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WILLEM JACOB LUYTEN

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A Biographical Memoir by

ARTHUR UPGREN

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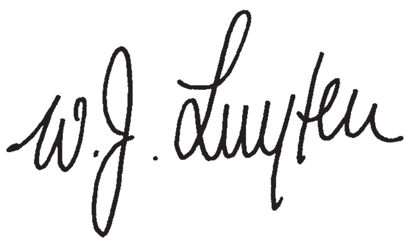

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WILLEM JACOB LUYTEN

March 7, 1899–November 21, 1994

BY ARTHUR UPGREN

WILLEM LUYTEN WAS the central figure in the determination of the stellar luminosity function, the frequency function of stars by their luminosity. In this, his major research contribution, he followed in the tradition of Dutch astronomers, mostly of the Leiden Observatory, which began before 1900 with J. C. Kapteyn and included P. J. van Rhijn, Ejnar Hertzsprung, Willem De Sitter, and Jan H. Oort. Luyten was one of a number of distinguished students of these scientists who emigrated to the United States and had a memorable career. His contemporaries included Bart J. Bok, Dirk Brouwer, Gerard P. Kuiper, Jan Schilt, Kaj Aa. Strand, and Peter van de Kamp.

Luyten spoke of his ancestry as part French, originating in Provence in the fourteenth century. The family name may have been Lutin and derived from lute players and minstrels attending the popes who resided in Avignon. In 1377 the popes moved back to Rome and the progenitor lute player resettled at the Court of Burgundy. The dukes there united the cities of Holland, and during ducal rule over the next century, the family may have found its way to the Netherlands. His mother's family name of Francken reveals her origin there.

Luyten, himself, was born of parents of North Holland, who had settled in Indonesia, then a colony of the Netherlands. His birth on March 7, 1899, was in the city of Semarang in north-central Java, where his father taught French in the local high school. Luyten lived there until 1912, when the family moved back to the Netherlands. At that time he spoke Dutch and French; he also became fluent in German and English before his high school graduation. Later in college he mastered Latin and Greek, and still later, he picked up some Spanish and Italian, and finally, in 1927, Russian. He was rightfully proud of his ability to learn to read and speak so many languages.

Willem Luyten's interest in astronomy dates from the 1910 appearance of Halley's comet over his home in Semarang. He made his first astronomical observations on Java in 1912, and continued them while a student at the University of Amsterdam, where he received a B.A. degree in 1918. His earliest research was published at that time and he completed his doctoral thesis four years later at the University of Leiden, where he was awarded his Ph.D. degree in 1921. He was Hertzsprung's first student there. Luyten's thesis was based on 13,500 visual observations of variable stars, some of which he made in high school and others with the 6-inch refractor at the Leiden Observatory. His contacts at Leiden included Kapteyn, de Sitter, and Paul Ehrenfest, at whose home he socialized on occasion with Albert Einstein, Hendrik Lorentz, and A. S. Eddington.

Although he became interested in many lines of astronomical research, Luyten's lifelong interest centered on the properties of the common nearby stars and especially their proper motions. Near the end of his career, he participated in International Astronomical Union Colloquium No. 97 on wide components in double and multiple stars held in 1987 in Brussels, which was dedicated to him. There he gave a review of his lifetime of research on these objects. In it he remarked that:

> We should remember that, . . . of the 6,000 stars [that] the average human eye could see in the entire sky, probably not more than thirty—or one-half of one percent—are less luminous than the Sun; that probably, of the 700-odd stars nearer than ten parsecs, at least 96% are less luminous than the Sun. There is not even ONE real yellow giant—such as Capella, Pollux, or Arcturus—nearer than ten parsecs and only about four Main-Sequence A stars.

He was always aware of the havoc this great dichotomy between the brightest and the nearest stars—fraught as it is with bias—could wreak upon anyone who did not take full account of it in their work.

Perhaps no one explored the immensity of this dichotomy in more detail than did Luyten. He turned his early interest in proper motions into a better calibration of the HR diagram than had been known at the time. His early years at the Lick Observatory and as a guest investigator at the Royal Greenwich Observatory witnessed his development and application of techniques using proper motions to estimate the distances of stars in large numbers. Through the use of Hertzsprung's concept of the reduced proper motion to obtain statistical parallaxes for common stars, he was the first to provide a realistic census of stars in the solar neighborhood and an HR diagram more truly representative of the fainter stars that dominate the solar neighborhood.

The reduced proper motion connects the apparent and absolute magnitudes (luminosities) with proper motion in much the same way as are the apparent and absolute magnitudes with trigonometric parallax. Just as the parallax fixes the absolute magnitude exactly, so do proper motions roughly determine it. Roughly, because proper motions of stars at a given distance differ considerably. But, if many stars are examined and the mean proper motion is calibrated on parallax, the method works.

It is worth noting that, not long ago, the only properties known about the majority of the nearest stellar neighbors were the apparent magnitude and the proper motion. In fact, the proper motion became the feature by which a faint nearby star could be recognized as such. In his autobiography published in 1987, Luyten cites his seventy years of work on this subject. His amazingly extensive and pioneering efforts in this domain dwarf those of anyone else. Since 1925 he determined over 200,000 proper motions, itself a testimonial to his stamina and dedication. In 1925 Luyten lost the sight of one eye in a tennis accident. Thus, he accomplished all of this with his remaining eye; it is probable that he has blinked, observed, and measured more stellar images than anyone else.

The preceding feat alone would merit a permanent place in the annals of astronomy, but his insight into the worth of the collected data lies even more at the center of his achievement. His Dutch predecessors—especially Kapteyn, van Rhijn, and his Danish mentor at Leiden, Ejnar Hertzsprung—picked up about where Sir William Herschel left off a century earlier in the study of the stellar makeup of the Milky Way. The luminosity function concept was well known by the time Luyten entered the scene, but it was he, working almost alone, who first filled in its faint end.

In 1923, after two years at the Lick Observatory, Luyten was offered a position at the Harvard College Observatory by Harlow Shapley. He spent the next seven years on its staff, the last two in Bloemfontein, South Africa. At both Lick and Harvard, Luyten was engaged in a number of other research subjects. While at Lick, he predicted and confirmed that the sodium D lines differ widely in intensity among the cooler stars, between giants and normal dwarfs of the same surface temperature. But his Harvard years became dominated by the study of proper motions that formed the major focus of research for the rest of his professional life.

At Harvard and Bloemfontein, he began his long association with the 0.6-meter Bruce refracting telescope. Between 1896 and 1910 at its former location at Arequipa, Peru, the telescope had been used to photograph almost the entire southern celestial hemisphere in three-hour exposures that reached the seventeenth magnitude. Altogether, the collection comprised more than 1,000 plates. These plates could serve as first-epoch observations for a large proper motion survey, and in 1927, with the aid of a Guggenheim Fellowship, the Bruce Proper Motion Survey began. Luyten took over 300 of the 1,000 plates forming the second-epoch material and blinked all of the plate pairs. Altogether 94,263 stars with significant proper motions were found. Most of these stars were brighter than magnitude 14.5 and had proper motions in excess of one-tenth of an arc second per year. The measurement of positions and proper motions for these stars took many years to acquire, and required a number of measurers, including myself during my undergraduate days at Minnesota. The final catalog appeared in 1963.

In compiling this catalog, Luyten showed much resourcefulness. In 1923 he published a paper in which he employed a cumulative probability plot, or probit plot, decades before its common use in astronomy. These plots outlined a technique for determining whether specific sets of data follow a Gaussian distribution by rendering the cumulative normal distribution into linear form. The test is often more robust than the Kolmogorov-Smirnov and similar goodness-of-fit tests for randomness.

In funding such a long-term project, he was creative and persistent; at different periods he acknowledged not only the National Science Foundation and the Office of Naval

Research but also other federal relief organizations, such as the federal student aid program and even the Works Progress Administration, along with a number of private philanthropic sources.

The Bruce Proper Motion Survey led to improvements in stellar kinematics at the faint end of the luminosity function, but it also provided a rich harvest of degenerate stars, known also as white dwarfs. These are end products of stellar evolution with degenerate matter in their interiors after the fusion process has compacted their atomic nuclei and compressed them into planet-size objects. One of the goals of the survey was to discover and identify many degenerate or white dwarf stars. Only three were known in 1921, when Luyten began his term at Lick, far too few to support the many theoretical studies made of them then and since. Luyten collaborated with E. F. Carpenter of the University of Arizona, E. Gaviola of the Cordoba Observatory, and G. Haro of the Tonantzintla Observatory to obtain colors of the faint proper motion stars found in the survey. From the colors, magnitudes, and assumed distances, the degenerates were identified as such and, by the time of its publication in 1963, Luyten had discovered the great majority of the several hundred then known.

With the completion of the Bruce survey project, Luyten sought to extend its achievements in the search for stellar neighbors, to fainter magnitudes, and to the northern celestial hemisphere, which was not observable with the Bruce telescope in its southerly locations. For these reasons, he initiated the immense project known as the National Geographic/Palomar Observatory survey. The name honors the principal sponsor and the 1.2-1.8-meter Palomar Schmidt telescope on which much of the plate material had already been obtained. This wide-field instrument had photographed the entire sky north of declination –34° and to stars of magnitude 18 and fainter.

This is the plate material that formed the Palomar Observatory Sky Survey of the 1950s and is still very useful today. It also provided an ideal first epoch for the measure of proper motions. Luyten quickly realized that the old blink machine at Minnesota, on which measures for the Bruce survey were made by hand, was much too slow for this project. He approached the Control Data Corporation with plans to build a rapid-scanning microdensitometer. The CDC machine, designed primarily by James Newcomb and Anton LaBonte, became the fastest of the new generation of automatic machines capable of measuring and blinking stellar images with high precision. It finally became possible to determine the proper motions of hundreds of thousands of stars in a short time; in a few years motions for 300,000 stars were found, doubling the number with these data. The catalogues that emerged from this effort are among the most widely used in the field. They include the first round of catalogues of 1955 to 1961, the LFT (Luyten-Five-Tenths) catalogue of 1,849 stars, and the LTT (Luyten Two-Tenths) catalogue of 16,994 stars with proper motions exceeding 0.″5 and 0.″2 arc seconds per year, respectively. Twenty years later, well after his retirement, he published their successors, the LHS (Luyten Half Second) and NLTT (New Luyten Two-Tenths) catalogues with the same limits, but with 3,583 and 58,700 stars.

Honors accrued to Luyten at about the time of his retirement in 1967; he was the Catherine Wolfe Bruce medalist of the Astronomical Society of the Pacific in 1968, and was elected to the National Academy of Sciences in 1970. Also in 1970 he received an honorary doctorate degree from St. Andrew's University, the oldest educational institution in Scotland; only Benjamin Franklin and two others preceded him in the award of this honor. He organized and headed the first conference held specifically on proper motions. The meeting was held at the Control Data Corporation in Minneapolis in April 1970, and the proceedings constituted the International Astronomical Union Colloquium No. 7.

However one obtains a value for the stellar luminosity function, one must calibrate the data for the many thousands of stars covered in the survey against a much smaller group of stars for which the individual luminosities are directly determined from the parallax. Until the present decade, these were few and were biased in one way or another. For his calibration sample Luyten used 610 stars with proper motions in excess of 0.5 arc seconds per year, and for which luminosities were available from trigonometric parallaxes.

In 1964 James Wanner completed a doctoral thesis at Harvard University on the same subject but with a different calibration group. Wanner used a limit in distance instead of proper motion as his major criterion. He used only stars within ten parsecs of the Sun—117 altogether—which also fulfilled secondary criteria in parallax and proper motion. Wanner's technique has the advantage of being far less susceptible to a bias towards stars with a high velocity across the sky. Both Luyten and Wanner used Hertzsprung's approach, but with proper motions being such a fundamental parameter in Luyten's work, a high-velocity bias is apparent in the result. Wanner's function comes closer to recent determinations that can to a large extent bypass proper motion and thus better represent all stars in this part of the galaxy.

This controversy became a matter of great contention, until settled by access to very large stellar samples with distances determined for each star individually. Luyten's function was vitiated only among the very faintest of stars;

unfortunately, these are the ones most critical to the study of certain aspects of stellar evolution and of other planetary systems. They are also among the hardest to model, to assign with confidence the interior domains of radiative and convective energy transfer by which the energy produced at the stellar core rises to the surface and out into space. In any event, the merit of his work is beyond reproach when we consider the data and methods available to him at the time.

Willem Luyten joined the faculty of the University of Minnesota in 1931, his appointment at Harvard having been terminated the previous autumn, apparently without cause. In his autobiography, Luyten contends that Henry Norris Russell, then the putative "dean of American astronomers," was instrumental in the termination. He describes their first encounter: Luyten had compared stellar luminosities from Mount Wilson spectral classifications and from parallaxes and had concluded that, if all M giants were assigned the same luminosity, the mean error in luminosity from parallax would be reduced. Upon seeing this work, Russell, according to Luyten, said, "Even if this were true, I could say it, but you can't." Young Luyten responded, "I thought that in science the only thing that mattered was what was said not who said it." These and further encounters allegedly turned the influential Russell against him.

Over his career, Luyten published some 500 research papers and wrote numerous popular articles for the *New York Times*, *Minneapolis Star and Tribune*, and other periodicals. His association with the *Times* began in 1925 with his report on the total solar eclipse of that year as seen from the air. He credits its editors with his success in obtaining the Minnesota position after a long job search.

At Minnesota, where a single astronomer was then in fashion, he succeeded the binary star astronomer and observer

Francis P. Leavenworth, who retired and died in 1928. At some time during the three-year interim, the observatory and its 0.25-meter refracting telescope were moved to the top of the then new physics building, a questionable improvement in location. Neither astronomer had a role in this decision. While a student there, I discovered that the coordinates of the old site had continued to be propagated in the literature. Luyten concurred, but he may not have corrected the error in the American Ephemeris and elsewhere, where the old coordinates were listed until at least 1980.

I knew his work habits well. He used a blink machine to align two plates taken years apart to discover the stars that moved noticeably, and were therefore likely to be nearby neighbors of the Sun. This was exhausting work, and none of the rest of us could stand to do it for long. With his one good eye, he could blink for hours at a time; his perseverance seemed limitless. The rest of us measured the locations of each moving star and several of its neighbors for positions and entered them in notebooks. In that computerless era, we needed to combine the two motion components along each of the two orthogonal axes, into a total motion and direction. From repeated use, I came to know the squares of all integers from 1 to 100 from memory. Luyten was a master in teaching students to make offhand estimates, always a difficult point to get across. For example, he encouraged the memorization of the logarithms of 2, 3, and 7. From these, one can quickly derive the logarithms of any integer up to ten and can interpolate larger ones closely.

At the completion of the information on motions in each field, he would assign magnitudes to the stars that had moved. Having none of the photometric equipment of today, he would, with an eyepiece in hand, call out the magnitudes to be recorded. He claimed that a certain image size was set at magnitude 12.7, as I recall, and he went on from there. He was well aware that emulsion and other differences produced a considerable magnitude error of as much as a full magnitude. On this he would cite a rule common to astronomers of his generation and all but forgotten since, that the systematic errors could be assumed to be about one-fifth of the accidental errors from all sources. (I heard this same remark from his contemporaries Bart Bok and Peter van de Kamp as well.)

Until his retirement in 1967, he regularly taught introductory astronomy, as well as some advanced courses, at the university. His enthusiasm extended to every corner of astronomy, as was evident in lectures and in conversation; I for one learned very much from him, inside and outside the classroom. He was a superb teacher, and he regaled the students with stories that revealed a delightful sense of humor. After getting off a bon mot, he retained his typical saturnine facial expression, but the twinkle in his eyes was noted by many.

His strained and sometimes hostile approach to some of his colleagues and the public in general never extended to students, as I well know. Typical of his gruff public manner was an item appearing in a column by “Mr. Fixit” in the *Minneapolis Tribune* in 1956. A woman had written for the identity of a brilliant star appearing in the sky. She cited her neighbor as an authority on astronomy who had never beheld such a spectacle before. “I referred your query to Prof. Willem J. Luyten, chairman of the University of Minnesota Department of Astronomy,” Mr. Fixit replied. “His comment: ‘If you removed the drama and hooey, the planet Venus is left.’”

Yet, it was clear that he knew the place and value of humor in his lectures and other remarks. In response to a student in my introductory course with him, who was having trouble visualizing a galaxy, he remarked that a galaxy looks like a cow pie. Typical of his humorous gruffness was his response to a persistent telephone. He finally interrupted a lecture in my celestial mechanics class to answer it. After a minute, he returned and grumbled, “Some SOB has a piece of shiny steel he thinks is a meteorite.” Amidst riotous laughter, he resumed his lecture. His fluency in English was assured if a bit florid. This is evident in his popular book on astronomy *The Pageant of the Stars*, first published in 1929, with a second edition appearing five years later.

Willem Luyten became a factor in my own enthusiasm for astronomy more than once. It was he who, in the spring of 1940, pointed out to me the five naked-eye planets strung along the ecliptic in the western sky at dusk. Later that year he invited me to see Jupiter and Saturn through the refractor. Yet, ten years afterward, when I matriculated at the university, I still had no thought of astronomy as a profession, and I took up engineering instead. After three years of a mediocre record based squarely on a lack of interest, I considered astronomy as a career. When I approached him about a change of careers, he promptly said, “You get the hell out of engineering and into astronomy, where you belong.” I have never regretted taking his advice.

Later, after my graduate work was completed, I fell afoul of his wrath more than once. At issue was a group of seven F-type stars near the North Galactic Pole that simple Poisson statistics strongly suggested must be physically associated. From spectroscopic and photometric evidence they appeared to form a small cluster of the old disk population, similar in age to the well-known clusters M 67 and NGC 188. Later known as Upgren 1, this is the fourth or fifth nearest cluster to the Solar System.

The evidence for physical association from proper motions was marginal, with 3 to 5 of the 7 stars showing parallel motion. Luyten's complaint was that proper motion information should be paramount in the recognition of a group of stars as a cluster. He published a partial refutation centered on this point, and never again discussed it, and soon turned his attention to correct the perceived mistakes of others. Recent radial velocities confirm five stars as members, though no longer gravitationally bound together.

More than once in his writings, Luyten quoted Lord Peter Wimsey, Dorothy Sayers's fictional detective, who remarked in *Gaudy Night* that "the point about it is that the only ethical principle which has made science possible is that the truth shall be told all the time. If we do not penalize false statements made in error, we open up the way for false statements made by intention." This comment became his touchstone for professional behavior, and in his own way he applied it relentlessly to himself and to his colleagues. Coupled with an intransigent approach towards the proprietary rights of one who first studies a star or group of stars, it led to repeated admonishments on his part of a number of distinguished colleagues in and out of astronomy. Such actions resulted in embittered relations and even total alienation between him and some of them. Most took it in stride or responded in kind. But the potential for harm to the career of a younger astronomer was not always negligible.

Luyten had a talent for alliterative broadsides in his publications. Some of his feistiest papers bore such titles and references to colleagues as "The Messiahs of the Missing Mass," "More Bedtime Stories from Lick," and "The Weistrop Watergate." They made for very amusing reading, but they were too disrespectful and too full of negative allusions to his colleagues and their work to be at all times in the best interest of science, even though much in them was factually correct. In his later years, he referred to himself as a curmudgeon, an epithet bestowed on him at times by others.

In this, too, a certain modicum of humor crept into his otherwise stern bearing. Although we met on several occasions since then, he last spoke to me at the general assembly of the International Astronomical Union in Patras, Greece, in 1982.

While living and working in South Africa, Willem Luyten met and married Willemina Miedema; it was a close marriage and lasted over sixty years until his death on November 21, 1994. The Luytens had three children, all among my neighborhood childhood acquaintances. Mona Coatzee is now on the faculty of the University of Pittsburgh, Ann Dieperink was a Fulbright scholar and is a practicing attorney, and James Luyten earned a Ph.D. degree in physics at Harvard and is now an oceanographer at the Woods Hole Oceanographic Institution in Falmouth, Massachusetts. All three are married to professional people and have families of their own.

In 1939, about when I first knew him, he and Mrs. Luyten built a house only a block from my own, not far from the university campus in Minneapolis. It was the only one of an art deco style—ultramodern for the time—in a neighborhood of gables, dormers, and pitched roofs. Although it appears conventional today, it is almost as conspicuously different from its neighbors as is Frank Lloyd Wright's Guggenheim Museum in New York City. In his home, as in so much of his life, he was a nonconformist among nonconformists. He lived in that house for the remainder of his life and died there over half a century later. In home and family life, he led a remarkably stable existence. He was a man of many interests in addition to astronomy. His well-known knowledge of wines, especially those of Burgundy, was occasioned by many annual visits to that region of France for tasting and other celebration.

Willem Luyten maintained his research activity during the years after his retirement. He remained steadfast to his principles, but principle is best tempered at times with compassion and forgiveness. This he too seldom realized in the course of his relations with other astronomers. Yet, however he may come to be judged by those who knew him, he remains almost universally respected as the great imaginative and dedicated scholar and scientist he was. They are likely to agree with Shakespeare that "he was a man, take him for all in all, I shall not look upon his like again."

MY PRIMARY SOURCE for this memoir was Willem Luyten's own autobiography (1987). Secondary sources were a paper by Helmut Abt in *Publ. Astron. Soc. Pac.* (80[1968]:247-251) written upon Luyten's award of the Bruce Medal, and obituaries by Dorrit Hoffleit in *J. Am. Assoc. Variable Star Obs.* (24[1996]:43-49) and by myself in *Publ. Astron. Soc. Pac.* (107[1995]:603-605) and *Q. J. Roy. Astron. Soc.* (37[1996]: 453-456). In addition, I relied on many memories I have of Willem and his family over nearly five decades and some correspondence with him. I have included only the anecdotes that I witnessed or verified from independent evidence.

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