Reflections on Our Galactic Neighbors

By Avi Loeb on April 1, 2021

*A*re extraterrestrials socially distancing from us? A cautious attitude towards travel would echo our social distancing in the COVID-19 era, during which we stay home out of fear from the risks involved in travel. Similarly, the most advanced technological civilizations might prefer to close themselves off in a self-sufficient technological habitat. It would be difficult to detect such civilizations, since they live quietly.

This state of isolation suggests a possible solution to Enrico Fermi's question "where is everybody?", whereby the period of time over which a civilization transmits detectable signals is not terminated by self-destruction but rather by technological prosperity and detachment.

Sealed technological cocoons would appear to an outside observer as a lack of engagement. This means no communications directed at us, no help with our rudimentary challenges on Earth, and no success in our SETI efforts to find them. In short, it means Fermi's paradox.

To our telescopes, such civilizations would appear indistinguishable from nature since their footprint is minimalistic by design. From their perspective, isolation offers the benefit of a strategy aimed at long-term survival against less-intelligent predators or space pirates who wish to steal their technological wealth. But they will always need to deposit trash. We could reveal it either by searching for the trash they dispose into space, similarly to investigative journalists who root around celebrities' trash cans looking for gossip.

My book, "*Extraterrestrial*", tells the story of the scientific discovery of `Oumuamua, meaning `scout' in the Hawaiian language, by the Pan STARRS facility in Hawaii on October 2017. As the first interstellar object detected near Earth from outside the Solar system, it looked weird, unlike any comet or asteroid seen before within the Solar system. The book details the unusual properties of `Oumuamua: it had a flattened shape with extreme proportions - never seen before among comets or asteroids, as well as an unusual initial velocity and a shiny appearance. It also lacked a cometary tail, but nevertheless exhibited a push away from the Sun in excess of the Solar gravitational force. As a regular comet, `Oumuamua had to lose about a tenth of its mass in order to experience the excess push by the rocket effect. Instead, `Oumuamua showed no carbon-based molecules along its trail, nor jitter or change in its spin period - as expected from cometary jets. The excess force could be explained if `Oumuamua was pushed by the pressure of sunlight, namely if it is an artificially-made lightsail – a thin relic of the promising technology for space exploration that was proposed as early as 1924 by Friedrich Zander and is currently developed by our civilization. This possibility would imply that `Oumuamua is possibly artificial space trash.

In September 2020, another unusual "asteroid" was discovered by Pan STARRS, showing an excess push by sunlight without a cometary tail. This object, labeled by the astronomical name 2020 SO, was not of interstellar origin like `Oumuamua but instead on an Earth-like orbit around the Sun. After tracing its trajectory back in time, it was found that 2020 SO is a stray rocket booster, left over from the Surveyor 2 lunar lander mission in 1966. Its discovery lends credibility to the notion that thin artificial objects with a large surface-to-weight ratio can be distinguished from natural objects based on their excess push away from the Sun without a cometary tail. Unlike the space trash 2020 SO, `Oumuamua could not have originated from us based on its high local speed, large size and trajectory.

The data we gathered on `Oumuamua is incomplete. To learn more, we must continue to monitor the sky for similar objects. The realization that we are not alone will have dramatic implications for our goals on Earth and our aspirations for space. When reading the news every morning, I cannot help but wonder whether we are "the sharpest cookies in the jar". Are there extraterrestrials smarter than us in the Milky Way? The only way to find out is by surveying the sky.

It is often said that "a picture is worth a thousand words". In my case, "a picture is worth sixty-six thousand words", the number of words in my book, *Extraterrestrial*. The desired picture of `Oumuamua could have distinguished between the object being a natural rock or an artificial object manufactured by an extraterrestrial civilization. The many anomalies exhibited by `Oumuamua forced all natural interpretations of it to invoke object types that we have never seen before – all with major drawbacks, like a hydrogen iceberg – which will likely evaporate by absorbing starlight during its journey, a nitrogen iceberg that is unlikely to exist in sufficient abundance, a dust "bunny" , a hundred times more rarefied than air - which might not have the material strength to withstand heating to hundreds of degrees by the Sun, or a tidal disruption relic – which would not possess the pancake-like shape inferred for `Oumuamua.

There is good reason to be optimistic, as there would be future opportunities to snap such a picture. The Pan-STARRS telescope discovered `Oumuamua while surveying the sky for a few years. It is therefore likely to find another object of its type every few years. The *Legacy Survey of Space and Time* (LSST) on the Vera C. Rubin Observatory will start collecting data in less than three years and should find many more `Oumuamua-like objects, possibly a new one each month.

Identifying artificial objects among the asteroids and comets in the Solar system is similar to searching for rare plastic bottles among the natural rocks on a beach. How can we obtain resolved images of weird interstellar objects to separate them from rocks? Two approaches come to mind. One is to deploy numerous cameras in advance within the orbit of the Earth around the Sun so that one of them will be close enough to the path of an interstellar object of interest. Another strategy is to launch a dedicated spacecraft equipped with a camera as soon as LSST identifies a weird interstellar object on its approach towards us.

A camera aperture with a diameter of four inches can resolve an `Oumuamua-like object with the size of a football field at a distance comparable to the diameter of the Earth. Having a camera in such proximity to an object passing at random within the plane bounded by the orbit of the Earth around the Sun would require deploying a hundred million cameras across that region, a staggering requirement. The number of cameras can be reduced by many orders of magnitude if they are attached to a propulsion system that can bring them to the right location at the right time when the object of interest arrives there. Of course, an intriguing photograph could motivate a follow-up mission of landing on the object and deciphering its purpose based on its composition. It would be particularly exciting to uncover a label stating "Made in Planet X" or to discover something like the Golden Record onboard the Voyager 1 and 2 missions that we sent out of the Solar system.

An advance warning of more than a year from LSST about an approaching object of interest would allow to launch a space mission from Earth that would intercept its orbit. This strategy resembles asteroid intercept missions, such as OSIRIS-Rex - which visited the asteroid Bennu and will return a sample from it to Earth in 2023.

Photography of interstellar artifacts will usher the new frontier of space archaeology, a field of space research noteworthy of mainstream attention just like traditional archaeology on Earth. Decades from now, the effort to study past technological civilizations based on the relics they left behind could be routine on academic campuses.

The possible existence of extraterrestrials will not go away if we ignore them, just like the Earth continued to move around the Sun after the philosophers refused to look through Galileo's telescope. We should keep in mind that most stars formed billions of years before the Sun and therefore technological civilizations that predated us had the opportunity to develop more advanced equipment than our century-old technologies. We could learn from them even if most of the equipment they deployed in space is not operational after billions of years. Finding their relics in our backyard saves us the long trip to their point of origin. By putting our hands on such equipment and attempting to reproduce it on Earth, we can shortcut our own technological development. Our technological future may lie in front of our eyes if we can only master the will to harness the evidence.

It is presumptuous to assume that we are special and worthy special attention from advanced species in the Milky Way. We may be a phenomenon as ordinary as ants are on a sidewalk. When crossing a sidewalk, we never pay tribute to every ant along our path. We learned recently that of order half of all Sun-like stars host an Earth-size planet in their habitable zone, allowing for the chemistry of life in liquid water on the planet's surface. Since the dice of life was rolled in billions of other locations within the Milky-Way under similar conditions to those on Earth, life-as-we-know-it is likely common. Fermi's paradox is pretentious in assuming that that we carry cosmic significance.

Why would our galactic neighbors care about how green our grass is? Given that stars like our nearest neighbor, Proxima Centauri, are much more abundant than the Sun, most habitable planets may be covered with dark-red grass, which appears pretty to the infrared eyes of most exo-vacationers. As a result, interstellar tourist agencies may find Proxima b as a more attractive destination than Earth.

When you enter a room full of strangers, you better not speak out but instead listen, because you never know whether it includes predators who will endanger your existence. Unfortunately, we did not follow this cautionary measure so far, as we had been broadcasting radio waves into space for more than a century. And if there are technological civilizations within a hundred light-years that monitor their sky with radio telescopes similar to ours, then they may already know about our existence. We could hear from them in the future. Our saving grace might be that chemical rockets, similar to those used in the Voyager or New Horizons missions, will take a million years to traverse a hundred light years. And so, we might be out for a prolonged suspense before encountering our cosmic neighbors.

But life's signatures will not last forever. The prospects for life in the distant future are gloomy. The dark and frigid conditions that will result from the accelerated expansion of the universe will likely extinguish all forms of life ten trillion years from now. Until then, we could cherish the temporary gifts that nature had blessed us with. Our actions will be a source of pride for our descendants if they sustain a civilization intelligent enough to endure for trillions of years. Here's hoping that we will act wisely enough to be remembered favorably in their big history books.

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