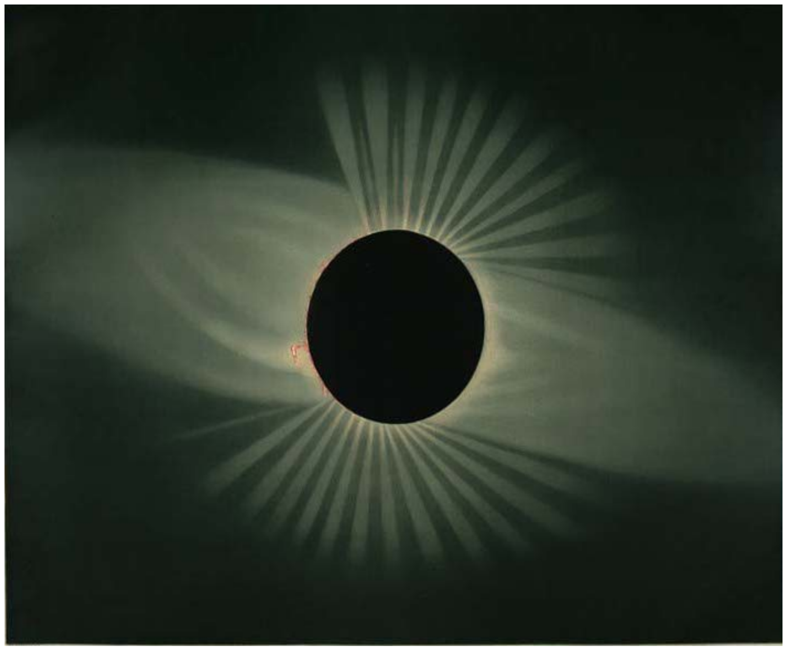
ECLIPSE
NEWSLETTER



The Eclipse Newsletter is for the amateur with an interest in Astronomy, Astrophysics, Cosmology, and related subjects with the intent of helping them develop and expand their knowledge.

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PLEASE SEND ALL PHOTOS, QUESTIONS AND REQUST FOR ARTICLES TO
pestrattonmcag@gmail.com

CONTENTS:

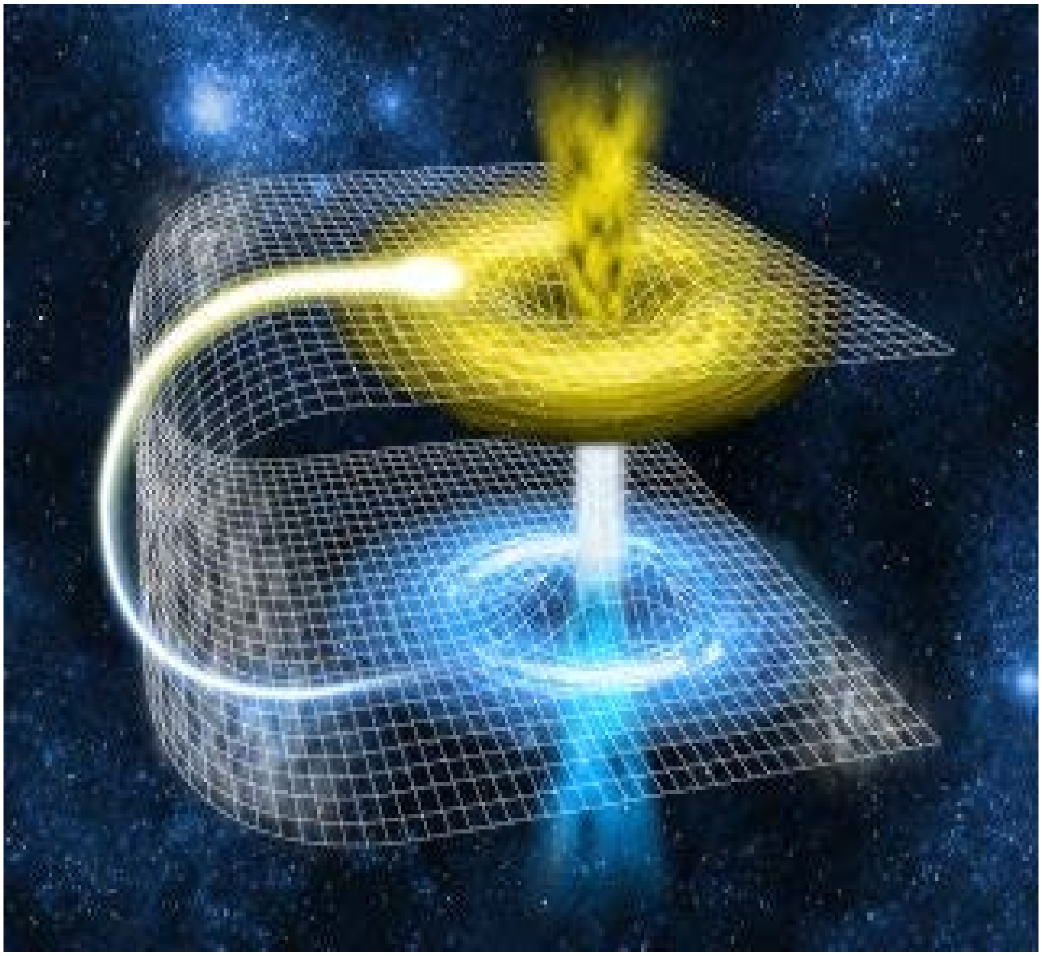
POSSIBLE METHODS OF INTERSTELLAR SPACE TRAVEL.

In the last issue, I cover topics of interstellar space travel but only one possible method of achieving it, the Alcubierre Warp Drive. In my opinion, this method has is the most likely to succeed. There are others but shall I say they belong in Star Wars movies or on Star Trek.

As a review, they include:

THE WORMHOLE THEORY

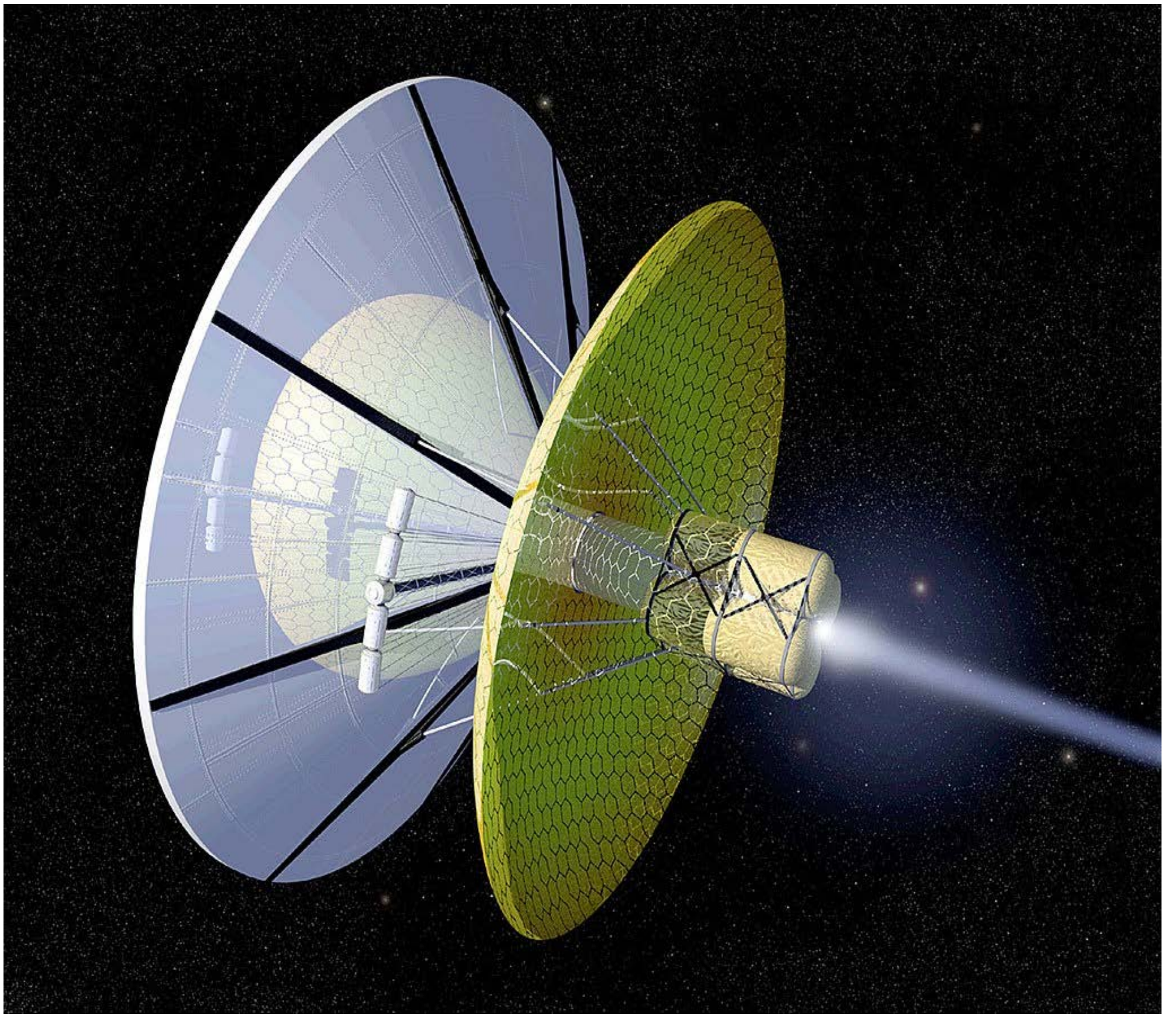
In 1935, Einstein and physicist Nathan Rosen used the theory of general relativity to elaborate on the idea, proposing the existence of "bridges" through space-time. These bridges connect two different points in space-time, theoretically creating a shortcut that could reduce travel time and distance. The shortcuts came to be called Einstein-Rosen bridges, or wormholes.



The illustration above demonstrates the Wormhole theory. The mesh area is time and space bent into a curve. The theory is as you enter the bent time and space at the yellow area and exit at the blue area, the distance is shorter than following a straight line.

There are different theories offered by those who study the possibility of Wormholes one being one being entering one could immediately kill you. If they exist, wormholes could very well connect two completely different space-times meaning the entry point might exist in a completely different era. That means traversing via wormhole comes with the risk of winding up in a different time in the universe's history.

BUSSARD RAMJET



The initial concept was based on nuclear fusion. Since the process of nuclear fission, the process of joining atoms to create energy, has yet to be accomplished, the idea of making energy from hydrogen. Using readily available hydrogen found all over the universe was adapted. A laser array in the solar system beams to a collector on a vehicle which uses something like a linear accelerator to produce thrust. This solves the fusion reactor

problem for the ramjet. There are limitations because of the attenuation (lessening in amount, force and magnitude) of beamed energy with distance.

Until now, I have offered methods of interstellar space travel based on going faster than the speed of light. Let's consider the alternative. Let's take our journey going as fast as we have gone to date.

THE GENERATIONAL SPACE SHIP.

It may look like the above vehicle or like this.

A generation ship, or generation starship, is a hypothetical type of interstellar ark starship that travels at sub-light speed.

Since such a ship might take centuries to thousands of years to reach even nearby stars, the original occupants of a generation ship would grow old and die, leaving their descendants to continue traveling.

The concept of a generation starship is a good example of how science and fiction influence each other. Many space scientists and engineers who contributed to the concept of a generation starship were also science fiction writers.

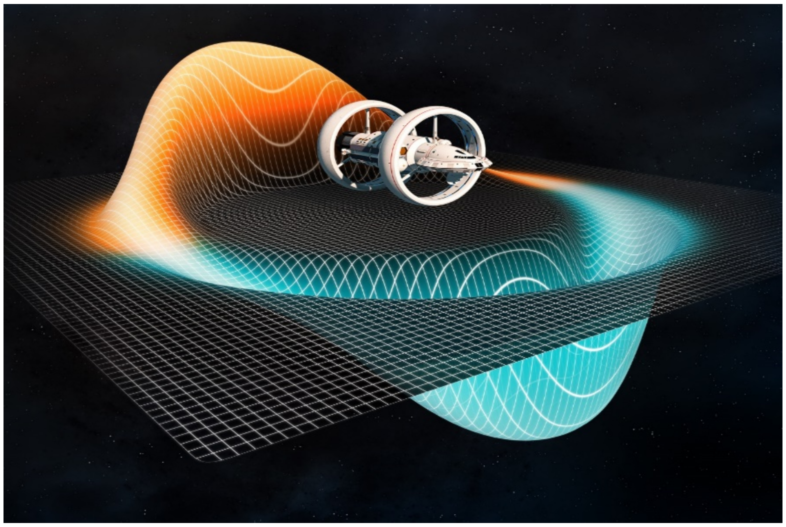
Rocket pioneer Robert H. Goddard was the first to write about long-duration interstellar journeys in his "The Ultimate Migration" (1918). In this he described the death of the Sun

and the necessity of an "interstellar ark". The crew would travel for centuries in suspended animation and be awakened when they reached another star system. Based on the information and 1918 technology, Goddard idea was to have the people sleep through the entire journey.

Where does Interstellar now stand?

Currently, only one method of Interstellar offers some hope.

The Alcubierre Warp Drive



I covered this method in the September – October Issue.

It offers possibilities but not yet probabilities. Where do we now turn?

It's certainly worth the effort to take a more serious look at

THE GENERATIONAL SPACE SHIP.

As you read the following, keep in mind that a Generational Space Ship does not need to be constantly under power. It only needs power when directional course changes are needed to keep it headed in the desired direction.

The whole idea of interstellar travel was created by fiction writers, but because it has many elements of good science in it, it is a very persuasive idea. It is an idea located smack in the middle of the 'gray area' between fantasy and reality, and this is what goads people on to try to imagine ways to make it a reality. One thing we do know is that it will be an expensive venture requiring an investment at the level of many percent of an entire planet's GDP.

By some estimates, the first interstellar voyage will cost many trillions of dollars, require decades to construct, and involve tens to hundreds of passengers and explorers. Assuming a project of this scope can even be sold to the bulk of humanity that will be left behind to pay the bills, how will the destination be selected? Will we just point the ship towards any star and commit these resources to a random journey and outcome, or will we know a LOT about where we are going before the fuel is loaded? Most of us will agree that the latter case for such an expensive 'one of' mission is more likely. By the way, let's not talk about the human Manifest Destiny to explore the unknown. Even Christopher Columbus knew his destination in detail (India!) and traveled within a very benign biosphere, free breathable atmosphere and comfortable gravity to get there in a few months.

So…where will we go?

Contrary to popular ideas, we will know our destination in great detail long before we leave our solar system. We will know whether the star has any planets, and we will know it has at least one planet in its habitable zone (HZ) where temperature would allow liquid water to exist. We will know if the planet has an atmosphere or not. We will know its mass and size, and perhaps more importantly, whether the planet has a biosphere. We will not invest perhaps trillions of dollars to study a barren Mars or Venus-like planet. All of these issues will be worked out by astronomical remote-sensing research at far lower cost than traveling there. If a nearby star does not have detectable planets, we will most certainly NOT mount a trillion-dollar mission to just 'go and see'!

The 10 nearest stars are: Proxima Centauri (4.24 lys), Alpha Centauri (4.36), Barnards Star (5.96), Luhman 16 (6.59), Wolf 359 (7.78), Lalande 21185 (8.29), Sirius (8.59), Luyten 726-8 (8.72), Ross 154 (9.68) and Ross 248 (10.32). This takes us out to a distance of just over 10 light years from Earth. The prospects for an interesting world to visit are not good.

Proxima Centauri has one recently detected Earth-sized planet orbiting inside its HZ, making it a Venus-like world of no interest. Alpha Centauri B has one unverified Earth-sized planet, but not in the star's liquid-water HZ. It orbits ten times closer than Mercury. There are no planets larger than Neptune orbiting this star closer than our planet Jupiter. Barnards Star has a no known planets, but a Jupiter-sized planet inside the orbit of Mars is exluded, so this is still a viable star for future searches for terrestrial planets in the star's HZ. Luhman 16 is a binary system whose members orbit each other every 25 years at a distance of 3 AU. A possible companion orbits one of these stars every month at a distance

closer than Mercury. As for the stars Wolf 359, Lalande 21185, Sirius, Luyten 726-8, Ross 154 and Ross 248, there have been searches for Jupiter-sized companions around these stars, but none have ever been claimed.

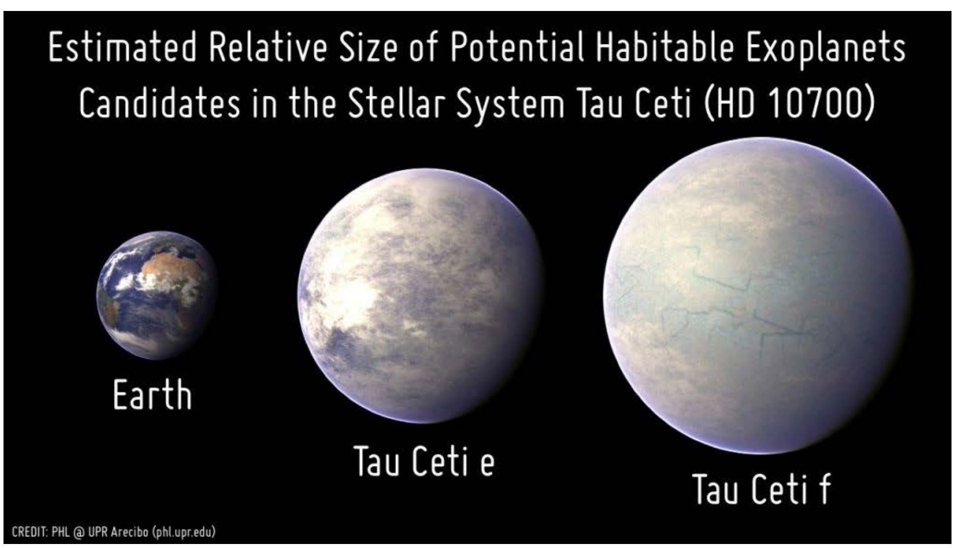
So, our nearest stars within 10 light years are pretty bleak as destinations for expensive missions. There is no solid evidence for Earth-sized planets orbiting within the HZs of any of them. These would not be plausible targets because there is so little return on the high cost of getting there, even though that cost in terms of travel time is the smallest of all stars in our neighborhood. This also sets a scale for the technology required. It is not enough to visit our nearest star, but we have to trudge 2 to 3 times farther before we can find better destinations.

Better Destinations.
Let's take a bigger step. Out to a distance of 16 light years there are 56 normal stars, which include some promising candidate targets.

Epsilon Eridani (10.52 ly) has one known giant planet outside its HZ. It also has two asteroid belts: one at about three times Earth's distance from our sun (3 AU) and one at about 20 AU. No one would ever risk a priceless mission by sending it to a sparse planetary system with deadly asteroid belts and no HZ candidates!

Groombridge 34 (11.62 ly) –The only suspected planet has a mass of more than five Earths. No mission would be sent to such a planet for which an atmosphere would probably be crushingly dense and probably Jupiter-like even if it was in its HZ.

Epsilon Indi (11.82 ly) – has a possible Jupiter-sized planet with a period of more than 20 years. No known smaller planets.



Artist rendering of the planets Tau Ceti e and f (Credit: PHL @ UPR Arecibo)

Tau Ceti (11.88 ly) probably has five planets between two and six times Earth's mass, and with periods from 14 to 640 days. Planet Tau Ceti f is colder than Mars and is at the outer limit to the star's HZ. Its atmosphere might be dense enough for greenhouse heating, so the world might be habitable after all. But this is guesswork not certainty.

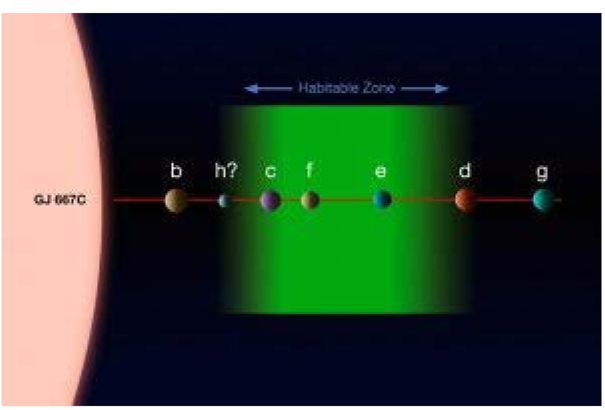
Kapteyn's Star (12.77 ly) – It has two planets, Kapteyn b and Kapteyn c, that are 5 to 8 times the mass of Earth. Kapteyn b has a period of 120 days and is a potentially habitable planet estimated to be 11 billion years old. Again, a massive planet whose surface you could never visit, so what is the point of the interstellar expedition?

Gliese 876 (15.2 ly) has four planets. All have more than 6 times the mass of Earth and orbit closer than the planet Mercury. Gliese 876 c is a giant planet like Jupiter in the star's habitable zone. Would you bet the entire mission that 876c has habitable 'Galilean moons' like our Jupiter? This would be an unacceptable shot in the dark, though a tantalizing one.

So, out to 15 light years we have some interesting prospects but no confirmed Earth-sized planet in its star's HZ whose surface you could actually visit. We also have no solid data on the atmospheres of any of these worlds. None of these candidates seem worth investing the resources of a trillion-dollar mission to reach and study. We can study them all from Earth at far less cost.

Best Destinations.
If we take an even bigger step and consider stars closer than 50 light years, we have a sample of potentially 2000 stars but not all of them have been discovered and cataloged. About 130 are bright enough to be seen with the naked eye. The majority are dim and cool red dwarf stars, which are still good candidates for planetary systems. In this sample we encounter among the known planetary candidates several that would be intriguing targets:

61 Virginis (11.41 ly) – It has three planets with masses between 5 and 25 times our Earth, crowded inside the orbit of Venus. The asteroidal debris disk has at least 10 times as many comets as our solar system. There are no detected planets more massive than Saturn within 6 AU. An Earth-mass planet in the star's habitable zone remains a possibility, but the asteroid belts make this an unacceptable high risk target.



Gliese 667 planets (Credit: ESO)

Gliese 667 (23.2 ly) –As many as seven planets may orbit this star, but have not been confirmed. All have masses between that of Earth and Uranus. All but one are huddled inside the orbit of Mercury. Planets c and d are in the star's HZ and are at least 3 times the mass of Earth. Their hypothetical moons may be habitable.

55 Cancri (40.3 ly)- All five planets orbiting this star are more than five times the mass of Earth. Only 55 Cancri e is located at the inner edge of the star's HZ and its hypothetical moons could be habitable. More planets are possible within the stable zone between 0.9 to 3.8 AU if their orbits are circular. This is a system we still need to study.

HD 69830 (40.7 ly) has a debris disk produced by an asteroid belt twenty times more massive than that in our own solar system. Three detected planets have masses between 10 to 18 times that of Earth. The debris disk makes this a high-risk prospect even if there are habitable moons.

HD 40307 (41.8 ly) Five of the six planets orbit very close to the star inside the orbit of Mercury. The fifth planet orbits at a distance similar to Venus and is in the system's habitable zone. The planets range in mass from three to ten times Earth. Again, is a planet in its HZ with a mass too great for a direct human visit a good candidate? I don't think so.

Upsilon Andromedae (44.25 ly) The two outer planets are in orbits more elliptical than any of the planets in the Solar System. Upsilon Andromedae d is in the system's habitable zone, has three times the mass of Jupiter, with huge temperature swings. Its hypothetical moons may be habitable.

47 Ursa Majoris (45.9 ly) The only known planet 47 Ursae Majoris b is more than twice the mass of Jupiter and orbits between Mars and Jupiter. The inner part of the habitable zone could host a terrestrial planet in a stable orbit. None yet detected.

There are still many more stars in this sample to detect, catalog and study so it is possible that a Goldilocks Planet could be found eventually. But we are now looking at destinations more than 20 light years away at a minimum. This will considerably increase the cost and duration of any interstellar mission by factors of five to ten times a simple jaunt to Alpha Centauri.

Other issues.

Would you really consider a planet with two to five times Earth's gravity to be a candidate? Who would want to live under that crushing weight? Many of the candidates we have found so far are massive Earth's that few colonists would consider standing upon. Their surfaces are also technologically expensive to get to and leave. But perhaps these worlds might have moons with more comfortable gravities? There is always hope, but will that be enough to risk a multi-trillion-dollar mission?

There is also the issue of atmosphere. None of the candidate planets we have discussed transit their stars, so we cannot detect their atmospheres and figure out if they have atmospheres and if their trace gases would be lethal. The perfect destination worth the expense of a trip would have a breathable atmosphere with oxygen. Since free oxygen is only produced by living systems, our target planet would have a biosphere. We can only hope that as the surveys of the nearby stars continue, we will find one of these. But statistics suggests we will have to search much farther than 50 light years and a few thousand stars before we encounter one. That makes the interstellar voyage even more costly, not by factors of five and ten, but potentially hundreds of times. But if the trip were to a world with a known biosphere, THAT might be worth the effort, but possibly nothing less than this would be worth the cost, the risk, and the scientific return.

So the bottom line is that the only interstellar destination worth the expense is either one in which colonists can live comfortably on the planet with a lethal atmosphere, hermetically sealed under a dome, or a similar planet with a breathable oxygen atmosphere and a biosphere. Statistically, we will find far more examples of the first kind of target than the second. But in the majority of the cases, we will not be able to detect the atmosphere of an Earth-sized world in its habitable zone before we start the trip, and will have to 'guess' whether it even has an atmosphere at all!

The enormous cost of an interstellar trip to a target ten or even hundreds of light years away will preclude any guess work about what we will find when we get there. Consider this: Investing $100 billion to travel to Mars, a low-risk planet we thoroughly understand in detail, is still considered a political pipe dream even with existing technology! What would we call a trip that costs perhaps 100 times as much?

By the way. If we travel 50 Ly away, we are still in the immediate neighborhood of our star.

Credit: Stens Space Blog

HOW ARE PLANETS MADE?

A cloud collapses to form a star and disk. Planets form from this disk. According to our current understanding, a star and its planets form out of a collapsing cloud of dust and gas within a larger cloud called a nebula.

Why are the terrestrial planets closer to the sun?
The planets in our Solar System formed from the solar nebula – the disc of gas left over from the formation of our Sun. ... The gas giants on the other hand, formed far enough away from the Sun that the temperature was cool enough for these volatile gases to condense, and form these huge, less dense planets.

WHAT CAUSES PLANETS TO FORM?

What is the process of planet formation?
Planetary Formation. Planetary Formation is thought to occur via an accretion process in a disk of gas and dust that settles into orbit about the host star. Small grains or ices, as they orbit, collide at low relative velocity and stick.

The various planets are thought to have formed from the solar nebula, the disc-shaped cloud of gas and dust left over from the Sun's formation. The currently accepted method by which the planets formed is accretion, in which the planets began as dust grains in orbit around the central protostar.

How do planets form from planetesimals?
A widely accepted theory of planet formation, the so-called planetesimal hypotheses, the Chamberlin–Moulton planetesimal hypothesis and that of Viktor Safronov, states that planets form out of cosmic dust grains that collide and stick to form larger and larger bodies. ... This is how planetesimals are often defined.