NATIONAL ACADEMY OF SCIENCES

# RAYMOND THAYER BIRGE

*1887—1980*

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*A Biographical Memoir by*

A. CARL HELMHOLZ



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Courtesy, Johan Hagemeyer, Berkeley, California

Raymond T. Birge

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*March 13, 1887–March 22, 1980*

BY A. CARL HELMHOLZ

RAYMOND THAYER BIRGE, a member of the National Academy of Sciences from 1932, died in Berkeley, California, on March 22, 1980, at the age of ninety-three. Prominent in the field of physics from 1920 to 1955, he retired as chairman of the Department of Physics at the University of California, Berkeley, after a tenure of twenty-three years. His determination of the precise values of physical constants and his work in spectroscopy established his excellence as a physicist, while his key role in building a world class Department of Physics at Berkeley established him as an equally outstanding administrator.

## EARLY LIFE

Birge was born on March 13, 1887, in Brooklyn, New York, into an old New England family. His father worked in river transport until 1898, when he became an executive in the laundry machine business and moved the family to Troy, New York. Raymond finished grammar school in Troy and graduated from Troy High School in 1905, valedictorian of his class. His lifelong interest in physics had already begun, but the honors he won were in Latin, there being no honors in science at that time.

Although Ray had planned to attend college, his father's

business failed just before his graduation from high school, and he entered the local business college instead to study bookkeeping. His accuracy and aptitude for numbers were evident, and he was soon asked to teach night classes to the beginning sections.

Fortunately, at this time, Ray's uncle, Charles T. Raymond, offered to pay his expenses for a college education. Delighted, Ray chose the University of Wisconsin at Madison, where another uncle, Edward Asahel Birge, was dean of the Faculty. Edward Birge, a pioneer in the field of limnology, served as president of the University from 1918 to 1925.

Ray, entering in 1906, began studying physics immediately and soon decided to major in it. He received his A.B. degree in 1909 after three-and-a-half years and a summer session, writing his senior thesis under L. R. Ingersoll on the reflecting power of metals. "As an experimental physicist," he later recorded, "my talents were perfectly circumscribed. I could take a piece of optical equipment, put it in perfect adjustment, and get with it as precise or more precise readings than had ever been gotten before. But I was quite unable to *construct* such equipment."

Since his academic work was excellent and he liked both Madison and the Physics Department, Birge decided to continue on to the Ph.D. He received his M.A. degree in 1910, and the *Astrophysical Journal* published his thesis, "Formulae for the Spectral Series for the Alkali Metals and Helium."

His Ph.D. thesis (1913,1), in which he photographed the band spectrum of nitrogen at high dispersion, was supervised by C. E. Mendenhall, the best-known member of the Department. Vigilant regarding possible sources of error and intent on achieving high resolution, he kept the temperature constant to better than 0.1°C and compensated for changes in atmospheric pressure by purposeful changes in temperature. His exposures ran up to five days. "For forty days I lived

in the laboratory," he wrote, "leaving it only for meals, and reading a number of thermometers every few hours, day and night." He finished this work at the end of the summer of 1913, though his degree was not officially awarded until 1914.

During his years in Madison Birge was one of the founders of a walking club, through which he met Irene Adelaide Walsh, who had come to Madison from Redfield, South Dakota. They were married on August 12, 1913. It was a very happy marriage. They remained devoted to each other, and Irene died just three weeks before Raymond.

After their marriage the young couple moved to Syracuse, New York, where Ray had accepted a position as instructor at Syracuse University, hoping to work with the well-known spectroscopist F. A. Saunders (Russell-Saunders coupling). Saunders, unfortunately, was away on sabbatical leave during the 1913–14 academic year, and in 1914 left Syracuse to join the physics faculty at Vassar College. Birge never got the chance to work with him.

Syracuse was a sterile place for a young and ambitious person, eager to teach and do research. Nevertheless, Ray stayed there for five years, winning promotion after two to assistant professor. While at Syracuse he published several papers: on temperature effects in the use of concave gratings; on "Mathematical Structure of Band Series," an extension of his thesis work; and, in the *Journal of the New York State Teachers Association*, on "Some Popular Misconceptions in Physics." With S. F. Acree of the New York State College of Forestry, he also published on the theory of chemical indicators and on the precise value of the Rydberg constant. This last short paper, which appeared in *Science*, showed his grasp of the importance of determining the value of this constant with extreme accuracy—in this case, to about five parts per million.

## BERKELEY

In 1918, unhappy with his situation at Syracuse, Birge wrote to E. P. Lewis. Then the new head of the Physics Department at Berkeley, Lewis, a fellow spectroscopist, had two openings for instructors for the next year. He raised the salary of one and offered it to Birge, who accepted with alacrity. Ray and Irene moved to Berkeley in the summer of 1918 and thus began his distinguished career at the University of California of thirty-seven years. Possibly stimulated by Gilbert Lewis (no relation), who had been appointed Dean of the College of Chemistry in 1912, Lewis was interested in promoting research in physics. Leonard Loeb, William H. Williams, Victor Lenzen, and Raymond Birge were the founding members of this ultimately outstanding Department.

The first task to which Birge set himself was the introduction of the Bohr theory of the atom. Gilbert Lewis had, with others such as Langmuir, formulated the cubical model of the atom that held sway on the campus. Over the next few years, with patience and persistence, Birge won over the Physics and then the Chemistry Departments—a feat he later described as one of his most important achievements. When asked what was the difference between chemistry and physics, he replied with a smile. "When Giauque and Johnston discovered the isotopes 17 and 18 of oxygen, that was chemistry because it was done in Gilman Hall. When King and I discovered the isotope 13 of carbon, that was physics because it was done in LeConte Hall." Since Birge started it in 1918, the cooperation of physics and chemistry in research and teaching has expanded and borne fruit.

During his early years in Berkeley, Birge published a steady stream of papers, many on band spectra, some on the accurate values of the physical constants. From 1920 to 1925, for example, he produced eleven publications and thirteen

abstracts of talks at American Physical Society meetings. In 1921 he published "The Balmer Series of Hydrogen and the Quantum Theory of Line Spectra" (1921,1), cited by Sommerfeld in his third edition of *Atombau und Spectrallinien*. This helped to build Berkeley's reputation, and in 1927, a committee appointed by the National Research Council with E. C. Kemble as chairman wrote the 400-page *Molecular Spectra in Gases*—about half of which was contributed by Birge (1926,1).

In 1925 Dr. Hertha Sponer (later Mrs. James Franck) came to Berkeley on an international fellowship and worked with Birge in the field of band spectra. Together they produced "Heat of Dissociation of Nonpolar Molecules" (1926,2). Theirs was the first quantitative method of determining this important constant, accomplished by extrapolating vibrational spectra to the limit of zero frequency. Hertha's knowledge of chemistry and Ray's of spectra made this a most profitable collaboration.

Birge realized, for example, that the Rydberg constant was determined by an exact relation of e, h, and m, and consequently that the best values of these constants determined by other means (in the case of m by e/m) must fit the best value of the Rydberg from experiment. A number of his papers previous to 1928 had been concerned with best values of the physical constants. In 1928 he submitted "Molecular Constants Derived from Band Spectra of Diatomic Molecules" to the *International Critical Tables* (1929,1), and it was natural that he should also submit a review paper, "Probable Values of the General Physical Constants" (1929,3), to the new *Physical Review Supplement*. Shortly after it was published, the name of this journal was changed to *Reviews of Modern Physics*, so that this important paper—probably the most important that Birge ever wrote—is the first article to appear in this journal.

"Probable Values of the General Physical Constants" is a

remarkable work, covering constants from the velocity of light through the mechanical equivalent of heat, and Avogadro's number to Planck's constant. The article was openly critical of the work of others, and Birge said in interviews that he might not have any friends left once it was published. Careful and painstaking, it established a whole new field in which he was clearly the leader, until DuMond and Cohen used his methods with computers in the late 1940s.

Regarding the propagation of errors, Birge wrote with J. D. Shea on least squares solutions of polynomials in 1924, and, eight years later, "Calculation of Errors by the Method of Least Squares" (1932,1). He then produced "On the Statistical Theory of Errors" (1934,1) and later, "Least Squares' Fitting of Data by Means of Polynomials," with a mathematical appendix by J. W. Weinberg, which appeared in *Reviews of Modern Physics* (1947,1). Birge himself considered this final paper a satisfactory conclusion to his long-standing work.

An interesting story is associated with Birge and King's discovery of the isotope of carbon of mass 13. A. S. King, of Mt. Wilson Observatory, was in Berkeley in July, 1929, at a meeting of the American Physical Society. At about 4 o'clock, after the close of the meeting, King showed Birge a plate he had taken of the Swan bands of carbon from a carbon furnace and questioned him about the possible origins of some faint lines in the bands. Birge, with recent experience on the isotopes of oxygen, immediately realized that these might be due to an isotope of carbon of mass 13. He measured them on his comparator, performed the calculations, wrote the paper with King, and by one o'clock the next morning mailed the article to *Nature* and to *Physical Review* (1929,2)—the fastest paper, he used to say, he had ever written.

Birge also investigated isotopes with D. H. Menzel, their work resulting in "The Relative Abundance of the Oxygen Isotopes and the Atomic Weight System" (1931,1). When

Menzel, at the Lick Observatory, consulted with Birge about measurements of spectra from the sun and the abundance of the isotopes, Birge noticed that the atomic weight of hydrogen measured in mass spectrographs did not agree with the chemically measured atomic weight. He noted that this discrepancy could be explained by the presence in hydrogen of mass 2, thereby prompting a flurry of experiments in the race to find the isotope; Harold C. Urey, then at Columbia, eventually won this race and was awarded the 1934 Nobel Prize in Chemistry for the discovery, but Birge's prediction on an abundance of 1 in 6000 for deuterium is quite close to the present value.

## CHAIRMAN OF THE DEPARTMENT OF PHYSICS

When E. P. Lewis died in 1926, Birge and E. E. Hall were appointed to the search committee for a new physics chairman. Hall was eventually named to the post and remained chairman until his death in November 1932. Because Hall was not widely acquainted with physicists, the responsibility for making new faculty appointments fell mainly to Birge and Loeb. This spectacular period saw the additions of E. O. Lawrence, J. R. Oppenheimer, R. B. Brode, F. A. Jenkins, and H. E. White to the Berkeley staff. When Hall died, Birge was named acting chairman, then chairman, a post he occupied until his retirement in 1955. During his tenure both faculty and graduate students quadrupled in number so that, shortly after he retired, 300 graduate students were enrolled.

Birge himself took great care with the quality of instruction and when chairman continued to teach graduate courses in physical optics and in reduction of observations. His very high standards for his department, both in teaching and research, account in very large part for the growth in distinction of physics at Berkeley.

Birge was presented with a new set of problems during

the years of World War II. His faculty dispersed to various locations around the country to do war work. Fortunately, he was able to find a number of substitutes among the physicists Lawrence brought to Berkeley for his Manhattan Project work. But he was faced with the problem of staffing a great many undergraduate courses for Army, Navy, and Air Force recruits in addition to Berkeley's regular quota of students, all with different schedules. With the help of his faithful secretary, Rebecca Young, he somehow managed in this exacting job.

At war's end, Berkeley's faculty returned, and the school became for many returning GI's the first choice for graduate work in physics. Classes and research work had to be started up again and expanded. Lawrence was anxious to build the 184-inch cyclotron, McMillan to build the synchrotron, and Alvarez to build the proton linear accelerator. Many graduate students were employed, and the faculty introduced several new fields of research. Nierenberg was brought to start work in atomic beams, Kittel and Kip in solid state theoretical and experimental physics, Reynolds in mass spectroscopy, Knight and Jeffries in magnetic resonance—all in addition to new faculty members in nuclear, high energy, and theoretical physics. Oppenheimer never returned to Berkeley full-time and left in October 1947 to become the Director of the Institute for Advanced Study at Princeton, Serber and Wick (with younger members like Chew and Lewis) managed the theoretical program. A new building was necessary, and with help from Harvey White, new LeConte Hall—joined to old LeConte—was opened in late 1950.

## HONORS AND DISTINCTIONS

The Department continued to grow after Birge's retirement in 1955, and the American Physical Society, meeting in Berkeley on December 21, 1964, set aside the afternoon to

dedicate another new building, Birge Hall. Birge was deeply moved by this tribute, one that so rarely comes to a person during his life.

He was also proud of his election to the National Academy of Sciences in 1932. The first physicist ever elected from Berkeley, it is a tribute to his administrative skill that his Department now contains more Academy members than any other physics department in the country.

Throughout his years on the faculty, Birge was active in the Academic Senate, and in 1946 the faculty voted him their highest honor—faculty research lecturer. He was also an active member of the Committee on the Calendar and served as chairman for several years. Campus wags used to accuse Birge of arranging the calendar so that physicists could attend the meetings of the American Physical Society and of the National Academy during the spring vacation. He himself liked to tell of one ideal calendar suggestion he had received, whose only fault was a schedule of fifty-three weeks in the year. Deeply dismayed by the "oath dispute" in 1949 and 1950, he did his best in the Academic Senate to avoid the imposition of a loyalty oath. He failed, and though he himself signed, several of his faculty refused to do so and left Berkeley because of it.

From 1942 to 1947 he served as Pacific Coast Secretary of the American Physical Society. This was before the days of air travel, and very few physicists came to Pacific Coast meetings. When Ray retired from this position, K. K. Darrow, secretary of the Society and a close friend, cited his outstanding work and commended him for saving postage and paper by writing small and single-spacing everything! In 1954 he was elected vice president of the Physical Society and succeeded to the presidency in 1955. He faithfully attended all the meetings and ran the Council sessions with expert fairness. In his retiring address, "Physics and Physicists of the

Past Fifty Years" (1956,1), he reviewed the evolving state of his science throughout his long career.

When Birge retired in 1955 the University of California awarded him the LL.D. degree, a fitting tribute to his long and distinguished service to the institution. He kept an office in LeConte Hall for a number of years and finished a history of the Physics Department from 1868, the year the University opened, to 1955. This admittedly not very readable work is yet packed with information, and is, for many matters, the only reference source available. Birge had known every Physics Department chairman except the first, John LeConte. He also contributed an oral history to the Bancroft Library in Berkeley.

## RAYMOND BIRGE, THE MAN

Ray and Irene Birge had two children, Carolyn Elizabeth (Mrs. E. D. Yocky) and Robert Walsh (married to Ann Chamberlain). Each had three children, and the Yocky's have three grandchildren.

Raymond Birge was a man of outstanding honesty and integrity. Reserved to most, he was yet loving to his family. His last scientific paper (1957,1) was read at the hundredth anniversary of the death of Avogadro in Turin, Italy, in September 1956. His opening remarks at this conference (1957,2) express, better than any biographer could, his lifelong reverence for and joy in science:

"Now, to me, the study of science is, in a sense, a religion. For there can scarcely be anything more marvelous than the structure of nature, nor anything more satisfying than to aid, even in the smallest way, in the gradual unfolding of the intricacies of our universe. From the beginning of the human race, man has speculated on the wonders of his environment, but there is and can be nothing in even his wildest speculation in any way comparable to the actual facts of nature. For just this reason, the true objective study of science offers a never-ending and wholly satisfying human endeavor: at least I have found it so."

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