On `Oumuamua by Abraham (Avi) Loeb, Harvard University (Nov 5, 2018)

My approach to the puzzling properties of `Oumuamua is purely scientific and evidence-based. I follow the maxim of Sherlock Holmes: "... when you have excluded the impossible, whatever remains, however improbable, must be the truth."

Are we alone? Our new paper suggests that the first evidence for an extraterrestrial technology may have just passed by the Earth a year ago. The object was dubbed `Oumuamua by the Pan-STARRS collaboration which spotted it on an orbit originating from outside the Solar System.

Since its discovery, `Oumuamua showed unusual features. These features make `Oumuamua weird, belonging to a class of objects that we had never seen before. Based on its reflection of sunlight, it was inferred to be much more elongated or flattened than any known asteroid or comet in the Solar System. We do not have an image of it. The information about its shape stems from the variation in reflected sunlight as it spins. Even a thin sheet that is folded as an umbrella might appear from a distance similar to a rotating cigar based on the variation of reflected sunlight.

Moreover, `Oumuamua's motion indicated that it originated outside the Solar System from the so-called “Local Standard of Rest" (obtained by averaging the random motions of all nearby stars), with less than one in 500 nearby stars being as slow in that frame.

But most intriguing was the fact that its trajectory deviated from that expected based on the Sun’s gravitational force. Such a deviation could be caused through a rocket effect from cometary outgassing (due to the vaporization of ice by heating from the Sun), but

no cometary tail had been seen around `Oumuamua. Moreover, cometary outgassing would have produced a variation in its rotation period, which was not detected. If not cometary outgassing, what could be causing the excess acceleration of `Oumuamua?

We propose that the peculiar acceleration of `Oumuamua is caused by the push (not heating) of radiation from the Sun. In order for sunlight to account for the observed acceleration, `Oumuamua needs to be less than a millimeter thick but tens of meters in size. A pancake-like geometry was previously suggested to explain the unusual tumbling motion of `Oumuamua as it spins. These inferred dimensions are unusual for rocks but we do not know whether `Oumuamua is a conventional asteroid or comet since we do not have an image of it. Our paper shows that a thin object of the required dimensions could survive its journey through the entire Milky Way galaxy unharmed by collisions with atoms or dust particles in interstellar space. We do not know how long its journey had been.

If so, ***what is the origin of `Oumuamua?*** One possibility is that the object is a light-sail floating in interstellar space into which the Solar System ran, like a ship bumping into a buoy on the surface of the ocean. A light-sail is a sail pushed forward as it reflects light. Indeed, the Spitzer telescope detected no thermal emission from `Oumuamua, indicating that its surface is cold and highly reflective. If the reflectivity is high, the inferred size of the object drops from a few hundreds of meters (which was deduced based on the albedo of rock) to a few tens of meters.

It is unclear whether `Oumuamua might be a defunct technological debris of equipment that is not operational any more or whether it is functional. Radio observatories failed to detect transmission from it at a power level higher than a tenth of a single cell phone.

If `Oumuamua originated from a population of similar objects on random trajectories, its discovery requires the production of a thousand trillion such objects per star in the Milky Way. This number exceeds considerably theoretical expectations for asteroids based on a calculation I published with collaborators a decade ago. However, the inferred abundance could be reduced considerably if `Oumuamua was on a reconnaissance mission.

Looking ahead, we should search for other interstellar objects in the sky. Such a search would resemble my favorite activity when visiting a beach with my daughters, namely examining shells swept ashore from the ocean. Not all shells are the same, and similarly only a fraction of the interstellar objects might be technological debris of alien civilizations. But we should examine anything that enters the Solar System from interstellar space in order to infer the true nature of `Oumuamua or other objects of its mysterious population.

_____

The paper by Shmuel Bialy and Abraham Loeb, titled “Could Solar Radiation Pressure Explain `Oumuamua’s Peculiar Acceleration?”, is scheduled for publication in *The Astrophysical Journal Letters* on November 12, 2018, and can be found at the link https://arxiv.org/pdf/1810.11490.pdf

ABOUT THE AUTHOR

Abraham Loeb

Abraham (Avi) Loeb is chair of the astronomy department at Harvard University, founding director of Harvard's Black Hole Initiative and director of the Institute for Theory and Computation at the Harvard-Smithsonian Center for Astrophysics. He chairs the Board on Physics and Astronomy of the National Academies and the advisory board for the Breakthrough Starshot project.