

SCIENTIFIC  
AMERICAN  
Space & Physics

# The Age of Perseverance

A NEW ROVER HAS LANDED ON MARS  
AND BEGINS A NEW ERA OF  
EXPLORATION ON THE RED PLANET

**PLUS**

TELESCOPES  
ON THE  
FAR SIDE OF  
THE MOON

HAVE WE  
BEEN VISITED  
BY ALIENS?

ANCIENT  
MASSIVE  
GALAXIES

WITH COVERAGE FROM

**nature**

# Astronomer Avi Loeb Says Aliens Have Visited, and He's Not Kidding

In conversation, the Harvard University professor explains his shocking hypothesis—and calls out what he sees as a crisis in science

*By Lee Billings*

Astrophysicist Avi Loeb at the unveiling of the Breakthrough Starshot initiative in New York City on April 12, 2016.

---

Lee Billings is a senior editor for space and physics at *Scientific American*.

**AVI LOEB** IS NO STRANGER TO CONTROVERSY. THE PROLIFIC HARVARD University astrophysicist has produced pioneering and provocative research on black holes, gamma-ray bursts, the early universe and other standard topics of his field. But for more than a decade he has also courted a more contentious subject—namely, space aliens, including how to find them. Until relatively recently, Loeb’s most high-profile work in that regard was his involvement with Breakthrough Starshot, a project funded by Silicon Valley billionaire Yuri Milner to send laser-boosted, gossamer-thin mirrorlike spacecraft called “light sails” on high-speed voyages to nearby stars. All that began to change in late 2017, however, when astronomers around the world scrambled to study an enigmatic interstellar visitor—the first ever seen—that briefly came within range of their telescopes.

The object’s discoverers dubbed it ‘Oumuamua—a Hawaiian term that roughly translates to “scout.” The unavoidably cursory examinations of this celestial passerby showed it had several properties that defied easy natural explanation. ‘Oumuamua’s apparent shape—which was like a 100-meter-long cigar or pancake—did not closely resemble any known asteroid or comet. Neither did its brightness, which revealed ‘Oumuamua was at least 10 times more reflective than one of our solar system’s typical space rocks—shiny enough to suggest the gleam of burnished metal. Most strangely, as it zoomed off after swooping by the sun, the object sped up faster than could be explained by our star’s waning gravitational grip alone. Run-of-the-mill comets can exhibit similar accelerations because of the rocketlike effect of evaporating gases jetting from their sunlight-warmed icy surfaces.

But no signs of such jets were seen around ‘Oumuamua. To Loeb, the most plausible explanation was as obvious as it was sensational: taken together with its possibly pancakelike shape and high reflectivity, ‘Oumuamua’s anomalous acceleration made perfect sense if the object was in fact a light sail—perhaps a derelict from some long-expired galactic culture. Primed by years spent pondering how we might someday find evidence of cosmic civilizations in the sky’s depths, he became increasingly convinced that, with ‘Oumuamua, the evidence had instead found us. In late 2018 Loeb and his co-author Shmuel Bialy, a Harvard postdoctoral fellow, published a paper in the *Astrophysical Journal Letters* arguing that ‘Oumuamua had been nothing less than humanity’s first contact with an artifact of extraterrestrial intelligence.

The paper has been a smash hit with journalists but has fallen flat with most of Loeb’s astrophysics-focused peers, who insist that, while strange, ‘Oumuamua’s properties still place it well within the realm of natural phenomena. To claim otherwise, Loeb’s critics say, is cavalier at best and destructive at worst for the long struggle to remove the stigma of credulous UFO and alien-abduction reports from what should unquestionably be a legitimate field of scientific inquiry.

Loeb has now taken his case to the public with the book *Extraterrestrial: The First Sign of Intelligent Life beyond Earth*, which is just as much about the author’s life story as it is about ‘Oumuamua’s fundamental mysteries. *Scientific American* spoke with Loeb about the book, his controversial hypothesis and why he believes science is in crisis.

[An edited transcript of the interview follows.]

**Hi, Avi. How are you?**

I’m good, but I have been losing sleep, because in order to cope with all the media requests, I’ve been doing interviews with, for example, *Good Morning Britain* at 1:50 A.M. and *Coast to Coast AM* at 3 A.M.—plus appearances on U.S. network and cable television. I’ve got about 100 podcast interviews to do in the next few weeks. And I already recorded long conversations with [podcasters] Lex Fridman and Joe Rogan for their shows. I’ve never seen anything like this; there has been so much interest in the book. I mean, there were 10 filmmakers and producers from Hollywood who contacted

me over the past few weeks! I joked with my literary agent that if a film comes out of this, I want to be played by Brad Pitt.

***Hah, indeed, the resemblance is uncanny. Based on your productivity, I've never gotten the sense that you get a lot of sleep anyway.***

My routine is to wake up each morning at 5 A.M. and go jogging. It's really beautiful when nobody's outside—just me and the birds, ducks and rabbits. And, yes, because of the pandemic, the past 10 months have been the most productive in my career. I don't need to commute to work. I don't need to meet so many people. And most important, I don't need to think about what's wrong with all the things that other people say!

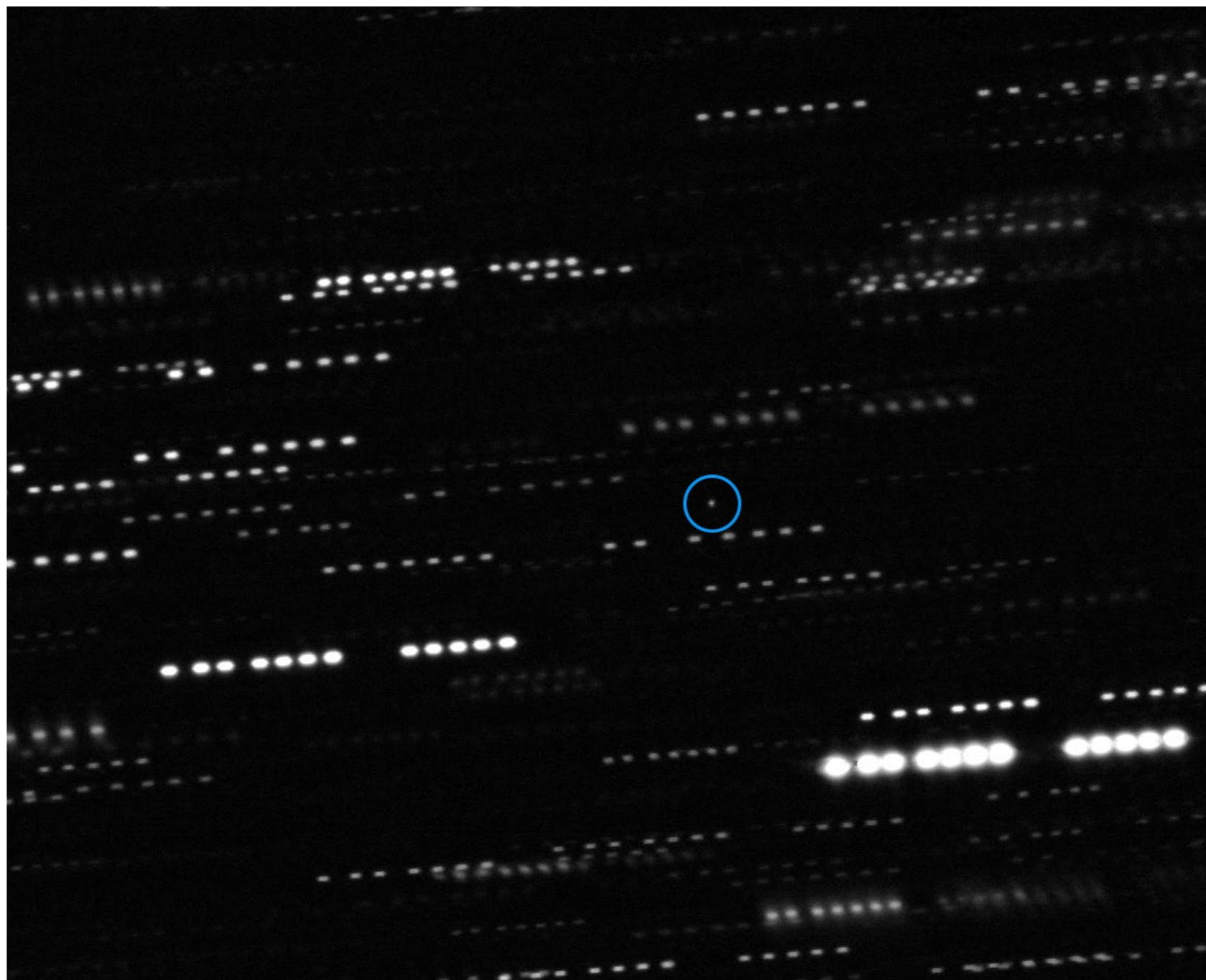
***Speaking of important things, here is one I think we both agree on: in science, we must keep each other honest. I mention it only because there's a point in Extraterrestrial where you claim you don't want the limelight and that you're not interested in self-promotion. How can that be true?***

Let me explain. I think talking to the media is an important opportunity because it allows me to share my message with a broader audience that otherwise would not have exposure to it.

***What is your message, exactly? I take it you're talking about more than 'Oumuamua.***

Yes. My message is that something is wrong with the scientific community today in terms of its health.

Too many scientists are now mostly motivated by ego, by getting honors and awards, by showing their colleagues how smart they are. They treat science as a monologue about themselves rather than a dialogue with nature. They build echo chambers using students and postdocs who repeat their mantras so that their



Marked with a blue circle, 'Oumuamua appears as a faint dot in the center of this image, which is one of the best available and combines observations from multiple different telescopes.

voice will be louder and their image will be promoted. But that's not the purpose of science. Science is not about us; it's not about empowering ourselves or making our image great. It's about trying to understand the world, and it's meant to be a learning experience in

which we take risks and make mistakes along the way. You can never tell in advance, when you work on the frontier, what is the right path forward. You only learn that by getting feedback from experiments.

Which is the other problem with science today: peo-

ple are not only motivated by the wrong reasons; they are also no longer guided by evidence. Evidence keeps you modest because you predict something, you test it, and the evidence sometimes shows you're wrong. Right now you have many celebrated scientists doing mathematical gymnastics about lots of untestable things: string theory, the multiverse, even the theory of cosmic inflation. Once, in a public forum, I asked [physicist] Alan Guth, who originated the theory, "Is inflation falsifiable?" And he said it's a silly question, because for whatever cosmological data an experiment gives us, a model of inflation can be found that accommodates it. And therefore, inflation is in a very strong position because it can explain anything! But I see this as a very weak position because a theory of everything is sometimes a theory of nothing. There may be no difference between the two.

To me, this bubble of imaginary stuff is like being high on drugs: You can get high and imagine that you're wealthier than Elon Musk, who is now the richest person in the world. That's a very fun thought. You can feel really good about it and talk about it with your friends. And if you're part of a big like-minded community, everyone can support and respect one another, and you give one another awards, and that's great, right? But then if you go to withdraw funds, if you want to really spend that money you think you have, you realize that you don't actually have anything. Just like going to an ATM, doing experiments can serve as a reality check. And in science, it's essential that we have that check—that we make testable predictions and put some skin in the game—because otherwise we won't learn anything new. I don't think that's properly recognized anymore.

***So speculating about string theory and multiverses is bad, but speculating about alien civilizations and their artifacts passing through the solar system is okay? You could say***

**“There are, of course, science-fiction stories about aliens, and there are many unsubstantiated UFO reports. Now, suppose there was some literature about the magical properties of COVID-19 that had no bearing in reality. Would that mean scientists should never work on finding a vaccine to this pandemic? No! I don't see the search for technological signatures any differently from the search for the nature of dark matter.”**

*—Avi Loeb*

***appealing to “aliens” can explain anything, too.***

The difference is: you can make predictions and test for the latter, and the speculations come from a conservative position.

If 'Oumuamua is a member of a population of objects moving on random trajectories, then based on its discovery with the Pan-STARRS telescope, you can estimate that we should very soon begin finding, on average, one of these objects per month after the Vera C. Rubin Observatory comes online. We can also establish a system of instruments—satellites, maybe—that would not only monitor the sky but also be able to react to the approach of such objects so we can get photographs of them as they come in rather than chasing them as they go out, because they move very fast. Not all this work needs to be in space, either: You can imagine meteors of interstellar origin as well, and we can search for those. And if you find any that ended up on Earth's surface, you might even be able to examine them with your own hands.

People ask why I get this media attention. The only reason is because my colleagues are not using common sense. Contrast string theory and multiverses with what I and many others say, which is that based on the data from NASA's Kepler mission, roughly half of the galaxy's sunlike

stars have a planet about the size of Earth, at about the same distance of Earth from the sun, so that you can have liquid water on the surface and the chemistry of life as we know it. So if you roll the dice on life billions of times in the Milky Way, what is the chance that we are alone? Minuscule, most likely! To say that if you arrange for similar circumstances, you get similar outcomes is, to me, the most conservative statement imaginable. So I would expect most people to endorse that, to hug me and say, “Great, Avi, you're correct. We should look for these things because they must be very likely.” Instead what I see is a backlash that shows a loss of an intellectual compass—because how else can you explain working on string theory's extra dimensions or the multiverse when we have no clue for their existence? But that is considered mainstream? That's crazy.

Allow me to put this in a very specific context. I'm obviously not a rebel outsider; I'm in leadership positions. I chair the Board on Physics and Astronomy of the National Academies [of Sciences, Engineering, and Medicine], okay? That board is overseeing the Astronomy and Astrophysics Decadal Survey, which will set major science priorities for NASA and the [National Science Foundation] when it is released later this year. Now, I see astronomers

talking about future telescopes costing billions of dollars, with the main motivation being to find life by looking for oxygen in the atmospheres of exoplanets. That is a noble wish. But if you look at Earth for its first two billion years or so, the planet did not have much oxygen in its atmosphere even though it had a lot of microbial life. That's point number one. Point number two is that even if you have oxygen, you can get it from natural processes such as breaking apart water molecules. So even if you spend these billions and find oxygen and maybe even find methane along with it, people will still argue about it forever. Look at how much discussion there has been about the potential detection of phosphine on Venus, which is a very unusual molecule, compared with oxygen. Anyway, my point is that with these same instruments—you don't need any extra investment of funds—you can actually get conclusive evidence for life, intelligence and technology. What would that be? Industrial pollution in the same atmosphere. You could, for instance, look for chlorofluorocarbons, these complex molecules only produced on Earth for refrigeration systems. If you found that on another planet, there is just no way nature would produce these molecules naturally. You would have conclusive evidence that life—and more—existed there.

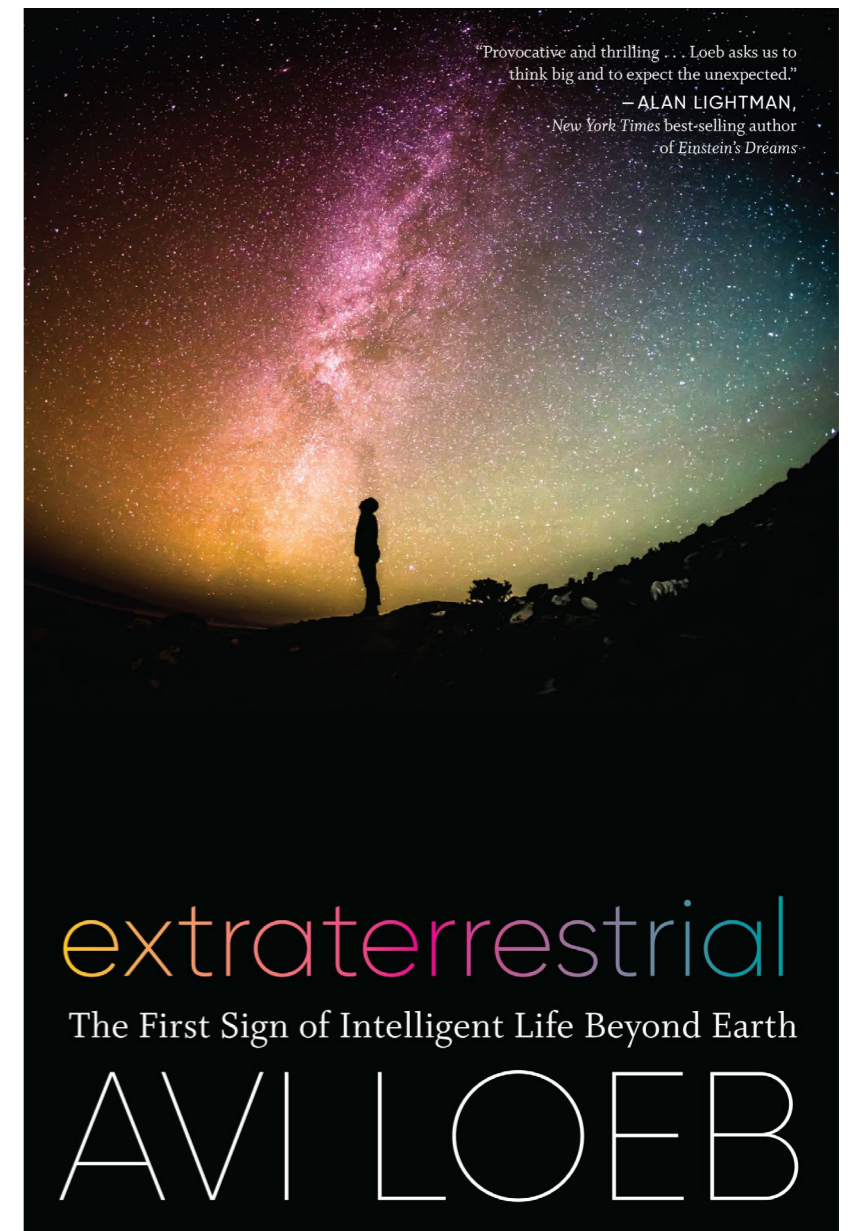
So what is the problem with saying that looking for industrial pollution is a worthwhile thing to do? What other than some sort of psychological barrier that prevents some scientists from admitting they want the search for technological signatures of alien civilizations to be at the periphery, with very little funding? What I'm saying is that these sorts of things should be prioritized and that they are conservative things to do because they will bring us the most information about the existence of alien life. And yet the opposite is being done right now.

***You write about a concept you call “Oumuamua’s wager,” after Pascal’s wager, 17th-century mathe-***

***matician Blaise Pascal’s argument that the benefits of assuming God exists outweigh the drawbacks. Similarly, you say believing ‘Oumuamua is an alien artifact would be a net good because it could catalyze a revolution in space science and technology centered on a more vigorous search for life and intelligence beyond Earth. Even if that hunt finds no aliens, your reasoning goes, we’d still gain a much deeper understanding of our cosmic context. And the investments behind it would enhance our ability to answer other questions about the universe and perhaps even help stave off our own extinction. But if the stakes are so high, what about the counterargument that going “all in” on promoting ‘Oumuamua’s putative artificial nature is reckless and dangerous? Your critics say you are doing more harm than good. For instance, you mentioned you appeared on Joe Rogan’s podcast, one of the most popular in the world. That’s great for selling books. But given Rogan’s reputation for spreading dangerous misinformation on his podcast, is that sort of thing a wise move? Would you also agree to be a speaker at a gathering of UFO “true believers” outside Area 51? Where do you draw the line for public outreach that risks enhancing the so-called giggle factor that has stymied progress in the search for extraterrestrial intelligence [SETI] for decades?***

Okay, here is my point of view. By and large, the public funds science. And the public is extremely interested in the search for alien life. So I must ask: If scientists are supported by the public, how dare they shy away from this question that can be addressed with the technologies they are developing?

There are, of course, science-fiction stories about aliens, and there are many unsubstantiated UFO reports. Now,



suppose there was some literature about the magical properties of COVID-19 that had no bearing in reality. Would that mean scientists should never work on finding a vaccine to this pandemic? No! I don't see the search for technological signatures any differently from the search for the nature of dark matter. We have invested hundreds of millions of dollars in searching for weakly interacting massive particles, a leading dark matter candidate. And so far those searches have failed. That doesn't mean they were a waste: going down dark alleys is part of the scientific process.

And in terms of risk, in science, we are supposed to put everything on the table. We cannot just avoid certain ideas because we worry about the consequences of discussing them, because there is great risk in that, too. That would be similar to telling Galileo not to speak about Earth moving around the sun and to avoid looking in his telescope because it was dangerous to the philosophy of the day. We should not want to repeat that experience. We need an open dialogue among scientists where people present different ideas and then allow evidence to dictate which one is right. In the context of ‘Oumuamua, I say the available evidence suggests this particular object is artificial, and the way to test this is to find more [examples] of the same and examine them. It’s as simple as that.

So how do you change this situation? I think the answer is to bring it to the public as much as I can.

***In your book, you link your outspokenness about ‘Oumuamua with a phrase, an ethos, you learned when you were a conscript in the Israel Defense Forces: “To lay your body on the barbed wire.” That is, to make personal sacrifices for the greater good. Are you to be a martyr for this cause, then? Have you lost friends or stature over it?***

No one has violently assaulted me or anything like that. Maybe people talk behind my back, which would make more sense, given my leadership positions. But I don’t really know. I have zero footprint on social media. Although I should say that I think my critics who are most vocal with nasty remarks on Twitter and elsewhere are relatively mediocre scientists. Most really good scientists would not behave that way—they would make arguments for or against my claims, and that would be enough. Nasty remarks don’t make sense—except, well, deep inside, I would not be surprised if many of these critics are actually quite intrigued by this possibility that ‘Oumuamua is artificial. But they don’t want to admit it.

So they loudly say the opposite.

Unfortunately, my situation is different from that of the young postdocs who I’ve worked with because they need to apply for jobs. I’m sure that people have approached them and said, “Look, this is dangerous for you.” And so they froze and basically stopped working on anything related. This isn’t surprising. If you create a hostile intellectual culture where something like SETI is not being honored, then young, bright people will not go there. But don’t step on the grass and then complain it doesn’t grow as you stand on it. Don’t block brilliant researchers from working on SETI and then say, “Look, nothing is being found. SETI is a failure!”

None of this means all of space science should be about SETI. If you look at the commercial world, companies such as Bell Labs in the past or Google now, they incentivize and allow for their personnel to pursue innovative “blue sky” research that is not immediately applicable for profit. But if you look at academia, it’s much more conservative than the commercial sector. That doesn’t make sense.

***How do you respond to the idea that for a person with a hammer, everything looks like a nail? Someone could uncharitably say what you are really doing here is attempting to curry further favor with wealthy benefactors, such as Yuri Milner, because you are an adviser for his Breakthrough Initiatives programs, which fund research related to SETI and light sails.***

It’s true for me—and everyone else, I think—that my imagination is limited by what I know. I can’t deny the fact that my involvement in Breakthrough was influential here. I was the one who suggested the light sail [proposed by physicist Philip Lubin] to Yuri Milner as a promising concept for interstellar spacecraft in the first place. So I had it in my vocabulary, and as a result of

that, I imagined it as applied to ‘Oumuamua. Now, you might ask, “Okay, well, isn’t that a biased view?” I would say this occurs again and again in physics and in SETI. In the context of SETI, you know, once we developed radio technology, we started searching the sky looking for radio signals. It was the same for lasers. It’s just natural that once you work on some technology that you imagine maybe it exists out there and search for it. So I would not deny that the reason the light sail idea was in my brain is because I had previously worked on it, yeah. But in terms of trying to motivate Yuri, that has nothing to do with it. Why would I do it this way when I can just approach him directly whenever I want to advocate my views? And it is not as if my work on ‘Oumuamua was coordinated with or supported by Breakthrough Initiatives. They have issued no press releases about my ideas. If anything, they might be worried—they have their own reputation to preserve and so forth. On this issue, I’ve had zero support from or communication with them. This was me being curious, not using ‘Oumuamua as some sort of a political vehicle in the context of Breakthrough. That has nothing to do with my motivation.

***After this, what comes next for you? Do you have plans?***

I just stepped down from being chair of Harvard’s astronomy department, so I really do have the ability now to move to the next phase. And the question is: What would it be? Life, of course, is not always what you’ve planned, but another leadership opportunity would be so tempting because I could try to shape reality in a way others would not. I couldn’t pass that up. But maybe we should exclude leadership possibilities from this. Maybe I won’t be offered anything again because of my ideas about ‘Oumuamua! That’s a possibility. Then I’d write more books, do more research and continue to jog every morning. ■