

Avi Loeb

Abraham "Avi" Loeb (Hebrew: אברהם (אבי) לייב; born February 26, 1962) is an Israeli-American theoretical physicist who works on astrophysics and cosmology. Loeb is the Frank B. Baird Jr. Professor of Science at Harvard University. He had been the longest serving chair of Harvard's Department of Astronomy (2011–2020), founding director of Harvard's Black Hole Initiative (since 2016) and director of the Institute for Theory and Computation (since 2007) within the Harvard-Smithsonian Center for Astrophysics.^{[1][2][3][4][5][6]}

Loeb is a fellow of the American Academy of Arts and Sciences, the American Physical Society, and the International Academy of Astronautics. In July 2018, he was appointed as chair of the Board on Physics and Astronomy (BPA)^[7] of the National Academies, which is the Academies' forum for issues connected with the fields of physics and astronomy, including oversight of their decadal surveys.

In June 2020, Loeb was sworn in as a member of the President's Council of Advisors on Science and Technology (PCAST) at the White House.^{[8][9]} In December 2012, *Time* magazine selected Loeb as one of the 25 most influential people in space.^[10] In 2015, Loeb was appointed as the science theory director for the Breakthrough Initiatives of the Breakthrough Prize Foundation. In 2018, he attracted media attention for suggesting that alien space craft may be in our solar system, using the anomalous behavior of ‘Oumuamua as an example.^[11] In 2019, and together with his Harvard undergraduate student, Amir Siraj, Loeb reported discovering a meteor that potentially originated outside the Solar System.^[12]

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אברהם לייב	
 <div>Loeb in April 2020</div>	
Born	<div>Abraham Loeb</div> February 26, 1962 <div>Beit Hanan, Israel</div>
Nationality	<div>Israeli</div> <div>American</div>
Alma mater	<div>Hebrew University</div> <div>(PhD)</div>
Scientific career	
Fields	Cosmology, <div></div> astrophysics
Institutions	<div>Institute for Advanced</div> <div>Study at Princeton</div> <div>Harvard University</div>

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Career

Loeb was born in Beit Hanan,^[13] Israel in 1962. He took part in the national Talpiot program before receiving a PhD in plasma physics, at age 24, from the Hebrew University in Jerusalem, in 1986. From 1983 to 1988, he led the first international project supported by the U.S. Strategic Defense Initiative. Between 1988 and 1993, Loeb was a long-term member at the Institute for Advanced Study at Princeton, where he started to work in theoretical astrophysics. In 1993, he moved to Harvard University as an assistant professor in the department of astronomy, where he was tenured three years later.^{[4][6][2]}

Loeb has written eight books and authored or co-authored about 800 papers on a broad range of research areas in astrophysics and cosmology,^{[2][5]} including the first stars, the epoch of reionization, the formation and evolution of massive black holes, the search for extraterrestrial life, gravitational lensing by planets, gamma-ray bursts at high redshifts, 21-cm cosmology, the use of the Lyman-alpha forest to measure the acceleration/deceleration of the universe in real time (the so-called "Sandage–Loeb test"^[14]), the future collision between the Milky Way and Andromeda galaxies,^[15] the future state of extragalactic astronomy,^[16] astrophysical implications of black hole recoil in galaxy mergers,^[17] tidal disruption of stars,^[18] and imaging black hole silhouettes.^{[19][3]} In 2010, he wrote a textbook entitled *How Did the First Stars and Galaxies Form?*^{[20][21]}

In 1992, Loeb suggested, with Andy Gould, that exoplanets could be detected through gravitational microlensing. In 1993, he proposed the use of the C+ fine-structure line to discover galaxies at high redshifts. In 2005, he predicted, in a series of papers with his postdoc at the time, Avery Broderick, how a hot spot in orbit around a black hole would appear; their predictions were confirmed in 2018 by the GRAVITY instrument on the Very Large Telescope which observed a circular motion of the centroid of light of the black hole at the center of the Milky Way, Sagittarius A*. In 2009, Broderick and Loeb predicted the shadow of the black hole in the giant elliptical galaxy Messier 87, which was imaged in 2019 by the Event Horizon Telescope. In 2013, a report was published on the discovery of the "Einstein Planet" Kepler-76b,^[22] the first Jupiter size exoplanet identified through the detection of relativistic beaming of its parent star, based on a technique proposed by Loeb and Gaudi in 2003.^[23] In addition, a pulsar was discovered around the supermassive black hole, Sagittarius A*,^[24] following a prediction by Pfahl and Loeb in 2004.^[25] Also, a hypervelocity star candidate from the Andromeda galaxy was discovered,^[26] as predicted by Sherwin, Loeb, and O'Leary in 2008.^[27] Together with his postdoc, James Guillochon, Loeb predicted the existence of a new population of stars moving near the speed of light throughout the universe.^[28] Together with his postdoc John Forbes and Howard Chen of Northwestern University, Loeb made another prediction that sub-Neptune sized exoplanets have been transformed into rocky super-Earths by the activity of Milky Way's central supermassive black hole Sagittarius A*.^[29]

Together with Paolo Pani, Loeb showed in 2013 that primordial black holes in the range between the masses of the Moon and the Sun cannot make up the dark matter.^[30]

Loeb led a team that reported tentative evidence for the birth of a black hole in the young nearby supernova SN 1979C.^[31]

In collaboration with Dan Maoz, Loeb demonstrated in 2013 that biomarkers, such as molecular oxygen (O₂), can be detected by the James Webb Space Telescope (JWST) in the atmosphere of Earth-mass planets in the habitable zone of white dwarfs.^[32]

Early universe

In a series of papers with his students and postdocs, Loeb addressed how and when the first stars and black holes formed and what effects they had on the young universe.

Together with his former student Steve Furlanetto, Loeb published a textbook, *The First Galaxies in the Universe*.^[33]

In 2013, Loeb introduced the new concept of "The Habitable Epoch of the Early Universe",^{[34][35]} and mentored Harvard undergraduate, Henry Lin, in the study of industrial pollution on exoplanets as a new method to search for extraterrestrial civilizations.^[36] In April 2021, Loeb presented an updated summary of his ideas of life in the early universe.^[37]

Panspermia

In 2020, Loeb published a research paper about the possibility that life can propagate from one planet to another,^[38] followed by the opinion piece "Noah's Spaceship" about directed panspermia.^[39]

‘Oumuamua

In December 2017, Loeb cited ‘Oumuamua's unusually elongated shape as one of the reasons why the Green Bank Telescope in West Virginia should listen for radio emissions from it to see if there were any unexpected signs that it might be of artificial origin,^[40] although earlier limited observations by other radio telescopes such as the SETI Institute's Allen Telescope Array had produced no such results.^[41] On December 13, 2017, the Green Bank Telescope observed the asteroid for six hours. No radio signals from ‘Oumuamua have been detected.^{[42][43]}

On October 26, 2018, Loeb and his postdoctoral student Shmuel Bialy submitted a paper exploring the possibility of the interstellar object ‘Oumuamua being an artificial thin solar sail accelerated by solar radiation pressure in an effort to help explain the object's non-gravitational acceleration.^{[44][45][46]} Other scientists have stated that the available evidence is insufficient to consider such a premise,^{[47][48][49]} and that a tumbling solar sail would not be able to accelerate.^{[50][51]} In response, Loeb wrote an article detailing six anomalous properties of ‘Oumuamua that make it unusual, unlike any comets or asteroids seen before.^{[52][53]}

On November 27, 2018, Loeb and Amir Siraj, an undergraduate student at Harvard College, proposed a search for ‘Oumuamua-like objects which might be trapped in the Solar System as a result of losing orbital energy through a close encounter with Jupiter.^[54] They identified four candidates (2011 SP25, 2017 RR2, 2017 SV13, and 2018 TL6) for trapped interstellar objects which could be visited by dedicated missions. The authors pointed out that future sky surveys, such as with Large Synoptic Survey Telescope, could find many more.^[55]

In public interviews and private communications with reporters and academic colleagues, Loeb has become more vocal regarding the prospects of proving the existence of alien life.^[56]

On April 16, 2019, Loeb and Siraj reported the discovery of the first meteor of interstellar origin.^[12]

Extraterrestrial: The First Sign of Intelligent Life Beyond Earth, a popular science account concerning 'Oumuamua, written by Loeb,^[57] was published in 2021.^{[58][59][60]}

The Galileo Project

In July 2021, Loeb became head of a new project called "The Galileo Project: "Daring to Look Through New Telescopes".^{[61][62]} The project was inspired by the detection of 'Oumuamua and by release of the Office of the Director of National Intelligence report on Unidentified Aerial Phenomena (UAP). As stated on the project's web-site, the aim is:

Given the recently discovered abundance of Earth-Sun systems, the Galileo Project is dedicated to the proposition that humans can no longer ignore the possible existence of Extraterrestrial Technological Civilizations (ETCs), and that science should not dogmatically reject potential extraterrestrial explanations because of social stigma or cultural preferences, factors which are not conducive to the scientific method of unbiased, empirical inquiry. We now must 'dare to look through new telescopes', both literally and figuratively.^[61]

The three main avenues of research are:^[63]

- Obtaining high-resolution images of UAPs and discovering their nature

A picture is worth a thousand words. For example, a megapixel image of the surface of a human-scale UAP object at a distance of a mile will allow to distinguish the label: "Made in Country X" from the potential alternative "Made by ETC Y" on a nearby exoplanet in our galaxy. This goal will be accomplished by searching for UAP with a network of mid-sized, high-resolution telescopes and detector arrays with suitable cameras and computer systems, distributed in select locations. The data will be open to the public and the scientific analysis will be transparent.

- Search for and research of 'Oumuamua-like interstellar objects
- Search for potential ETC satellites

The project was covered by many independent publishers, among them *Nature*, *Science*, *New York Post*, *Scientific American*, *The Guardian*, etc.^[64] To the allegations that studies of UFO is pseudo-science, Loeb answers that the aim of the project is not to study UFO based on previous data,^[65] but to study Unidentified Aerial Phenomena "using the standard scientific method based on a transparent analysis of open scientific data to be collected using optimized instruments."^[66]

Media appearances

In 2006, Loeb was featured in a *Time* magazine cover story on the first stars, and in a *Scientific American* article on the Dark Ages of the universe. In 2008, he was featured in a *Smithsonian* magazine cover story on black holes, and in two *Astronomy* magazine cover stories, one on the

collision between the Milky Way and the Andromeda Galaxy and the second on the future state of our universe. In 2009, Loeb reviewed in a *Scientific American* article a new technique for imaging black hole silhouettes. Loeb received considerable media attention^[67] after proposing in 2011 (with E.L. Turner) a new technique for detecting artificially-illuminated objects in the Solar System and beyond,^[68] and showing in 2012 (with I. Ginsburg) that planets may transit hypervelocity stars or get kicked to a fraction of the speed of light near the black hole at the center of the Milky Way.^[69]

Science magazine published an article about Loeb's career in April 2013,^[70] and *Discover* reviewed his research on the first stars in April 2014.^[71] The *New York Times* published a science profile of Loeb in December 2014.^[72] In May 2015, *Astronomy* posted a podcast of an hour-long interview with Loeb in its series entitled "Superstars of Astronomy".^[73] In April 2016, Stephen Hawking visited Loeb's home and attended the inaugurations of the Starshot and Black Hole Initiatives that Loeb leads.^[74]

Loeb's eBook on Kindle details his career path from childhood on a farm with interests in philosophy to chairing the Harvard astronomy department and directing the ITC, and includes opinion essays on the importance of taking risks in research and promoting diversity. Loeb writes opinion essays on science and policy.^{[75][76]}

On January 14, 2021, Loeb appeared on the *Lex Fridman Podcast* (#154),^[77] on January 16, 2021, on the *Joe Rogan Experience* podcast (#1596).^[78]

Honors and awards

Loeb has received many honors, including:^[5]

- 2015 – Elected Fellow of the *International Academy of Astronautics* (IAA) SETI Permanent Committee
- 2015 – Elected Member of the American Physical Society (APS)
- 2014 – Member of the Board on Physics & Astronomy (BPA) of the National Academies
- 2013 – Chambliss Astronomical Writing Award from the American Astronomical Society, for the book "How Did the First Stars and Galaxies Form?" (2010)
- 2013 – Miegunyah Distinguished Visiting Fellowship, University of Melbourne, Australia
- 2012 – Elected member of the American Academy of Arts & Sciences
- 2012 – Galileo Galilei Chair (Cattedra Galileiana) Award, Scuola Normale Superiore, Pisa, Italy
- 2011 – Sackler Lecturer in Astronomy, Leiden Observatory, Netherlands
- 2011 – Las Cumbres Observatory Prize Lecturer in Astrophysics, UC Santa Barbara
- 2009 – Distinguished Visiting Scientist at the Carnegie Observatories, Pasadena
- 2007 – Inaugural Australian Institute of Physics (AIP) End of Year Lecturer
- 2007 – Merle Kingsley Distinguished Visitor at the California Institute of Technology (Caltech)
- 2006/7 – John Bahcall Lecturer at Tel Aviv University University
- 2006 – Salpeter Lectureship at Cornell University
- 2004 – Distinguished Visiting Professorship at the Faculty of Physics and the Einstein Center for Theoretical Physics, Weizmann Institute of Science
- 2002 – *Guggenheim Fellowship*^[79]
- 1987 – The Kennedy Prize, Hebrew University of Jerusalem

See also

- CNEOS 2014-01-08

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External links

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- [Loeb's recent preprints](https://arxiv.org/find/astro-ph/1/au:+Loeb/0/1/0/all/0/1) (<https://arxiv.org/find/astro-ph/1/au:+Loeb/0/1/0/all/0/1>)
- [Loeb's published papers](http://adsabs.harvard.edu/cgi-bin/nph-abs_connect?sim_query=YES&aut_xct=NO&aut_logic=OR&obj_logic=OR&author=Loeb%2C+A&object=&start_mon=&start_year=&end_mon=&end_year=&ttl_logic=OR&title=&txt_logic=OR&text=&nr_to_return=100&start_nr=1&query_type=PAPERS&select_nr=50&select_start=1&start_entry_day=&start_entry_mon=&start_entry_year=&min_score=&jou_pick=ALL&ref_stems=&data_and=ALL&group_and=ALL&sort=SCORE&aut_syn=YES&ttl_syn=YES&txt_syn=YES&aut_wt=1.0&obj_wt=1.0&ttl_wt=0.3&txt_wt=3.0&aut_wgt=YES&obj_wgt=YES&ttl_wgt=YES&txt_wgt=YES&ttl_sco=YES&txt_sco=YES&db_key=AST&version=1&version=1&db_key=AST) (http://adsabs.harvard.edu/cgi-bin/nph-abs_connect?sim_query=YES&aut_xct=NO&aut_logic=OR&obj_logic=OR&author=Loeb%2C+A&object=&start_mon=&start_year=&end_mon=&end_year=&ttl_logic=OR&title=&txt_logic=OR&text=&nr_to_return=100&start_nr=1&query_type=PAPERS&select_nr=50&select_start=1&start_entry_day=&start_entry_mon=&start_entry_year=&min_score=&jou_pick=ALL&ref_stems=&data_and=ALL&group_and=ALL&sort=SCORE&aut_syn=YES&ttl_syn=YES&txt_syn=YES&aut_wt=1.0&obj_wt=1.0&ttl_wt=0.3&txt_wt=3.0&aut_wgt=YES&obj_wgt=YES&ttl_wgt=YES&txt_wgt=YES&ttl_sco=YES&txt_sco=YES&db_key=AST&version=1&version=1&db_key=AST)
- [An introductory movie to Loeb's book](https://www.cfa.harvard.edu/~loeb/Movie/Loeb_hidef.mov) (https://www.cfa.harvard.edu/~loeb/Movie/Loeb_hidef.mov)
- [Search for Interstellar Monuments](https://www.scientificamerican.com/article/looking-for-interstellar-monuments/) (<https://www.scientificamerican.com/article/looking-for-interstellar-monuments/>) (Avi Loeb; *Scientific American*; September 2021).

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