NATIONAL ACADEMY OF SCIENCES

ERNEST GEORGE MERRITT

1865—1948

A Biographical Memoir by

PAUL L. HARTMAN

Biographical Memoir

NATIONAL ACADEMIES PRESS
WASHINGTON D.C.

Photo ca. 1926

ERNEST GEORGE MERRITT

April 28, 1865–June 5, 1948

BY PAUL L. HARTMAN

Ernest George Merritt, emeritus professor of physics at Cornell University and long-time member of that department and personification of American physics, died June 5, 1948, in Ithaca, New York, after a short illness. He was born April 28, 1865, (two weeks after Lincoln's assassination) in Indianapolis. As a youngster he already showed an inclination toward his adult vocations of editor and scientist. By the age of eight or so, in Indiana no less, he had founded and edited two journals, *Sea Breeze*, and its successor, *The Mountain Echo*, which he also printed and bound; and he had obtained a modest telescope which he housed in his small observatory. The *Indianapolis Journal* reported on "the boy astronomer (whose) eager study of the stars may some day make him famous."

In high school Merritt showed a talent for mathematics, winning a small prize. After one year at Purdue he went to Cornell's engineering school, graduating with a degree in mechanical engineering. When the mathematical and astronomical inclinations disappeared is not clear. Whatever transpired, he failed his first course in physics but became so enamored of the subject (and possibly of Cornell's demonstration lectures) that he decided to make physics his career, earning after graduation a master's degree in physics and becoming an instructor in 1889, followed by assistant professor in 1892, all in the Cornell physics department. After this last appointment he spent a year in Berlin studying with Max Planck, among others. He remained a friend of Planck's to the time of Planck's death, sending relief packages to the family following the end of World War II. The extant notes he took on Planck's thermodynamics course are beautifully done. He became a full professor in 1903 and head of the department in 1919, succeeding Edward L. Nichols. He held that position until his retirement in 1935, when he became "E. Merritt, emeritus," a title he had long looked forward to.

In 1893 Nichols, with Merritt as co-editor, founded *The Physical Review*, recognized today as the world's premier journal of physics. They were joined shortly by their colleague, Frederick Bedell. The three ran the journal until it was taken over by the American Physical Society in 1913, Bedell continuing as managing editor for another decade. Not only did they manage the journal but were major contributors, along with other Cornellians, then past and then present. They wrote scientific articles, short communications, notes of interest, book reviews, and obituaries. Merritt, like his colleagues, reviewed many books on physics—from Dolbear's *Matter, Ether, and Motion* (a treatise not widely referred to these days) to one of his last, Boltzmann's *Populare Schrifter*, a collection of his talks and magazine articles, including some on thermodynamics. In his review Merritt was critical of the inclusion of "Reise einer deutschen Professors in Eldorado" on the author's visit in the summer of 1904 for a course of lectures he gave at the University of California. In his last contribution to the journal, Merritt (1938) extolled in a memorial for Edward Leamington Nichols, then recently deceased, the accomplishments and attributes of his colleague. Reading it, one is reminded of the writer himself.

Of Merritt's many technical papers the first appeared in volume I of *The Physical Review* and was titled "On a method of photographing the manometric flame with applications to the study of the vowel A." For this paper he used a translated photographic plate and the manometric flame—a primitive oscillograph in which a small bright flame made sensitive to sound vibrations is imaged on the moving plate.

In 1898, with Nichols, Bedell, and Professor Shearer, he heeded the call of Professor A. G. Webster of Clark University to about forty physicists in the country to meet at Columbia University to form an American Physical Society. The meeting was held and Rowland was named its first president, Merritt its secretary, and Nichols a member of its council. Merritt had been secretary of Section B (Physical Sciences) of the American Association for the Advancement of Science and later chairman of the section. He served the new society well and after fifteen years as secretary he became president for two years (1914-16) and a member of its council for still more years. Twenty years after its founding the society took over the *Review*. Thus, altogether, beyond his university duties, Merritt served American physics one way or another for over forty years. As early American Physical Society secretary he had responsibility for organizing the frequent meetings of the body; in many a crisis he had to deliver a paper himself to fill out a program. Physics has changed over the years.

His interests were diverse. Perhaps his major research contribution was the extended series of investigations he did with Nichols on the luminescent properties of over 100 materials: phosphorescence and fluorescence at low and moderate temperatures, the decays and recoveries, etc. In their work together over the years Merritt and Nichols were seen almost as a single individual. The work resulted in a long Carnegie Report (No. 298, 1912) followed a decade and half later by another (No. 284, 1928) of Nichols, Howes, and Wilber, a continuation of the first. But Merritt had other interests: acoustics (exemplified by his manometric flame), electromagnetic oscillations, radio propagation (particularly on either side of sunset and during auroras and a notable Ithaca total solar eclipse), gaseous discharges, and many "kathode" ray experiments.

Early on, Merritt was much interested in the fundamental particles of the gas discharge, as were others here and in Europe. Recall that the electron had been discovered by the turn of the century but there was still much to elucidate, such as whether the "kathode" ray entity was that of photoelectricity and that of the emission from a heated filament. With filaments obtained from Edison (used in his incandescent lamps) Merritt and O. M. Stewart went beyond the inventor's Edison effect and studied the phenomenon in rarefied gases and in their best vacuum. The vacuum plots seem remarkably modern.

He studied the reflection of cathode rays at a metal surface. It was known that charged particles came from a surface bombarded by a cathode ray beam, but it was not clear whether they arose from another mechanism of emission or were part of the original beam merely bouncing off. In a rather neat and simple arrangement Merritt agreed on the reflection hypothesis. In a tube, highly evacuated for those days, a beam from a concave cathode was focused on a pin hole in a plate located at the intersection of the main column and a side arm of his vacuum tube, the plate set at an angle of 45° to the incident beam. In either arm beyond this plate was another plate also perforated such that any beam passing through the incident pin hole or that reflected from the surface surrounding it would be restricted in divergence to form a small visible light area on the glass envelope at the end of each arm. He found that the reflected spot in the side arm was deflected with a horseshoe magnet by the same amount as the primary beam in the main arm, supporting the ballistic nature of the reflection of the particles. Independently, Lenard in Europe was coming to the same conclusion, but all investigators were a long way from Davisson and Germer. The experiments and techniques then available now seem very primitive. Attainable vacua were hopelessly inadequate, but the concepts were sound and results were achieved.

With Stewart again he studied the photo effect, about the nature of which there was still question. Particles leaving a metal plate illuminated obliquely by ultraviolet light incident through a quartz window on their vacuum tube impinged after acceleration onto a collector at some distance in front of the illuminated plate. On either side of the collector was another similar electrode. The small collected currents were measured with an electrometer by the rates of charge accumulation. With an applied magnetic field the charging rates of the three collectors could be changed corresponding to the deflection of particles in their traverse from the emitter to the collectors, allowing their identification as cathode rays.

As noted in the memorial statement for Merritt in the Cornell Faculty Necrology for the year of his death, he "sought always to analyze his results and interpret them in the simplest possible terms . . . . When demonstrating the then-new phenomena of electric waves to graduate students, he was the envy and the inspiration of his pupils because of his skill in throwing together crude pieces of apparatus that could work perfectly to demonstrate the point in mind." As might be gathered from his first Cornell exposure to physics, he took great delight in lecture demonstrations. One of his most successful was on Hertzian waves. Instead of the feeble spark of Hertz's receiver spark gap, barely visible except to a few hovering over it, Merritt combined it with another gap and a Geissler tube such that when the receiver gap broke down the Geissler tube flashed, easily visible to a large audience.

He brought out the essential sameness of the particles emitted from metal cathodes by light as by temperature. He was early in the use of silicon as a detector of short radio waves. Strict linearity with intensity having been shown in photoemission, he, with Nichols, was prompt in using the effect in film photometry. The 1921 (and 1951) cumulative index of *The Physical Review* illustrates the diversity of his interests (and the variety of books he reviewed).

He was concerned with what he saw as the inadequacy of the university in support of research and sought to enhance it. And he was a good teacher. He would lecture and arrive at a result, appearing to be as surprised at the outcome as he wished his audience to be. One recalls his last lecture; it related naturally enough to the gas discharge. He had a demonstration, his wife watching from the back row. The pump started up; with voltage across the discharge tube it presently broke into color and, beaming, he looked up at those watching as if to say, "Look at that, would you?" and then went on to the rest of his lecture.

While Merritt and his wife were of the Quaker persuasion, they did not hesitate to support their country during the two world wars. In World War I at New London he directed experimental and development work related to submarine detection. After Pearl Harbor he wrote to the Navy to inquire why in protecting the harbor it had not used some of the methods developed earlier. Secretary of the Navy Frank Knox responded that such had been used, with some positive results, but things were so chaotic during the attack that no great success could be claimed for the installations. Merritt suggested to DuBridge some subjects which the Radiation Laboratory at MIT might pursue, but, then in his late seventies, he took no active part in World War II efforts. During the war he and his wife were busy with Bundles for Britain and elsewhere. Following the war they took active roles in alleviating the distress of war victims, both enemy and friend. It was during this time that they were helpful to the Plancks.

His university duties were many. While it remained for his successors to implement, it was under his chairmanship that the Cornell physics department decided to get into nuclear research and later the high energy field, areas in which it became preeminent. Beyond the department leadership he was the first dean of the Cornell graduate school and for three years served as faculty member on the Cornell Board of Trustees. He and his wife were gracious people, hosts to many, truly of the "old school." During his Cornell years more than 400 physicists received training in the department, many of them going on to become heads of physics departments, spreading the physics "word," a not insignificant factor in the growth of the enterprise in this country.

Merritt had a long interest in photography, not only in his science but also as a hobby. He took delight in making movies on a winter's day, and then showing the hilariously amusing antics of motorists attempting to negotiate one of Ithaca's steep hills after a sudden heavy snow. And to catch on film from a constant-velocity boat alongside a Cornell racing crew, the surges backward and forward of the rowed shell relative to a fixed marker on his own vessel—ahead each time the backward facing crew, oars out of the water, slid toward the coxswain, bracing itself for the next pull on the oars, and the seeming retardation as the crew slid back on the pull stroke. A nice show of momentum conservation complicated by the friction of the shell-water interface and the movement of the oars themselves. The effect would have been greater with a heavyweight crew sliding back and forth than with featherweights, but that variation on the theme was not captured by his camera.

Following a visit to Cornell by Max Born on a miserable winter's day, Merritt sent him a photo of a more benign Ithaca and a strip of film taken of Millikan in a Cornell lecture—alongside, a strip of density variation "conveying the lecturer's words," a technique "developed in a laboratory not far from here," he wrote Born.

One amusing story he enjoyed recalling and which he wrote up (to be found in the Cornell Library Archives) may not be inappropriate. Following the gift of a liquid air machine to the Cornell physics department there was to be a public lecture on low temperature. In preparation, burned out ceiling lamps in the lecture hall were replaced. The rejects, and there were quite a few of these, were where the janitor had left them, in a carton on the floor near the lectern and below a fire extinguisher on the wall. The hall was so crowded that Merritt could see the demonstrations only through a door at the front. All was going well until a spectator sitting on the front table, squirming about for a better view, knocked the fire extinguisher off the wall onto the box of old lamp bulbs, spilling out the contents. Some of the bulbs popped and the extinguisher went into play, spraying the audience. There was panic. Liquid air was obviously on the loose. People scrambled out, crunching more lamp bulbs, adding to the pandemonium. Merritt said he had not learned much but "it was sufficiently interesting."

Ernest Merritt was a rather small pixieish man, somewhat hard of hearing, eyes sparkling, who obviously enjoyed what he was doing, just a delightful person. In his research he did not make momentous discoveries but in his associations and activities he made a large contribution to American physics. It is for that and for his long useful service to the enterprise that he should be remembered.

SELECTED BIBLIOGRAPHY

Merritt published almost exclusively in *The Physical Review.* A partial list follows—what one hopes he might consider his most important papers. Not included are book reviews and many abstracts of papers given at meetings. A complete list is in *The Physical Review* cumulative index published in 1921, followed by another in 1951.

1893

Photography of manometric flame. *Phys. Rev.* 1:166.

1895

On the absorption of certain crystals in the infra-red as dependent on the direction of the plane of polarization. *Phys. Rev.* 2:424.

1897

The distribution of alternating current in cylindrical wires. *Phys. Rev.* 5:47.

1898

The magnetic deflection of reflected kathode rays. *Phys. Rev.* 7:217.

A vacuum tube to illustrate the slow diffusion of the residual gases in high vacua. *Phys. Rev.* 6:167.

1899

A lecture demonstration to show the influence of ultra-violet light on the spark discharge. *Phys. Rev.* 5:306.

The resistance offered by iron wires to alternating currents. *Phys. Rev.* 9:294.

1900

With O. M. Stewart. The development of kathode rays by ultraviolet light. *Phys. Rev.* 11:230.

1904

With O. M. Stewart. Conductivity produced in rarefied gases by an incandescent kathode. *Phys. Rev.* 18:239.

With E. L. Nichols. On fluorescence spectra. *Phys. Rev.* 19:18.
With E. L. Nichols. Conductivity of fluorescent solutions. *Phys. Rev.* 19:396.

1907

With E. L. Nichols. The influence of the red and infra-red rays upon the photoluminescence of Sidot Blende. *Phys. Rev.* 25:362.

1909

With E. L. Nichols. The spectrophotometric study of certain cases of kathodo-luminescence. *Phys. Rev.* 28:349.

1910

With E. L. Nichols. The distribution of energy in fluorescence spectra. *Phys. Rev.* 30:328.
With E. L. Nichols. Further experiments on luminescence absorption. *Phys. Rev.* 31:500.

1911

With E. L. Nichols. The fluorescence and absorption of certain uranyl salts. *Phys. Rev.* 33:354.
With E. L. Nichols. Studies in luminescence, on fluorescence and phosphorescence between +20 and -190 degrees. *Phys. Rev.* 32:38.

1912

The silicon rectifier used with short electric waves and the theory of contact rectifiers. *Phys. Rev.* 32:630.
With E. L. Nichols. A method of using the photoelectric cell in photometry. *Phys. Rev.* 34:475.

1914

With E. L. Nichols. Note on the fluorescence of frozen solutions of the uranyl salts. *Phys. Rev.* 3:457.

1915

Luminescence. *Phys. Rev.* 5:319.

1917

With E. L. Nichols. The influence of water of crystallization upon the fluorescence and absorption spectra of uranyl nitrate. *Phys. Rev.* 9:113.

1921

Photoelectric phenomena in coated audion bulbs. *Phys. Rev.* 17:525.

1930

With D. Morey. The polarized fluorescence of solutions of rhodamine-B and uranine. *Phys. Rev.* 36:1386.

1938

Edward Leamington Nichols. *Phys. Rev.* 53:1.