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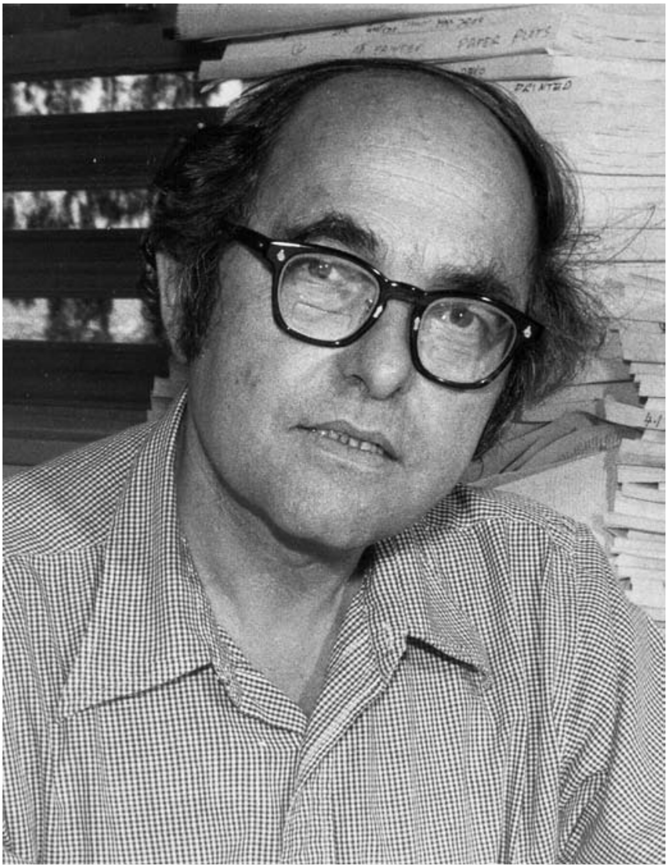
GERSON GOLDHABER
1924–2010

A Biographical Memoir by
GEORGE H. TRILLING

Biographical Memoir



Gerson Goldhaber

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February 20, 1924–July 19, 2010

BY GEORGE H. TRILLING

GERSON GOLDHABER, WHOSE "NOSE FOR DISCOVERY" led to remarkable research achievements that included leadership roles in the first observations of antiproton annihilation, and the discoveries of charm hadrons and the acceleration of the universe's expansion, died at his Berkeley home on July 19, 2010, after a long bout with pneumonia. He was 86.

His father, originally Chaim Shaia Goldhaber but later known as Charles Goldhaber, was born in 1884 in what is now Ukraine. He left school at age 14, and was entirely self-educated after that. He traveled (mostly on foot) through Europe and in 1900 ended up on a ship bound for East Africa. Getting off in Egypt, he developed an interest in archeology, and eventually became a tour guide at the Egyptian Museum in Cairo. He returned from Egypt to his parents' home in Ukraine every Passover, and, in 1909, married there. His wife, Ethel Goldhaber, bore three children (Leo, Maurice, and Fredrika, always known as Friedl) in 1910, 1911, and 1912, respectively. After the end of World War I, the family moved to Chemnitz, Germany, where they operated a silk factory business, and where Gerson was born on February 20, 1924. By the time the Nazis took power in 1933, many of their relatives, including Gerson's grandparents, had moved to Chemnitz, and he grew up in a loving family environment. Sadly, a large proportion of these relatives eventually perished in Nazi camps.

Fortunately, Gerson's parents with their oldest and youngest sons, Leo and Gerson, left soon after the Nazi takeover and arrived in Cairo, where Gerson's father set up a large tour guide service. The middle son, Maurice, had been studying physics in Berlin since 1930 and, after the Nazi takeover, moved to Cambridge, England, where he completed his graduate education. Maurice then moved to the University of Illinois in 1938 and subsequently to Brookhaven National Laboratory. He has had a distinguished career, receiving the Wolf Prize and serving as Brookhaven's director. As of this writing, in September 2010, Maurice at age 99 is the only one of the four siblings still living. The only woman among these siblings, Friedl, left Chemnitz in the early 1930s, spent several years in Vienna, where she married and, in 1937, moved with her husband to Palestine where she lived the rest of her life.

Gerson left Egypt to attend Hebrew University in Jerusalem in 1942. His parents and oldest brother stayed in Egypt until 1947, at which time they also moved to Jerusalem. In 1949, the parents came to the United States and in the last few years of their lives settled in Berkeley. Gerson received an M.Sc. degree from Hebrew University in 1947 and subsequently went to graduate school at the University of Wisconsin in Madison, where, in 1950, he was awarded a Ph.D. degree in physics.

In Jerusalem, Gerson met Sulamith Low, then a chemistry student, and, in 1947, she became his wife. She also earned a master's degree in 1947 at Hebrew University and a Ph.D. in nuclear chemistry from the University of Wisconsin. Gerson and Sula had one son, Amos Nathaniel (commonly known as Nat), presently a successful venture capitalist in Berkeley.

In his thesis research at the University of Wisconsin, Gerson developed a technique to measure gamma-ray spectra from excited nuclei using photographic emulsion with a heavy (50 percent by weight) loading of D_2O. This technique permitted the observation of proton recoils produced by deuterium photodisintegration, and provided a measure of the gamma-ray energy. Remarkably, deuterium photodisintegration was first considered and observed by Gerson's brother Maurice and James Chadwick in 1934.

Gerson became an instructor at Columbia University in 1950, and his research efforts took a large leap upward in energy. Using pion beams in the ~100 MeV energy range produced by the 340 MeV Nevis cyclotron, with G. Homa and L. M. Lederman, he studied pion-nucleon interactions, again using photographic emulsions. Unfortunately, the pion beam energies chosen caused him and his collaborators to just miss discovering the (I = 3/2, J = 3/2) pion-nucleon resonance.

In 1953, Gerson became a U.S. citizen and moved to the University of California, Berkeley, first as an acting assistant professor, and in 1954 a regular assistant professor. Advancing through the ranks, he became a tenured associate professor in 1958 and full professor in 1964. He was also appointed faculty senior scientist at what is now the Lawrence Berkeley National Laboratory (LBNL). He retired in 1991 but remained as a professor in the graduate school, extremely active in research until he became ill with pneumonia in 2008.

In Berkeley, Gerson's research took another upward leap in energy, focusing on beams from the newly completed 6.2 GeV Bevatron. His wife, Sula, shifted into physics and became his close collaborator. One of Gerson's senior colleagues wrote about him at that time that "he has been helped indefatigably by his wife Sulamith who is a passionate worker and pushes continuously on her husband." Gerson played a major role in establishing the antiproton identity of the negative particles, of mass equal to the proton mass, whose existence had been established by the Nobel Prize experiment of Chamberlain et al.[1] Using photographic emulsions, Gerson, Gosta Ekspong, and colleagues followed an antiproton candidate to rest, establishing from its range that its mass was close to that of the proton, and then determined conclusively that the energy released in the form of newly created pions and nuclear fragments exceeded significantly the rest energy of a proton. This established the process of annihilation of an antiproton with a proton or neutron, and demonstrated unequivocally that the negative particles of proton mass observed in the initial electronic experiment were indeed antiprotons.

Further experiments by Gerson and colleagues in photographic emulsion and in a propane bubble chamber provided much more quantitative information on the annihilation process. One interesting aspect came in the study, done in collaboration with Sula and graduate student Wonyong Lee, of pion-pion correlations involving the final-state annihilation pions. It was observed that the distribution of angles between like-charge pions differed markedly from that between unlike-charge pions. The explanation, provided with the help of theorist Abraham Pais, lay in the effect of the Bose-Einstein statistics obeyed by pions. (As an aside, it might be mentioned that Wonyong Lee subsequently had a distinguished career at Columbia University, and that his son, Adrian Lee, is now a faculty member of the Berkeley physics department.)

Gerson, in collaboration with Sula and many colleagues, also made numerous exploratory measurements of K-meson (now called kaon) properties, such as mass, lifetime, and interaction behavior. Initially this work was done with photographic emulsions. More detailed K^+-nucleon inelastic scattering studies were done in collaboration with a UCLA group led by Harold Ticho, using the newly built 15-inch hydrogen bubble chamber. Measurements at higher kaon-beam energies were done by Gerson, with William Chinowsky and collaborators, using the 20-inch hydrogen bubble chamber at Brookhaven National Laboratory. One notable result from that work was the determination of the K* resonance spin to be 1.

In a 1963 LBNL reorganization, Gerson, Sula, and their postdocs and students joined me (G.T.) and my colleagues to form a new research group, the Trilling-Goldhaber group (TG), which worked together until 1989. Its accomplishments during that period resulted in large part from Gerson's extraordinary insight into where to look to find important new science. In 1965, there was another important but tragic event: in the course of a visit to India, Sula suddenly died from a previously undetected brain tumor. In 1969, Gerson married Judith Margoshes Golwyn, a science writer, playwright, and poet. They became the parents of two daughters: Michaela, now a theater director and playwright in Berkeley and New York, and Shaya, now a cinematic makeup artist in the San Francisco Bay area.

Gerson and collaborators from the TG group continued the detailed study of K^+-nucleon interactions with K^+ beams of momenta between 800 and 1600 MeV/c, using the new Berkeley 25-inch hydrogen bubble chamber. This work yielded rates and mass spectra for resonant states produced in these collisions with excellent statistical precision. There was also work at much higher energies using the 72-inch bubble chamber at the Bevatron and later its reincarnation as the Stanford Linear Accelerator Center (SLAC) 82-inch bubble chamber. An important result from the Berkeley running was the first observation of destructive interference between ω and ρ^0 decays. The SLAC running, with 12 GeV/c K^+ incident on the deuterium-filled 82-inch chamber, led to the production and identification of an anti-Ω particle, the first ever observed.

By the early 1970s, it was becoming clear that the group had gone about as far as it could in the bubble chamber study of kaon-nucleon interactions over a large range of energies. In a move toward a completely new direction pushed largely by Gerson, a collaboration was formed that included, beside our TG group, William Chinowsky from Berkeley and the SLAC groups headed by Burton Richter and Martin Perl, to study high-energy electron-positron collisions from the newly constructed storage-ring/collider SPEAR. This collaboration became known as the SLAC-LBL collaboration. We (the TG group) helped build the Mark I detector, and then worked with our new collaborators on the analysis of the data. Gerson immediately moved to understand the new type of data, very different from the bubble chamber output that he was used to. He had an important role in the decision-making leading to the November 1974 data run that produced the discovery of the J/ψ , the first identified hadron state containing both a c-quark and c-antiquark, establishing the existence of the fourth (c, or charm) quark, and completing the second quark generation. In 1976, Gerson and François Pierre produced the first data analyses demonstrating the existence of charm hadrons, that is, hadrons with nonzero value of the charm quantum number (hence containing only a single c-quark or a single c-antiquark). It is also worth mentioning here the discovery by the same collaboration, achieved under the leadership of Martin Perl, of the τ lepton. In 1977, in recognition of his achievements, Gerson was elected to the National Academy of Sciences and chosen California Scientist of the Year. In 1983, he was elected a foreign member of the Royal Swedish Academy of Sciences and, in 1991, a fellow of the American Academy of Arts and Sciences. François Pierre and Gerson were jointly awarded the Panofsky Prize of the American Physical Society in 1991 "for the discovery of charmed particles."

The SLAC-LBL collaboration, eventually augmented by participation from other institutions, continued the study of electron-positron collisions, using a newly built and more powerful detector (Mark II), and extended the effort to the higher energies (30 GeV CM energy) made available by the turn-on in the early 1980s of the PEP storage-ring/collider at SLAC. This energy increase made possible the observation of yet another more massive quark, the b-quark, previously discovered by Lederman and colleagues at Fermilab.[2] One of the main results of the PEP research effort was the discovery of the relatively long lifetimes of B-hadrons. This work was led by our SLAC colleagues John Jaros and Nigel Lockyer,[3] and a similar result was simultaneously obtained by the MAC collaboration at PEP with William Ford as the leader of that analysis.[4] This result subsequently had important positive implications for the feasibility of the B-hadron CP-violation studies later carried out successfully in the BaBar and Belle experiments.

With the observations at CERN of the W and Z bosons by C. Rubbia and collaborators,[5] the electron-positron CM energies of potential interest rose to at least 100 GeV. With such an energy it would be possible to study in detail the resonant production of the Z boson and its decay modes. This was the motivation for construction of the LEP Collider at CERN, and it was also the physics motivation for the development and construction of the SLAC Linear Collider (SLC), under the leadership of Burton Richter. The Mark II detector was the first at the SLC, and one of its important early results was to provide strong evidence that the total number of light-neutrino generations was just the three already known.

Gerson's scientific activities during this period were not confined to research. During the 1980s, he and Robert Cahn wrote the textbook *The Experimental Foundations of Particle Physics*, published in 1989 by Cambridge University Press. Each chapter of this text consists of an explanatory discussion of a particular development in particle physics, followed by reprints of the important discovery papers, followed by numerous homework exercises. This text has found considerable use in university particle physics courses. A second edition, with substantial additions to bring it up to date, was published in 1999.

At the end of the 1980s, my professional partnership with Gerson ended when he chose to move to a completely different area of physics, namely cosmology. He joined the LBNL Supernova Cosmology Project (SCP). It is of interest to quote from Gerson's personal accounts his description of how he became interested in SCP.

> In 1989, as I was thinking about my next experiment, I was invited by Carl Pennypacker to join in the search for the discovery of the "Fate of the Universe" in what was at that time called the "Deep Supernova Search."[6]

> The subject appealed to me, as did the proposed technique, since it involved evaluating images. Evaluating images is something I have been doing throughout my physics career, beginning with emulsions in the 1950s, to bubble chambers in the 1960s, to computer-reconstructed particle events in the 1970s and 1980s. Thus, the supernova experiment with its computer-reconstructed optical images, seemed to be a nice fit with my experience and inclinations.[7]

The team that Gerson joined was led by Berkeley physicists Carl Pennypacker and Saul Perlmutter, working within Richard Muller's research group. By 1992, on Gerson's recommendation, Saul was also appointed the group leader, and the project became known as the Supernova Cosmology Project. The team was studying exploding stars known as supernovae. Their interest in supernovae arose from the fact that, for an identifiable class of such supernovae (type Ia), the intrinsic luminosity (after some appropriate corrections) was expected to be the same from supernova to supernova (hence, the descriptive term “standard candle”). Thus the actually observed luminosity of such a supernova provided a measure of its distance from earth. The idea then was to study the relation between each supernova’s distance and its red-shift value (z), which indicated how much the universe had expanded since the observed light originated. This relation could be expected to verify how fast the expansion of the universe was slowing down, and whether the mass density had the expected (from inflation theory) critical value in which the expansion would continue ever more slowly, tending asymptotically to a zero expansion rate.

The data-taking procedure, as described in Gerson’s personal account, was as follows:

> In brief, the method involves taking reference images and discovery images three weeks apart…Saul chose the three-week time interval judiciously with regard to the phases of the moon. All measurements are made during “dark time,” since the distant supernovae are too dim to take measurements during the bright period of the moon.

Saul Perlmutter played the major role in developing this procedure and the subsequent analysis techniques to the point of success.

In 1992, the LBNL group found its first supernova, which at the time was the most distant supernova ever observed. In 1997, the team published a paper based on seven observed distant supernovae, which seemed to exhibit the behavior expected for the mass density having the critical value expected from inflation theory.

The statistics of seven events are small, and the study of a greatly increased number of supernovae yielded a very different result. In late 1997, an analysis of data based on 38 (soon after, 42) supernovae, in which Gerson played an important role, showed that the supernovae were fainter than expected, indicating the extraordinary conclusion that the universe's expansion was accelerating rather than slowing down. This surprising conclusion was independently reached by a competing research group, the High-z Supernova Search Team,[8] and has subsequently stood the test of time, repeatedly bolstered by complementary measurements from many sources, such as the cosmic microwave background (CMB) experiments. *Science* selected the discovery of the universe's accelerated expansion as the Breakthrough of the Year 1998. In summary, the universe's mass density is about 30 percent of what had been expected, and the remaining 70 percent of the energy density needed for a flat universe, that gives rise to the accelerated expansion, is called "dark energy." There is now a large international program exploring dark energy.

So far, this memoir has concentrated on Gerson's considerable scientific accomplishments, but he had other important talents. Starting during the lonely time following his first wife's death, he developed an interest in artwork and became an excellent watercolorist. In his later years he made numerous watercolors and gave many to his friends on various occasions. I still treasure the one he gave me on my 60th birthday. He illustrated two lovely books of poems written by his wife, Judith: *Sonnets from Aesop*[9] and more recently *Sarah Laughed*,[10] each containing more than 100 poems and a watercolor illustrating each poem. The first of these books won the Independent Publishers Book Award as one of the 10 best books published by an independent or university press in 2005.

This brings us to the last few years of Gerson's life. Judith, his wife, has written an extremely moving account of that part of their life affected by his health problems. These problems began with an almost deadly bout of pneumonia in London, coincident with the events of

September 11, 2001. He recovered, but scars remained in his lungs. In March 2008 after returning from memorial services held at the University of California, Riverside, for his former graduate student, Benjamin Shen, he again developed a life-threatening bout of pneumonia. After many weeks, first in intensive care and then in rehabilitation centers, Gerson came home hoping to be on the road to recovery. Quoting directly from Judith's account, "Gerson's Last Days":

> I won't go into detail about the various recurrences of pneumonia that began around Thanksgiving 2008, and the subsequent emergence of other illnesses involving Gerson's heart, kidneys, immune system, skin, eyes, ears, and just about every other human organ except, thankfully, his brain. Each illness and hospitalization left him weaker, and with more medicines and procedures to contend with. However he was always himself. There was never a more patient patient. I never heard him speak harshly or impatiently to myself, the children, or any caregiver…His final hospitalization, for still another pneumonia, complicated by congestive heart failure, began in May 2010, a few days after Mother's Day…This time, however, there was no talk of rehab centers, physical therapy, return to normal life, or further treatments. We were told that our choices were a skilled nursing facility or home. So we took him home…Gerson seemed to revive again as soon as he came home, and lived for another month. He had no pain at all, just weakness and tiredness so extreme that he had to be helped with everything, from eating his meals to moving from the bed to the wheelchair.[11]

Gerson passed away on Monday, July 19, a little after 11 a.m.

Gerson Goldhaber surely ranks as one of the most productive experimental physicists of the 20th century. Unlike many other experimentalists, his strength did not lie in the development of new instrumentation. Instead, it lay in his uncanny ability to recognize, in even imperfect experimental data, the hints of potentially new and interesting behavior. He was relentless in pursuing these hints, making effective use of computer analysis, until their origins were well understood. Much of the time these pursuits led nowhere interesting, but on a few all-important occasions they led to great discoveries. Put more bluntly, Gerson had an extraordinarily sensitive nose for digging out new scientific discovery. One of his favorite activities was to look at plots showing measured populations as a function of some physical quantity. More than once he thereby discovered unexpected peaks whose interpretation led to important new knowledge. Gerson's choice of scientific directions to pursue was very much influenced by his "nose for discovery." His moves into e^+e^- collisions in 1970 and supernova cosmology in 1989 turned out, in hindsight, to be the best possible discovery directions.

Gerson was not only an outstanding scientist; he was also a wonderful human being. He had great concern for human rights. In our 25-year collaboration I never saw him get angry. He mentored 23 Ph.D. students, many of whom had distinguished subsequent careers. It was also important to him that credit be properly assigned for important scientific accomplishment. He always insisted that, in collaborative papers, the researchers principally responsible for the work be listed first in the author list of the publication. Gerson's passing is a large loss to all of us who knew him, and a great loss to science.

Gerson is survived by his wife, Judith; his son, A. Nathaniel; his daughters, Michaela and Shaya; and his grandsons, Sam, Ben, and Charles. As mentioned earlier, he is also survived by his older brother, Maurice.

In preparing this memoir I have received valuable information and insights from Gerson's widow, Judith; his nephew, Michael Goldhaber; and his colleagues and collaborators, Robert Cahn and Saul Perlmutter.

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