***October 2, 2017***

# ***Autobiographical sketch***

## Parents

My father's family had its roots in Germany for seven centuries. My grandfather, Albert Loeb (after whom I am named), survived the famous battle of Verdun against France and was even awarded a medal for it when Hitler came to power. He later threw the medal away and decided to immigrate to Palestine (before Israel was born) following a town gathering in Netze in which a member of the Nazi party argued that the jews are using up the resources of Germany for their own benefit. My grandfather stood up and asked the gentleman: "How dare you say these words when you personally dodged the draft in the first World War as a communist while I was on the German front?" The speaker replied: "We all know about your patriotic contributions, Mr. Loeb; I was talking about the other Jews." At that point my grandfather decided to leave Germany, while other branches of the family stayed, believing that they could leave with the last train. Unfortunately, that train led elsewhere and all 65 of his family members were killed in the holocaust. Albert eventually settled in a small village in Palestine, called Beit Hanan, at around 1936. During the War, he gave the British (who occupied Palenstine at that time) aerial photographs of Netze, Waldeck and the Edersee, including a large dam for electricity which was later demolished by the British air force. We visited Netze with my father, David Loeb, a couple of decades ago around the time when a new street was named after my grandfather, the “Albert Loeb-weg” (since the family was highly regarded and included the only jews in town).

My mother’s family had distant roots in Spain; her maiden name Ben Bassat possibly derived from the Ba’al Shem Tov, a jewish mystical rabbi who founded Hasidic Judaism. She was born and raised in the city of Sofia, Bulgaria and studied in a French monastery before entering college. The Bulgarian king at the time protected the Bulgarian Jewish community from the Nazi regime during the war. My mother, Sara, stopped her college studies and immigrated with her parents to Israel in 1948. They settled in Beit Hanan, a village which was primarily inhabited by immigrants from Bulgaria (and took the form of a collective, “moshav”, where individual families own their own farm). There she met and got married to my father. In the first decades of their marriage, she raised my two older sisters (Shoshi and Reli) and me and dedicated her time to our education and well being. When we left home, she went back to a University and completed a PhD in comparative literature, while publishing her dissertation as a book, entitled: “Franz Kafka: A Question of Jewish Identity”, which was translated from Hebrew to English. Earlier, she completed her undergraduate studies when I was a teenager. During that period, I attended philosophy classes with her and enjoyed reading numerous books on philosophy, primarily on existentialism.

## From childhood to Harvard


**Childhood photos from Beit Hanan, taken from a family album (right) and from the Israeli National Photo Collection (left). The family home is shown in the background, along with my two sisters riding a tractor on the left.**

I can trace my far-flung musings to my childhood on the family farm in Israel, about 20 kilometers from Tel Aviv, where I was born in 1962. My father was head of Israel's industry for pecans. The family also raised chickens and grew oranges and grapefruits. Each afternoon I collected eggs. On weekends, I would drive a tractor into the hills and spend hours reading books by existential philosophers like Jean-Paul Sartre or Albert Camus that my mother bought for me. I often considered returning to my home village, which offers a more relaxing style of living.

In my first day of school, I arrived to class and found all the kids jumping up and down on their desks. I looked at them and thought to myself: "Should I join them? Does it make any sense to jump this way?". The teacher entered the room, looked around and said to the class: "Look at how well behaved Avi is. Can't you all follow his example?" I wished to tell her that I was not particularly well behaved, but just delayed by asking myself whether I should join all the others. That question ended up as the theme of my scientific career later in life.

I originally wished to be a philosopher, not a physicist. But being born in Israel,

I was obligated to serve in the military in 1980 when I turned 18. Philosophy appealed to me because it addressed the most fundamental questions, but I was also good at physics. And so I was fortunate to be selected for the Talpiot program that had been established a year earlier and whose goal was to enable a group of two dozen recruits per year to pursue intellectual work in defense-related research in place of the standard military service. This sounded closer to philosophy than running in the field as a regular soldier. I felt privileged to have been selected for this elite group and did my best to justify it.

And so at age 18, I joined this program and abandoned my desire to study philosophy. I studied physics and mathematics at the Hebrew University of Jerusalem and underwent brief training in paratrooping, driving tanks, and other soldiering. Following three years of military training and undergraduate studies, we were asked to pursue work on military or industry projects with immediate practical applications. But because of my love of philosophy I was driven to pursue creative intellectual work, which was not abundant in these work environments. I visited a research center that was not on the list of official work places available to us. After the visit, I used a typewriter to produce a formal-looking document outlining a research project based on some handwritten notes on oil-stained paper that was handed to me during a lunch meeting by Shalom Eliezer, who later became my PhD advisor along with Lazar Friedland from the Hebrew University.

As a result, this outside-the-box research proposal was approved at first for a trial period of three months and later for the remaining five years of my military service, between 1983 and 1988. I was given some slack by the higher authorities because I had excelled early on during my military training. Following a conversation with an experimentalist, Zvi Kaplan, my research evolved quickly in a new direction, employing a full department, and was the first project to receive international funding from the Strategic Defense Initiative (SDI) in the United States. The US-based funding meant that I visited Washington DC every few months.

During and after my graduate program I worked at the Soreq Nuclear Research Center, where I led a project to propel masses using electric discharges to ignite material with lower atomic weight than gunpowder, such as polyethylene. I earned a Ph.D. in plasma physics at age 24, the first in the Talpiot program, and completed this compulsory service two years later.

I completed my PhD in plasma physics a couple of years before the end of my compulsory service and wondered what to do afterwards. One evening, during a bus ride back from work, I brought up this issue with a colleague, Arie Zigler, and he mentioned that the most prestigious postdoctoral fellowships at that time were awarded by the Institute for Advanced Study (IAS) at Princeton, where Einstein worked late in his career. During a subsequent visit to the United States, I attended a conference in Austin, Texas, and met Marshall Rosenbluth, who had

been a faculty member at IAS from 1967–1982. I asked Marshall if he would recommend that I visit IAS. Marshall's answer was a definite yes. I immediately called Michelle Sage, the administrative officer at IAS, and asked if I could visit that coming week. She replied, "We do not allow just anyone to visit us. Please send me a copy of your CV and I will let you know if you can visit." I mailed her a list of 11 publications and called her again a few days later. This time she gave me permission to visit and scheduled the visit for a Friday at the end of my trip. When I arrived at her office early that morning, Michelle said, "There is one faculty member here with available time, Freeman Dyson. Let me introduce you to him." I was thrilled as I remembered Dyson's name from textbooks on quantum electrodynamics. When I met Freeman in his office, he said, "Oh, you are from Israel. Do you know John Bahcall?" "No, I have never heard of him," I said. "Let me introduce you to him," Freeman said. "John likes Israelis. He is married to one."

Fortunately, John was in his office that morning, and we had lunch together. When he heard that Rosenbluth had advised me to visit, he suggested that I visit again for a month in spring 1987, and so I did. In the meantime John contacted Yuval Ne'eman, the most prominent Israeli physicist at the time, and asked for more information about me. Yuval made enquiries and sent a positive report back to John. At the end of my second visit, John invited me to his office and said, "We would like to offer you a five-year position if you switch to astrophysics, but to formally make this offer I need you to arrange for two recommendation letters." I was extremely excited, and as I ran down the stairs in E-building, which hosted the astrophysicists at IAS, I saw David Spergel, who had just started the first year of his postdoctoral fellowship there. I told David that John had just made me an offer, and he replied, "How is that possible? The five-year members are supposed to meet with John this afternoon and discuss the candidates".
When they did, John asked them, "Avi looks promising; should we make him an offer?" So once again, I had an offer that I could not decline, even though I really wanted to get back to my old love of philosophy.

The "wild risk" that Bahcall, who died in 2005, took in hiring me is remarkable; I would find it difficult to do the same for a young candidate in my equivalent status today. I had to learn everything back then from scratch. I did not even know what caused the Sun to shine (an embarrassing limitation, since this was Bahcall's primary research interest). Plasma physics is a state that matter reaches at high temperatures when atoms are broken into a sea of free electrons with a negative electric charge and ions with a positive charge. Even though most of the ordinary matter in the universe (including the interiors of stars like the Sun) is in a plasma state, the research field of plasma physics focused on laboratory conditions which are different from those realized in space. It was a grand leap for me to shift to astrophysics, since I needed to learn the basic vocabulary before I could write original papers. The first research project that I pioneered centered on the question of when and how the atomic matter in the universe was transformed into a plasma.

After three years at IAS, I was encouraged to apply to junior faculty positions, including one at the Harvard Astronomy department. Initially Harvard made an offer to another candidate who declined the position — presumably because the prospects for tenure were slim, given that the previous person to receive tenure from within Harvard Astronomy had been Josh Grindlay, a couple of decades earlier. As a result, I received the offer, which I gladly accepted, because in the case of not receiving tenure I could always go back to my father's farm and work there. After all, I had been used to collecting eggs every afternoon growing up as a child on that farm. I arrived at Harvard in February 1993.

My first original research centered on the "epoch of reionization"—the long era when ultraviolet light from stars and galaxies split the universe's dark fog of neutral hydrogen into protons and electrons, starting about 100 million years after the big bang. In papers establishing a now-accepted paradigm, I explained, along with my students and postdocs, the physics of how ionized hydrogen "bubbles" spread into ever-evolving patterns as stars and quasars lit up, like a cosmic sponge growing more porous with time. The leftover neutral hydrogen emitted a hum of radiation at a wavelength of 21 centimeters. My calculations suggested that low-frequency radio antennae on Earth could tune into that hum, stretched out up to 3 meters long on its way here by the ongoing expansion of space. The more distant the hydrogen, the more its observed humming gets stretched. We studied in detail how astronomers could harness that "redshift" to create a tomographic atlas of the hydrogen fog burning off during the cosmic dawn, a process that took up to a billion years. These theoretical underpinnings promoted major radio-astronomy efforts in Australia, Europe, and South Africa to unveil those patterns.

Three years after arriving to Harvard (1996), my collaborator Fred Rasio encouraged me to apply to a faculty position at Cornell University. I did not know anyone at Cornell but decided to apply, given that the prospects for tenure at Harvard were unclear. To my surprise, I received an offer for a tenured appointment at Cornell, and when I mentioned this offer at Harvard it was clear that I needed to decide whether to accept or decline the Cornell offer before Harvard could decide whether to tenure me. I arranged a meeting with the wisest person on campus, Henry Rosovsky, a former dean of the Faculty of Arts and Sciences. Henry asked for some background information and then advised, "Stay at Harvard". I declined the offer from Cornell, and six months later, in December 1996, I received tenure at Harvard.

At that point, it was too late to return to philosophy as my day job; I was immersed in an intense research program. Around the same time, I realized that this arranged marriage was actually my old love dressed up in different clothes. In other words, I figured that astronomy addresses questions that were previously in the realm of philosophy or religion, such as "How did the Universe

start?" and "What is the origin of life?" Therefore, I actually have the privilege of addressing philosophical questions using modern scientific means. In addition, being a theorist rather than an observer makes me less vulnerable to outside circumstances that are beyond my control, such as bad weather, allocation of observing time on telescopes, or long delays in the construction of suitable instruments. Instead, I can wake up in the morning with an inspiration for an idea that was never considered before and flesh it out to a full paper the same day.

In 1999, I married Ofrit Liviatan with whom we had two girls, Klil (born in 2001) and Lotem (2005). We moved to our home in Lexington, Massachusetts in 2005.

In 2007 I became director of the Institute for Theory and Computation within the Harvard Smithsonian Center for Astrophysics. In 2011, the time came to appoint a new Chair to the Harvard Astronomy department. Another faculty member was offered the job and declined, so I was offered this job. Three years later, my service was extended to a second three-year term, and then to a third three year term. In July 2015, Yuri Milner and Pete Worden visited my office and offered me to lead the Starshot project, aiming to visit the nearest star within our lifetime. After six months of critical examination of various propulsion schemes with my students and postdocs and subsequent extensive discussions with Yuri Milner, Pete Worden and Pete Klupar, we converged on a plan to launch a lightweight spacecraft attached to a sail with a powerful laser beam. Incidentally, my first presentation of the scheme in Yuri's home in Palo Alto was prepared on a weekend retreat with my family in a goat farm at the Israeli Negev. In 2016 we publicly announced the Starshot project in New York City. A couple of weeks later, we also inaugurated the Black Hole Initiative (BHI) with Harvard colleagues, Shep Doeleman, Peter Galison, Ramesh Narayan, Andy Strominger and S.-T. Yau. This interdisciplinary center, of which I am the founding director, is the only center in the world to focus on black holes. It brings together physicists, mathematicians, and philosophers, and completes the circle of my interests since childhood. Stephen Hawking came to the inauguration of Starshot and the BHI in April 2016 and attended dinner at our home in Lexington.

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**Abraham (Avi) Loeb** is the *Frank B. Baird Jr. Professor of Science* at Harvard University. Loeb published 4 books and nearly 600 papers with an h-index above 90. He serves as Chair of the Department of Astronomy, Founding Director of Harvard's Black Hole Initiative and Director of the Institute for Theory and Computation (ITC) . He also chairs the Advisory Committee for the Breakthrough Starshot Initiative, serves as the Science Theory Director for all Initiatives of the Breakthrough Prize Foundation,

and holds the Sackler Senior Professorship by Special Appointment at Tel Aviv University. He is an elected fellow of the American Academy of Arts & Sciences, the American Physical Society, and the International Academy of Astronautics, as well as Vice Chair of the Board on Physics and Astronomy of the National Academies. Within Harvard, Loeb serves on the President's Task Force on Diversity and Belonging , the FAS Dean's Faculty Resources Committee, and the Provost's Allston Academic Planning Committee. In 2012, TIME magazine selected Loeb as one of the 25 most influential people in space. Click here for Loeb's commentaries on innovation and diversity.