Seeding the Milky Way with life using 'Genesis missions'

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A new instrument called the Search for Extra-Terrestrial Genomes (STEG) is being developed to find evidence of life on other worlds. Credit: NASA/Jenny Mottor

When exploring other planets and celestial bodies, NASA missions are required to abide by the practice known as "planetary protection." This practice states that measures must be taken during the designing of a mission to ensure that biological contamination of both the planet/body being explored and Earth (in the case of sample-return missions) are prevented.

Looking to the future, there is the question of whether or not this same practice will be extended to extra-solar planets. If so, it would conflict with proposals to "seed" other worlds with microbial life to kick-start the evolutionary process. To address this, Dr. Claudius Gros of Goethe University's Institute for Theoretical Physics recently published a paper that looks at planetary protection and makes the case for "Genesis-type" missions.

The paper, titled "Why planetary and exoplanetary protection differ: The case of long duration Genesis missions to habitable but sterile M-dwarf oxygen planets," recently appeared online and is due for publication by the journal *Acta Astronautica*. As the founder of Project Genesis, Gros addresses the ethical issue of seeding extrasolar planets and argues how and why planetary protection may not apply in these cases.

Put simply, the Genesis Project aims at sending spacecraft with gene factories or cryogenic pods could be used to distribute microbial life to "transiently habitable exoplanets – i.e. planets capable of supporting life, but not likely to give rise to it on their own. As Gros previously explained to Universe Today:

"The purpose of the Genesis project is to offer terrestrial life alternative evolutionary pathways on those exoplanets that are potentially habitable but yet lifeless… If you had good conditions, simple life can develop very fast, but complex life will have a hard time. At least on Earth, it took a very long time for complex life to arrive. The Cambrian

Explosion only happened about 500 million years ago, roughly 4 billion years after Earth was formed. If we give planets the opportunity to fast forward evolution, we can give them the chance to have their own Cambrian Explosions."

The purpose of a Genesis-type mission would therefore be to offer extra-solar planets an evolutionary short-cut, skipping the billions of years necessary for the basic life forms to evolve and moving directly to the point where complex organisms begin to diversify. This would be especially helpful on planets where life could thrive, but not emerge on its own.

"There is plenty of 'real estate' out in the galaxy, planets where life could thrive, but most probably isn't yet." Gros recently shared via email. "A Genesis mission would bring advanced uni-cellular organisms (eukaryotes) to these planets."

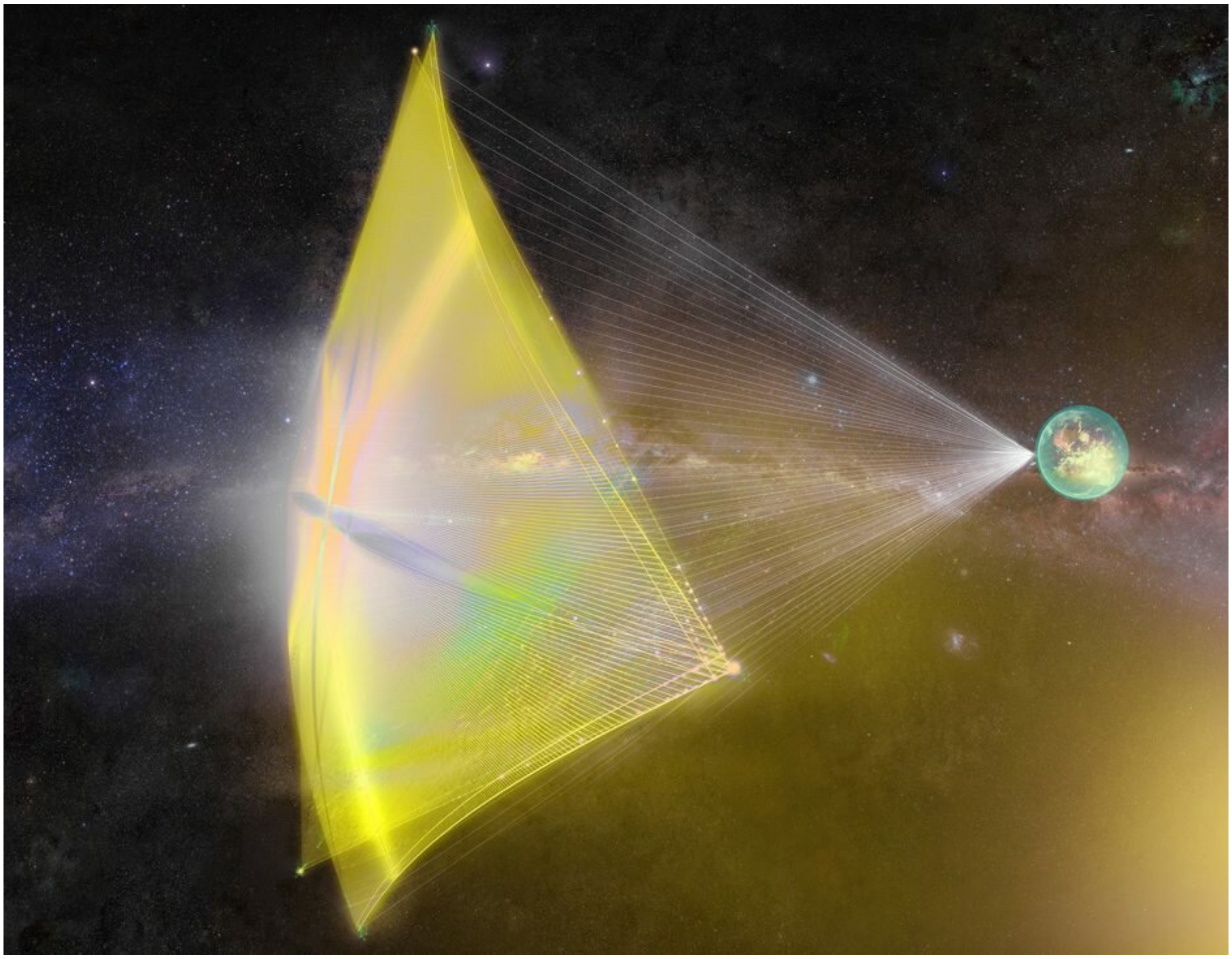
Addressing the issue of how such missions could violate the practice of planetary protection, Gros offers two counter-arguments in his paper. First, he argues that scientific interest is the main reason for protecting possible lifeforms on solar system bodies. However, this rational becomes invalid because of the extended duration that missions to extrasolar planets entail.

Simply put, even when we consider interstellar missions to the nearest star systems (ex. Alpha Centauri, which is 4.25 light years away) time is the key limiting factor. Using existing technology, a mission to another star system could take anywhere from 1000 to 81,000 years. At present, the only proposed method for reaching another star within a reasonable timeframe is the directed energy launch system.

In this approach, lasers are used to accelerate a light sail to relativistic speeds (a fraction of the speed of light), a good example of which is the proposed Breakthrough Starshot concept. As part of Breakthough Initiative's goal of achieving interstellar spaceflight, finding habitable worlds (and possibly intelligent life), Starshot would involve a light sail and nanocraft being accelerated by lasers to speeds of up to 60,000 km/s (37,282 mps) – or 20 percent the speed of light.

Based on a previous study conducted by Gros (and one by researchers from the Max Planck Institute for solar system Research), such a system could also be paired with a magnetic sail to slow it down as it reached its destination. As Gros explained:

"Directed energy launch system deliver the energy an interstellar craft needs to accelerate via concentrated laser beams. Conventional rockets, on the other hand, need to carry and to accelerate their own fuel. Even though it is difficult to accelerate an interstellar craft, at launch, it is even much more demanding to decelerate at arrival. A magnetic field created by a current in a superconductor does not need energy for its upkeep. It will reflect the interstellar protons, slowing such the craft."



Project Starshot, an initiative sponsored by the Breakthrough Foundation, is intended to be humanity's first interstellar voyage. Credit: breakthroughinitiatives.org

All of this makes directed-energy propulsion especially attractive as far as Genesis-type missions go (and vise versa). In addition to taking far less time to reach another star system than a crewed [mission](#) (i.e. a generation ship, or where passengers are in cryogenic suspension), the goal of introducing life to worlds that would not otherwise have it would make the cost and travel time worthwhile.

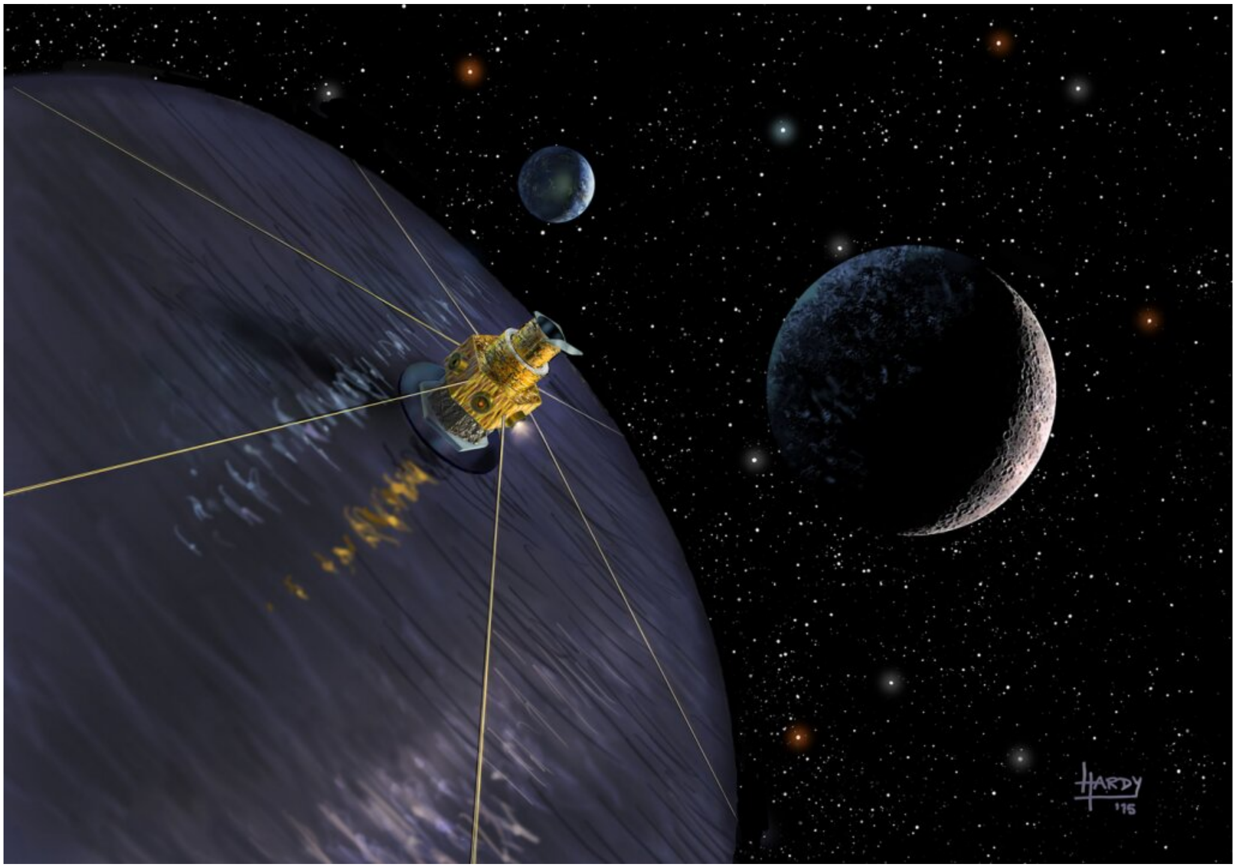
Gros also points to the fact that the presence of primordial oxygen may actually prevent life from emerging on exoplanets that orbit M-type (red dwarf) stars. Ordinarily considered a sign of potential habitability (aka. a biomarker), recent research has shown that the presence of atmospheric oxygen does not necessarily point the way to life.

In short, oxygen gas is necessary for the existence of complex life (as we know it) and its presence in Earth's atmosphere is the result of photosynthetic organisms (such as cyanobacteria and plants). However, on planets orbiting M-type stars, it may be the result of chemical disassociation, where radiation from the parent star has turned the planet's water into hydrogen (which escapes into space) and atmospheric oxygen.

At the same time, Gros points to the possibility that primordial oxygen could be a barrier to prebiotic conditions. While the conditions under which life emerged on Earth are still not entirely understood, it is believed that the first organisms emerged in "microstructured chemo-physical reaction environments driven by a sustained energy source" (such as alkaline hydrothermal vents).

In other words, life on Earth is believed to have emerged in conditions that would be toxic for most lifeforms today. It was only through an evolutionary process that took billions of years that complex life (which depends on oxygen gas to survive) could emerge. Other factors, such as a planet's orbit, its geological history, or that nature of its parent star, could also contribute to planets being "transiently habitable."

What this means, in terms of Earth-like extra-solar planets that orbit M-type stars, is that planetary protection would not necessarily apply. If there is no indigenous life to protect, and the odds of it emerging are not good, then humanity would helping life to emerge locally, and not hindering it. As Gros explained:



Artist’s impression of the Dragonfly spacecraft concept. Credit: David A Hardy (2015)

"Mars was transiently habitable, having clement conditions early on, but not now. Others may be habitable for a 2 or 3 Billion years, a time span that would not be enough for plants and animals to evolve indigenously. If life never emerges on a planet, it will remain sterile forever, even if it could support life. Oxygen is likely to preempt life emerging in the first place, being toxic to the chemical reaction cycles that are the precursors of life."

It is a concept that has been explored a length in science fiction: an advanced species plants the seeds of life on another planet, millions of years pass, and sentient life results! In fact, there are those who believe this is how life began on Earth – the Ancient Astronauts theory (which is pure speculation) – and by doing this ourselves on other planets, we would be carrying on this tradition of "directed panspermia."

In the end, the purpose behind the practice of planetary protection is obvious. If life emerged beyond Earth, then it is distinct and deserves a chance to thrive without interference from humans or invasive Earth organisms. The same holds true for life on Earth, which could be disrupted by alien organisms brought back by sample-return or exploratory missions.

But in the event that terrestrial planets orbiting the most common star in the galaxy are not a likely to place to find life (as recent research is suggesting), then transporting terrestrial organisms to these planets might actually be a good idea. If humanity is alone in the Universe, then spreading terrestrial organisms this way would be in the service of life.

And if, though it is a farfetched possibility, life on Earth is the result of directed panspermia, then it could be argued that humanity has a duty to seed the cosmos with life. While the payoff would not be immediate, the knowledge that we are giving life a shot on worlds where it might not otherwise exist is arguably a worthwhile investment.

Invariably, the issues of extra-terrestrial life and planetary exploration is a controversial one, and one that we are not likely to resolve anytime soon. One thing is for sure though: as our efforts to explore the solar system and galaxy continue, it is an issue that we cannot avoid.

More information: Why planetary and exoplanetary protection differ: The case of long duration Genesis missions to habitable but sterile M-dwarf oxygen planets. arxiv.org/pdf/1901.02286.pdf

Source: Universe Today