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WE CAN SPREAD OUR GENETIC MATERIAL

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Abstract. Despite our inability to send humans to the stars we still can send our Earth genetic material toward them, with small chance it will reach exoplanets around them. Our chance is embedding interstellar objects (ISO) which constantly trespass our Solar system with samples of organisms which can withstand long cry-preservation. New researches in biology return promising results. If the number density estimates based on the discovery of two ISOs are even approximately correct, there should be a number of ISO in the solar system at any one time. Future sky surveys should start finding a regular stream of 1I-type ISOs. 2I-type interstellar comets appear to be much rarer, and will probably be a decadal phenomena. A long term program to find and visit ISOs can start now with existing technology. Recently it is demonstrated that a mission to $1I/$'Oumuamua would be feasible, even without Solar Oberth Maneuver, and could be used to explore ISOs. New technology and new instruments will be required to best find passing ISOs, and also crucial development of technology for safely embedding. We will disscuse chance of life samples to survive flight to other stellar system.

1. INTRODUCTION

We discuss conceptual our plan to contribute to interstellar panspermia. We propose to use interstellar objects passing through Solar System to send biological samples to extrasolar systems. However, it was found recently (Madhusoodanan 2014; Smith et al. 2017) that some microorganisms may be unaffected by protective measures practiced in spacecraft assembly clean room facilities. That way we are already engaged in unintended interplanetary panspermia. In addition, Shober et al. 2022, claim that we are not isolated from interstellar space and that life forms can be transferred to other solar systems (Siraj & Loeb, 2020).

2. PANSPERMIA

Our studies of the universe suggest that the universe is not hospitable for life as we know. We are confident that life is existing on some other planets in our Galaxy. We just do not know if we will ever be fortunate to prove it. We simple think we can spread our genetic code using existing technology. Most suitable life form to spread is the genetic code of bacterial spores, which allows bacteria to remain in a dormant state in the absence of nutrients. In light of panspermia, the important question is if bacterial spores could survive in space. In following, we will briefly point to some of experiments which proved that life samples can really survive flight to exoplanets.

3. RADIATION PROTECTION

The biggest problem for the interstellar panspermia is our inability to accurately aim space probes to extrasolar systems (Bailer-Jones & Farnocchia 2019). We do not have enough knowledge of future positions of nearby stars even with much improved stellar movements data. Also the interstellar space probe acceleration complites in our Solar system and we do not have opportunity for midcourse directions adjustments. Our present radioisotope thermoelectric generators with ^{241}Am are not enough to support mission longer than 10000 years (Bennett 2006). For example, microbial payloads launched by solar sails (more conventional than proposed by (Heller & Hippke 2017) at speeds up to 0.000234 c (70,000 m/s) (Liewer et al. 2000) would reach targets at 20 light-years or about 85 thousand years. Tiniest errors in detection of stars movement can make huge difference of the final position over that period of time. That means that we need to spread fleets of microbial capsules to stars, where some of them may land on planets or be captured by asteroids and comets and later delivered to planets. These microbial capsules cannot be protected from galactic radiation for such a extended period. In addition, spraying possible extraterrestrial civilization with dead biological samples can be considered hostile. One very important aspects of embedded life sample on the ISO is that it will have bigger radiation protection than same sample sent on an artificial space probe. Embedding capsules with biological samples inside interstellar objects (asteroid or comet) would increase protection from galactic radiation enough to endure long travel to the stars (Valtonen et al. 2009). Besides testing captured ISO in our Solar system further tests of hypervelocity impacts and biological samples should be done (Burchell 2001). It is thus important to test and develop protecting shells that biological sample situated inside could survive hypervelocity entry within ISO (Deller et al. 2016). The other option is to use outgoing ISO plan reported in (Heina et al. 2017). It is also important for successful entry in exoplanet atmosphere.

4. LAUNCHING OF THE PANSPERMIA PAYLOAD

'1*I*/'Oumuamua was the first interstellar object (ISO) detected passing through the Solar System. It was discovered by Robert Weryk (Meech, Weryk, Micheli et al 2017) using the Pan-STARRS telescope at Haleakala Observatory, Hawaii, on 19 October 2017, 40 days after it passed its closest point to the Sun. When first observed, it travelled about 33,000,000 km from Earth, heading away from the Sun, it will leave the Solar System. It will take roughly 20,000 years to cross the Solar System before exiting and continuing to travel through interstellar space.

Mission proposed by Seligman & Laughlin 2018, will be planned in the vicinity of such an object. Most plausible will be to repeat the Deep Impact mission (A'Hearn et al, 2005). The kinetic energy imparted via a high-impact velocity collision with an incoming ISO would excavate a substantial plume of subsurface debris. As in Deep Impact mission the content of this ejected material should be examined spectroscopically by a flyby spacecraft, permitting an ISO's true composition to be better assessed. Such mission strategy requires far less propulsive energy than velocity-matching or sample-return missions, and requires only that the ISO trajectory is determined in sufficient time for an interceptor to be sent. With the detection capabilities of the

Panoramic Survey Telescope and Rapid Response System (Pan-STARRS) project, and soon, the Large-Scale Synoptic Survey Telescope (LSST) project, they (Engelhardt et al. 2017; Seligman & Laughlin 2018) can estimate the waiting time of an order of 10 years between favorable mission opportunities. Please note that we will not be able to use all of ISO because we will not be able to make intercept trajectory.

In addition to this, we propose, sending biological samples on an ISO which pass through Solar system. We propose preparing biological samples with enhanced sturdiness against exposure to vacuum and low temperature conditions inside hard protection shell. These shells should then be embedded inside ISO by firing from nearby space probe after the first probe that would be spectroscopically monitored.

Because of the transient nature of Interstellar Objects (ISO), as discussed by Seligman and Laughlin in 2018, there is a compelling need to have both the rocket and experimental payload meticulously prepared and on standby, ready for a mission to intercept an ISO. It is reasonable to assume that ISOs possess asteroidal density characteristics, akin to $1I$/'Oumuamua's, which was estimated to have a density falling within the range of 1500 to 2800 kg $m^{-}3$, according to McNeill, Trilling, and Mommert in 2018. However, subsequent research papers have introduced questions regarding 'Oumuamua's density, as articulated by Micheli et al. in 2018. They argue that "the magnitude of the observed acceleration implies an unreasonably low bulk density, roughly three to four orders of magnitude below the typical density of Solar System asteroids of comparable size."

Remarkably, we have gained substantial insights into the nature of the first interstellar object, thanks to the work of Seligman et al in 2021 and Bergner & Seligman in 2023. First they discused acceleration from CO afther that acceleration from radiolytically produced H2 in H2O ice. Additional information about the potential structure of ISOs can be gleaned by studying interstellar objects captured within the Solar System, as proposed by Siraj & Loeb in 2019. Notably, while $1I$/'Oumuamua's estimated travel time to our nearest star is on the order of 50,000 years, it does not follow a trajectory in that direction. A significant challenge in our proposal lies in the inability to precisely target an ISO and predict when it will encounter other extrasolar systems, although calculations can be made after the injection of our sample. In contrast, the second interstellar object, comet Borisov, exhibits more expected behaviors and characteristics, as observed by Guzik et al. in 2019.

5. TIME OF FLIGHT OF THE PANSPERMIA PAYLOAD

However, interstellar distances are large, so time that the biological sample would have to spend in the ISO before possible hitting a host planet could range over millions of years. The exact survival lifetime of bacteria is unknown, however there are indications that bacteria can survive for at least millions of years (Bidle et al. 2007). We also have information that life can survive suspended even for longer time (Cano & Borucki 1995). This study involving the isolation of bacterial spores, from the abdomen of extinct bees preserved in amber suggests that bacterial spores can remain viable for at least up to 25 million years. Recently, two viable soil nematodes Panagrolaimus aff. detritophagus and Plectus aff. parvus were revived from the samples of Pleistocene permafrost deposits of the Kolyma River Lowland after being in cryobiosis for an estimated (3-4)$\times 10^4$ years (Shatilovich et al. 2018). We need to think about freezing samples which is a great challenge, as freezing of intracellular water is regularly lethal. The only exception reported so far, outside of cryopreservation, is the nematode Panagrolaimus davidi, which can withstand freezing of all body water (Wharton & Ferns 1995). From higher plant species, at present, plants of Silene stenophylla are the most ancient, viable, multicellular, living organisms. Regenerated plants were brought to flowering and fruiting and they set viable seeds. They are regenerated from 30,000-y-old fruit tissue buried in Siberian permafrost (Yashina et al. 2012). Thus, although panspermia appears most likely to transfer bacteria and eukaryota spores, it may also transfer more complex organisms. This could possibly save a lot of time to potential evolution on the host planet.

6. SURVIVAL IN TRANSIT

The question of whether certain microorganisms and its spores can survive in the harsh environment of outer space has intrigued biologists since the beginning of spaceflight. In contrast to higher life forms, Bacteria and Archaea can grow and survive under a wide range of adverse environmental conditions. Consequently, microorganisms are considered to be the most likely candidates for panspermia (Marion et al. 2003; McLean, Welsh,& Casasanto 2006). During space travel, organisms would be in high vacuum, under negligible gravity, deficient in liquid water and nutrients, and they would be exposed to temperature extremes (Nicholson et al. 2005). Space is nutritional inhospitable surroundings with respect to water and organic compounds; although we can pack with samples some amount of organic compaunds, we do not know how long will be a flight. In light of our attempt of the interstellar panspermia, the important question is what could survive long exposure in space. We do know that flight time would be longer than 10^4 years and we can hypothesize that with the low metabolic rates that would result from the extremes in cold and desiccation, nutritional needs would not exist. That is why we prefer biological samples in state of suspended animation. Unfortunately, unlike bacteria and eukaryotes, no known species of Archaea forms spores. Studying of the physiological requirements of survival in space of the Archaea was practically useless for our long lasting attempt. A large number of microorganisms have been selected for exposure experiments, exposing samples of life forms on Earth to space. The best candidates for seeds of life are bacterial spores, which allow bacteria to remain in a dormant state in the absence of nutrients. Studies showed that bacterial spores could survive the extreme conditions of outer space for several years if they were protected from extraterrestrial solar UV radiation (Dose & Gill 1994; Wassmann et al. 2012). The survival of spores treated with the vacuum of space, shielded against solar radiation, is substantially increased, if they are exposed in the presence of glucose as protective.

More complex organisms can be highly resilient as well. Some species of the phylum Tardigrada (Jönsson 2007; Chakraborty & Roy 2017) survived for days in the vacuum of the harsh outer space even when unshielded from radiation (Erdmann & Kaczmarek 2017), capable of handling the conditions of open space, and being cryogenically frozen and revived. Our biological sample should consist of spores of bacteria and eukaryote and some tardigrada and nematode in cryopreservation.

7. DISCUSSION

Fears of science are sometimes hidden and articulated through ethics, that we have a tendency to invoke to regulate the applications of science. Deliberately sending life samples from Earth across local Universe is contrary to the ethic of the preservation of nature and space agencies present protocols. We are planning to send biological samples on larger distances. Totally pessimistic view is that our civilization will not last enough time for our ISOs with embedded biological samples to reach other stellar systems. Only in that case we do need to worry, humanity has nothing to lose from sending life samples into the interstellar space.

The interstellar panspermia is proposed on the basis of the following ethical contemplation: "the moral obligation to insure the survival of the genetic code common to all living organisms, and the desire to the conquest of extensive habitats by life" (Tepfer 2008). All this can be questioned but it is not scope of this paper. It is clear that with our attempt with the interstellar panspermia we cannot ensure survival of humanity but only genetic code and we can spread life. We do not question existence of other life in our Galaxy but we have a doubt we will ever meet them or communicate with them. An ethical doubt is the possibility of interference with indigenous biota. We have warning examples of destroyed civilizations by Western civilization spreading across Americas. Diseases killed millions of Indians but on the other side we do not have records of immediate destroyed wild species of animals or flora. If we succeed hitting extrasolar planet with life samples we cannot be sure that several microorganism and spores will not disrupt possible existing ecosystem on exoplanet. We have examples that imported species invaded new territory. There is a claim that "The chances for a destructive interference may be minimized by the proper selection of pansperms" (Meot-Ner & Matloff 1979) but we do not know on which knowledge of exobiology such claims are based upon. We cannot avoid making risk by sending the biological samples. Also this is risky business because of the simple fact that even if we succeed hitting a habitable planet without life after hundred thousand years long flight, there is no guarantee that we will transfer life on it which is our primary task. For example just imagine that panspermia is performed by an old technological civilization on the Venus but not on the Earth.

Recently renewed interests for interstellar missions just fortified belief that it is not possible to send humans. There are some other problems, for example, Breakthrough Starshot (Lubin 2016), and solar sail (Heller & Hippke 2017) missions plan to send back information of interstellar system using their fleet of small probes, but they need to overcome huge technological problems. We do not have such a plan. Our advantage is based on economy; because our technology is basically ready. One is sure, after more than six decade of space flight we do not have technology which can accelerate near close to 0.002 c several tons needed for the radiation shielding. In order to start with our panspermia attempt we need first to explore potential interstellar objects captured in Solar System (Siraj & Loeb 2019) to check real density of ISO. Funding and sending maximum hundreds of rockets in a span of thousand years towards incoming interstellar objects is not a big financial problem for our civilization. With such number of biological samples sent our chance to hit some extrasolar planet increase. On other side we will not have direct gratification from this project and it will be hard to persuade political authorities for funding it. For next hundred years our best chance for panspermia attempt is using passing interstellar objects as the transport vehicle. At the end we can just spread the life but not the civilization.

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