assessments and maintain the pressure to act on climate change.

Cicerone's natural leadership was evident in the scientific problems he pursued or convinced others to pursue. Recognizing societal aspects was a hallmark of his work. His intellect, insight, kindness, and collegiality made him a pleasure to work with. Cicerone's vision of biogeochemistry and global change has altered graduate education internationally and influenced the way many of us approach global-change research. We will miss his regular questions and curiosity about the planet.

Michael Prather
University of California, Irvine
Richard Stolarski
Johns Hopkins University
Baltimore, Maryland

David Ritz Finkelstein

Theoretical physicist David Ritz Finkelstein, professor emeritus at Georgia Tech, died at home in Atlanta on 24 January 2016.

Finkelstein was born in New York City on 19 July 1929. He graduated from City College of New York with honors in both physics and mathematics, and in 1953 he received a physics PhD at MIT, for a thesis supervised by Felix Villars. He worked at Stevens Institute of Technology from 1953 to 1960, at Yeshiva University until 1976, and then at Georgia Tech until his death.

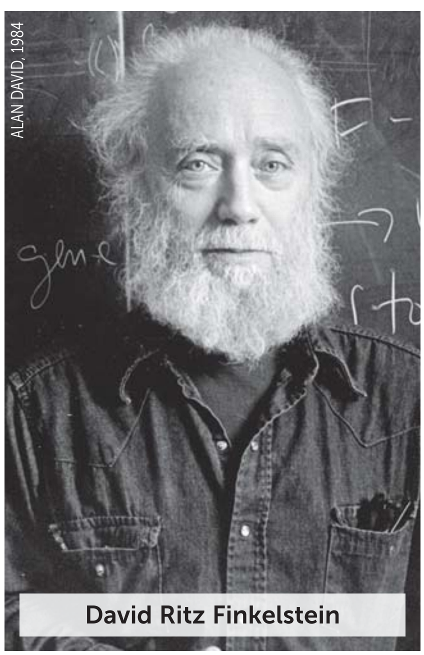
In a 1955 paper, Finkelstein addressed the question of whether an anomalous spin-½ state had been overlooked for the gravitational field. His discovery of the topological origin of such anomalous spins and a speculation that all physical variables may be topological in origin was the thread that led him in the 1950s and 1960s to kinks, the unidirectional membrane, and anyons, antecedents of anomalous quantum numbers in the fractional Hall effect and in high-temperature superconductivity.

A 1957 seminar Finkelstein gave on extending Schwarzschild's metric—a basic ingredient of the current understanding of black holes—was a revelation to Roger Penrose. Afterward, Penrose explained to Finkelstein his spin networks, and for years thereafter the two men exchanged their research subjects. Finkelstein saw quantum spins as a possible route into the quantum nature of reality and took such ideas to unusual depths.

In 1958 Finkelstein was the first to describe what is now known as a black hole—his "unidirectional membrane." The work influenced Lev Landau, Penrose, and eventually John Wheeler, and it was instrumental in bringing general relativity into mainstream physics. Although today it is considered his key contribution, for Finkelstein it was only a step in his overarching program to bring topology into quantum physics. He, together with Charles Misner in 1959 and Julio Rubinstein in 1962, discovered kinks—particles extended over a finite volume rather than concentrated at a point—topological charges, and topological spin-statistics theorems.

Finkelstein was among the earliest scientists to understand the role of quantum vacua, and he wrote some of the earliest papers on solitons in quantum theories. His 1962–63 papers with Josef Jauch, Samuel Schiminovich, and David Speiser were the first to formulate a unified *SU*(2) gauge theory of massive vector bosons and light and thus introduced electroweak unification before Sheldon Glashow, Abdus Salam, and Steven Weinberg. Or, as Finkelstein put it, "I'm afraid I'm another one of the infinite number of people who did the Higgs field before Higgs."

Even while making such seminal contributions to theory, from 1955 to 1971 Finkelstein pursued a parallel career as a plasma physicist. He is remembered as an exquisite experimentalist and was proud of the theory he developed with Rubinstein and James Powell for ball lightning.


ALAN DAVID, 1984

David Ritz Finkelstein

During the summer of 1965, at the height of the civil rights movement, Finkelstein took his family to Mississippi after receiving a temporary NSF–American Physical Society appointment as a visiting scientist with the physics department of Tougaloo College, a historically black school. His efforts as acting department head included expanding the physics program and helping found Public Radio Organization, whose goal was to offer African Americans in central Mississippi unbiased news reporting and a community forum. The courage of the people he worked with in Mississippi influenced him profoundly.

In 1979 Finkelstein became the chair of Georgia Tech's school of physics, with the goal of raising the department to the level of its MIT sister department. When he failed to submit a budget, he was deposed by senior faculty. He soon realized that his failure as an administrator freed him to pursue his dream, so he started his second life, in which he dedicated himself to formulating a universal physical theory consistent with both quantum theory and gravity.

A charismatic mentor, Finkelstein involved numerous dedicated students in his efforts to quantize geometry. In 1946 he'd already realized that while classical logic was commutative, quantum physics was not. Hence, before a correct quantum spacetime theory could be formulated, the foundations of mathematics and logic itself had to be replaced by quantum logic. (For a full exposition, see his *Quantum Relativity: A Synthesis of the Ideas of Einstein and Heisenberg*, Springer, 1996.) A decade ago he reminisced, "When I began my own research I took it for granted that it had three stages: I would first find a theory in which I could at least potentially believe, then compute its consequences, test it against experimental data, and return to stage 1 for an improved version. After about forty years I could not help noticing that I was still in the first stage."

In Sidney Coleman's words, Finkelstein "was a brilliant scientist with a passion for long shots. This meant that nine times out of ten he devoted his talents to ideas that do not pay off, but, one time out of ten, they *do* pay off. When this happened, Finkelstein's work was found to be of a great significance, extraordinary penetration, and ten years ahead of everyone else's, as was the case when topological conservation laws entered the mainstream of quantum field theory."

A few days before his death from idiopathic pulmonary fibrosis, Finkelstein had his laptop in his bed and was still working. He was a man who truly loved life.

Predrag Cvitanović
Georgia Institute of Technology
Atlanta
Leonard Susskind
Stanford University
Stanford, California

Edward Joseph Lofgren

Edward Joseph Lofgren, an innovative builder of particle accelerators, passed away in his residence at Piedmont Gardens in Oakland, California, on 6 September 2016 at age 102. He had outlived the entire first generation of scientists at Ernest Lawrence's Radiation Laboratory (now Lawrence Berkeley National Laboratory). Lofgren will be remembered for his incredible skills in transforming ideas into practical hardware, his close association with Lawrence, and his uncanny intuition about the talents and potential of his Berkeley staff.

Lofgren was born in Chicago to Swedish immigrants on 18 January 1914. He moved with his family in 1927 to Los Angeles, where he grew up during the depths of the Depression. Although he had been admitted to Caltech, Lofgren didn't have enough money to enroll there. By working on various bench jobs, he was able to complete two years at Los Angeles Junior College but still could not afford Caltech. Instead, to complete his education, he transferred in 1936 to the University of California (UC), Berkeley, where a scant five years earlier the first cyclotron had been operated at Lawrence's Radiation Laboratory.

During 1938–40 Lofgren was a research assistant to Lawrence, who saw him as a talented physicist able to transform bold ideas into hardware. Lofgren's first task was to improve uranium hexafluoride ion sources for the calutron, a mass spectrometer that Lawrence had transformed from the 37-inch cyclotron, to separate ^{235}U from ^{238}U. As a result of that work, Lofgren interrupted his graduate studies to contribute to the Manhattan Project efforts of the Berkeley team, first at Oak Ridge to help with the development of the calutron farms and then at Los Alamos to work on detonators in Luis Alvarez's group. Lofgren's research on ion sources, conducted under Lawrence's supervision, became the basis of his thesis for his 1946 PhD from UC Berkeley.

LAWRENCE BERKELEY NATIONAL LABORATORY

Edward Joseph Lofgren

With the initiation of the multi-GeV Bevatron project in 1949, Lawrence invited Lofgren to return to Berkeley Lab. Lofgren was able to demonstrate the phase-stability principle of Edwin McMillan and Vladimir Veksler by changing the RF frequency to match the cyclotron frequency of the particles as they accelerated to relativistic speeds in the 37-inch cyclotron; Lofgren thus made the machine the first synchrocyclotron. Soon after, Lawrence appointed Lofgren as the chief physicist on the project of building the synchrotron. His appointment marked the beginning of the "Berkeley approach" of managing accelerator projects as a partnership between a chief physicist and a chief engineer, who for the synchrotron was William Brobeck.

From 1950 through 1952, most of the laboratory's efforts were diverted to building the ill-conceived Materials Testing Accelerator at the Livermore Laboratory. But with its impending termination, progress on the Bevatron quickly advanced. By the time the Bevatron began operation in early 1954, Lofgren was the leader of both a particle-physics research group, which competed with Owen Chamberlain and Emilio Segrè's group to discover the antiproton, and the accelerator group that was charged with commissioning and operating the Bevatron. Although Lofgren's group lost the antiproton race, it did discover the antineutron in 1956.

Lofgren kept the Bevatron competitive for particle-physics research by initiating a modernization campaign in 1960. It included adding an extraction system that brought the beam to a newly constructed experimental hall. However, by 1970 the machine was nearing the end of its utility for particle physics; the last such experiment ended in January 1971.

To renew the scientific viability of the Bevatron—rechristened the Bevalac—Lofgren and Hermann Grunder headed a project to bring heavy ions 45 meters downhill from the SuperHILAC linear accelerator to the synchrotron, where they would be injected. The new configuration enabled groundbreaking research in relativistic heavy-ion nuclear physics and extensive studies in radiation biology and ion-based cancer therapy for deep-seated tumors.

In 1973 Andrew Sessler appointed Lofgren to be associate director for accelerators at the Lawrence Berkeley Lab. He was responsible for the newly formed accelerator division, which operated the Bevalac and concentrated on high-energy and heavy-ion physics research and advanced accelerator R&D. Lofgren served in that role until his retirement in 1979. It was fitting that Lofgren's final official act at the lab was ceremonially turning off the Bevatron for the last time in February 1993.

Lofgren's many projects included the 200 BeV design study conducted at Berkeley Lab; the study's report formed the basis for the cost estimate and site selection for a new proton synchrotron. To the disappointment of Lofgren and his Berkeley colleagues, their proposal to build the machine near Sacramento was declined in favor of a competing proposal to build the accelerator—with a rather different design—in Illinois at what is now Fermilab.

Understanding how the physical world works was at the core of Lofgren's being. He never grew tired of hearing about new discoveries in physics or explaining physical phenomena, such as how the fog forms in San Francisco, to his neighbors at Piedmont Gardens.

William Barletta
Fermi National Accelerator Laboratory
Batavia, Illinois
Massachusetts Institute of Technology
Cambridge
Jose Alonso
Lawrence Berkeley National Laboratory
Berkeley, California