Aron Bernstein, professor emeritus of physics, dies at 88

Bernstein was a member of the Hadronic Physics Group in the Laboratory for Nuclear Science, and a longtime anti-nuclear weapons activist.

by Sandi Miller for the Department of Physics

Aron Bernstein, professor emeritus of physics and longtime anti-nuclear proliferation activist, died on January 14th, 2020, after a short battle with cancer. He was 88.

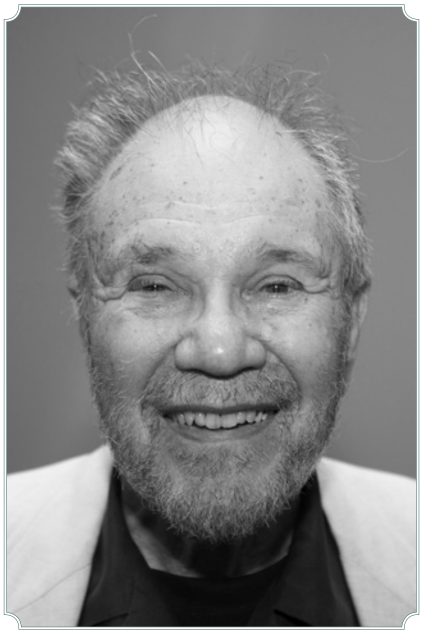
Aron Bernstein joined MIT in 1961, and taught a broad range of physics courses from first-year to graduate level for 40 years. A member of The Hadronic Physics Group in the Laboratory for Nuclear Science, his research was in intermediate energy physics, including nuclear and particle physics, with an emphasis on studying the basic structure of matter. He was also active in the anti-nuclear weapons movement with the Council for a Livable World, the Union of Concerned Scientists, and the Nuclear Weapons Education Project.

"Aron was one of those rare beings—a thoughtful scholar, a good and cheerful person, and someone who worked with a lightness of being to make the world a better place," said Jim Walsh, a senior research associate in MIT's Security Studies Program, who worked with Aron in the classroom and on the board of the Council for a Livable World. "He was a gentle soul, but also a persistent, if humble, instigator. He had a deep commitment and boundless energy for university students and for efforts to eliminate nuclear weapons."

Born April 6, 1931, he grew up in Brooklyn and Queens, the son of Abraham and Lillian (Dashevsky) Bernstein, and the older brother of Grace. His father owned an engraving business specializing in mercury-and-glass thermometers. A physics major at Queens College, he was inspired by his professor Banesh Hoffman, who had worked with Albert Einstein. Bernstein recalled Hoffman promising an instant A if the class could solve a difficult math problem. "Aron and one of his friends worked on it for days," recalled

Bernstein's wife, Susan Goldhor. "They took it very seriously and they actually came up with a solution. I don't know if he got an A, but from the professor's viewpoint there was an elegant solution, and theirs was a cobbled-together solution. Aron was like that, he would work on something and would not give up."

However, Bernstein was stumped by foreign languages, which was a requirement, so he switched to Union College, where he received a bachelor's in physics in 1953. He then pursued his doctorate at the University of Pennsylvania, where he recalled a memorable colloquium featuring MIT Professor Victor "Viki" Weisskopf. "His physical intuition made a vivid impression on me, and I still remember him rubbing his fingers together to show his pleasure at getting to the nub of things," said Bernstein.



After receiving his PhD in 1958, Bernstein became a postdoc at Princeton University. He recalled asking his advisor Donald Hamilton to let him attend a summer program on nuclear physics in Colorado that featured Weisskopf. "I decided to present a project I'd done with my fellow postdoc Max Brennan," Bernstein recalled. "I remember pacing the streets the evening before, wondering what Viki would ask me. After a few hours pacing around, I realized that Viki would say, 'Very nice, but please explain how it works.' I would then smile and explain on my fingers. Amazingly, that's exactly what happened."

Soon after, Bernstein was drawn to interview at MIT. "He sort of fell in love with MIT and Cambridge," recalled his wife. "He had a dream that was linked to MIT, where he was on the subway and every single person had a white coat and was a scientist."

He started in 1961 as an assistant professor of physics, and used accelerators around the world to study the structure of atomic nuclei by looking at reactions started by beams of particle accelerators. His first accelerator at MIT was the Markle cyclotron, an atom-smasher built in 1938 for nuclear and medical research, and newly refurbished. Bernstein saw it as an underutilized workhorse, and used its 30 MeV alpha particle beam to perform low-energy nuclear physics experiments. "We could get a lot of experiments done with the cyclotron," he said. "We were quite active using a solid-state detector, so we had decent resolution. We made a lot of physics hay, so to speak, with this beam."

Photo: Bryce Vickmark

When Bernstein and four others came up for tenure in the mid-’70s, he had Weisskopf in his corner. “All four (other) physics candidates for promotion that year were turned down, but I was the one Viki successfully fought for,” recalled Bernstein.

Bernstein was an experimental nuclear scientist but also worked on the theoretical side of physics. He collaborated with multiple laboratories at home and abroad, including France as a Guggenheim fellow, Germany as a Humboldt fellow, and in an exchange program with the physics and political science departments at Oxford’s Balliol College.

“He covered a lot of ground,” said his colleague, professor of physics Robert Redwine. “He was highly esteemed.” Redwine and Bernstein wrote papers together, and alternated on round-the-clock shifts for weeks during accelerator experiments, most often at the former Bates Linear Accelerator Center in Middleton, Massachusetts. “We would work rather intensely together,” Redwine said.

Bernstein organized an internationally recognized chiral dynamics workshop in 1994. After the first two workshops, he stepped back to serve on its advisory committee. “He spent a lot of time to make sure it was useful, not just a bunch of senior people talking, and it was so successful they are still held every three years,” said Susan. “His attitude was ‘Let the young people run it.’ Some people are always angling to be senior author or to get more credit. Aron didn’t care about that. He only cared about the physics and mentoring young people.”

Bernstein’s family used to tease him for not winning a Nobel prize like many of his physics colleagues. But as the saying goes, to be rich in friends is to be poor in nothing. And Bernstein had a talent for making friends among colleagues, students, and others around the world. After his death, Susan received condolence emails from many of Bernstein’s former students and colleagues, and they all expressed how much he had touched their lives.

“Aron was the colleague I talked the most with about physics and also learned from the most about science,” said one former colleague, Haiyan Gao. “Aron’s passion for physics is contagious and tremendously inspiring. He has always been so nurturing to young scientists and extremely generous in sharing his physics insight, knowledge and wisdom.”

“He was a dedicated classroom teacher who knew what he was talking about,” said Redwine. “He really liked to connect to people. He was good at making what he was saying relevant to you.”

Victor F. Weisskopf Professor of Physics Alan Guth was an MIT first-year in 1964 when he took Bernstein’s 8.01 class, and he also chose Bernstein for his junior lab 8.14 (Experimental Physics II). That project extended into a senior thesis, and then a master's thesis. "From the beginning of this project, Aron made me feel for the first time like I was a physicist, and not just a student," said Guth. "He always made the people he was speaking to feel important. When I was still an undergraduate, but had started working with him, he always invited me to the meetings of his research group, treating me like any other member of the group."

Bernstein's former grad student and Jefferson Lab worker Peter Bosted recalled Bernstein's "twinkle in his eye" and his generosity with his time. Bernstein's former grad student Itaru Nakagawa said that "research with Aron was a joy for me." Bernstein's postdoc Cesar Fernandez-Ramirez said, "Aron became a mentor to me and showed me how I should conduct myself as a scientist and a human being. The world is a better place, thanks to people like him."

Bernstein was a member of Phi Beta Kappa and Sigma Xi, and a fellow of the American Physical Society and the American Association for the Advancement of Science. He retired from the physics department in 2001 after 40 years.

Nuclear arms control activist

Bernstein never retired from keeping an eye on the hands of the Doomsday Clock. "The disarmament project is his capstone project, because it married his political and research passions," said his son, Dan Bernstein MCP '86. "He was really a peace activist."

Among those he teamed up with were fellow peace advocates Weisskopf and Phil Morrison, both Manhattan Project veterans; future Nobel laureate and professor of physics Henry Kendall; microbiologist Salvador "Salva" Luria; Center for Theoretical Physics founder Herman Feshbach; and professor of linguistics Noam Chomsky.

"I was always aware of the fact that if I had been 20 years older, I would have been in the Manhattan Project," Bernstein said. "I was fortunate in my career to have worked closely with, and to have been inspired by, three such extraordinary people as Viki, Salva, and Phil. I regularly got phone calls from Salva commanding me to "get your head out of the cyclotron and come to my office and do something important. Viki…was a tremendous sounding board and a moral force that I greatly benefitted from."

In 1969, Bernstein helped form the Union of Concerned Scientists and participated in its "Scientists Strike for Peace," which disrupted research and classes to protest U.S. and MIT involvement in the Vietnam War. The strike led MIT to the divestment of the Instrumentation Laboratory (now Draper Laboratory), a U.S. Department of Defense contractor.

"The organizers were distressed, on the one hand, with the low level of political engagement of the scientific community, and more specifically with the role of military research on university campuses," Bernstein wrote in a 50-year retrospective on the strike.

Years later, Bernstein joined a similar campaign to reject research funds for work related to President Ronald Reagan's "Star Wars" space-based missile defense system.

He served on the National Advisory Board of the Council for a Livable World, an organization aimed at educating Congress on issues of arms control. "He was quick to offer advice, and just as quick to offer and provide help," said Executive Director John Tierney.

Bernstein chaired a Federation of American Scientists chapter at MIT and the MIT Faculty Disarmament Study Group, and was the advisor to a student group on arms control, MIT's Global Zero.

Bernstein and his contemporaries grew up prepared for a Russian nuclear attack, practicing classroom duck-and-cover exercises, and working in buildings set up with basement bomb shelters. But he soon became aware that his post-Cold War students didn't quite understand this nuclear threat. He gathered a group of volunteers, including Redwine and Los Alamos weapons program veteran Mike Hynes, to launch the Nuclear Weapons Education Project. The idea was to supplement curriculums to increase nuclear-weapon literacy, and to set up a website to share information.

In his final years, Bernstein continued to visit universities, and cultivated a network of physicists around the country on behalf of this project. "We were still having meetings and discussions on this a few months ago," said Redwine. "It became more difficult for him because of health reasons, but he was still involved." Guth added that Bernstein possessed an "inexhaustible concern for helping to make the world a better place."

Family life

Bernstein married Marlene Reshall in 1956, and raised two children, Dan and Amy. The couple divorced in 1975.

His family benefited from Bernstein's ability to combine his work with travel and a love of the outdoors. In 1968, he took them on his sabbaticals to France and New Mexico. When China opened up to the West in the late '70s, he not only wanted to make connections with Chinese physicists, he took Dan with him, with detours to Japan, India, Germany and England. Wherever he traveled for work, he'd find a spot to go hiking. He enjoyed living in Cambridge, Massachusetts, so he could bike to work and take his family sailing on the MIT boats, and family time was spent snowshoeing, cross-country skiing or sailing.

Bernstein met second wife Susan Goldhor through mutual friends. "I thought he was kind of cute and had a really nice smile," she recalled. Susan, a biologist with an interest in mycology, recalled Bernstein joking that "I did mushrooms, and he did mushroom clouds." On their first date, they hiked the White Mountains. Then they planned a longer hike. "I didn't have the right socks, and I got blisters. These were big hikes every day. I was really having a hard time, I was in pain, I was exhausted, and so I complained to Aron about this. Aron hated whiners, so he wrote me a letter afterward that it wasn't going to work out, that he wasn't going to deal with whiners. He was a very, very straightforward person—he didn't play games."

She convinced him that she wasn't actually a whiner, and he took her to a Mozart concert at Jordan Hall. Bernstein loved music, "nothing later than Schubert, and preferably a lot earlier—I couldn't get him to go to a Mahler concert." They married in 1990. Hiking was a shared passion, and they bought a vacation home in the White Mountains. "We hiked in summer, fall, and winter —I remember hiking in a blizzard. Until Aron was 86, we were still hiking and snowshoeing together. The hikes got shorter but the pleasure was still there."

And he was still biking into MIT until the last couple of years, to work on his anti-nuclear projects or meet with friends.

Bernstein "was the kind of person to whom it is quite difficult to say no, even when you should," said Walsh. "He cared about you, the person sitting across from him in his office, and cared about the fate of humanity, and both are the better for it."

"Aron was certainly one of the most wonderful people I've known," said Guth. "His dedication to helping to build a better world was unbounded."

Bernstein is survived by his wife, Susan Goldhor; daughter Amy Bernstein; son Dan Bernstein and daughter-in-law Efrat Levy; and three granddaughters, Dara, Meirav and Tali. The Department of Physics is planning a memorial celebration to be announced later this year.

This article was adapted from the online version published February 3, 2020, by the MIT News Office and reprinted here by kind permission.

Thomas Dupree, professor emeritus of nuclear science and engineering and physics, dies at 86

Highly regarded physicist was well-known for studying plasma turbulence in terms of coherent structures.

by Paul Rivenberg for the Plasma Science and Fusion Center

Thomas H. Dupree, a professor emeritus in both the Department of Nuclear Science and Engineering and the Department of Physics, passed away on February 11th, 2020, at the age of 86.

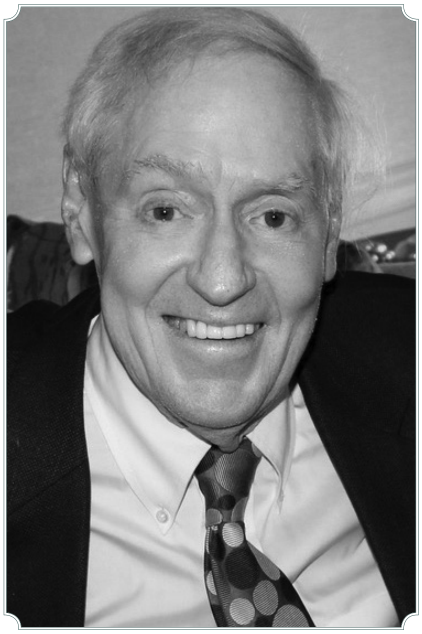
Focusing on theoretical plasma physics, Dupree was well-known for studying plasma turbulence in terms of coherent structures. Understanding plasma's unpredictable behavior has been a continuing challenge in the pursuit of fusion energy. Dupree's articles published in the 1980s and '90s continue to be cited in support of current research.

Professor of nuclear science and engineering Ian Hutchinson remembers Dupree as highly regarded among plasma scientists: "He gained a reputation throughout the plasma community as having formidable powers of algebra and analytic theory. He was driven by the intellectual challenge of these very deep theoretical questions."

Born in Santa Monica, California, in 1933, Dupree began his career at MIT as an undergraduate, completing his SB in 1955 and his PhD in physics in 1960. He joined the MIT faculty in 1961, receiving his double appointment as full professor in 1969.

Professor emeritus of nuclear science and engineering Kent Hansen met Dupree as a fellow undergraduate physics major at MIT, maintaining a friendship with him through graduate school and later as a professional colleague. He remembers the young Dupree as "very bright, very well-spoken, very reserved but engaged, with a good sense of humor," as well as being "a superb tennis player." The two friends acted as ushers for each other's weddings.

Dupree married Andrea Kundsin in 1961. They met at a mixer for students from MIT and Wellesley College, where Kundsin was studying astronomy. She would later earn a PhD in astrophysics from Harvard University, and serve as president of the American Astronomical Society, as well as associate director of the Harvard-Smithsonian Center for Astrophysics.



Dupree's teaching abilities were honored in 1987 with an MIT Graduate Student Council Teaching Award. He retired from teaching one year later at the age of 55, though he continued to do research.

In parallel with his academic career, Dupree was engaged in real estate development with his brother, Fred. Their first project in 1962 was 1010 Memorial Drive in Cambridge, Massachusetts, a now-iconic residential tower on the banks of the Charles River. He and his wife lived there themselves until they needed more room for a growing family. Their son, Tom Jr., was born in 1970 and their daughter, Catherine, in 1973.

Thomas Dupree is survived by his wife, son, and daughter, and his four grandchildren: Andrew, Caroline, Aoife, and Lochlann. The family has requested that donations in Thomas Dupree's memory may be made to the MIT Department of Physics.

This article was adapted from the online version published February 28, 2020, by the MIT News Office and reprinted here by kind permission.

Professor Emeritus Ulrich Becker, who made major contributions to particle physics, dies at 81

Longtime MIT physicist and mentor created instruments that advanced high-energy physics, including the Nobel Prize-winning discovery of the J particle.

by Sandi Miller for the Department of Physics

Ulrich J. Becker, a professor emeritus in the Department of Physics, passed away on March 10th, 2020, at age 81, after a long struggle with cancer.

Becker became emeritus in 2011 after 42 years with MIT, but he never really retired; he continued to mentor students in his fourth-floor Grad Lab until shortly before he died.

Known to many as Uncle Bravo, Becker used his engineering talents and endless curiosity to discover elementary particles in his pursuit of the secrets of the universe. Becker's career in experimental high-energy physics included key contributions to the 1976 Nobel Prize in Physics for the discovery of the J particle. He was also a major contributor to the Alpha Magnetic Spectrometer (AMS) on the International Space Station, the advancement of international collaborations in high-energy physics, and other instruments and discoveries that impacted high-energy physics research.

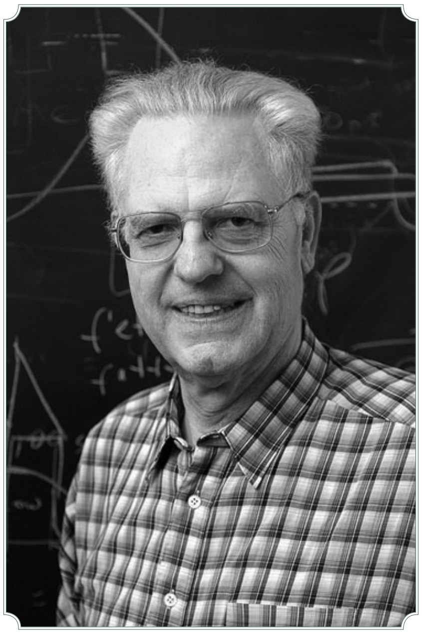
"Ulrich Becker was a gifted physicist who made major contributions to particle physics," says Samuel C.C. Ting, the Thomas Dudley Cabot Institute Professor of Physics at MIT. "Over more than half a century of collaboration, I found him to be an exceptional physicist not only in the invention of precision instruments but, most importantly, in that he had good taste in physics."

Early life

Ulrich Becker was born in Dortmund, Germany, on December 17, 1938. On that day, nuclear fission was discovered in Berlin. Just a few months before, Germany reissued to its Jewish citizens passports stamped with the red letter "J," and launched the Kristallnacht pogrom.

During World War II, Becker, with his brother Peter and parents Auguste (Bühner) and Georg Becker, took shelter in the basement of their apartment building while bombs fell overhead.

After the war, his father ran a laboratory supply business in Dortmund and would send the teenage Ulrich on deliveries. “He learned a lot of dirty secrets of industry like planned obsolescence,” says his daughter, Katharina Becker, and that left him disillusioned. He tried his hand as a coal miner, a steelworker, and an electrician, but he was also good at math and science.



“He started thinking about why would something as awful as World War II happen, and why so many were killed, and the inequity of it all — why did it have to be that terrible?” says Katharina. “In the end it was an existential question: Why would God let war happen?” Raised as a Lutheran, Becker decided that if he studied physics, he might be able to ask God a few of these questions.

After graduating from the University of Marburg, Becker pursued his PhD at the University of Hamburg, focusing on the photo-production and leptonic decays of vector mesons. He was able to show that all vector-mesons behave like heavy photons, that they displayed diffraction and converted back to virtual photons.

The Nobel pursuit

In 1964, physicists proposed the concept of the subatomic particles known as quarks. These fundamental particles and corresponding antiparticles bind together to form other particles, like protons and neutrons. There were three types of quarks—up, down, and strange—while the proposed fourth, the charm quark, remained a theory.

Samuel Ting was leading an experiment at the Deutsches Elektronen-Synchrotron (DESY) Laboratory in Hamburg, Germany, when he met doctoral candidate Becker in fall 1965. The group was using the six-billion electron volt synchrotron light to measure the size of the electron. Ting decided to sponsor Becker’s research, so he joined the group. “He made important contributions to the data analysis of this experiment,” recalled Ting.

It was a complementary match: Becker was a dogged researcher, and Ting was a master in organization and politics.

They presented their results at the XIIIth International Conference on High Energy Physics at Berkeley in 1966. The results showed that electrons have no measurable size, which contradicted earlier results from both the Cambridge Electron Accelerator and Cornell University.

Becker then completed his PhD under mentor Peter Stähelin, founder of DESY and co-founder of CERN, and remained at DESY to study the photoproduction and leptonic decays of vector mesons.

In 1970, Becker joined the MIT faculty, counting among his mentors Victor Weisskopf and Martin Deutsch, and was promoted to associate professor in 1973, and full professor in 1977. The following year he joined the team of Glenn Everhart, Terry Rhoades and Min Chen at Brookhaven National Laboratory (BNL) to design a precision spectrometer. "He developed high-precision, radiation-resistant proportional chambers, which operated at a very low voltage in order to function smoothly in a high radiation environment at rates of 20 MHz," says Ting.

Ting's group used the spectrometer in their experiment, smashing protons into a fixed target of beryllium to produce heavy particles that would then decay into electrons and positrons. They were hoping to find heavy particles. Instead, they produced an unexpected curve in the data.

Becker and Ting worked day and night to process the data, to figure out what they had actually found: A heavy particle with a lifetime that was about a thousand times longer than predicted.

"We had no idea why the hell this was," Becker said in a 2014 *MIT Technology Review* interview. "We were highly suspicious of it, but since it was so clear cut, there was very little room for doubt."

Becker recalled that the announcement of what they found had been delayed, due to budget and disbelief. "Brookhaven couldn't pay their electric bill, and I had to ask Martin Deutsch for $30,000 so they could pay the bill. He flatly refused. And then he said I had to give a seminar, so I gave a seminar in October 1974, and we had the data that showed the peak at 3.1 GeV."

Becker's first round of findings was in September to early October, but "it wasn't something we had been expecting," Becker recalled. They were confirmed later that October, and Becker pasted one of the graphs on top of another. (Becker held onto this graph, and later, when he moved into his Grad Lab, he hung these breakthrough results on his display case.)

"Ulrich showed up at the Center for Theoretical Physics excited, in his Germanic way, with two graphs: one with a sharp peak and the other with a broad one," recalls Robert L. Jaffe, Morningstar Professor of Physics and MacVicar Faculty Fellow at MIT. "He was explaining that one graph showed their data on electron-positron-pair production at BNL and the other showed the pair-autocorrelation function. I, of course, assumed that the sharp peak was the autocorrelation function and the broad, relatively uninteresting one was the enhancement in the electron-positron mass distribution. It took a few minutes for me to figure out that the situation was the reverse and that the electron-positron pair enhancement was narrower than the experimental resolution. Ulrich smiled broadly. My jaw dropped and the world was never quite the same!"

Meanwhile, Burton Richter '52, PhD '56, was reviewing measurements of collisions of electrons and positrons at Stanford Linear Accelerator Laboratory's particle collider when he too found something surprising: a heavy particle with an unusually long lifetime.

Ting flew to Stanford that November and ran into Richter. After discussing their results, they quickly organized a lab seminar, presented their results on November 11, 1974, and published their findings, separately, in the same issue of *Physical Review Letters*.

In early 1975, Becker went to Germany for a talk about their result. He recalled to *Technology Review* that theoretical physicist Werner Heisenberg interrupted his talk to comment, "Whenever they don't know what it is, they invent a new quark." To which Becker replied, "Look, Professor Heisenberg, I'm not arguing whether this is charm or not charm. I'm telling you it's a particle which doesn't go away.' Dead silence. It got very cold in the room. Then Heisenberg said, 'Accepted.'"

What followed were rapid changes in high-energy physics, which became known as the "November Revolution." Physicists decided that the J/Ψ consisted of one charm quark and one anti-charm quark. It also created structure and predictability for fundamental particles, which physicists dubbed the Standard Model.

Ting's group called the new particle "J," which is one letter away from "K," the name of the "strange" meson; "J" also resembles the Chinese character for Ting's name. Richter's group called it "Ψ" (psi).

The discovery led to Ting and Richter sharing the Nobel Prize in Physics in 1976. According to Nobel rules, only three people at most can win for any single discovery, and if Ting's colleagues at MIT had tried to nominate a collaborator from the Ting team, then Richter's colleagues at Stanford would have wanted to nominate a colleague from their team.

"If only one of the groups—MIT—discovered it, I am convinced Becker would have been included in the Nobel Prize for it," says Wit Busza, Francis Friedman Professor of Physics Emeritus and MacVicar Faculty Fellow at MIT, who had worked with Ting's team alongside Becker in Hamburg.

When asked recently about missing out on the Nobel Prize, Becker just shrugged. "That's what happens."

In the late 1970s, one of Becker's chambers that he had designed for the J particle experiment was exhibited at the Smithsonian Institution.

His passion for discovery led him to build detectors and run other experiments at DESY, Brookhaven, MIT, and CERN. "He just wanted to get to the bottom of things," says his daughter.

"He was not in the limelight, he was very modest," says Boleslaw Wyslouch, director of the Laboratory for Nuclear Science. "He had a deep knowledge of particle physics, having contributed himself to some of the most important discoveries. His main contribution was to build the detectors that worked extremely well in experiments that led to major discoveries."

Getting the drift

Becker developed several other major instruments widely used in experimental particle physics, and that were the catalyst for many major discoveries.

His large-area drift chamber would provide large acceptance coverage for experiments, and his drift tubes enabled physicists to measure particles near the interaction point. Those developments led to Becker to design and build the huge muon detectors for the MARK-J experiment at DESY, which resulted in the discovery of the three-jet pattern from gluon production.

This led to his leading hundreds of colleagues in designing the muon detector, one of three main outer layers of the L3 detector, one of four large detectors on the Large Electron-Positron collider (LEP), at CERN, to study the electro-weak interference. The outer layer of the L3 detector held a magnet that generated a field 10,000 times stronger than the average field on the Earth's surface. L3 started data taking in 1989 and stopped in 2000, to be replaced by the Large Hadron Collider. "The results from L3 provided accurate confirmation of the Standard Model," says Ting.

He also made important contributions to advancing international collaboration in high-energy physics.

"The readiness of Professor Becker to help in training our colleagues, his deep understanding of the Mark-J experiment and his superb teaching skills deserves our highest recognition," says Manuel Aguilar of the Centre for Energy, Environment and Technology. "His friendly approach, his behavior and deep understanding of physics, made all of us to feel very comfortable, and that is something we did most appreciate and will never forget."

In 1978, Becker went to China to select 18 young physicists to work with the MIT group. This was the first group of young Chinese physics students to work outside China after the Cultural Revolution. Many of them went on to lead the Chinese high-energy physics research program and launch an international collaboration.

"Professor Becker was an old friend of Chinese high-energy physicists," says Institute of High Energy Physics physicist Hesheng Chen PhD '84, who was mentored by Becker for 40 years. "He taught and advised many Chinese physicists to do the Mark-J experiment and the L3 experiment."

Alpha Magnetic Spectrometer

Becker also worked with professor of physics and department head Peter Fisher, and MIT Electromagnetic Interactions Group senior research scientists Joseph Burger and Michael Capell, among others, on building an Alpha Magnetic Spectrometer (AMS). This was another Ting project, which aimed to record the tracks of millions of cosmic ray particles, the debris released by explosions in distant stars.

The idea for the AMS was born while Becker and Ting were on a coffee break while working on the L3. "We sat in Building 44 and thought, 'How can we prove or disprove the prejudice that there is only matter?' One anti-carbon nucleus could change our whole perception of the universe," Becker said to MIT News. The idea was to search for anti-matter, but because anti-matter is destroyed in Earth's atmosphere, the research would need to be done in space.

"I had this dream to build an experiment that would have fewer than 100 collaborators and could fit on a table," Becker told *Nature*. NASA greenlighted the project, but it ballooned to 500 scientists from 56 institutions, and would need a vastly larger table. Its 0.86-tesla magnetic field is 17,000 times bigger than Earth's. "Sam Ting doesn't like to do small things," said Becker.

The first AMS cosmic ray detector flew in the STS-91 shuttle payload in June 1998 and gathered about 100 hours of data. The first large magnet experiment ever placed in the Earth's orbit, the AMS's instrumentation allowed researchers to measure higher-energy particles with greater accuracy. Becker was alternately excited and mystified by the results: 100 million particles were detected with four times as many positrons as electrons showing up near the Earth's magnetic equator. But not a single anti-carbon nucleus was found.

Becker then went on to help design the transition radiation detector for Ting's AMS-02, which sought to conduct a more extensive search for rare cosmic ray particles while mounted on the International Space Station in May 2011. In March 2013, Ting reported initial results, saying that AMS had observed over 400,000 positrons. By March 2020, AMS had collected over 155 billion cosmic ray events.

Becker never did set up his own research group, choosing instead to spend nearly his entire career collaborating with Ting. "They had an incredible, very complementary interaction," says Busza. "Ting is brilliant when it comes to judgment, organization, political skills, and obtaining funding. While Becker is brilliant in the design and building of experiments, in instrumentation and analysis of data. As a result of both of those people, their research program has been extraordinarily successful."

In 2002, Becker received a NASA Recognition Letter for "Success in the First AMS Flight" and in 2006 was named a fellow of the American Physical Society.

Says Ting, "Professor Ulrich Becker was a person of integrity and a good friend." Adds Busza, "For Ulrich, physics was an essential part of life."

A mentor to many

Becker was a mentor to many talented physicists, including thesis advisor to MIT's Wyslouch, Capell, and Joseph A. Paradiso, and Reyco Henning from the University of North Carolina. "Ulrich was a mentor of mine, and to many of us," notes Peter Fisher.

"He was extremely friendly but also very stern," says Wyslouch. "I would have never called him by his first name. I think once I called him Ulrich, and it just didn't work. Professor Becker exuded authority." Wyslouch recalled trying to score "some brownie points" with his professor by spending weekends repairing a 1974 Datsun. "He really appreciated students who liked to build things and use their hands."

Wyslouch had also worked with Becker for 10 years in Ting's group. "He just knew everything, he had this approach to things, to check things very quickly, calculate things very quickly, we were always in awe of his knowledge and his experience," he says. "He was a very good manager of people."

Former student Teresa Fazio '02 recalls his patience. "I can hear him saying, 'Och, Teresa. This is not good,' when I had written particularly boneheaded or incorrect things in my thesis. When someone reported an experiment had failed or equipment didn't work or something from Aachen or CERN was late, his typical response was, 'Oh, well...Next?' Considering some of the things that went wrong, he remained remarkably chill." She also recalled him adjourning his Friday afternoon journal club every week by saying, "So, we go for beer?"

Students recalled that his idea of lab shoes were Birkenstocks and socks, and memorably, the time he fed a stray dog that turned out to be a coyote. Students also joined him in kayaking trips and were invited to his house for pizza and his wife Gerda's rhubarb tarts.

In 2013 Becker transitioned to emeritus status, but despite his battle with blood clots and prostate cancer, he came in every day to mentor students in his meticulously created fourth-floor Grad Lab that held many abandoned experiments and broken equipment, which he had rescued for repair and demonstration. At the age of 81, he even learned Python.

The Department of Physics recently held an informal ceremony where Becker officially handed over the keys to his lab. "After that, he got sick," recalls his daughter.

Ulrich Becker is survived by his wife Gerda (Barthel), children Katharina, Peter and Robert, and grandchildren Jarin and Hannah.

The Department will host a memorial service at a date to be announced. The family has requested that donations in his memory may be made to the American Cancer Society.

This article was adapted from the online version published April 9, 2020, by the MIT News Office and reprinted here by kind permission.