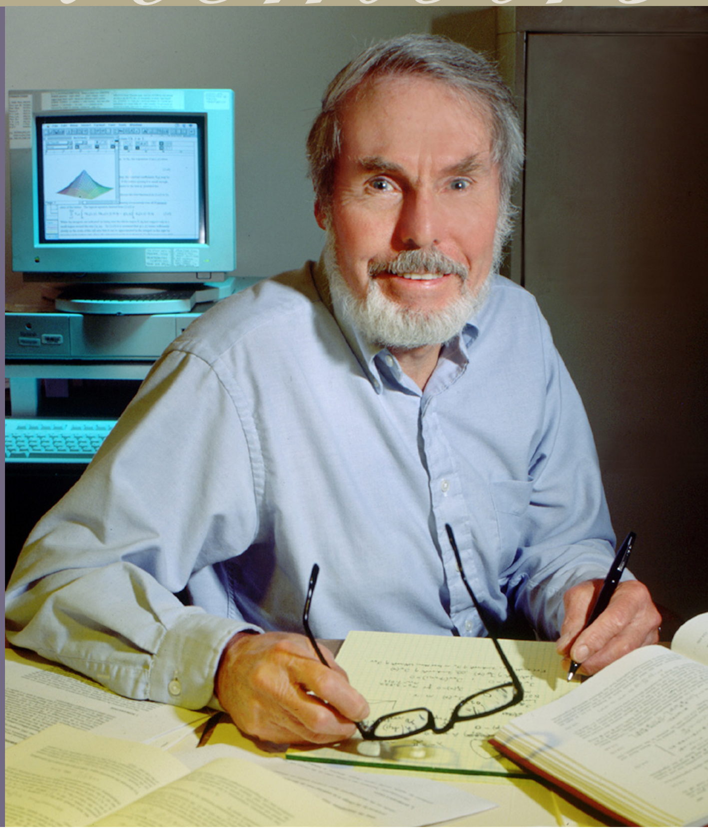
# J. David Jackson

1925–2016

BIOGRAPHICAL *Memoirs*



*A Biographical Memoir by*
*Robert N. Cahn*

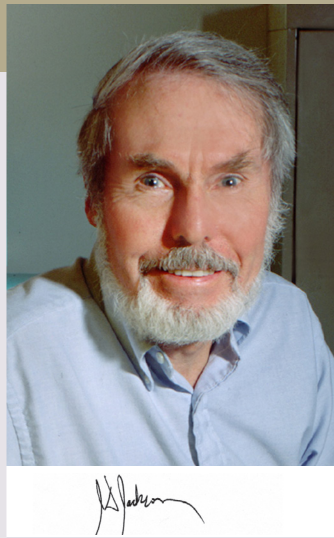


NATIONAL ACADEMY OF SCIENCES

# JOHN DAVID **JACKSON**

*January 19, 1925–May 20, 2016*

Elected to the NAS, 1990



*By Robert N. Cahn*

John David ("Dave") Jackson, a Canadian-born theoretical physicist, contributed significantly to particle, nuclear, and atomic physics. He is best known, however, for his text *Classical Electrodynamics,* which has been a fixture in physics graduate education around the world for more than 50 years. It is generally referred to simply as "Jackson." This textbook, which has inspired fear and wonder alike in generations of students, clearly reflects the author's fascination with physical phenomena, his renowned mathematical dexterity, and his appreciation of the elegance of physical laws.

Jackson's major contributions to research included the theory of muon-catalyzed fusion; the analysis, with Kurt Gottfried, of angular distributions in quasi-two-body elementary particle collisions; and the elucidation of charmonium-state decays. Jackson influenced the development of physics research throughout the United States as well as internationally—particularly through his work on the nascent Superconducting Super Collider. An active promoter of civil liberties and human rights, he was one of the leaders of the efforts to free Andrei Sakharov, Yuri Orlov, and Anatoly Shcharansky from Soviet imprisonment.

## Early years

Dave was born in London, Ontario in 1925. His father, Walter David Jackson, ran London's Western Fair Association and was elected to the Canadian Agricultural Hall of Fame; his mother, Lillian Margaret Jackson, had been a schoolteacher before her marriage. After attending local schools in London, Dave entered the University of Western Ontario in 1942. The physics curriculum there was nearly devoid of quantum mechanics, but it was strong in electromagnetism and mathematics. His first exposures there to Fourier series and expansions in orthogonal functions left their mark.

## MIT

Dave did his graduate work at MIT, a big step up from Western Ontario. Dave reflected, "In later life, I learned that prominent universities occasionally take a chance on admitting a student from an obscure institution. Evidently, I was one of those." In June 1946, the young graduate student sat down with Julius Stratton, the author of the 1941 classic *Electromagnetic Theory* and future president of MIT, who proposed what Dave described as "a small problem on radiation pressure." Dave returned with the solution the following day.

Dave Jackson in 1943, as a student at Western Ontario, taking data on magnetic hysteresis.

The lacunae in his background were quickly filled in, especially through Victor Weisskopf's course in quantum mechanics. John Blatt, whose collaboration with Weisskopf would later produce the classic book *Theoretical Nuclear Physics*,[1] was then a postdoc. When Dave became a member of Weisskopf's group, Blatt provided direct oversight for him.

For his thesis, Dave studied low-energy neutron-proton scattering, comparing to data by means of the effective range approximation

$$k \cot \delta = -\frac{1}{a} + \frac{1}{2} r_0 k^2$$

where $k$ is the momentum, $a$ is the scattering length, $\delta$ is the phase shift, and $r_0$ is the effective range of the potential. The essential point of this expression, which was developed by Julian Schwinger, is that low-energy scattering cannot distinguish more than the two parameters $\alpha$ and $r_0$ and, in particular, cannot distinguish detailed potential shapes. Using this formalism, Jackson and Blatt published papers on both n-p and p-p scattering. While Dave entered the equations in his thesis by hand, the text was typed by his fiancée and future wife, Barbara Cook.

## McGill

In a decision he later attributed to "foolishness and [Canadian] chauvinism of youth," in leaving MIT, Dave chose an assistant professorship at McGill University over a postdoc position offered by Hans Bethe at Cornell University. Theoretical physicists at McGill were assigned to its Department of Mathematics, the consequence of a decree from Ernest Rutherford during the time he was at the university. A heavy teaching load limited the opportunities for research, but still had its benefits. Among Dave's students was Kurt Gottfried, doing a master's thesis before moving on for a Ph.D. at MIT; Dave later collaborated with Gottfried in some of Dave's most important work. Other students from his time at McGill included Seymour Vosko, a condensed matter theorist; and Hubert Reeves, an astrophysicist.

While at McGill, Dave and his student Harry Schiff solved a problem in atomic physics that exemplified Dave's taste and talents. The standard calculation of the probability that a proton passing by a hydrogen atom will capture the atom's electron had been done in 1930, but it disagreed with data available in 1952. Dave identified neglect of the interaction between the two protons as the cause of the discrepancy. This new contribution led to a nasty integral, which he insisted on evaluating analytically. This he realized could be achieved by adroitly adapting a trick that Richard Feynman had invented for four-dimensional integrals, to the three-dimensional challenge at hand. The final expression, replete with peculiar rational numbers and odd transcendental functions, agreed perfectly with the data, and the Jackson-Schiff paper on this work is cited frequently to this day. A well-posed problem, a firm understanding of the basic concepts of theory, and an exceptional talent for calculation: these were the mark of Dave's early work and his subsequent papers over the next sixty years.

## Princeton: Muon-catalyzed fusion and beta decay

A Guggenheim Fellowship in 1956–1957 gave Dave the chance to spend a sabbatical in a more intense research environment: Princeton University. The best stimulus, however, arrived at his doorstep on December 29, 1956. The front page of the *New York Times* declared, "Atomic Energy Produced by New, Simple Method. Coast Scientists Achieve Reaction Without Uranium or Intense Heat – Practical Use Hinges on Further Tests." A team at Berkeley, led by Luis Alvarez, had observed muon-catalyzed fusion, $\mu^- pd \rightarrow He^3 \mu^-$, in a bubble chamber.[2]

Dave's response was to develop a comprehensive treatment of this process based on the faster and more promising fusions of *dd* and *dt*. He found that the *Times* had been too optimistic. No further tests were needed to conclude that this was not an inexhaustible supply of energy because about one in 100 of the fusions resulted in the outgoing muon being captured by the newly formed helium nucleus and thus rendered impotent before it could generate enough energy to compensate for the energy required to produce the muon initially. By January 5, 1957, a draft of Dave's article was on its way to Luis Alvarez, and five days later the manuscript was sent to the *Physical Review*.

The next month, it was the *Physical Review* itself that provided the exciting news: parity violation in weak interactions. The $^{60}Co$ experiment of C. S. Wu et al.[3] showed that both parity (P) and charge conjugation invariance (C) were violated, and that time reversal invariance (T) might also be violated in beta decay. Sam Treiman and William Wyld, both then at Princeton, invited Dave to join them in the calculation of possible time-reversal effects, which would be exhaustive in considering the combinations of scalar, pseudoscalar, vector, axial vector, and tensor interactions. Less than three weeks after Dave's submission of the muon-catalysis paper, this team's determination of all possible T-violating effects in beta decay was also submitted to the *Physical Review*.

At the same time that Dave's research was beginning to have a significant impact, two lasting preoccupations also began: the writing of books and summer-school lectures. Lectures that he gave in Alberta, Canada, in August 1957 became the basis of a deceptively thin book, *The Physics of Elementary Particles*. Despite a disclaimer that this was "an introductory account of elementary particle physics with a minimum of formal apparatus," it was a thorough review of what was known at the time—rather complete on beta decay and weak interactions, necessarily primitive in its treatment of the strong interaction. Dave's increasing visibility led to an offer by the University of Illinois at Urbana-Champaign, which became the home of the Jackson family—Dave, his wife Barbara, and their children Ian, Nan, Maureen, and Mark—from 1958 to 1967.

## Classical Electrodynamics

The first edition of *Classical Electrodynamics* (with its distinctive dark green cover familiar to physics graduate students of the 1960s and 1970s) came out in 1962, while Dave was at Illinois, but much of the book's content came from his time in Montreal. Bill Wyld, who had come to Illinois at the same time as Dave, carried bound volumes of the notes from Dave's course in electromagnetism at McGill. When Dave returned to teaching the electromagnetism course, the McGill notes became the basis for the book.

Through its three editions, the basic structure of the text remained constant: electrostatics, magnetostatics, then the Maxwell equations; plane waves, wave guides, then simple radiating systems; relativity, charged-particle collisions, then a complete treatment of radiation. Nevertheless, a very significant evolution occurred between the first edition and the third, which came out in 1998. The growth from 641 to 806 pages disguised the true growth because the third edition had much larger pages. Perhaps more apparent to students, there were about twice as many problems in the third edition than in the first. And what problems! At a 60th birthday celebration, Dave was regaled by a recording made by physics graduate students from Cornell, intoning their version of a song from *The Sound of Music*, with the opening line "How do you solve a problem out of Jackson in any less than geologic time?" Less determined students can now find solutions to the Jackson problems online. Before the Internet, students and faculty frequently requested that he publish his own solutions but he summarily rejected these requests. Having someone do the problems for you, he reasoned, would be like having someone take a hike in the mountains for you: you would miss all the pleasure that would come from your own exertion and accomplishment.

Many a student surmised that Jackson must have had an inordinate fondness for Bessel functions. This conclusion was correct. For Dave, special functions were things of beauty to be treasured by those with the proper aesthetic sensibilities. Indeed, there were treatises on Bessel functions on his shelf and a reproduction of a German postage stamp honoring Bessel on the wall of his office. But too many students failed to see that "Jackson" was not a text about mathematical functions but about nature. The first edition reflected Dave's own research interests. Plasma physics, for example, was included; it had been the topic of two summers of research in Los Angeles and the basis of his only paper coauthored by Murray Gell-Mann. Similarly, bremsstrahlung, radiative beta decay, and energy loss by swiftly moving charged particles were not obvious topics for a text on classical electrodynamics, but being of particular interest to Dave they provided the opportunity to show how classical arguments provide a basis for understanding quantum-mechanical phenomena.

The later editions were enhanced by Dave's continuing exploration of electromagnetic phenomena in nature and in technology. Thus he included the study of Schumann resonances by treating the space between the Earth's surface and the ionosphere as a cavity; he explained Alfvén waves in the ionosphere itself; he explored the propagation of light in multimode optical fibers; and he derived how undulators and wigglers work in synchrotron light sources.The dust jackets of the second and third editions featured pictures—including the sunrise over the Illecillewaet Glacier in Glacier National Park, British Columbia,

and the three peaks of Nilgiri in Nepal—that Dave himself had taken on hikes with his daughter Nan. These editions also contained more reflections on everyday observations from nature, such as why the sky is blue and why sunsets are red. The explanations are given, together with a detailed plot of the spectrum of sunlight in different circumstances. "The reader may meditate on the fundamental question of biological evolution on this water-soaked planet, of why animal eyes see the spectrum from red to violet and of why the grass is green." So suggests the author in the text that accompanies plots showing the index of refraction and the absorption coefficient for water from $10^2$ Hz to $10^{22}$ Hz.
These editions also reflected Dave's growing interest in the history and foundations of physics. When is classical electrodynamics applicable? How well is it established that the photon is massless? His admiration for the galaxy of greats—in addition to the traditional list of Faraday, Ampère, Maxwell, et al., his personal heroes L. H. Thomas and Ludvig Lorenz (not Hendrik Lorentz, a traditional hero)—was apparent in the explanations of their contributions.

## CERN

Dave's 1963–1964 sabbatical at CERN (Conseil Européen pour la Recherche Nucléaire) initiated a long-term connection with this laboratory, which was and is the center of European high-energy physics. Kurt Gottfried was at CERN at the same time, and he and Dave attacked the problem of "quasi-two-body scattering"—collisions resulting in the production of two particles that subsequently decay, producing a multiparticle final state. The challenge was to understand the strong interaction mechanism responsible for the scattering, and the idea was to use the angular distributions of the final state particles to infer its nature. The tools were the helicity formalism of Maurice Jacob and Giancarlo Wick[4] and its extension by Wick and Larry Trueman.[5] The resulting technique became the standard for all subsequent analyses of this sort.

The basis for the Gottfried-Jackson analysis was the hypothesis that if the momentum transfer was small, the collision of initial particles must be glancing—at the edge of the particles that is to say, peripheral. The relatively long-distance interaction should then be dominated by the exchange of light particles. A subsequent Gottfried-Jackson paper[6] evaluated the effect of more central collisions, which resulted in absorption of the incident beam and affected the distribution in momentum transfer.

## Strong Interactions and Teaching

In the 1960s there was a convincing theory for electromagnetism (quantum electrodynamics, or QED) and an impressive phenomenological theory for weak interactions (an updated version of Fermi's theory of 1934). But strong interactions remained a hard nut to crack. Among the few believable tools was the apparent analyticity of scattering amplitudes. In some instances, analyticity could be proved, in other instances conjectured. A major development was the realization by Tullio Regge that one could consider the partial-wave amplitudes—the amplitudes of fixed angular momentum—to be analytic functions of the angular momentum variable, *l*, with poles (Regge poles) in the *l* plane.[7] This development was perfectly aligned with Dave's delight in special functions and complex analysis.

**Dave and Barbara Jackson in Berkeley, 1973.** (Photo courtesy of Maureen Jackson)

After leaving Urbana-Champaign for the University of California, Berkeley, in 1967, Dave regularly taught a course on particle physics. It featured many of the topics in which he had been directly involved and culminated in current topics in Regge theory. In this endeavor, he was in his element. One day, staring up at the blackboard filled with contours in the complex plane and formulae from *Higher Transcendental Functions* by Erdélyi et al.,[8] he paused, sighed, and said just loud enough for the class to hear, "Born a century too late!" Many of Dave's students (Jack Donohue, Gerald Hite, and Gordon Kane at Illinois, and Chris Quigg, Rick Field, and the present author at Berkeley) were trained in this period when his focus was on the strong interactions. Berkeley was a stronghold for such work, with Geoffrey Chew as visionary leader and Stanley Mandelstam as brilliant innovator. Dave's teaching wasn't confined to the classroom or his book. He was the author of a long list of summer-school lectures, which were intended as instruction for students. In 1960 at Edinburgh, for example, he provided an "Introduction to Dispersion Relation Techniques." In 1962 at Brandeis, it was a 150-page discourse on weak interactions. At Les Houches in 1965, he lectured on "Particle and Polarization Angular Distributions for Two- and Three-Body Decays," and also on "Peripheral Interactions," topics that he and Gottfried had developed.[9] Returning to Edinburgh in 1973, he provided an "Introduction to Hadronic Interactions at High Energies," treating the new topic of "inclusive reactions," wherein only one of the many particles in the final state is observed.[10]

In 1972, the National Accelerator Laboratory (not yet Fermilab) in Batavia, Illinois, was just beginning its experimental program. A pioneering spirit pervaded the laboratory under its director, Bob Wilson. Dave volunteered to spend a year as the leader of the fledgling Theoretical Group, which included a strong team of young physicists. Marty Einhorn, together with Dave, instituted a weekly Friday afternoon meeting designed to bring experimenters and theorists together. To ensure good attendance, wine and cheese were provided. The Wine and Cheese seminar was a great success and continues to this day.

## The J/ψ particle: The November revolution and its aftermath

Dave was captivated from the outset by the discovery of the J/ψ particle, the lowest-energy ($J^{PC}=1^{--}$)-bound state of a charmed quark and anti-quark. Alerted by Berkeley colleagues the afternoon of Sunday, November 10, 1974, he worked furiously to understand this remarkable resonance observed at the SPEAR electron-positron collider at SLAC. (That the same particle had been observed by Sam Ting's group at Brookhaven in a very different experiment was unknown to anyone outside that group.) The observed width of the resonance was remarkably small, about 2 MeV, consistent with the energy spread of the colliding beams. But applying the standard tools of his nuclear physics training to the available data, including the relative frequency of mu-pair and hadronic final states, by Monday Dave concluded that the true width was about 50 keV. He was unable, however, to persuade the experimental team to include this astonishing result in the paper[11] announcing the discovery.

The two-body system of a charmed quark and its anti-quark, charmonium, turned hadronic physics into atomic physics. Dave applied the well-known Thomas-Reiche-Kuhn sum rule,[12] as well as the more obscure Kirkwood-Wigner sum rule,[13] to infer upper and lower limits for the radiative widths of p-wave charmonium states decays to the J/ ψ and the total widths of the same p-wave states.

## Superconducting Super Collider

Among the many leadership positions Dave held, including Chair of the Berkeley Physics Department (1978–1981) and Associate Director and Head of the Physics Division at the Lawrence Berkeley Laboratory (1982–1984), none so well matched his scientific talents as being Deputy Director for Operations of the Central Design Group of the Superconducting Super Collider (1984–1987). During this period, while carrying out his management responsibilities, he wrote notes on many aspects of the SSC magnets, as well as on heating by synchrotron radiation from the highly relativistic proton beams, on copper plating of the beam tube, and on power-supply failures. He oversaw the creation of the Conceptual Design Report[14] and was himself a major contributor to the document, which ran to 2,000 pages. His earliest contribution to the project was coining the name "Superconducting Super Collider." He came up with that name while serving as a member of the *High Energy Physics Advisory Panel*, which in 1983 concluded that the ongoing effort to build the 800-GeV center-of-mass Colliding Beam Accelerator should be ended and replaced by the design of a much-higher-energy machine.

## Style and history

It was characteristic of Dave to eschew fancy formulations and instead rely on fundamentals. A good example was his derivation of the energy dependence of gravitational scattering at small angles. Motivated by Gerard 't Hooft's tour de force calculation of the effect at ultra-high energies, obtained by gluing together two flat space-times separated by a gravitational shock wave, Dave considered the scattering at all energies.[15] A classical treatment using the relativistic Lagrangian obtains 't Hooft's result at ultra-high energies and shows how a surprising factor of four relates it to the totally non-relativistic result. A quantum-mechanical treatment using the Glauber approximation in impact parameter space then reproduces 't Hooft's scattering amplitude, but again extended to cover all energies.

A meticulous editor himself, Dave was the scourge of any editors—or indeed, physicists—who failed to meet the proper standards. He served as editor of *Annual Reviews of Nuclear and Particle Science* from 1977 through 1993, living up to Feynman's description of editors in his account of the Challenger inquiry as people "who changed all my *which*es to *that*s and all my *that*s to *which*es".[16] On one occasion Dave felt compelled to address the editors of *Physical Review Letters*, threatening to write to the ruling powers of the American Physical Society "about the leaky sieve that you call refereeing, languorous and gutless editors, and other relevant matters." On another occasion[17] he wrote "The paper…is the trigger for the release of my pent-up annoyance at the laziness of authors who, when reinventing the wheel, fail to bother to give credit to the cavemen who preceded them." A comment published in *Physical Review Letters,*[18] disparaging an earlier paper published there, ended, "The conclusion…is not just counterintuitive: It is wrong."

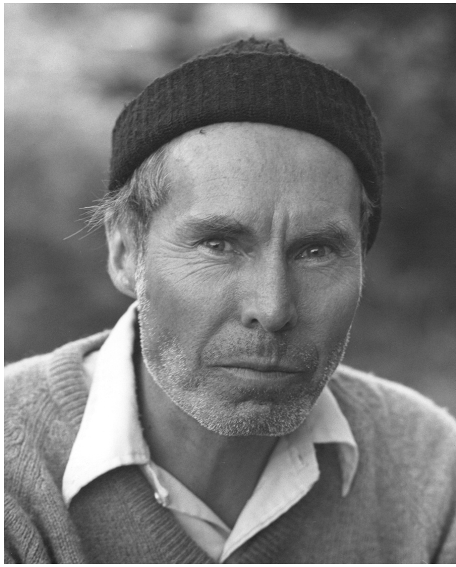
Throughout his career, Dave wrote monographs, some of which were published in *Reviews of Modern Physics*, *American Journal of Physics*, *Physics Reports*, and summer school proceedings. In "The Nature of Intrinsic Magnetic Dipole Moments," he asked whether these moments were due to a circulating current or to an actual pair of slightly separated magnetic monopoles. His conclusion was that if they were due to monopoles, the 21-cm line in hydrogen would appear at 42 cm. In 1975, Dave provided a didactic treatment of the transverse polarization of electrons in a storage ring generated by synchrotron radiation. This was an occasion to refer to the remarkable work[19] of L. H. Thomas in deriving in 1927 the classical fully relativistic equation for the motion of a charged particle with spin in an electromagnetic field (and obtaining the famous factor of one-half required to explain spin-orbit splittings), some 32 years before the treatment by Bargmann, Michel, and Telegdi.[20] Dave treated the topic extensively in *Classical Electrodynamics*, and he paid tribute to Thomas's career in the Biographical Memoir written for the National Academy of Sciences 2009.[21]

Rainbows were a particular delight to Dave, especially multiple rainbows arising from multiple internal reflections of light inside the water droplets; he deemed these occurrences to be beautiful demonstrations of optics, both geometrical and diffractive, and a fine photograph of a double rainbow hung on his office wall. A monograph,[22] "From Alexander of Aphrodisias to Young and Airy," gave Dave the opportunity to indulge his penchants both for history and Bessel functions; it was in Airy's exploration of rainbow supernumeraries that he introduced the eponymous modified Bessel functions of order one-third.

Setting the record straight, on whatever the issue, was a continuing interest of Dave's. In one of his last publications, he described examples of the "Zeroth Theorem of the History of Science," which he stated as "a discovery named after someone often did not originate with that person." Thus the Lorentz gauge for electrodynamics was actually proposed not by the Dutchman Henrik Antoon Lorentz but by the Dane Ludvig Valentin Lorenz. The Dirac delta function is properly credited to Oliver Heaviside, who introduced it as the derivative of the Heaviside Θ function. The Weizsäcker-Williams technique of virtual quanta to describe the effect of rapidly moving electrical charges turned out to have been anticipated by Enrico Fermi a decade earlier. Schumann resonances—low-frequency electromagnetic modes confined between the earth and the ionosphere—were in fact proposed by G. FitzGerald (of the FitzGerald contraction) and by Nikola Tesla.

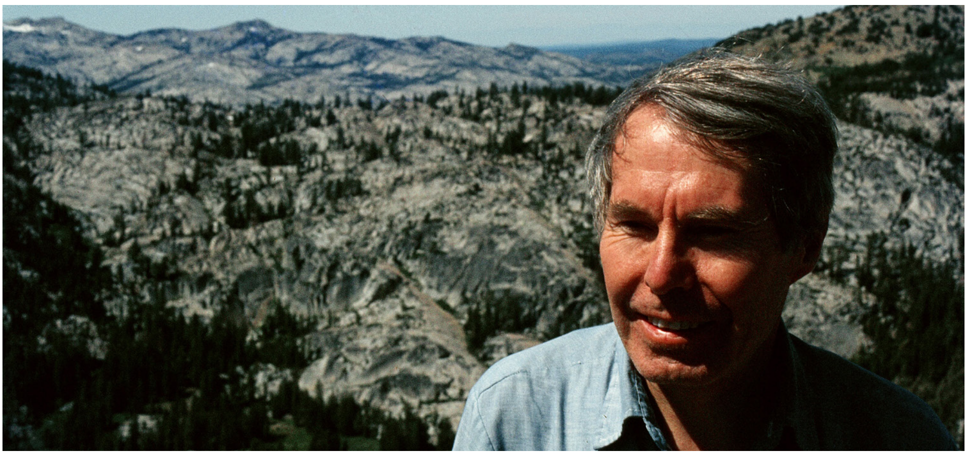
Dave carried out another historical investigation with Lev Okun, a long-time friend and colleague. They traced the development of gauge invariance from its beginnings in the development of electrodynamics in the mid-19th century through its introduction into quantum mechanics in 1926. In the first part of this study, Ludvig Lorenz, mentioned above, emerged as the hero; and in the second part, Vladimir Fock.

## Mountains



Lake Ediza, 1978.
(Photograph courtesy of K. Gottfried.)

The covers of the second and third editions of *Classical Electrodynamics* depicted Dave's joy of being in the mountains. The visit to CERN in 1963–1964 led to his first trip to the Lötschental Valley and its charming Hotel Fafleralp, reached by Swiss postal bus. In 1981, Dave hiked the 200-km "Haute Route," from Chamonix to Zermatt. He and his daughter Nan made a 28-day trek in the Himalayas in 1983. In 1984, it was Mt. Fuji, with Roy Schwitters, who was to become director of the SSC. His 1966 trek in the Sierras with Kurt Gottfried was the first of dozens there, always accompanied by family or physics colleagues such as Okun. A strong hiker, he usually left younger colleagues in the dust. His planning was always thorough, with routes on the topographic maps attuned to the mountain's contours so that, for example, he could avoid the path of steepest descent. The risk of giardia was eliminated by dropping the right number of crystals of iodine into the water bottles. The crystals were maintained in small bottles, with the solubility as a function of temperature recorded on a label. Still, roughing it didn't exclude having some Zinfandel to accompany dinner or fresh eggs at breakfast.



Jackson in the high country of Desolation Wilderness, 1982. (Photo by R. N. Cahn.)

## Citizen

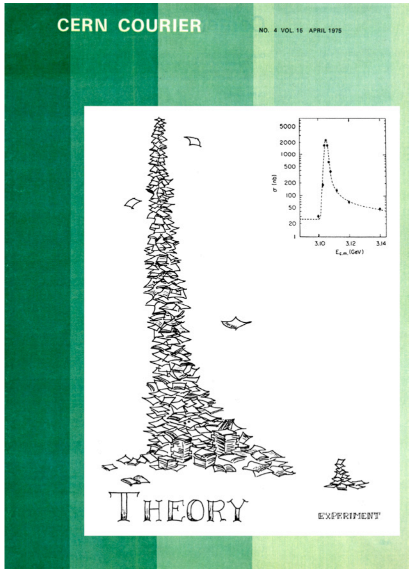
Dave was proudly Canadian and chose to become an American citizen only in 1988. He was intensely engaged in politics and civic matters throughout his life, and his commitment to citizenship manifested itself locally, nationally, and internationally. He was devoted to promoting the role of women in the physics community. At Berkeley, he worked to increase their numbers among the faculty and students alike; in recognition of these efforts, female graduate students presented Dave with a certificate in 1981 conferring on him "the title of Honorary Woman, with all the rights and privileges thereto pertaining, in recognition of outstanding achievements as chairman of the Physics Department 1978–1981."As a member of the physics community, Dave served on numerous major committees, such as the *High Energy Physics Advisory Panel* mentioned above. He was among the leaders of Scientists for [Soviet dissident scientists] Sakharov, Orlov, and Shcharansky, and even offered himself as a "hostage" to guarantee the conduct of Sakharov's wife, Elena Bonner, so that the Soviet authorities would allow her to come to the United States for heart bypass surgery in 1984. He was an active member of the Union of Concerned Scientists, the ACLU, and the Sierra Club. Dave was elected to the National Academy of Sciences in 1990 and to the American Academy of Arts and Sciences in 1989. He was a Fellow of the American Physical Society and of the American Association for the Advancement of Science. He received the Berkeley Citation in 1993 and had been given the Distinguished Teaching Award from the University of California, Berkeley, in 1986. In his address upon being presented with this award, he said, "A science teacher in a university, particularly a physics teacher, has a wonderful job. … All the physics teacher must do is convey the wonder, the beauty, the elegance, the simplicity of physics." The American Association of Physics Teachers established the John David Jackson Award for Excellence in Graduate Physics Education in 2010. McGill also established a J. D. Jackson Award for Excellence in Teaching. Dave himself established three scholarships for physics students at the University of Western Ontario.

## Simple tastes and high standards

Dave's tastes were simple to state: for reading, the *New York Times*, *New Yorker,* and contemporary novels (especially by Canadian authors); for music, jazz (Miles Davis, saxophonists Ben Webster and Dexter Gordon) and folk (Pete Seeger, Joan Baez, and Phil Ochs); for humor, the wry style exemplified by Bob (Elliot) and Ray (Goulding), and by Bob Newhart. While at the University of Illinois, listening to folk music and political satire on the *Midnight Special* weekly broadcast from Chicago on WFMT was a regular habit. Dave's meticulous recordkeeping of research notes, correspondence, coursework, lecture notes, and faculty meeting agendas extended to his outside interests as well. On reel-to-reel tapes, Dave captured the *Midnight Special* from 1964 to 1967. His journals include his own reviews of every book he read between the mid-1970s to the mid-2000s. He enjoyed international travel, quite aside from that associated with physics conferences; he visited his daughter Nan when she was a Peace Corps volunteer in Morocco and his daughter Maureen, twice, when she was pursuing studies in Turkey.

Dave enjoyed drawing, especially illustrating paths to new research opportunities, usually impeded by fearsome bureaucratic obstacles.  He was particularly pleased when his portrayal of the line shape of the J/ψ resonance, as a large pile of theory papers and a much smaller pile of experimental papers, was used as the cover of the *CERN Courier*.

Dave set high standards for himself, and by meeting those standards through hard work and application of his native talents, he set an example for those around him. These standards applied not just to solving difficult problems in electrodynamics or to understanding new experiments in high-energy physics, but also to standing up for principles of individual freedom, to providing leadership for the research and academic communities, and to supporting those who had obstacles to overcome in reaching their own goals.



The cover of the *CERN Courier*, April 1975, with Jackson's drawing illustrating the flood of the theoretical papers generated by the few revolutionary experimental papers. The shapes of the piles mimic the line-shape of the J/ψ resonance, shown in the inset. (Courtesy CERN)

## ACKNOWELEDGMENTS

This memoir draws heavily on an autobiographical article by Dave that was published in 1999. Titled "Snapshots of a physicist's life," it appeared in Volume 49, Issue 1, of Annual *Reviews of Nuclear and Particle Science.*

The author is grateful to Nan and Maureen Jackson, Kate Metropolis, Chris Quigg, and George Trilling for their help in preparing this memoir. Frontispiece courtesy of Lawrence *Berkeley National Laboratory, © 2010 The Regents of the University of California, through the Lawrence Berkeley National Laboratory*.

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