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OBSERVATIONS

How to Approach the Problem of 'Oumuamua

The first interstellar object ever found provides an excellent test of the scientific process

Artist's impression of the interstellar object 'Oumuamua.

ESO/ M. Kornmesser *FLICKR* (CC BY 2.0)

On October 19, 2017, the first interstellar object detected in the solar system, 'Oumuamua, was discovered by the Pan-STARRS survey. The six anomalies exhibited by this weird object since its discovery imply that it is nothing like the garden variety of asteroids or comets born in the solar system. What is it then? 'Oumuamua's deviation from a Keplerian orbit around the sun, combined with the lack of evidence for cometary outgassing, promoted the option that it might be a lightsail of artificial origin.

As a result, numerous reporters asked me recently for the "gut feeling likelihood" that I assign to the possibility that 'Oumuamua is artificial. I declined to give them a quantitative answer. My past experience taught me not to rely on gut feelings in situations like this, because gut feeling is guided by prejudice (labeled by Bayesian statisticians as the "prior probability"). And prejudice is shaped by experience, so we bring the risk of missing unexpected discoveries if we always expect the future to resemble the past.

Some social media aficionados declared with great confidence that 'Oumuamua is not artificial in origin. But they did not provide evidence to support their claim. They argued along the lines that "there are things we do not understand, which are nevertheless thought to originate from natural causes."

But this is no excuse for leaving the artificial-origin option off the table for 'Oumuamua. The notion that an alien civilization might exist rests on the facts that our civilization exists and that the physical conditions on the surfaces of many other planets resemble those on Earth. The possibility of a "message in a bottle" from another civilization should therefore not be dismissed ab initio. After all, there are mainstream concepts that are far more imaginative than this possibility,

but similarly unproven.

For example, what could be stranger than postulating the existence of extra dimensions in order to unify quantum mechanics and gravity? Or postulating a new form of matter made of as-yet-undiscovered particles to explain the motion of stars in galaxies? Yet, the concepts of extra dimensions and dark matter serve as mainstream dogmas in physics and astronomy today.

Why do scientists contemplate the existence of a new form of matter instead of arguing that there are things we do not understand about ordinary matter? Because ordinary matter shows anomalous motions, and conventional interpretations of these anomalies are not compelling. In the same vein, ‘Oumuamua showed an anomalous orbit, and conventional cometary outgassing was tightly constrained by the Spitzer Space Telescope, which did not detect dust or carbon-based molecules in the vicinity of the object and found it to be at least 10 times more shiny than a typical comet.

In addition, the spin period of ‘Oumuamua did not change as we would expect from cometary outgassing. If the advocates for a natural origin of ‘Oumuamua have a good explanation for its orbital anomaly and lack of detectable outgassing, they should present this explanation in a scientific paper so that it would be tested with future analysis of existing data or future data on similar objects. This would be equivalent to suggesting theories of dark matter made of conventional material, or modified gravity, as alternatives to the notion of a new form of invisible matter.

Galileo Galilei taught us through experimentation that despite our gut feeling, heavy objects do not fall faster than light objects. Similarly, experiments have taught us that “spooky action at a distance” is a feature of quantum mechanics, despite Albert Einstein’s gut feeling that such a thing was impossible. The lesson from these historic examples is that in questions of science, we should base our inferences on evidence and not prejudice. Before the truth becomes evident, there is a long period of uncertainty with some “gut feelings” being misguided.

How can we gather more data on the population of ‘Oumuamua-like objects, so as to shorten the period of uncertainty about their origin? The simplest approach would be to seek new interstellar objects in surveying the sky. The Large Synoptic Survey Telescope (LSST) will offer far better sensitivity than Pan-STARRS and should find many ‘Oumuamua-like objects once it starts operating in a few years. If LSST does not find any new interstellar objects, we will recognize a seventh anomaly about ‘Oumuamua, namely that it was special. In such a case, we would have to chase it down in order to learn more about its mysterious origin.

Out of the entire population of interstellar objects, there should be a small subset that passed close to Jupiter, lost orbital energy and became trapped in the solar system. For these objects, the sun-Jupiter system acts as a fishing net.

In a new paper with Harvard undergraduate Amir Siraj, we found that the trapped ‘Oumuamua-like objects could be distinguished from asteroids or comets that were born in the solar system based on their unusual orbits, which would sometimes be highly inclined or counter-rotating relative to the planets. In addition to predicting tens of expected discoveries by LSST, our paper identified four specific candidates for trapped interstellar objects that might already have been discovered by past surveys.

Fly-by photography or landing on trapped interstellar objects would educate us about their shape, composition and origins, saving the need to send interstellar probes to their distant birthplaces. We might also discover traces of primitive life-forms on them from another planetary system, confirming the possibility of interstellar panspermia. But ultimately, the search for “a message in a bottle” provides a unique opportunity for finding out that we are not alone, even if only one out of many interstellar objects originates from a technological civilization.

Since ‘Oumuamua appears to be weird, its birthplace must be very different from what we currently imagine, irrespective of whether it is natural or artificial. And the most important point to keep in mind is that this object is what it is, independent of what the popular opinion is on Twitter.