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LOUIS BYRNE SLICHTER
1896–1978

A Biographical Memoir by
LEON KNOPOFF AND CHARLES P. SLICHTER

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LOUIS BYRNE SLICHTER

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BY LEON KNOPOFF AND CHARLES P. SLICHTER

LOUIS SLICHTER WAS one of the foremost geophysicists of the twentieth century, an outstanding leader, scholar, and teacher. He was a pioneer in studies of inverse problems of geophysics, heat flow and cooling of the earth, free oscillations of the earth, solid-earth tides, crustal seismology, and the application of physical methods to the exploration of mineral deposits. His was the first work in many of these fields.

Slichter was born in Madison, Wisconsin, the second of four sons of Charles Sumner Slichter, professor of mathematics and dean of the Graduate School at the University of Wisconsin, and Mary Louise (Byrne) Slichter, also a teacher. The family life centered on the university, and the family environment offered enormous stimuli and challenges to excellence, always within a framework of mutual respect and good humor. All four brothers succeeded to positions of eminence in the professional and academic worlds. Louis received his undergraduate B.A. from the University of Wisconsin in 1917. He later recalled with pleasure the weekly coaching he had from Professor Max Mason of the Physics Department at Wisconsin. Mason himself had been a student of Louis' father.

The United States was already a participant in World War I at the time of Louis' graduation. Immediately after his graduation Mason, who was already active in antisubmarine warfare research, enlisted Louis' participation in a project to detect enemy submarines acoustically. Mason's solution to improve the signal-to-noise problem was to set up phased, linear arrays of sonic receivers on each side of the bow of a destroyer.¹ In the summer of 1917 Lake Mendota, next to the Wisconsin campus, was the site of the first experiments on this project. Later that year Louis and his work on submarine detection moved to the Naval Experiment Station at New London, Connecticut; he was commissioned Ensign Louis Slichter, USNR. For a time he was assigned to the sub-chaser base in Plymouth, England. Testing was done in the dangerous zone of the Atlantic. The shipboard installation of instruments was becoming a reality by the time the war ended.

Louis returned to Wisconsin in 1919 for graduate studies under Mason; he received the Ph.D. in physics in 1922. His dissertation concerned the construction of a device to display the waveform of an acoustic signal, which he did by mechanically linking the motion of a conical aluminum diaphragm to a mirror whose deflection was recorded photographically. His approach was characteristic of his entire career in instrumentation: He developed and solved the coupled differential equations for the vibration of a diaphragm into the fore and aft acoustic spaces and used the results to control the design. After receiving his Ph.D., Louis was a physicist with Submarine Signal Corp. in Boston from 1922 to 1924, where he worked on problems of echo sounding. In 1925 he applied his echo-sounding experience to locate a major, dangerous leak in the Dix Dam in Kentucky, at 287 feet the highest earth-filled dam in the world at the time it was built.

In 1924 the United Verde Copper Co. asked Mason to conduct research on the problem of finding ore by "remote sensing." The partnership of Mason, Slichter, and Gauld had contracts with United Verde and with a number of other well-known firms until 1930. In 1925 Mason became the president of the University of Chicago, and the responsibility for the work of the partnership was largely Louis'. The focus of the work was the detection of electrically conducting and magnetic ore bodies by magnetic profiling, applied DC electrical potential methods, and electromagnetic induction methods, the latter by measuring the perturbation of the field of AC signals from small local antennas at frequencies up to 1 kilohertz. As usual the fieldwork had a theoretical foundation. Slichter's first prospecting paper, in 1928, was a calculation of the susceptibility of dispersed magnetic particles as a function of their concentration, and showed that the great Kursk magnetic anomaly and his own magnetic profiles over the Falconbridge nickel body in Canada could be explained in terms of these susceptibilities. His theory of the electromagnetic response of a conducting sphere was in accord with the field profiles at Falconbridge. The company carried out fieldwork on ore bodies in eastern and western Canada, the western United States, Mexico, and Peru. In the Peruvian instance Slichter worked at an elevation of 16,000 feet. The citation for the award of a lifetime honorary membership in the Society of Exploration Geophysicists includes these words: "It is relatively easy to imagine the amazement of mining geologists in those early days of geophysical prospecting at the success of applications of Maxwell's equations to the location of buried ore bodies."

Slichter was interested in prospecting problems in his later career as well. He showed that probabilistic models could be of great use in developing strategies for exploration (1955, 1959, 1960). He argued that both our petroleum

and mineral natural resources were exceedingly underpriced (1959). He estimated that the cost of burning gasoline at 1959 prices was equivalent to paying a manual laborer 1 cent per eight hours of work to expend the same amount of energy; in 2003 gasoline prices the equivalent hourly rate is 1 cent per hour. Slichter was concerned with global population growth and with the acceleration in the rate of consumption of our nonrenewable resources. He proposed that geophysical exploration to discover new deposits would help extend the world's metal resources.

By 1930 the Great Depression had put a damper on the mining industry's enthusiasm for finding metallic ores, and the firm of Mason, Slichter, and Gauld was a casualty. In 1930 Louis had a one-year appointment as research associate at Caltech and used the opportunity to sharpen his mathematics, physics, and geophysics skills. Most of his theoretical papers from this time forward on inverse problems, heat flow, and free oscillations display elegant skills in applied mathematics. Waldemar Lindgren, chair of the Geology Department at MIT, wanted to start a program of geophysics in his department, and during the Caltech year Louis was invited to join the MIT faculty. (His Dix Dam experience served as one of the core examples of geophysics in his recruitment lecture at MIT.) Louis served at MIT as associate professor from 1931 to 1932 and then as professor of geophysics from 1932 to 1945. His was the first appointment in solid-earth geophysics at MIT.

At MIT Slichter originated the study of the geophysical inverse boundary value problem, which is that of the determination of the distribution of properties of the earth in its interior from measurements over the surface. He published papers on the inverse problems of travel-time seismology (1932), electrical resistivity (1933), and electromagnetic induction (1933). He returned to some of these problems a

number of times in later years. Slichter recognized that the solutions to these problems are non-unique. A notable example was his demonstration that it is impossible to obtain the velocity cross-section uniquely in a low-velocity zone from the travel times of seismic waves. His postdoctoral student Chaim Pekeris published the solution to the inverse problem for seismic waves, which is to determine the elastic constants and density at depth from observations of the motion of the surface.

For an application of the inverse conductivity problem, Louis carried out an audacious experiment to measure the electrical conductivity of the earth at depth under Massachusetts. Thirty miles of public utility electric power lines, from Clinton to West Roxbury, were removed from public use and reconnected as a source circuit around midnight when public consumption was low. Ten to 25 amps DC commutated about once per second were passed through the ends of the grounded power lines; the earth completed the circuit. The potentials at roughly 100 electrodes to a range of 50 miles were measured by temporarily taking over the toll telephone lines of the New England Telephone and Telegraph Co. throughout the state. These were used as leads to one terminal of a potentiometer, with the other terminal connected to a reference ground. He succeeded in inverting the observations and obtained a conductivity profile to a depth of 8 km in the earth's crust (1934); below that depth the conductivity increased significantly and could not be resolved. Not only would extension to greater depth have required a greater separation of the source current electrodes and hence greater power but also the one-dimensionality of the model would no longer have been valid because of the proximity of the conducting Atlantic Ocean. It is debatable whether the successful result or the preliminary arrangements were the more remarkable.

Slichter's explosion seismology studies in New England and Wisconsin were the first crust and mantle refraction seismology experiments from controlled explosion sources with sufficient range to explore the thickness of the crust and the seismic velocity in the mantle below. He invented a portable array of three-component, short-period seismographs (1936) that made use of the innovative zero-length spring developed by Lucien LaCoste shortly before. The magnification was up to 100,000. Recorder times were synchronized to radio signals. Twelve such portable three-component seismographs were used in six large time-controlled quarry blasts in New York and Connecticut in 1938 and 1939; forty-two useful records were obtained to distances of 205 km. Six timed blasts in the Upper Michigan Peninsula, Wisconsin, and Iowa were also observed (1952). He obtained a 6.32 km/sec crustal P-wave velocity and a mantle velocity of 7.82 km/sec with a crustal thickness of 23.5 km under the Connecticut River Valley (1939). The structure he deduced under the Upper Michigan Peninsula was that of a crust of thickness 42 km with P-wave velocity from 6.0 to 7.0 km/sec below a surficial sedimentary layer 1.6 km thick, and a mantle P-wave velocity of 8.17 km/sec. The findings of later investigators were in excellent agreement with these values. The campaign of 1938-1939 showed that a sensitive, portable system of seismographs, not tied to fixed observatories, was a practical tool for exploring the structure of the earth's crust and upper mantle. Crustal and upper mantle explorations of this type became a hugely popular, widespread activity in Europe and North America in the 1960s and 1970s.

Slichter recognized that the problem of temperature distribution in the earth was fundamental to any discussion of the development of the earth and the formation of its surface features. His 1941 paper on the thermal history of the earth, which took into account radioactivity as a source of internal

heat, was an important influence in developing our present concepts of the earth's internal processes. He solved the problem of heat transfer within a sphere in the presence of a variable heat source distribution and showed that only a small proportion of the heat produced within the earth would reach the surface if the mechanism of heat transfer were that of thermal conduction. In this model the thermal time constant of the earth is very long compared to its age, and only the outer layers contribute to the surface heat flow. He showed that even a minute amount of convection in the mantle, as small as 1 mm per year, could transport 100 times more heat to the surface than the amount transferred by conduction (1940). This was the beginning of his belief that mantle convection was an important process in the dynamics of the earth's mantle. He argued that heat flow measurements by themselves were inadequate to resolve the state of the earth's interior and proposed that a study of atomic vibration theory might prove useful for understanding conductivity at depth (1940). His graduate and postdoctoral student, Norman Haskell, determined the effective viscosity of the earth's mantle from the rebound of the surface due to the removal of the glacial load. Both the heat flow and the viscosity studies were important precursors to later work on modeling mantle convection.

Well before the start of World War II, Louis' academic life at MIT was interrupted by his involvement once again with issues of national defense; as a member of Division 6 of the National Defense Research Council, he was again concerned with the problems of enemy submarines. In the fall of 1940 he was a member of a Navy department subcommittee that studied the effectiveness of the Navy's program for submarine detection. In the spring of 1941 he flew to Britain to establish collaborative liaison between the antisubmarine research establishments of the U.S. and British

navies at the request of President Jewett of the National Academy of Sciences. He was responsible for the development of magnetic and electromagnetic devices for the detection of ships and submarines. In Pasadena he was a member of a group that worked to understand why torpedoes launched from low-flying aircraft ricocheted off the sea surface. Unfortunately, scaled models plummeted. Louis solved the latter problem by an ingenious modification of the air flow around the nose of the model.¹

In 1944-1945 a new Institute of Geophysics at the University of California was proposed by members of the faculty at UCLA. Once the proposal was approved, a committee of faculty from both the northern and southern campuses of the University of California, appointed by President Sproul, agreed in October 1945 to locate the headquarters at UCLA, to define the activity of the Institute as research in "the physics of the atmosphere, of the ocean and of the solid earth," and to select Slichter, by then a member of the National Academy of Sciences, having been elected in 1944, as their first choice for director. In November 1945 and again in March 1946 the committee inquired into Slichter's interest in the directorship. At the war's end Louis had taken a professorship at the University of Wisconsin, where he initiated instruction in geophysics. Later he stated, "While in the war work, I made a firm promise to myself not to engage in any major research project until I'd taken about a half year off and looked around a bit." His replies to the inquiries from UCLA were that it had been too short an interval since his arrival at Wisconsin for him to contemplate another move. He hoped that "major decisions such as the UCLA one should be deferred if possible." His response "left the door open." In July 1946 the Institute was formalized, and Joseph Kaplan, one of the authors of the original proposal and a member of the committee, was appointed acting

director. Kaplan's view was of a partitioned Institute in which atmospheric research would be carried out at Los Angeles, oceanographic research at the Scripps Institution of Oceanography (then administratively a part of UCLA), and solid-earth research at Berkeley. To this end he made offers of positions to atmospheric scientists C. E. Palmer and R. E. Holzer and oceanographer W. H. Munk.

In the summer of 1946 Slichter began seven months of visits to centers of geophysics in California and the two Cambridges² with the support of a fellowship from the Rockefeller Foundation. Immediately upon returning to the United States in the first week of January 1947, Slichter contacted the chair of the UCLA committee, V. O. Knudsen, to indicate his interest in the directorship. The travel of 1946 was evidently a time of decision making with regard to the Institute and thinking how its program might be organized if he were the director. The committee recommended that the appointment be made as quickly as possible. In mid-July Slichter accepted an appointment as professor and director of the Institute of Geophysics, effective July 1, 1947.³ The Slichter family arrived in September.

With Louis' appointment the model of an Institute at UCLA devoted exclusively to atmospheric science was moot. In 1948 David Griggs, a world-class solid-earth experimentalist, began a professorial appointment in the Institute. The Institute on the Los Angeles campus now consisted of two atmospheric and two solid-earth geophysicists. All budgeted positions had been filled. It took a number of years for the Institute of Geophysics to make additional new appointments. Except for the short-lived appointment of an atmospheric scientist to an assistant professorship in 1949, no appointments were made until 1954 with the addition of two faculty members in geochemistry. From then on, the Institute grew with distinction. Slichter's view was that most

areas of geophysics should be represented in the Institute, with special emphasis on areas of research that were outside the mainstream at any given time. From the beginning the Institute was to be a university-wide organization. During Louis' tenure as director, the annual scientific meetings of the Institute, held in rotation on each of the La Jolla, Berkeley, and Los Angeles campuses, were the premier national meetings in geophysics. A branch of the Institute of Geophysics on the La Jolla campus came into being in 1960 under Munk's directorship. This is the first example of a multicampus, multidisciplinary institute at the University of California, a model that was emulated in other fields only decades later. Slichter was the director of the state-wide Institute as well as director for the Los Angeles branch. Today there are seven branches of the Institute at campuses and laboratories of the University of California. An insightful account of the difficult early years of the Institute and of Slichter's unselfish dedication to its development has been given by C. B. Palmer.⁴

By the time of his retirement, the Institute was a distinguished model for other departments and institutes of geophysics. His view of the Institute was that distinction, independent of subdiscipline, should be the qualification for membership, and through his distinguished leadership it came to be. At the time of his formal retirement from the faculty at UCLA in 1965, 11 members of the Institute of Geophysics and Planetary Physics at UCLA were members (7) or future members (4) of the National Academy of Sciences. (The name had been changed in 1960.) "The Institute of Geophysics and Planetary Physics was Louis' greatest achievement."⁴ He brought distinguished scientists from a variety of disciplines to UCLA to participate in a continuing colloquy in the interdisciplinary fields of the physical sciences of the natural environment. The Institute

is the chief monument to his genius with people, and the multidisciplinary Institute mirrored and expressed his own breadth.

Louis organized the famous conference at Rancho Santa Fe on the "Evolution of the Earth" (1950), which synthesized ideas from diverse fields in understanding the basic problems of the earth. Participants were a Who's Who in seismology, geochemistry, geochronology, petrology, heat flow, physics, chemistry, astronomy, and fluid mechanics. A product of the conference was to put forward the argument that fractionation of the continents might provide enough differential heating to drive convection processes in the earth's mantle.

The task of building the Institute did not deter Louis from continuing his research on problems of fundamental importance. At UCLA he began research on the gravity field of the earth. Influenced by recent observations by F. A. Vening Meinesz and by the models of Griggs, both strong advocates of mantle convection and continental drift, Louis organized expeditions to measure variations of gravity over topographic features of the sea floor by pendulum observations in submarines.

The earliest information about the elastic properties of the earth's interior was derived by Kelvin on the basis of studies of ocean and solid-earth tides. Despite the fundamental information that could be derived from tide studies, these were largely neglected until Slichter began a program of observations using modern instrumentation. Starting in 1950, through his contact with LaCoste, Louis acquired a number of LaCoste's ultrasensitive earth-tide gravity meters; these were deployed to study the earth's tides and later in seismological pursuits. He was soon recognized as a world leader in the analysis of the solid-earth tides. In 1957 twelve temporary earth-tide measuring stations were installed in equatorial regions around the world during the International

Geophysical Year (1963). He discovered that the oceans were a potent influence on measurements of the diurnal and semidiurnal vertical solid-earth tides at coastal sites, and could produce phase shifts in the observations of as much as three hours (1953). From observations made during a total eclipse of the sun, he was able to place an upper bound on the cross-section for shielding of gravitational fields by matter (1965).

The tidal gravimeter at UCLA was an ideal instrument for recording the first observations of the spheroidal free oscillations of the earth excited by the great Chilean earthquake of 1960 (1961). The lowest frequency observed was that of the quintuplet mode ${}_0S_2$ with a period of 54 minutes. All modes except the purely radial ones had uncertain central frequencies because of the unequal excitation of the multiplets, broadened due to attenuation. These observations of the earth's resonance spectrum formed a basic dataset for inversion to obtain earth structure. The ground state, which is the spectral triplet ${}_1S_1$ corresponding to the Foucault pendulum oscillation of the inner core about the center of mass, was not observed. Slichter showed that the period of this spectral term, estimated to be around five hours, would provide the most direct evidence for the density of the inner core, as it depends critically on buoyancy effects (1961). The elusive "Slichter mode" remains undetected to this day.

In the more than 15 years following his retirement Slichter led an active research program that focused on gravimetric and seismological measurements at the South Pole. There were two motivations for this research. First, the high rigidity of the earth's mantle at periods as long as 54 minutes, and the low rigidity of a viscous mantle with a time constant of the order of 10,000 years, suggested the presence of a cross-over between these timescales. The rigidity measurements

could be extended to fortnightly and bi-fortnightly periods through a study of the tides. Measurements at the South Pole were a strong option because of the absence of the strong diurnal and semidiurnal tides present at lower latitudes. Second, the multiplet splitting of spectral resonances due to the earth's rotation and flattening, would be absent at the Pole, and it might be possible to measure the spectrum with greater accuracy than at lower latitudes. Louis was able to make the first direct observation of the fortnightly solid-earth tide, a considerable achievement because uninterrupted records of deformation over many fortnightly cycles were needed with a stable instrument at the Pole; the work appeared posthumously (1979). The result showed that the rigidity of the earth at these periods was consistent with seismic values and that the crossover was at still longer periods. A strong earthquake during the years of operation of the instruments at the Pole never took place in his lifetime, and the seismic part of his Antarctic program was not completed. He was very disappointed to be denied permission to travel to the South Pole to visit the installation because of his physical condition in these later years of his life.

Because his genius at defining new fields, his theoretical skills, and his devotion to rigorous data gathering were more widely known, his skills as an instrumentalist were not as often spoken of. He invented and patented a number of important geophysical devices that included the electromagnetic induction apparatus for location of buried conducting ore bodies, and downhole resistivity-measuring devices in boreholes; the latter patents were sold to the Schlumberger Company. The Slichter seismographs were operated at several seismological observatories for a number of years. He invented a suspension system to minimize the minute but significant effects of tilt of the ice platform at the South Pole on gravimetric measurements; the invention was, as always, buttressed

by extensive mathematical calculations. At the time of his death he was developing a tiltmeter for installation in the ice at the South Pole to measure the horizontal component of the earth's deformation at tidal periods.

Louis was a man of great, good humor, as illustrated by remarks about parental discipline after childhood exploratory excursions onto thin ice on nearby Lake Mendota. "We were sternly forbidden to get out on the lake during those times. This restriction was strongly enforced by the switch. Each brother had to be taught independently about the laws of the land. The other three always enjoyed these lickings rather well, so I think it all contributed to the greatest happiness of the greatest number."⁵ Louis, more so than the other brothers, exhibited mechanical talents in his early years, a forerunner of his later skills as an instrumentalist and experimentalist. He was encouraged to use his father's workshop. In his teens he gave a preview of coming attractions by designing and building an ice boat driven by an aircraft propeller and motor rather than by sail. Unfortunately, this engineering marvel slipped beneath thin ice on its first voyage. Louis jumped to safety. Knowing of its meaning to its designer, his father arranged to have it recovered from the bottom of the lake. For many years Louis kept the propeller in his office.

Louis was an outstanding sailor and iceboater. In July 1947, just before coming to UCLA, Louis and his family spent a holiday in Maine, where, of course, he rented a sailboat and entered the races. The rental craft was reputed to have had a very bad racing record over the years, but Louis quickly used his mechanical, fluid mechanics, and strategic skills to overcome its shortcomings. The usual racing crowd expected little from the rental craft, skippered by someone from the Midwest with little experience on the ocean. Louis won all the races in which he was the skipper.

During two successive summers while in graduate school, Louis ventured west for a mountain-climbing career in the high Sierra with the noted mountaineer Norman Clyde. They made the first ascent of the West Vidette in August 1920.⁶ Louis was an avid swimmer. In his mid-sixties he astonished his colleagues at the Institute upon his return from a family vacation in Hawaii by displaying his certificate as a qualified surfboarder.

Louis was identified in the minds of his colleagues with his continuing spirit of good humor, which was a real part of his creativity and leadership. His friendship, warmth, and contagious enthusiasm were an integral part of his ability to generate an extraordinary affection for him among his colleagues. His office was filled with his wit and his wisdom. It is difficult to say whether Louis' own brilliant scientific achievements or his kindly personal influence over those associated with him were of greater significance. His post-doctoral students included leading geophysicists both in the United States and abroad. Through his warmth and vitality, as well as his penetrating insights, he stimulated his colleagues to identify good science and to avoid the temptations to join the ranks of those he characterized as the "great windbags of science." Despite a long battle against ill health caused by adult-onset diabetes, he maintained a cheerful manner. His almost daily appearances at his laboratory to the very end of his life were punctuated by enthusiastic and stimulating discussions with his colleagues, who continued to learn from this great teacher to the end of his career. Martha, Louis' companion for more than 50 years, was closely identified with him in the affection of his colleagues. She and their two daughters, Mary Lou Slichter Whaling and Susan Merry Slichter, survived him at the time of his death.

Among the honors that Louis Slichter received were the Presidential Certificate of Merit (1946), a Rockefeller Foun-

dation Fellowship (1946), the Jackling Award of the American Institute of Mining and Metallurgical Engineers (1960), the William Bowie Medal of the American Geophysical Union (1966), and an honorary life membership in the Society of Exploration Geophysicists (1959). The Distinguished Service Citation "in recognition of eminent professional services" was presented to the four Slichter brothers by the University of Wisconsin (1957). He was the Thirty-eighth Annual Faculty Lecturer of the University of California, Los Angeles (1963). He was awarded the LL.D. by the University of Wisconsin (1967) and the D.Sc. by the University of California, Los Angeles (1969). He was elected to membership in the National Academy of Sciences (1944) and was the chair of its Geophysics Section (1960). He was a fellow of the American Academy of Arts and Sciences, a fellow of the American Physical Society, and a fellow of the American Geophysical Union. Slichter Hall at UCLA and Slichter Foreland on the Martin Peninsula in Antarctica have been named for him. There is a collection of scientific papers in his honor.⁷

NOTES

1. Slichter's detailed account of the acoustic submarine detection work of World War I and the torpedo entry work of World War II can be found on pages 212-217 and 227-229, respectively, of W. Weaver. Max Mason, 1877-1961 *Biographical Memoirs of the National Academy of Sciences* 37 (1964):205-236.

2. Rockefeller Foundation Archives.

3. Louis' appointment came only after a series of events in the first half of 1947 in which he played no direct role. Upon receiving Louis' expression of interest in the position in the first week of January, the committee, now renamed Advisory Board, was polled and by January 13 unanimously and strongly endorsed the offering of the directorship to Slichter (letter from Knudsen to President R. G. Sproul, February 7, 1947, recommending appointment.) On January 31 Kaplan received a letter from Sproul, which stated in part, "The form covering your change in status . . . to Professor of

Physics and Director of the Institute of Geophysics, which you submitted recently, has been approved . . .” (Knudsen to F. A. Brooks, April 11, 1947.) The board declined Kaplan’s request that it ratify the change in status (Knudsen to Sproul, February 7, 1947). Kaplan stated that the change in title came as a surprise (Kaplan to Knudsen, April 8, 1947); Sproul’s letter of January 31 indicated that it had come at Kaplan’s initiative. Kaplan accepted; two weeks earlier he had voted to confirm Slichter. The formal paperwork for the change in title arrived at the end of March 1947: Kaplan had been appointed director for one year retroactive to July 1946. Upon learning of the change in Kaplan’s title, some on the board expressed concern, since the action was contrary to their recommendation (Brooks to Knudsen, March 31, 1947). Knudsen promised to protest in behalf of Slichter’s nomination if it became necessary. (Knudsen to Brooks, April 11, 1947). There is no record that a protest was necessary. After completion of the appointment process, Sproul sent a cordial letter of appointment in early 1947. Louis accepted in late July. Kaplan’s appointment as director was indeed only for one year. “Kaplan has had an unfortunate experience in some ways because he was not told that his directorship was acting. However there seems to be no one on the committee who thought that he should have been named director.” (P. Byerly to Slichter, September 2, 1947) As a consequence of these events, an unfortunate rift between Slichter and Kaplan developed that was irreparable.

4. C. E. Palmer. Louis Byrne Slichter: Builder of the Institute of Geophysics and Planetary Physics. *J. Geophys. Res.* 68(1963):2867-2870.

5. T. J. Tugend, interviewer. *Mr. Geophysics, Louis B. Slichter* (An oral history). Los Angeles: University of California, 1984

6. H. Voge, ed. *A Climber’s Guide to the High Sierra*. San Francisco: Sierra Club, 1954.

7. Papers in Geophysics Honoring Louis Byrne Slichter. *J. Geophys. Res.* 68(1963):2867-2983, 3627-3634.

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