NATIONAL ACADEMY OF SCIENCES

OTTO LAPORTE

1902—1971

A Biographical Memoir by

H. R. CRANE AND D. M. DENNISON

Biographical Memoir

Otto Laporte.

OTTO LAPORTE

July 23, 1902–March 28, 1971

BY H. R. CRANE AND D. M. DENNISON*

OTTO LAPORTE was a member of the small group of brilliant young theoretical physicists who received their training during the middle 1920s under the guidance of Arnold Sommerfeld in Munich.

Otto Laporte was born in Mainz, Germany. His ancestral lineage came from French Huguenot families who fled from France to Switzerland during the period of intense religious persecution in the late seventeenth century. They were later allowed by Frederick the Great to move to Prussia, where they and their descendants became, for the most part, civil servants in the Prussian State. It appears that Otto was the first member of his family to devote himself to science or any other scholarly career. His father was a career officer in the Imperial German Army, and his specialty was heavy artillery. During the years before World War I, Colonel Laporte was successively stationed in the heavily fortified cities of Mainz, Cologne, and Metz, and it was in these cities that young Otto Laporte received his early schooling.

After the war broke out, the family was evacuated from Metz and returned to Mainz, where Otto's mother's family lived. They remained there for the duration. The first four years following that move—Otto's twelfth to sixteenth—were formative ones, and

* Dr. Dennison died April 3, 1976.

his real interest in science became apparent. During that period he experimented extensively with optics and spectra, within the limitations of the meager materials that he could manage to come by in time of war. His father was able to get for him a glass prism from a periscope. Not satisfied with the dispersion of the glass prism, he proceeded to build a triangular cell of glass plates held together with glazier's putty and filled with carbon disulfide. When, in his words, "the carbon disulfide dissolved the putty, escaped and stank up our house terribly"* the method had to be abandoned. For a light source he built a satisfactory electric arc. He also built a spark coil that worked and embarked on building a much larger one; however, as he recalled, the tedium of winding the secondary overcame him, and the project was dropped. Having received an electrostatic machine from the effects of a cousin who was killed in the war, he did experiments that amazed onlookers—for example, making his sister's hair stand on end.

It surely must have appeared from this early work that if Otto Laporte was to have a career in physics, it would be in the experimental rather than the theoretical direction. This idea would have been strengthened by the fact that he was at the same time having difficulties with mathematics and English in school. This, he said later, was because the courses involved only repetitious drill and endless numerical calculations requiring interpolation of five-place logarithm tables. Since failure in these subjects would have been a blot on the family honor, he was provided with extra tutoring. Anyone knowing Laporte later in his life would be hard put to understand these early difficulties, because a command of these two skills, mathematics and languages, would stand out in a most striking way.

Perhaps one may conclude that even a bad experience in school cannot completely suppress the abilities of a gifted student. At any rate, Otto Laporte was soon to come under the influence of excellent and inspiring teachers.

* From a taped interview; see Acknowledgments.

The years immediately following the war were very difficult ones for the Laporte family, as of course they were for many others. In the early spring of 1920 the family moved to Frankfurt, to stay for only a year, where the young Laporte attended the University. It was here that he chose the branch of the road leading to theory rather than experiment. In a taped interview with Professor Thomas S. Kuhn of Princeton University, made late in his life (see acknowledgments), Laporte recalled how it came about.

KUHN: You start out with this great interest in building things; you do a lot of experiments at home, some of them very elaborate. You go, though, to Sommerfeld, and your career is pretty much in theory. Was there a conflict here? Were you always clear that you wanted to be a theoretical physicist? How did these two sides of things relate?

LAPORTE: I think it is due to the fact that more formal teaching goes on in theoretical physics. Experimental physics is not really being taught except on a much lower level. When I went to Frankfurt, right away I was under the influence of some very great men. The oldest one there was a mathematician named Arthur Schoenflies, whom you know, of course, as the man who first formalized the theory of the space groups of lattices, but who has many, many other great achievements. He was then an old man, but he gave *beautiful* courses. And then there were two younger mathematicians; one was Ludwig Bieberbach and the other, a small wizened man named Ernst Hellinger.

KUHN: You went to lectures by *all of them* from the very beginning?

LAPORTE: Yes.

KUHN: You were at Frankfurt for only one year, yes?

LAPORTE: Yes. And in physics I took the lectures of [Max] Born and [Alfred] Landé; Landé was then a young Privatdozent. From Born I took heat, which was what he was doing in his cycle. Now it should perhaps be said at this moment that it was a great disadvantage of the German system that you don't get any advice from appointed advisors. I just took the courses whose subjects interested me, and they were all much too difficult. Now if I had been in the clutches of some sufficiently energetic advisor he would have just told me not to take these courses, but I wasn't told that; I was completely on my own.

In the summer of 1921 the Laporte family found it necessary to leave Frankfurt. Their apartment was taken over by the German Army of the French Occupation, and the housing short-age in Frankfurt became so acute that there was little chance of finding another place. The family moved to Munich. The choice of that city was greatly influenced by the facts that Arnold Sommerfeld was the professor of theoretical physics at the University of Munich and that he was establishing there one of the foremost centers of physics in Europe. Max Born had sent Sommerfeld a very enthusiastic recommendation regarding Laporte, and the young man found himself accepted and welcomed by the group of theorists who had been drawn there by the presence of Sommerfeld. He was given the initial task of talking at their seminar on a new paper by Albert Einstein and W. J. de Haas. The subject of the paper was new to Laporte, but he was helped by Wolfgang Pauli, who was Sommerfeld's personal assistant at that time. Other members of the group of young theorists were Werner Heisenberg, Gregor Wentzel, Karl Herzfeld, and Paul Ewald. This was a lively and very gifted company into which Laporte was plunged. His continuing acceptance by that group speaks well of the young Laporte's innate ability, since in point of fact his training had not really been extensive. Actually, when he arrived in Munich, he had never read Sommerfeld's famous book *Atombau und Spektrallinien,* which was the indispensable "bible" for most physicists of that era. This omission in Laporte's education was quickly repaired, however.

The central figure dominating and inspiring the group was, of course, Arnold Sommerfeld, and it is clear that Otto Laporte, who was then in his early twenties, acquired the clarity of expression and creativity which were to be his characteristics for the remainder of his life. In addition to attending Sommerfeld's lectures, Laporte had the opportunity for much personal contact with Sommerfeld, either at Sommerfeld's home or in the course of the long walks which they often took. These conversations included the classical subjects of hydrodynamics and electrodynamics as well as the developing field of quantum theory. Laporte's first independent research resulted in an article on the diffraction of electromagnetic waves around a sphere, an article which was published in the *Annalen der Physik* in 1923, just a few months before his twenty-first birthday. In this paper Laporte discussed a set of solutions that are now known as creeping waves or Regge poles.

The old, prewave mechanics version of quantum theory was at the height of its success in the early and middle 1920s. It had served to correlate, and in that sense to explain, a great many experimental results. It was, however, inherently illogical, and there was a growing distrust of the old theory and a search for what was to become the present-day quantum theory. Among the directions that the search took were those of attempting to understand the more complex atomic spectra, to classify the spectral lines, and to find the energy levels. Typical spectra of this type were those of iron, vanadium, and chromium.

At about this time Sommerfeld spent time in the United States, mainly as a visiting professor at the University of Wisconsin. He also traveled to the important spectroscopic installations—for example, the one at Mount Wilson. When he returned to Munich, he brought with him new spectroscopic data—in particular, data on the spectra of iron and vanadium. Laporte set about the task of unraveling and understanding these. His analysis of the vanadium spectrum was published in December of 1923, while that of the extremely complex iron spectrum appeared the following year. This latter research formed the basis of his dissertation for the doctoral degree, which was awarded in 1924. In the course of his successful investigations of these spectra, he discovered the fundamental principle known among spectroscopists as the "Laporte rule." This rule classified the atomic energy states into two types, which he had called odd and even states. He found that no radiative transitions occurred between unlike states. This was the first statement of the principle that was later to be known as the conservation of parity. The principle has assumed fundamental importance in elementary particle theory, not only because of its almost universal validity, but also because of the great interest attached in recent years to certain exceptions.

The year 1924 was momentous for Otto Laporte in several respects. In addition to his completion of the analysis of the iron spectrum and the acceptance of his Ph.D. thesis, he was awarded one of the first of the International Education Board fellowships. These had been newly established by the Rockefeller Foundation for the purpose of allowing young post-doctoral scientists to continue their research anywhere in the world. Professor Sommerfeld had learned, while on his visit to the United States the year before, that these fellowships were about to be set up, and he highly recommended his student, Laporte, for one of them.

Laporte elected to spend the period of his fellowship, 1924–1926, in Washington, D.C. at the National Bureau of Standards. He was drawn there by the excellence of their spectroscopic laboratory and in particular by the presence of the very able experimental spectroscopist William F. Meggers. The advantages of the association were mutual: Meggers and the other experimentalists had been anxious to hear firsthand reporting of the theoretical advances that were being made in Europe in the fields relating to spectroscopy. In response to this need, Laporte was instrumental in starting a regular weekly seminar. This grew rapidly to include many of the scientists of the Washington area, and it continued to meet throughout Laporte's stay at the Bureau. Among persons included were Gregory Breit, Merle Tuve, Paul D. Foote, F. L. Mohler, Arthur Ruark, and Harold Urey. Most notable in the seminar series was Laporte's interpretation of the first three papers of Schrödinger, which introduced the matrix method in quantum theory. These talks, Laporte recalled later, required a great deal of work on his part. That period was a yeasty one in the Washington area, and it was remembered so fondly by the seminar participants that they staged a reunion twenty-five years later. In Laporte's words, "We felt sheepish as well as reminiscent. We gave another colloquium."*

The two years spent in Washington were formative ones as well as productive ones for Laporte. He published a number of spectroscopic researches. But perhaps a more important aspect for his future was his close association with experimentalists for the first time in his life. In spite of his early interest in experiments he had been entirely under the influence of theorists since the age of about eighteen. Here at the Bureau he became greatly impressed with the power of experiment, and this must have had much to do with the fact that he turned to experimental research in the last chapter of his career.

In the autumn of 1926 Laporte joined the staff of the Physics Department of the University of Michigan as an instructor. In the following year he became an assistant professor. By inviting Laporte, Professor Harrison M. Randall, the department chairman, wished to build up the field of theoretical physics at Michigan. He realized, however, that it would be necessary to create a nucleus of theorists if the venture was to be successful. Accordingly, in 1927 Laporte was joined by George E. Uhlenbeck, Samuel A. Goudsmit, and David M. Dennison, who remained his colleagues for many years.

In 1928 Laporte was invited to be a guest lecturer at the Imperial University in Kyoto, Japan. During the year he received an urgent request from Sommerfeld asking him to lecture in Munich during the period in which Sommerfeld was to be absent on a trip to America. Laporte was able to honor this request, although it meant cutting his visit to Japan somewhat short. It also meant that he had to make a nonstop journey of two weeks duration via the trans-Siberian railway in order to arrive in Munich on time, an adventure he did not soon forget.

* From a taped interview; see Acknowledgments.

His initial visit to Japan made a lifelong impression on Otto Laporte and led to his taking leaves of absence from the University of Michigan to lecture at the University of Tokyo in 1933 and again in 1937. During these periods he became proficient in the Japanese language and in the art and literature of Japan. He was truly an expert in the understanding and appreciation of Japanese poetry. While there, he submitted a haiku in a national competition and won recognition. In the interval between these visits, in 1935, Laporte became a naturalized United States citizen.

Otto Laporte's expertise in both the language and culture of Japan was to be of great value to this country from 1954 to 1955 and again from 1961 to 1963, when he served as scientific advisor to the American ambassador in Tokyo. The U.S. State Department cited Laporte for playing a key role in securing the landmark atomic energy agreement between the two countries. These were not the only occasions in which Laporte had served his adopted country with distinction. From 1949 to 1950 he was intelligence analyst for the U.S. Army of Occupation in Heidelberg, Germany.

A review of Laporte's bibliography shows that up until the early 1940s his principal researches continued to be centered in the field of spectroscopy, although a few of his publications related to various quantum mechanical problems, making use of his great knowledge of mathematics. In 1944 he began, in effect, a new career. He entered the field of fluid dynamics with a paper in which he found an exact solution to the problem of the lift of an airfoil of elliptical outline. Two years later he was presented with the unexpected opportunity to do experiments in fluid dynamics by means of a shock tube. Lincoln Smith, a member of the Michigan faculty, had somewhat earlier initiated work in this field and had assembled apparatus of an advanced design. Smith left the University in 1946, and Laporte took over the directorship of the project. This was a really new departure from his earlier work, since it meant taking responsibility for an experimental project and directing the graduate students who had started their theses under Smith. He did exceedingly well at it, and many successful investigations resulted. These included the use of reflected shocks to produce such high local temperatures that spectroscopic phenomena which had hitherto been inaccessible could be studied. He continually had graduate students in the shock tube project. His last doctoral student, John Yoder (Ph.D., 1971), constructed a cryogenic tube and investigated shocks in low-temperature hydrogen gas. The resulting measurements clearly showed those quantum effects that arise from the existence of the two forms of hydrogen, ortho and para.

In some respects the final chapter of Laporte's scientific life, which we have called a new career, was not really new but rather the convergence of a number of the interests he had had for a long time. The success with which he directed the experimental part of the shock tube program perhaps harks back to his boyhood project of constructing an arc and a workable spark coil. His interest in the hydrodynamical problems associated with the shock phenomena was surely related to the early days in Munich, where many of the discussions were centered about hydrodynamics. For example, his friend Werner Heisenberg wrote his Ph.D. thesis in that field. And finally, of course, Laporte's long experience with spectroscopic problems allowed him to recognize the possibilities of using the shock tube for observing spectra under conditions that had not been accessible before.

Otto Laporte was one of the charter members of the American Physical Society's Division of Fluid Dynamics and served as its chairman in 1965. He exerted strong influence in directing the attention of physicists to an area of study that was to be, for many of them, new and highly rewarding. Soon after his death the Division of Fluid Dynamics established, in recognition not only of his scholarship but also of his early guidance of the organization, the Otto Laporte Memorial Lectureship, to be given annually. Richard G. Fowler gave the first of the lectures in 1972. Fowler has published a paper* based on his lecture that is rich in detail on Laporte's contribution to the Division as well as on facets from the history of his career.

Special recognition should be made of Otto Laporte's graduate teaching. His early association with European lecturers in theoretical physics in an era when a certain elegant formality was practiced came through in Otto's teaching in a desirable way, but at the same time his lectures were not so structured that he could not pursue byways when it suited him to do so. What came through most strongly to the better students was his deep appreciation for the beauty of physics and of mathematical proofs. In the opinions of these select students the view of physics that they gained from him was of more future influence than the physics itself. Laporte's sense of mathematical discipline did much to maintain the "tone" of teaching in the whole graduate program, and his course was both a high point and a hurdle in each graduate student's career.

Almost by definition most people are amateurs in the areas of their hobbies or side interests. Not so with Otto Laporte. He had several hobbies, and he went into each with almost the intensity and erudition he gave to physics. His mastery of the Japanese language and knowledge of the culture that he gained during several years on assignments to Japan have been mentioned. He continued to cultivate these interests for the rest of his life; for example, he became an authority on netsuke, small carved figurines, of which he had a notable collection.

Otto Laporte was a horticulturist of much more than amateur standing, specializing in plants of the cactus and the euphorbia families and certain other succulents. His collection of these plants was extensive, particularly in respect to the euphorbias of the rare medusa form. He kept up correspondence with horticul-

* *Phys. Today*, 26, no. 11 (1973):23–29.

turists in other parts of the world in his efforts to obtain unusual specimens. He published on euphorbias and cacti. One of the present writers (H.R.C.) once traveled with Laporte to New York to attend a physics meeting, where immediately upon arrival the two went to a botanical garden on Long Island. A botanist from South Africa was waiting there, by Laporte's prior arrangement, to talk about the Welwitschia plant, a plant that grows only in the Nambi Desert and in the south of Angola and that is estimated to live more than 2000 years. Laporte came away with some seeds as well as the information he sought. An everyday kind of incident was recalled by a former student: the student, while waiting for Laporte's class to begin, was gazing out of the window at a row of Lombardy poplars. Before he was aware of it, Laporte had come up behind him and was saying, "You know, all the Lombardy poplars in the world are one single tree—they propagate only by cuttings because they are males and the female is no longer extant."

Music was the third of Laporte's side interests. His own piano playing was passable but venturesome, and was indulged in for his own enjoyment. But his real expertise was in his wide knowledge of the literature of music and his wide acquaintance with professional musicians in this country and abroad. He was quite at home discussing the fine points of musical composition and performance with the best of experts.

Laporte was married to Eleanor Anders in 1933. She died in 1957. He remarried in 1959. His second wife, the former Adele Pond, and their three children, Claire, Irene, and Marianne, survive him.

Otto Laporte died March 28, 1971, a victim of cancer which progressed rather rapidly. His death came after his name had been slated for presentation for election to the National Academy of Sciences at the annual meeting in April of the same year. Taking an action it had never before taken, the Academy elected Otto Laporte to membership, posthumously.

ACKNOWLEDGMENTS

THE AUTHORS WISH especially to thank the Center for History of Physics of the American Institute of Physics for the use of the transcript of a taped interview with Otto Laporte, which was conducted by Professor Thomas S. Kuhn of Princeton University, January 29–30, 1964, as part of the Sources for the History of Quantum Physics Project. Much of the information throughout the memoir was drawn from the transcript. The authors are also indebted to Professor Richard G. Fowler of the University of Oklahoma for important information received through private correspondence and to Professor George W. Ford and Professor Otto G. Graf of the University of Michigan for information and valuable advice.

CHRONOLOGY

1902	Born July 23, Mainz, Germany. Parents: Wilhelm Laporte and Anna Geyl. Sisters: Luise and Marianne (m. Roger Gillette).
1923	Analyzed iron and vanadium spectra. Enunciated Laporte rule.
1924	Ph.D., University of Munich, under Arnold Sommerfeld. Thesis: "Exact Treatment of Scattering of EM Waves by a Sphere."
1924–1926	International Education Fellow; studied in Europe, Japan, and finally in the United States in the spectroscopy section of the National Bureau of Standards.
1926	Joined University of Michigan faculty as instructor in physics.
1927	Promoted to assistant professor.
1928	On leave from University of Michigan; lectured at Kyoto Imperial University.
1933	Married Eleanor Anders (d. 1957).
1933	On leave from University of Michigan; lectured at Tokyo University.
1935	Became naturalized U.S. citizen.
1937	On leave from University of Michigan; lectured at Tokyo University.

1944	Changed field of activity from atomic spectroscopy to fluid mechanics.
1945	Promoted to full professor.
1946	Assumed charge of shock tube laboratory at University of Michigan.
1949–1950	Scientific Intelligence Analyst, U.S. Army of Occupation, Heidelberg.
1951	Initiated researches on reflected shock waves.
1954–1955	Served as scientific attaché at American Embassy in Tokyo.
1956	Cited by U.S. State Department as instrumental in securing atomic energy agreement between the United States and Japan.
1959	Marriage (second), to Adele Pond.
1961–1963	Returned to Tokyo as scientific advisor to the U.S. ambassador.
1965	Chairman, Division of Fluid Dynamics, American Physical Society.
1968	Sabbatical leave in Munich.
1971	Died March 28, Ann Arbor, Michigan.
1971	Elected, posthumously, to the National Academy of Sciences.

BIBLIOGRAPHY

1923

Propagation of electromagnetic waves. Ann. Physik, 70:595–616.

The arrangement of vanadium lines in multiplets. Phys. Zeits., 24:510–15.

1924

The structure of the iron spectrum. Part I. Zeits. Physik, 23:135–75.

The structure of the iron spectrum. Part II. Zeits. Physik, 26:1–22.

1925

With G. Wentzel and A. Lande. Dashed and displaced terms in spectra. Zeits. Physik, 31:335–38.

With W. F. Meggers. Rules of spectral structure. J. Optical Soc. Amer. and Rev. Sci. Inst., 11:459–63.

Primed terms in the spectra of the lighter elements. Washington Academy of Sciences Journal, 15:409–13.

1926

With C. C. Keiss. Displaced series in the spectrum of chromium. Science, 63:234–36.

Series and ionisation potentials in the iron spectrum. Proc. Nat. Acad. Sci. U.S.A., 12:496–503.

Fundamental terms of spectra of first and second periods. Zeits. Physik, 39:123–29.

Absorption spectra of the palladium and platinum group. Phys. Rev., 28:642–64.

With A. Sommerfeld. The spectroscopic significance of the magneton numbers in the iron group. Zeits. Physik, 40:333–43.

1927

With J. R. Lang. Second spark spectrum of zinc, Zn III. Phys. Rev., 30:378–86.

Screening constants from optical data. Phys. Rev., 29:650–54.

1928

Interpretation of paramagnetism in the iron group. Zeits. Physik, 47:761–69.

With J. E. Mack and R. J. Lang. Application of the x-ray laws to optical spectra of higher rank and the classification of Ga IV and Ge V. Phys. Rev., 31:748–72.

1930

With D. R. Inglis. Resonance separations in configurations of type p^5s and d^9s. Phys. Rev., 35:1337–41.

1931

With G. E. Uhlenbeck. Application of spinor analysis to the Maxwell and Dirac equations. Phys. Rev., 37:1380–97.

1932

First spark spectrum of caesium (Cs II). Phys. Rev., 39:458–66.

First spark spectrum of rubidium (Rb II). Phys. Rev., 38:843-53.

Approximation of geometric optics as applied to a Dirac electron moving in a magnetic field. Phys. Rev., 42:340–47.

1933

Kowalewski's top in quantum mechanics. Phys. Rev., 43:548–51.

1937

Absorption coefficients for thermal neutrons. Phys. Rev., 52:72–74.

1938

Elastic scattering of Yukawa particles. Part I. Phys. Rev., 54:905–12.

1942

Term formulae for the configuration d^5. Phys. Rev., 61:302–4.

Degeneracies among terms of a configuration of equivalent electrons. Phys. Rev., 61:305–8.

1943

With J. E. Mack. The spectrum of neutral tungsten, W I. Phys. Rev., 63:246–97.

1946

Rigorous solutions for the spanwise lift distribution of a certain class of airfoils. Quart. Appl. Math., 2:232–50.

1948

Polyhedral harmonics. Zeits. Naturforsch., 3a:447.

1953

With R. N. Hollyer, Jr., A. C. Hunting, and E. B. Turner. Luminosity generated by shock waves. Nature, 171:395.

1958

With W. R. Johnson. Interaction of cylindrical sound waves with a stationary shock wave. Phys. Fluids, 1:82.

With J. Meixner. The Kirchhoff-Young theory of the diffraction of electromagnetic waves. Zeits. Physik, 153:129.

1964

With T. S. Chang. Reflection of strong blast waves. Phys. Fluids, 7:1225.

1965

Sir William Rowan Hamilton. Michigan Quarterly Review, 4:254.

1966

With R. G. Fowler. Resistance of a plasma slab between juxtaposed disk electrodes. Phys. Rev., 148:170.

1967

With R. G. Fowler. Weber's mixed boundary-value problem in electrodynamics. J. Math. Phys., 8:518.

1969

Spectroscopy by means of shock waves. In: *Proceedings of the Arnold Sommerfeld Centennial Memorial Meeting and of the International Symposium on the Physics of One- and Two-Electron Atoms, Munich, September 1968.* Amsterdam: North Holland Press.

1970

On Kepler ellipses starting from a point in space. Amer. J. Phys., 38:837.

1971

With M. J. Yoder. Low temperature shock waves in molecular hydrogen. In: Eighth International Shock Tube Symposium, Imperial College of Science and Technology, London, July 1971 (preprint).

1972

With T. S. Chang. Curved characteristics behind blast waves. Phys. Fluids, 15:502.