EXPEDITION TO A STAR SYSTEM

Revision 1.1
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This is an evolving document that will have many updates.

Introduction

This document will examine many of the requirements and factors for an IMAGINED expedition in a large spacecraft to one of the nearest candidates for an earthlike planet orbiting a nearby star. The imagined back story is that approximately in the year 2057, one hundred years after the Sputnic launch, astrophysicists using a high technology space telescope have located a 20 km diameter asteroid that is due to crash into the earth 15 years hence. Noting a 20 km diameter asteroid having eight times the mass of the 10 km dinosaur killing asteroid 65 million years ago would cause the end of civilization, it has suddenly become time for humans to put aside their petty wars and religious differences and face up to how to build a huge spacecraft capable of moving a fragment of the earth's life forms to a new planet. The parallel to the Biblical story of Noah's Ark is not lost on the gatherings scientists and engineers who will be tasked to figure out how to launch a Hail Mary expedition to a distant star in less than 15 years.

Now it should be known (if not already) that stars are a long way from our solar system. Astronomical distances of stars in space are measured in units of a light-year. A light-year is how far light and radio waves travel through space in one year. The speed of light has been measured by scientists as 186324 miles per second. That distance is equivalent to approximately 7 and a half times around the earth, in one second. So what is a light-year? Multiply how far light can go in one second by scaling up to one year (Hint: multiply by 3600 to get an hour, the by 24 to get a day, and by 365.25 to get a year). Next comes the question, how long can a spacecraft take to go that far? Well, two things (at least) limit how fast a spacecraft launched from earth could go to travel across the light-year. One, there's only so much speed you can ever get from a chemical rocket engine without using an ion propulsion engine. Two, the rocket engine will run out of fuel and just coast along at that top speed. Here we will skip some math figuring out all those things about fuel and just work with a different method.

NASA has just announced that in November 2026 the Voyager 1 spacecraft will have traveled the distance of one light-day since it was launched to leave the solar system. One light-day in 49 years since launch. Multiply that distance by 365 to make one light-year, i.e. 49 time 365 days. That comes out to about 17900 years. So the fastest spacecraft for outer space visitation would take 17900 years to go one light-year in distance, compared to the human history since 17900 years ago, around 16000 BCE (roughly). So what were humans (homo sapiens) doing back then? Maybe they were hanging out in caves waiting for another 6000 years for the last ice age to end.

Well, there's another problem. There is not another star system only one light-year from us. The closest one is 4.3 light-years away (Proxima Centauri with a few planets) and known to be highly unlikely to be a place where a habitable earth-like planet would exist.

We will assume that in the year 2057 astronomers have identified such a planet, one that has all the markers for earthlike habitability ("Planet H"). The star is 11.2 lightyears from our solar system in the constellation Eridanus. The resulting travel time would be just 11.2 times the travel time for one light-year, or 200,000 years. (Now remember that homo sapiens has been around for maybe 300,000 years.)

So all we have to do is fly some humans to planet H in order to save humanity from extinction, taking 200,000 years to do it. There will be no second chance to get it right. Maybe this is a tough job? Well below we will expand to list the large number of the other problems that have to be solved along with the timing issues. The following topics will likely be reformatted as they expand.

Initial Sanity Checking

A trip lasting 200,000 years amounts to 5000 or so generations. Can the human gene pool that will exist inside the spacecraft carry on to support near zero evolution of home sapiens for all that time, assuming no other deleterious events? Cosmic particle radiation (to be further described) will have to be blocked because high energy particle radiation can cause genetic damage or mutations.
More on that follows below. Also, existing viruses and bacteria inside the spacecraft must be benign and continue to be benign over thousands of repetitive reproduction cycles. What are the chances for all of the above?

Through those generations all political and religious beliefs have to remain stable so that there will be no arguing about the “truth”.

There will be only one chance to visit one planet. Upon arrival, and before landing of the spacecraft, the chemical composition of the “soil” surface must be very similar to soil on earth in, say, the year 2040, include no elements dangerous to human life. Secondary requirements include compatible water supplies, atmospheric pressure and atmospheric composition (no objectionable level of hydrogen sulphide, for example). Life forms on the surface must be determined to be compatible with homo sapiens genetics and physical requirements. Arrival requires rocket descent to counteract spacecraft external surface heating, which requires in addition, a supply of useful rocket fuel and working descent computers that have never been used in 200,000 years and that have not accumulated any cosmic particle damage to any of the electronic circuitry. Because of the mass of the spacecraft being very large, there must be a means of descent of the landing parties and enough residual thruster fuel to perform many safe landings.

No known earthly chemical power sources will survive for 5000 generations. The only long term power source will need to be a nuclear reactor. No conceivable reactor power supply will contain enough spare fuel rods to continue running that long and there is no currently known way to reverse the nuclear reactions in order to always have enough fuel rods.

Worldwide, thousands upon thousands of currently educated physicists support the Standard Model of particle physics. In that Model there is no belief that gravity or any of the other three of the four basic forces can be fundamentally altered or reversed by intelligent homo sapiens. As part of that Model there are two groups of particles that exist. Particles with mass can never travel at the speed of light. Massless particles (such as photons, i.e. light) may only travel as the speed of light as determined by the local dielectric constant. There are physics equations that supply descriptions of what happens when massive particles are accelerated to extremely high velocities. And, such acceleration requires alteration of energy levels to such an extent that all known chemical rocket fuel reactions have a limit on how much thrust energy can be released. Thruster fuel energy is gone when used. The energy and fuel used will not be able to be retrieved and used again. There is and will be only existing known limits on those energy levels and so a rocket launch can only accelerate the mass of the rocket to some limited velocity before the fuel runs out. The spacecraft velocity achieved by thruster force will have a limit that is very much less than the speed of light.

So with all that bad news, the following discussions will carry on as if nothing is impossible. Also, the discussions will continue here even though already it should seem useless to continue on topics that would be overwhelmed by the effects of just waiting 200,000 years to get to the target. Hammering on the obvious is part of the point here.

Optimum number of travelers

1. Citizens of the modern world are used to living with many advantages of modern technology supporting all their daily activities. The spacecraft environment will need to support means to keep people of all ages as happy as possible. Living quarters should be better than living in an RV but with obvious space limitations because people will not be able to spread out to far. To wit:

- Absolutely necessary to create a long-term 1G gravity environment while keeping air pressure liveable (around 1000 millibars), air temperature around 23 degrees C, with air mixture controlled to match average human requirements for cleanliness, pollution, and anti-microorganism removal. The 1G environment requires a way to simulate gravity, which implies a rotating vehicle like a large wheel.

- Communications equipment providing television, telephone, Internet must not fail or degrade.

- Social media (and allow for evolution of that)

- Newspapers, books, sometimes audio media and theaters

- Medical facilities and staff (which involves continuous training over the generations)

- Places for worship, education, and sports

- Hobbies

- Day and night environment support (offices, living spaces, bathroom, shower, sustenance, cooking, exercise, play, sleeping) which must include odor control and other obvious accessories...

- Continue general life support to include all phases of birth, growth, adult life, aging, and death

- No means of external resupply for food

- Continuous operation without access to outside space and no useful outside illumination

- Outside particle radiation mediation

- HVAC equipment keeping the living quarters comfortable

- Clothing of all types to match the environment being lived in but also to satisfy emotions

- Utilities providing potable water, electricity, natural gas, all of which must not fail or degrade.

- 24/7/365 life fulfillment with day/night cycles (while traveling in permanent dark space)

2. All the above begins to set vehicle requirements.

- Reasonably comfortable launch and descent transfer vehicles

- Governmental authorities support and interaction (police, fire, services, schools, playgrounds)

- Systems for purchasing and financial control

- Disposal of trash and remains, including recycling life forms and trash, reuse of materials

- Sanitary conditions are maintained

- All supplies necessary to maintain the above

- Recollection of expendibles to include all liquids, gases, and solids inside the spacecraft

- Replacement/backfill of all expendibles using all necessary re-manufacturing steps including all the equipment and technologies necessary to make medicines, semiconductors, and so forth.

In order to continue the human race living in a long term spacecraft environment, there needs to be consideration of what is necessary from the list above to satisfy continuation of “daily” life for the long term. “Division of labor” requirements must fully cover all requirements for degree of skills and education and be satisfied with a calculated number of skilled individuals that can cover all the job requirements. That number will assume replacement/recycling with new staff over the years (e.g. human birth, aging, and death. (The implications of that latter bear on serious issues with life cycling and human emotion.)

3. People do not appreciate their life being bothered by any the following, so therefore none of the following conditions can be tolerated inside the spacecraft.

- Pests of any kind

- Disease

- Violence or war

- Significant deviation from a 1G gravitation environment

- Loud noises that will never stop

- Continuous darkness

- Deviation from what we like for “air” composition, pressure, temperature, smell, etc.

- “Weight” differing dramatically from the 1G environment on the ground.

4. With no complete analysis to be provided here, we propose 1000 “citizens” are required and that this number will naturally vary a little, with serious control by authorities, who are also citizens. Note that recent news reported an aircraft carrier to have 5000 people on board.

Optimum spacecraft shape and configuration

- Mass is a problem: the assumed 1000 citizens will require lots of “rooms”

- the 1G environment implies that the whole spacecraft is a large rotating wheel, similar to the sample shown in the movie *2001: A Space Odyssey* . People will live in the outer portion of the wheel with the 1G simulated gravity provided by centrifugal force.

- For the size and shape of this kind of spacecraft, there are at least two problems:

How to build and launch it (size of rocket engines, how to assemble, etc.).

Because a “rotating wheel” configuration has the “interesting” dynamics similar to a rotating bicycle wheel held on only one end of the axle, there is a large problem with precession due to any off-center mass. In the case of the aforementioned spacecraft, precession angular velocity and another effect, nutation, might increase with time unless controlled. (In this document no mathematical derivations will be included, including those of “relativistic” effects.) Any amount of precession will also make tracking alignment with the universe and the ultimate Noah 2.0 target very difficult (200,000 years is a long time to not lose sight of where the expedition is headed).

TO BE CONTINUED

Traveler life support issues
(to be continued)

On-board equipment and food
(to be continued)

Control of particle radiation damage
(to be continued)

Keeping track of the target (star movements, galactic rotation, etc.)

Revision list

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