the ship equals 1 year and 2 days on Earth.

Advantages Of Space Habitats

1. Access To Solar Energy
2. Easier Trade - Trade from a space habitat to a planet would be easier than from one planet to another, due to less hassles entering and exiting planetary gravitational fields.
3. Space Manufacturing - A space habitat can become self-sufficient in producing food and water for its population. Raw materials can be acquired from asteroids to produce tradable goods. There is enough building material in our main asteroid belt to build enough habitats to equal the surface area of 3,000 Earths.
4. Zero-G Environment - For swimming, hang-gliding and flying airplanes!

Space Habitat Necessities

Oxygen can be obtained from lunar rocks. Nitrogen can be brought in and recycled, or extracted from comets and moons. Air can be recycled through gardens or hydroponics

food production. Catalytic burners can decompose industrial pollutants such as volatile oils, as seen in today's nuclear submarines. Cryogenic distillation can slowly remove tougher mercury vapor and noble gases that cannot be catalytically burned. After the distillation, carbon dioxide and water can go straight into agriculture. Nitrates, potassium and sodium in leftover ash can be recycled as fertilizer. Minerals such as iron, nickel and silicon can be purified and reused industrially.

Zero gravity weakens bones and muscles, and imbalances calcium and the immune system in humans. To counter this, a colony would have to rotate to simulate gravity. Most people are comfortable with a rotational radius of 500 meters at a rate of less than one revolution per minute. A small percentage will experience dizziness and vertigo.

The habitat could be shielded from cosmic rays by its outer structure and air. (I would also suggest a barrier of water, as it absorbs radiation, or a coat of regolith or other space dirt or rock to repel cosmic rays.) When it comes to heat, a space habitat is like a giant thermos bottle. Solar heat is absorbed from the outside and radiates toward the center. Convection or chilled coolant could help keep the population on the edges of the habitat comfortably cool. The outer surface must be able to withstand or avoid impacts from meteorites and cosmic dust. Large mirrors or periscopes could be used to direct sunlight into the habitat.

A good location for a space habitat is near Luna, for the access to raw materials and the proximity to a major trade market in Earth.

Types Of Rotating Habitats

An O'Neill Cylinder is 20 miles long and 5 miles wide, and made of steel. It has a total surface area of 314 square miles. This is roughly the size of Guam, Malta or Rhode Island. A Bishop's Ring can be larger, the size of continents, if a strong material is used, such as carbon nanotubes and graphene. McKendree Cylinders are huge at 10,000 km, or 6,200 miles, and can be linked together like a string of sausages.

Rotating habitats are extremely difficult to finance and build, as materials have to be moved from a terrestrial world into space. Care must be taken with heat dispersion and habitat size, or else some sections will be too warm and uncomfortable. Excess heat must radiate out into space. A rotating habitat is designed like a washing machine. That is, it has an outer shell that stays stationary, and an inner section that turns. You cannot see this habitat spinning in space, because the velocity would cause it to break apart.

The outer shielding super-structure can be reinforced by hydrogen and helium, which are both plentiful in space. This would be an effective barrier against cosmic radiation. Consider that higher Earth's atmosphere has 14 pounds per square inch of pressure, preventing most cosmic radiation from reaching the planet's surface.

The interior habitat doesn't have to be built flat. It can have dips and rises to simulate lakes and hills. A dedicated reactor suspended in the center of the cylindrical habitat can maintain universal lighting. One difficult effect to reproduce is a natural-looking blue sky. Perhaps an additional colored layer can be inserted between the light reactor and the population level. A lot more dirt will be needed to simulate a natural landscape and agriculture, but less if hydroponics are utilized to produce food.

Bernal Sphere - First proposed in 1929, this habitat is shaped in a hollow spherical shell. This was designed for a target population of 20,000 to 30,000 people. Updates to

this concept include Island One. This design has a diameter of 500 m (1600 feet) and spins are 1.9 RPM, enough to produce full Earth gravity at the equator. This is described as a long valley running along the equator, big enough for 10,000 people. It is an optimal size for air pressure and radiation shielding, and would be lit by angled mirrors. Island Two is larger at 1800 meters diameter, with an equator of 6.5 km (4 miles), and a good size for an industrial base.

Stanford Torus - This NASA design can house an estimated 10,000 to 140,000 people. The model for 10,000 people is 1.8 km (1.1 miles) wide and shaped like a doughnut. It rotates once per minute, creating 0.9 or 1.0g of artificial gravity. Spokes connect to a central hub with zero gravity, making it a good place for ship docking and some industry. The interior would appear as a river and valley with the ends curving upward. Areas in the ring would be dedicated to agriculture and housing.

Building materials would come from the moon or asteroid mining, and moved to the ring by a mass driver. The diameter of the tube is 130 m (430 feet). Six spokes linking to the hub would each have a diameter of 15 m (49 feet). The radiation shield would be composed of almost 2 meters (6 feet) of raw lunar soil.

O'Neill Cylinder - Proposed in the mid-1970s, this habitat consists of two separate cylinders, one within the other, spinning counter to each other to cancel out gyroscopic difficulties presented when aiming the habitat at the sun. The two cylinders are 8 km in diameter (5 miles), and up to 32 km long (20 miles). Each cylinder has six 'stripes' on it, running lengthwise. These stripes alternate as transparent windows and habitable land masses. A third ring (16 km, 10 miles in radius), would spin at a different speed to allow for farming. The industrial sector is located in the center of this ring, taking advantage of lesser gravity and benefiting some manufacturing processes. Building materials would come from the moon, shot out like a train or cannon from a mass driver.

To simulate gravity O'Neill's Cylinder would rotate 2 times per hour. People would not notice this unless they turn their heads or drop an object, which would fall a few centimeters from the expected spot. Air pressure would be half that found on Earth, to save on gases and allowing for thinner walls. Mirrors outside the windows would reflect sunlight into the habitat. The windows would not be designed as giant panes of glass, but as smaller units in case they get damaged. The movement of the cylinders can create momentum to turn the habitat 360 degrees, without the use of rockets and saving fuel.

Lunar Bases

The most important factor in setting up a lunar colony is WHY would you do it? Simply explaining this off as a research center, such as in the Space 1999 scenario, is not feasibly enough. The most valuable material found on Luna is Helium 3, but it simply isn't worth the trouble to set up a base and mine for that because of the vast amount of regolith that has to be sifted through to get at the Helium 3. Other abundant lunar material such as oxygen, silicon and nickel we already have plenty of.

Solar power is good for a moon base, as Luna's thinner atmosphere lets a lot more sunlight in. Vehicles running on solar energy would be ideal. Solar collectors built as towers would get more sun, as the horizon wouldn't obscure them. Polar bases would get sunlight longer than equatorial bases. Nuclear power is a good second choice.

Glass or clear surface domes are a bad choice for moon bases. This is because of the heavy amounts of solar and cosmic radiation that would normally be blocked off or filtered on Earth, but they won't be on Luna. A better choice would be an underground base, or a surface base covered with moon regolith with mirrors reflecting sunlight in.

Communication time between the moon and Earth would lag by 4 to 5 seconds. This would make for stunted conversations and clunky Earth people to Luna robot remote control.

Telescopes and giant lasers could be built bigger and will work more efficiently than on Earth.

Space Colony Notes

Dunbar's Number - This estimates the approximate number of people one individual needs around them to maintain healthy social and romantic relationships.

About 5 - very close friends
15 - 20 - good friends
35 - 50 - acquaintances
150 - 160 - total members in a tribe
Over 160 - additional recognizable people

A colony of 10,000 people is calculated to double every 25 years. It would take approx. 500 years for the initial colony to reach Earth's present population.

Dead Aliens

Wrap your head around this, which I tried to simplify a bit. If, in the last 10 billion years, 10% of stars spawned an intelligent civilization, and if each civilization is visible for an average of 10,000 years, then every 1 million stars would have 1 currently visible civilization. This area would be a circle of 400 light years in radius. That means that theoretically we would have at least one other intelligent, interstellar species, besides us, somewhere around us right now. In a sci-fi scenario, that would translate to one space-capable species every 400 light years.

Two good candidate solar systems for possible extinct alien species are 82 G Eridan and Delta Pavonis. Both stars are about 20 light years away from Earth, and are estimated to be at least 6 billion years old. The species on any life-supporting planets would have gone extinct hundreds of thousands or millions of years ago. There would be nothing left of their society except rubble, and no ruins or buried technology as seen in pop movies. A destroyed or collapsed atmosphere might cause some artifacts to erode slower. Artifacts might last longer on moons, unless meteor impacts have demolished them.

Arriving colonists would not be colonizing planets right away, as they would have mastered space habitats and interstellar, long duration travel by then. They won't jump off their ship immediately. A colonizing ship might first spot alien technology on a moon, and send probes in for a closer look. A manned exploration vessel would go in next. If any habitats, doors or walls are found, explorers will not try to enter them. They will use drills to make holes, keeping internal pressures intact, and send in devices with cameras attached to them.

Explorers might take the door apart for study on how it was constructed. They will not try to pressurize any structures so they can walk around without space suits, because this will cause oxygen to be present that would erode any sensitive artifacts. If the aliens from the moon base watched their home planet get destroyed due to war or disaster, they may have left a record of their culture behind, including mummified bodies and a collection of their accomplishments and knowledge. The last survivors might even leave a trail of clues to the bottom of a shaded crater, where colder temperatures can preserve bodies or other artifacts for a longer time than on the surface. It is even possible that DNA or other genetic material might be hidden there that would allow these people or their clones to be replicated.

Not every single living creature on an extinct planet might have perished. Life might still be found in the bottom of the oceans, or in deep cave systems.

As a general rule of thumb, the more advanced a civilization is, the faster its tech will degrade and vanish. Think about that! We're more likely to find cave paintings on an extinct alien planet than computer chips!

Improbability Issues

This topic strays away from the main purpose of the article. I thought it worthwhile to include it, as I will certainly delve into quantum jumping and multi-verse subplots in my fiction project.

Mechanistic Universe - Everything in the universe runs strictly on mathematical principles. There is no random chance or novelty, as the future is predetermined and can be predicted by math.

Copenhagen Interpretation - There is only one reality, and everything within the universe is in a constant state of flux. The future is random or novel until an observer witnesses it. (See the example of Shrodinger's Cat.) The fluctuation is going on at the atomic level.

Many Worlds Theory - In this theory, everything that can possibly happen does happen on an infinite number of worlds. (See the Butterfly Effect in Time Travel paradox speculation. Basically, this is where something minor you do today can affect people greatly in the far future.)

Pilot Wave Theory - This wasn't mentioned in the video I watched, but I thought it worthy of inclusion. In this theory, a ball is dropped into viscous liquid that has no friction, bounces an infinite number of times and creates new ripples with every bounce. These ripples intersect each other as seen in the Double Slit Experiment. They represent space-time and can be measured as a range or pattern. The uniqueness of Pilot Wave Theory, from my metaphysical perspective, is who initially drops the ball? Just like you need an observer to create the Double Slit Experiment by shooting photons through apertures, in Pilot Wave you need an initiator to start the process. None of the other theories proposed by scientists really address the idea of Intelligent Design.

Moving on; if you become Dr. Who and transport yourself to a location on another world, is the person who arrives at the destination truly you, or is it a collection of your possibly false memories? If a super 3D printer maps you down to the atomic level and reproduces you, is that really you? Can there be two of you at once, and is the You on a

different planet the same as the You on Earth? Isaac Arthur put together a very good and though-provoking analysis, which I will jot down below.

Dyson Dilemma Conditions

1. It is actually possible to build a Dyson Sphere, and doing so makes sense.

2. It is possible to engage in interstellar colonization.

3. No method of power generation exists which is vastly superior to stars, nor can matter and energy simply be summoned from nowhere for free.

4. Faster Than Light Travel, or to travel to other realities or dimensions, is either not possible or not incredibly easy.

5. Civilizations do not inevitably wipe themselves out.

6. Most civilizations will expand their population, territory and resources if they can comfortably do so.

Following these conditions, a civilization doesn't need to expand and colonize into space. Potentially, it can travel to other realities or dimensions, find a suitable new planet there with the right living conditions or resources, and simply take what it needs. If that's the case, theoretically we might be competing with other Earths that develop the same inter-dimensional travel methods for the best new planets out there.

Again, if you travel to another universe, it is your data or your mass? If your data is duplicated from empty space-matter, i.e. reassembly of atoms, that's not you. If it is your actual mass that travels from Point A to Point B, then you've just added mass and energy to another dimension, therefore increasing the size of the new universe and decreasing it from the one you've left behind. In Many Worlds Theory, your jumping from one place to the next could theoretically happen trillions of times, with only a small variance between your selves.

(See the story of John Titor, Time Traveler, for a Many Worlds Theory where similar worlds have variances between 3 and 5 percent. That also ties in with Quantum / Mandela Effect where some people, like myself, are noticing how the universe is constantly changing around them in all aspects.)

Isaac Arthur doesn't like Many Worlds Theory. I heard one physicist stating that nature would conserve its energy with temporary time-line splits, or short tributaries in a river of time, that would later join back up with the main body. That makes more sense to me, based on what I can see in Earth nature and biological or weather cycles. Nature does not simply waste its energy. From a metaphysical point of view, it also makes sense, as some people have very strange experiences that defy what is known in physics, events that cannot be replicated and are usually dismissed by academia, but which are very real for the person who went through them. Reality refuses to be categorized and defined by Science. In a Hologram Universe, Many Worlds and time-line splits are as possible as a person playing a video game, having their character die, and then resuming the game with a revived character. (If your video game character dies and is revived, is it really the same character, or a different one? Do you see what I'm saying now, about going to another planet and you still being you?)

Sources

Dead Aliens by Isaac Arthur (Youtube)
Infinite Improbability Issues by Isaac Arthur (Youtube)

Interstellar Colonization by Isaac Arthur (Youtube)
Interstellar Highways by Isaac Arthur (Youtube)
Megastructures 04 - Rotating Habitats by Isaac Arthur (Youtube)
Moon Base Concepts by Isaac Arthur (Youtube)
O'Neill Cylinder, article on Wikipedia
Space Habitats, article on Wikipedia
Stanford Torus, article on Wikipedia