From Cosmic Dawn To Milkomeda, And Beyond

The thoughts of Harvard theorist Avi Loeb traverse the universe, past and future—and he urges young researchers to be just as daring

CAMBRIDGE, MASSACHUSETTS—A file cabinet drawer in the office of Abraham (“Avi”) Loeb is simply labeled “IDEAS.” It holds a single hanging file with a few Manila folders, each containing sheets of paper displaying equations in Loeb’s crisp penmanship. “I have ideas all the time; they just bubble up,” he says. “I keep adding a piece of paper here if I don’t have time to work on it.”

In Loeb’s 20 years at the Harvard-Smithsonian Center for Astrophysics, those minimalistic sheets have seeded a breadth of research rivaled by few theorists in astrophysics. His prodigious publication record spans three books (including an award-winning popular volume), 430 papers, and counting.

Loeb is best known to cosmologists for illuminating the messy physics of the “cosmic dawn,” when light from the first stars and galaxies seared holes into the hydrogen gas that suffused the new universe. He and his many colleagues have also described how to spot ancient gamma ray bursts, how giant black holes may have grown and merged, and how to take the first image of a black hole—key predictions that led to campaigns to observe such extremephysics. But his ruminations have also spawned papers on searching for aliens, detecting light from nearby alien civilizations, and counting.

Loeb tries to foster this mix of serious data-driven theory and adventuresome projection among students and researchers at Harvard’s Institute for Theory and Computation (ITC), which he directs. “Following Avi’s work can be quite dizzying,” says Mordehai Milgrom of the Weizmann Institute of Science in Rehovot, Israel, one of Loeb’s first tutors in astrophysics. Adds Frederic Rasio, an astrophysicist at Northwestern University in Evanston, Illinois: “There is hardly a question in astrophysics—any subject, really—that Avi has not touched at some point.”

Plucked from the farm

The 51-year-old Loeb traces his far-flung musings to his childhood on a village farm in Israel, about 20 kilometers from Tel Aviv. His father was head of Israel’s industry for pecans; the family also raised chickens and grew oranges and grapefruits. After collecting eggs and doing other chores with his two older sisters, Loeb would drive a tractor into the hills and spend hours reading books by existential philosophers. “I often considered returning,” he says. “It’s a more relaxing style of living.”

At age 18, Loeb was chosen with two dozen other young men for an elite Israeli military program called Talpiot. He studied physics and mathematics at the Hebrew University of Jerusalem and underwent basic training in paratrooping, driving tanks, and other soldiering. During and after his graduate program he worked at the Soreq Nuclear Research Center, where he led a weapons project to propel masses using electric discharges to ignite material with lower atomic weight than gunpowder, such as polyethylene. He earned a Ph.D. in plasma physics at age 24 and completed his compulsory service 2 years later.

Loeb’s innovations at Soreq caught the attention of U.S. Air Force Gen. James Abrahamson, who came to Israel as the first director of President Ronald Reagan’s Strategic Defense Initiative program. The general’s staff invited Loeb to visit the United States, where the era’s leading plasma physicist, Marshall Rosenbluth, steered him toward the Institute for Advanced Study (IAS) in Princeton, New Jersey. There, noted astrophysicist John Bahcall first invited Loeb for a 1-month stay, then stunned him with an offer of a 5-year appointment—but only if Loeb switched from plasma physics to astrophysics. Loeb marvels at the “wild risk” that Bahcall, who died in 2005, took in hiring him. “I owe him my career,” he says.

From IAS, Loeb took an assistant professor job at Harvard in 1993, despite warnings that promotion was improbable. “At the time, Harvard viewed junior faculty almost as a glorified postdoc,” says Harvard astrophysicist Jonathan Grindlay. “It was not a healthy environment.” But nearly 4 years later, when Loeb had tenure offers from Cornell University and the Weizmann Institute, Harvard made the rare decision to keep him. “He said we would be glad we hired him,” chuckles Robert Kirshner, the astronomy department chair at the time. “Avi has mellowed a bit, but this great self-confidence has remained in place.”

From darkness to light

Loeb’s promotion came at a time of profound personal change. He divorced his first wife, who lived separately in New York in a marriage that never had worked, and months later met Ofrit Liviatan in Israel—through a connection arranged by the pair’s mothers. Liviatan, a lawyer in Israel, joined Loeb in Cambridge a year later. She now lectures in Harvard’s Department of Government.
pursuits that helped chart a course for observers. In a 1992 study at IAS, Loeb and Andrew Gould, who is now at Ohio State University, showed that planets circling other stars could reveal themselves by causing brief flares of light from background stars via gravitational “microlensing”—still the only method that exposes exoplanets in distant parts of the Milky Way. And about a decade ago, Loeb and colleagues calculated that gamma ray bursts—the most powerful explosions known—near the margins of the observable universe should remain visible to telescopes. NASA’s Swift satellite soon confirmed the predictions.

The studies reflect an unshakable tenet of Loeb’s work: contact with data. He avoids the mathematical conjectures of what he calls “theory bubbles,” and he steers students away from them as well. “There is one real-