Detecting Heat from Extraterrestrial Probes in the Solar System with JWST

By Avi Loeb on May 25, 2021

One of the most fascinating conversations I had about my book *Extraterrestrial* was with high-school kids. They were genuinely curious and did not carry a baggage of prejudice or self-importance. At the end of our chat, they brought up the most consequential question: “what are the primary goals of our civilization?”

I explained that the two biggest tasks on the agenda of the human species are extending the longevity of our civilization and exploring the Universe.

The first objective includes curing pandemics, avoiding wars, limiting climate change, shifting threatening asteroids away from Earth, and ultimately spreading our “eggs” in multiple baskets by *traveling to space*. The exploration objective was pursued so far with telescopes or by sending spacecraft to destinations within the solar system.

But we can do better and reach the stars, literally speaking. The *Starshot project* - for which I chair an advisory board, aims to launch a probe that would visit the nearest star system, Alpha Centauri, within decades. This requires motion at a fraction of the speed of light, an improvement by a factor of a thousand in speed relative to chemical rockets, similar to the jump in speed from *Ford Model T Car* to the *New Horizons spacecraft*. The Starshot technology - a *lightsail* pushed by a powerful laser beam, was already envisioned long ago in a paper written by Robert Forward in 1962, my birth year. Starshot attempts to realize the concept imagined by Johannes Kepler in a letter to Galileo Galilei from 1610: “Given ships or sails adapted to the breezes of heaven, there will be those who will not shrink from even that vast expanse”. Traveling to new worlds around other stars could be even more revolutionary than the expeditions that discovered the Americas.

The kids followed-up with the question: “should we expect extraterrestrial civilizations with similar goals?” I answered “yes” out of a sense of *cosmic modesty*. The latest data from the *Kepler* Space Telescope implies that roughly half the Sun-like stars have an Earth-size planet at about the same separation from them. Having similar temperatures and chemicals on the surfaces of tens of billions of Earth-like planets in the Milky Way galaxy, could have led to multiple technological civilizations capable of launching Starshot-like probes. Most stars formed billions of years before the Sun, allowing such probes the opportunity to traverse the Milky Way galaxy many times, long before we came to exist.

The next question was obvious: “could we detect probes of interstellar origin wheezing through the Solar system at a fraction of the speed of light?” Gladly I already studied this question quantitatively. In a paper with my colleague Thiem Hoang, I *calculated* that the *James Webb Space Telescope* (JWST), scheduled for launch on October 31, 2021, can detect
the thermal infrared emission from nearby probes larger than a football field and moving faster than a tenth of the speed of light. Even without artificial lights onboard, the unavoidable heat generated by friction with the surrounding gas would be detectable all the way out to a few times the distance to the Kuiper belt, at a hundred times the Earth-Sun separation – roughly where the Voyager spacecraft are located.

Since JWST has a rather limited field of view, the probes would be discovered more effectively by survey telescopes that cover a larger fraction of the sky. But would we pay attention to anomalous objects that are moving so fast across our sky? Ordinarily, astronomers focus on Solar system objects moving at tens of miles per second - the typical speed of comets or asteroids in the vicinity of Earth. This speed is ten thousand times slower than the speed of light. Outliers moving at a fraction of the speed of light could appear so unusual that they might be ignored. In addition, objects that are much smaller than the height of the Statue of Liberty would also tend to be missed because they do not reflect enough light from the Sun, the lamppost which illuminates the darkness of space within the Earth-Sun region. There may be many small probes floating through the Solar system that would be missed with survey telescopes like Pan STARRS or even the forthcoming Vera C. Rubin Observatory.

A detection of interstellar probes could be alarming given the potential threat that it signals. Once a survey telescope identifies an unusual object that arrived into the Solar system from interstellar space, we could launch a spacecraft that would intercept its trajectory and examine it, just as the OSIRIS-REx mission landed and took a sample from the asteroid Bennu that will be brought to Earth in a return capsule on September 24, 2023.

The school kids were thrilled to hear about the potential for a landing mission on an artificial object with a return sample, given that we might put our hands on a technology that is far more advanced than we currently possess. In their mind, the experience would resemble the thrill of checking out the features of a futuristic cell phone, well in advance of its public release time.

Hours after my conversation with the kids, I received a message from their teacher stating: “Thank you so very much for the extremely interesting presentation! We all loved it. Because of your presentation, I am now interested in the field of astronomy. Thank you for your kindness in taking time to speak with kids!”

But the truth was that I benefitted even more from the exchange. The young generation of today gives me hope for a better future. Our kids might one day connect with other kids on exo-planets. When faced with a new object, most kids examine it from all angles with an open mindset. On the other hand, adults arrive at their assessment from a fixed vantage point to save effort based past experience. When asked by the Harvard Gazette: “what is the one thing you would change about the world?”, I replied: “I wish that my future colleagues would behave more like today’s kids when exploring new objects in our sky that appear different from what we had seen before”.

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ABOUT THE AUTHOR

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