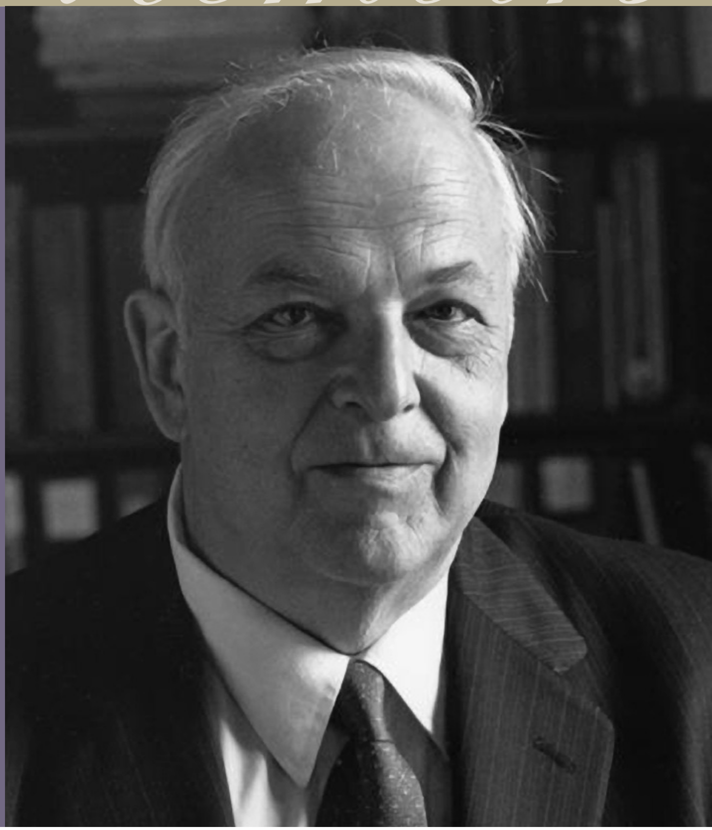
Burton Richter

1931-2018

BIOGRAPHICAL *Memoirs*



A Biographical Memoir by
Persis Drell, Vera Luth,
and Maury Tigner

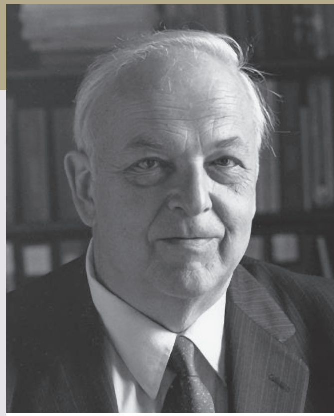
NATIONAL ACADEMY OF SCIENCES

BURTON **RICHTER**

March 22, 1931–July 18, 2018

Elected to the NAS, 1977

Burton Richter was Professor Emeritus at Stanford University, former director of the Department of Energy's SLAC (Stanford Linear Accelerator) National Accelerator Laboratory, and winner of the 1976 Nobel Prize in physics. A great scientist and a great leader, Burt, as he was known to his colleagues, was widely respected for his role in the development and exploitation of accelerator technologies, his visionary leadership as director of the National Accelerator Laboratory, and his important contributions in science and energy policy nationally and internationally. His development of accelerator technologies resulted in important discoveries by others as well as his own Nobel prize-winning discovery.



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By Persis Drell, Vera Luth, and Maury Tigner

Burt was born on March 22, 1931, in Brooklyn to Abraham and Fanny Richter and was raised in the Queens neighborhood of Far Rockaway. A chemistry set in high school captured the young Burt's interests. He entered the Massachusetts Institute of Technology (MIT) in 1948 and received a bachelor's degree in physics in 1952 and a Ph.D. in 1956. Burt's interest in experimental particle physics and particle accelerator technology developed early in graduate school. After initially studying nuclear effects in mercury, he spent a semester at Brookhaven National Laboratory learning about Cherenkov counters and then did his thesis studying photoproduction of pi-mesons at the 350 MeV MIT electron synchrotron.

Burt then moved to Stanford University, where he used the 700 MeV electron beam of the Mark III linear accelerator to probe the electromagnetic force. First as a research associate and later as a member of the Stanford faculty, Burt did a series of photoproduction experiments probing the validity of quantum electrodynamics at small distances. In 1957, he teamed up with Gerard K. O'Neill of Princeton University, who suggested head-on collisions of electron beams to produce substantially higher energies than a single beam hitting an stationary target. They formed a small group of young scientists and engineers to develop the design of a two-ring electron collider with 500 MeV electrons injected from the Mark III linear accelerator. Within a year, colleague Wolfgang K. Panofsky secured funding from the Office of Naval Research to build this unique e-e- colliding beam experiment. It took almost a decade to build and learn how to operate this complicated device and the associated detector and to finally test the validity of quantum electrodynamics at the highest precision.

In 1960, he married Laurose Becker and they had two children, Elizabeth (1961) and Matthew (1963).

In 1963, as work on the e-e- rings continued, Burt moved to the new SLAC laboratory, where construction of the high-energy linear accelerator and the experimental facilities was underway. Discussions initiated by him and his faculty colleague, David Ritson, resulted in a proposal for an e+e- storage ring named SPEAR, which was submitted to the funding agency. Based on the experience with the e-e- collider, they were convinced that the necessary luminosity could be achieved and that the clean e+ e- annihilation to hadronic states at modest energies of up to 10 GeV would be adequate to advance the frontiers of particle physics. Unfortunately, the proposal did not receive funding for several years despite strong recommendations from the High Energy Physics Advisory Panel. During this period, the collider design was simplified to a single storage ring. In parallel, Burt's group designed and built a magnetic spectrometer at SLAC to study photoproduction of K mesons. Finally, in 1970 the project was approved to be funded from the SLAC operating budget, including the storage ring and the multi-layer cylindrical detector, the design of which became the prototype of all future colliding beam detectors.

L-R: Martin Perl, Burt, and Gerson Goldhaber.
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Burt Richter had realized that his group at SLAC was overloaded with responsibilities for the construction of SPEAR and the detector. Fortunately, Martin Perl joined the effort and Burt invited the research groups of Willy Chinowski, Gerson Goldhaber, and George Trilling at Lawrence Berkeley National Laboratory (LBL) to join the collaboration, to contribute primarily to the data processing and some detector components. The first colliding beams were achieved in early 1972 and the detector was ready a year later!

The early results of the SPEAR data close to 3.1 GeV and above were very puzzling, until a special effort in November 1974 revealed a narrow giant resonance that was named psi. Unbeknownst to the SLAC-LBL collaboration, the same resonance, named J, had been observed at Brookhaven National Laboratory by the MIT group led by Sam Ting! The simultaneous discovery of the J/psi was honored by the shared 1976 Nobel Prize awarded to Richter and Ting. Additional data from SPEAR revealed a spectroscopy of similar states. These new resonances were interpretated as bound states of new quark–anti-quark pairs. This fourth quark, referred to as "charm," had been predicted for many years by theorists. The impact of this and further discoveries based on SPEAR data, including the discovery of a third charged lepton by Martin Perl and his group, were fundamental to the establishment of the Standard Model of particle physics.

Burt continued to advocate the development and use of the e+e- storage rings of increasing energy: for instance, PEP at SLAC, PETRA at the Deutsches Elektronen-Synchrotron (DESY) in Germany, and ultimately LEP at the European Organization for Nuclear Research (CERN) in Switzerland. Long before LEP was built, Burt realized that the scaling laws for electromagnetic radiation from circulating electron beams made e+e- storage rings unaffordable at energies higher than LEP. He started to focus on a new frontier: e+e- linear colliders. Although Burt did not invent the concept of linear colliders, he recognized the scientific opportunity that they could offer and played a significant role in promoting e+e- linear colliders as the primary choice for the future of high-energy particle physics.

Burt succeeded Panofsky as director of SLAC in 1984. Under Burt's leadership, the SLAC Linear Collider (SLC) was built, the world's first and, to date, only linear collider. The technical challenges were enormous, requiring Burt to personally lead efforts to improve the accelerator operation. The technical developments of the SLC laid the ground work for much of the current discussion about their future use at the highest energies.

Burt's leadership of SLAC was visionary. In the mid 1990s, perhaps his greatest contribution was looking ten to twenty years into the future: he planned for developments in the SLAC infrastructure that have allowed the laboratory to continue first-rate science after high-energy particle accelerators were no longer feasible on the SLAC site. He recognized that pursuing an x-ray Free Electron Laser (FEL) at SLAC, by exploiting a decade of accelerator developments for a future linear collider for particle physics, could provide revolutionary science opportunities in biology, medicine, chemistry, surface physics, materials science, and engineering, drawing users from around the world. Equally important, it would offer a stable home for the tremendous accelerator physics research team that had grown at SLAC under his leadership into one of the foremost in the world. Burt did not flinch from designing a future of SLAC National Accelerator Laboratory that would lead to a dramatic redistribution of power and resources among its primary missions. He demanded outstanding science to drive future opportunities!

After retiring as director of SLAC in 1999, Burt began to focus on climate change and energy issues, encouraging other scientists to do so as well. In 2010, he authored a book for the general reader, Beyond Smoke and Mirrors: Climate Change and Energy in the 21st Century. He was a member of the Department of Energy's Nuclear Energy Advisory Committee and chaired its fuel cycle subcommittee from 2000 to 2013, among other government advisory roles.

Throughout his career, several characteristics consistently enabled both Burt's personal accomplishments as well as those of SLAC. They were his foresight, his energy, and his perseverance. Burt's accomplishments were recognized nationally and internationally with a variety of honors and prizes in addition to his Nobel Prize, including the National Medal of Science, the Fermi Award from the Department of Energy, membership in the National Academy of Sciences, and fellowships of the American Academy of Arts and Sciences and the American Association for the Advancement of Science. He was also a member of JASON, an independent scientific advisory group established in 1960, that provides consulting services to the U.S. government on matters of defense science and technology. Burton Richter earned a high and lasting place in the roster of American scientists and scientific leaders. He passed away on July 18, 2018, at the age of 87.

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