

What Else Did V. M. Slipher Do?

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Abstract. When V. M. Slipher gave the 1933 George Darwin lecture to the Royal Astronomical Society, it was natural that he spoke on spectrographic studies of planets. Less than one-sixth of his published work deals with globular clusters and the objects we now call galaxies. In his most productive years, when he had Percival Lowell to give him direction, Slipher made major discoveries regarding stars, galactic nebulae, and solar system objects. These included the first spectroscopic measurement of the rotation period of Uranus, evidence that Venus's rotation is very slow, the existence of reflection nebulae and hence interstellar dust, and the stationary lines that prove the existence of interstellar calcium and sodium. After Lowell's death in 1916 Slipher continued making spectroscopic observations of planets, comets, and the aurora and night sky. He directed the Lowell Observatory from 1916 to 1954, where his greatest achievements were keeping the observatory running despite very limited staff and budget, and initiating and supervising the "successful" search for Lowell's Planet X. However, he did little science in his last decades, spending most of his time and energy on business endeavors.

1. Introduction

Vesto Melvin Slipher, always referred to and addressed as "V. M." (Giclas 2007; Hoyt 1980b) came to Flagstaff in August 1901, two months after completing his B.A. in mechanics and astronomy at Indiana University, because his professor, Wilbur Cogshall, had persuaded Percival Lowell to hire him temporarily. He arrived at age 25 and stayed there 53 years. After retirement he lived 15 more years in Flagstaff. I will discuss his life in Flagstaff, which I divide into five parts, and his research on the night sky, the aurora, planets, comets, stellar radial velocities, variable stars, and interstellar gas and dust. We have heard from others about his early life and his work on globular clusters and galaxies. The closest thing to a published biography is William G. Hoyt's *Biographical Memoir* (Hoyt 1980b).

2. Great Achievements under Lowell, 1901–1916

In his early years at Lowell Observatory, Slipher was not his own man. This was fortunate, as together he and his employer made a formidable team. As John S. Hall wrote in an obituary in *Sky and Telescope* (Hall 1970),

Slipher and Lowell had complementary temperaments. The latter was brilliant, enthusiastic, and a driving personality. ... Slipher, on the other hand,

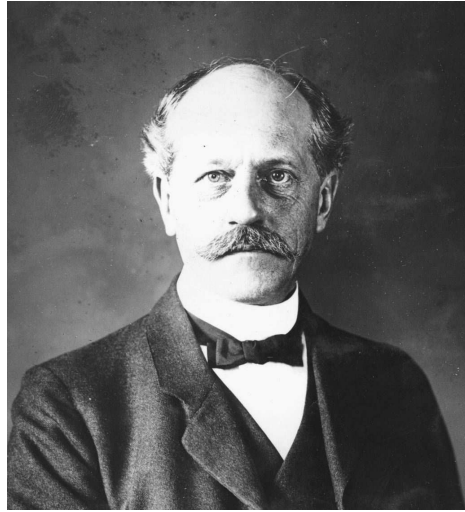


Figure 1. Percival Lowell, 1904 (courtesy Lowell Observatory Archives (LOA))

was deliberate, fastidious, patient, and showed a high order of technical knowledge.

Lowell knew what he wanted, and Slipher provided it.

Lowell, of course, was primarily interested in the solar system, with special emphasis on Mars. He wanted Slipher to find chlorophyll, as well as oxygen and water there. As we have heard, he asked Slipher to obtain a spectrogram of a spiral nebula because he thought of it as a newly-forming solar system. However, he allowed Slipher to spend some of his time on his own pursuits, and Slipher was interested in the then-fashionable fields of measuring stellar radial velocities and discovering spectroscopic binary stars. His first publication, in the *Astronomical Journal* in 1902 (Lowell 1902), was a report of measurements of the variable velocity of zeta Herculis with the new spectrograph.

In the paper he compares his average radial velocity of -74.4 with the -74.6 reported earlier by Lick Observatory's W. W. Campbell, who was swiftly becoming recognized as the world's leading astronomical spectroscopist. (As a teacher I would take points off for not specifying units. This is especially bad because Slipher sometimes discussed velocities in miles per second. I had to go to Campbell's article (Campbell 1902) to find that the velocities were in "km", at the time the standard abbreviation for km/s. It is possible that young Slipher was unaware of this convention.)

Volume 1 of the *Lowell Observatory Bulletin*, dating from 1903 to 1911, shows that Slipher was already an important member of the small Lowell team. The volume contains 62 articles, 13 of them by Slipher alone and one co-authored by him. There are 38 by Lowell, some of them including spectroscopic observations by Slipher, and 10 by other members of the staff.

Slipher's publications in this early volume present spectroscopic observations of stars, including spectroscopic binary stars, standard velocity stars, and stars of variable radial velocity, of the Moon and planets, and of Halley's comet. He also began an extensive study of the Crab Nebula, which he never published.

Among his most important discoveries in this period were two involving the interstellar medium. In 1909 he published an account (Slipher 1909a) of the selective absorption of light in space, proof that there were calcium ions in the interstellar medium between the Sun and a number of stars in Scorpius, Orion, Ophiuchus, and Perseus. In each case the sharp, weak calcium lines remained stationary while lines from the binary stars shifted back and forth. This confirmed a hypothesis made earlier by Johannes Hartmann of Potsdam, who found stationary calcium and sodium lines in Nova Persei in 1901 (Vogel 1901) and calcium again in the single-line spectroscopic binary delta Orionis in 1904 (Hartmann 1904). According to historian Daniel Seeley (Seeley 1973, p. 83), “Hartmann set the stage for investigations into interstellar gas but Slipher provided the first real progress – his observations indicated that the interstellar lines were not a singular phenomenon and his interpretation proved to be accurate.” However, Seeley also notes, “Slipher’s interpretations of the stationary line data, published in a *Lowell Observatory Bulletin*, either were not widely known or were ignored.”¹

Slipher found the first reflection nebula, evidence of what we now call interstellar dust, in 1912 (Slipher 1912b). He noted that he found the spectrum of the cloud surrounding Merope, a star in the Pleiades, to be identical to that of the star, and that this could be explained by assuming that “the nebula is disintegrated matter similar to what we know in the solar system, in the rings of Saturn, comets, etc., and ... it shines by reflected star light.” However, he ended this paper, published in December 1912 while he was in the midst of obtaining his measurement of the huge velocity of approach of the Andromeda Nebula, with

The observation of the nebula in the Pleiades has suggested to me that the Andromeda Nebula and similar spiral nebulae might consist of a central star enveloped and beclouded by fragmentary and disintegrated matter which shines by light supplied by the central sun. This conception is in keeping with spectrograms of the Andromeda Nebula made here and with Bohlin’s value for its parallax.

Also of considerable importance – it was cited on the awarding of two of his gold medals in the 1930s (Stratton 1933; Einarsson 1935) – was his work on the planets. As early as 1903 he showed that his spectrograph could measure the rotation period of Mars (Slipher 1903). He obtained a period of 25 h 35 min, “or just one hour longer than the true period.” At a time when many thought the rotation period of Venus was about 24 hours he showed that it had to be far longer than that. In fact the rotation was too slow to measure. The following year he published spectrograms of Uranus and Neptune, and compared them with the purely solar radiation from the Moon. By 1906 he had added Jupiter and Saturn. After experimenting with new sensitizing dyes on his plates, he found a combination which allowed him to be the first to extend his spectrograms past 7000 Ångstroms into the red, so in 1909 he provided completely new analyses of the spectra of all four major planets (Figure 2). He found new absorption bands in these planets, stronger in the more distant ones, and he failed to find evidence of oxygen in any of them.

He was able to show that his spectrograph could detect the rotation of Uranus (Slipher 1912a). He had tried in 1903 without success. Six years later Lowell pointed

¹Seeley (1973, p. 84)

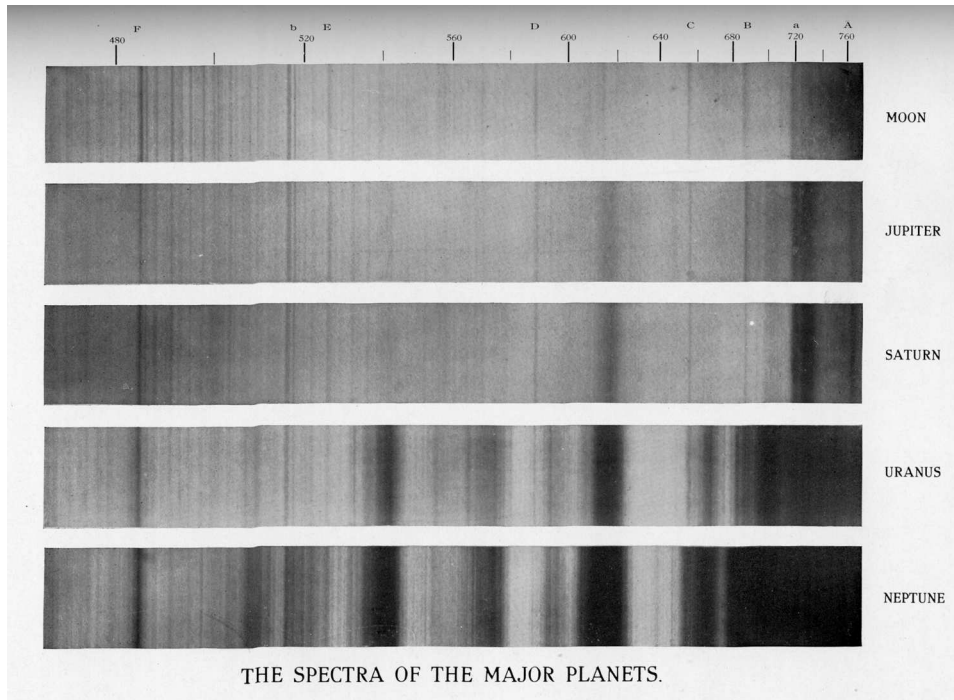


Figure 2. The Spectra of the Major Planets (Slipher 1909b).

out to him that the line of sight component of the rotational motion had increased, and he tried again. By 1911 he obtained seven good spectrograms, and his results were published the following year. Both he and Lowell measured the plates, without knowing their orientation. His final result was a rotation period of 10h 50 min, not particularly good by today's standards (the current accepted value is 17h 14min), but the first to be measured.

It was during this period that Wilbur Cogshall, who had taught V. M. astronomy at Indiana University, wrote him (Cogshall 1908a) and suggested that the University might award him a Ph.D. for research he had done at Lowell. V. M. was enthusiastic, replying, "Your letter was received a few days its content surprised me for the P.H.D. degree has been furthest from my thoughts. ... I hardly feel deserving of the honor," (Slipher 1908). He sent what he considered "by far, my best work" – a published paper on the spectra of the planets – to serve as his thesis, but almost lost the degree when Lowell declined to allow him to go to Bloomington in June 1908 to defend his thesis. Cogshall suggested (Cogshall 1908b) that Lowell was offended that Slipher was even asked to defend. The patrician Bostonian thought that the degree should simply be conferred. Slipher received the degree a year later, with all residence and course requirements waived.

By the time of Lowell's death the day after Slipher's 41st birthday, V. M. had begun examining the night sky with heroic exposures (Slipher 1916), discovering what he called the permanent aurora, with a greenish line known from aurorae present in all his spectrograms. He had also added observations of nebulae and interpretations



Figure 3. Lowell wedding, 1908 (courtesy LOA).

involving the interstellar medium to his published work. And of course he had observed what we now call galaxies, but this gathering has heard plenty about that.

3. Lowell's Death Brings New Responsibilities and Cares, 1916–1926

Lowell's unexpected death on 12 November 1916, just eight years after his marriage (Figure 3) and one year after appointing V. M. assistant director and designated successor, was a disaster for his observatory and its staff. For the next decade successive trustees fought legal battles with Lowell's widow over the estate. She received half the income, and it was a struggle to keep the observatory open. As acting director, V. M. had to be extremely parsimonious. Slipher had married in 1904 and his children were nine and five when Lowell died. He was justifiably concerned with supporting his family. The daily ration of milk from the Observatory cow, Venus, was helpful but not sufficient.

Slipher started buying rental properties and eventually bought a number of ranches. He owned and operated a furniture store at one time. He also took part in civic activities, serving as president of the school board when his children were in school and joining with others to found the Museum of Northern Arizona. He served as chairman of the board of Flagstaff's premier hotel, the Monte Vista. Founded by public subscription, including a major donation from author Zane Grey, it was built by the city in 1927. Meanwhile the Sliphers raised their family on Mars Hill (Figure 4).

Despite these distractions, Slipher continued to be astronomically productive. It was during this period that he published observations of the spectra of both galactic and extragalactic nebulae and measured rotation speeds of planets. He made his only forays into solar astronomy, leading eclipse expeditions to Kansas in 1918 (Slipher 1922) and Baja California in 1923 to photograph the spectrum of the solar corona, and he continued the Lowell-inspired search for water, oxygen and chlorophyll on Mars (Slipher 1924). He also published his first investigations of the spectra of lightning, the aurora, and the night sky (Slipher 1916, 1917, 1919).



Figure 4. V. M. Slipher, wife, daughter 1909 (courtesy LOA).

4. The Last Productive Years, 1926–33

Slipher was appointed Director of the Lowell Observatory in 1926, after the final settling of the Lowell estate (Smith 1994). Mrs. Lowell continued to receive some of the income until her death in 1954. Correspondence between V. M. and trustee Roger Lowell Putnam shows that the Observatory was frequently in the red, and paychecks were not always issued on time. The trustee often helped with an extra check for \$500 or \$1000, and he even got his mother to pay the salary so that the observatory could have a secretary. The Observatory staff lost heavily when Flagstaff's only bank failed in 1932 (Giclas 1987).

During this period Slipher published his most extensive work on the night sky, zodiacal light, and the aurora, and he published additional spectroscopic observations of Venus, Mars, and comets. Every time C. E. Kenneth Mees of Eastman Kodak came up with an emulsion that was sensitive a little farther out into the infrared Slipher used it to extend his planetary observations. One of his night sky spectrograms involved exposures totaling 147 hours! He also continued his observations of nebulae and studies of the interstellar medium.

His most famous work during this period was again an effort to carry on the work of his master. Lowell had spent years computing orbits (with much of the tedious calculation done by assistants, especially Elizabeth Williams) and attempting to make a prediction that would lead to the discovery of a ninth planet that would account for the perturbations of Neptune. In his highly mathematical 1915 book, *Memoir on a Trans-Neptunian Planet* (Lowell 1915), he called it Planet X. He had employed as many as five computers in Flagstaff and Boston and had hired three successive "Lawrence Fellows" to observe in Flagstaff searching for the planet, but he died without knowing whether it

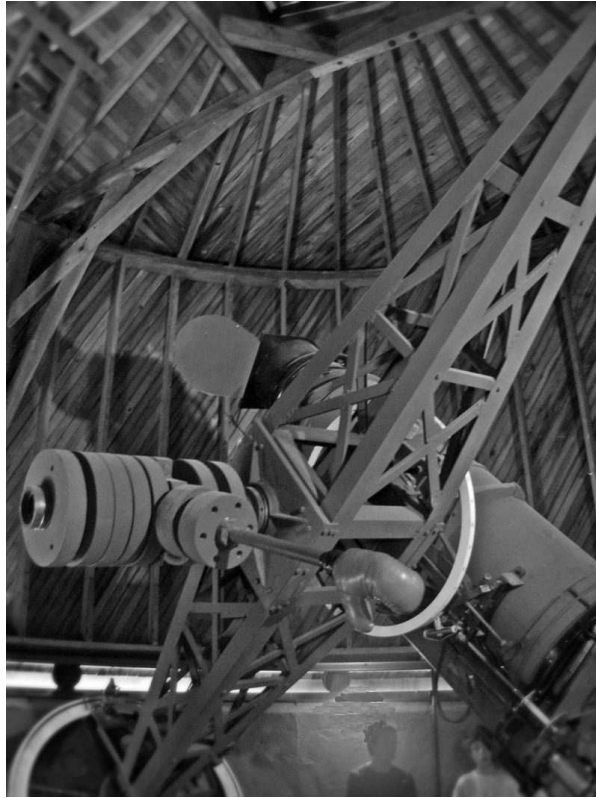


Figure 5. The Lawrence Lowell Telescope. (Courtesy Traci Lehman.)

existed. In his book he had suggested two regions of the ecliptic, in opposite directions, where the planet might be found.

In 1927 glass disks for a 13-inch refractor became available, and Slipher suggested to the trustee that they be purchased and made into a telescope to resume the search for Planet X. Trustee Guy Lowell personally purchased the disks and planned to have the telescope made, but he died later that year. At this point another member of the Lowell family, Percival's brother A. Lawrence Lowell, then president of Harvard, stepped in and funded the building of the telescope. It arrived in Flagstaff in 1929 and was erected on a mounting built by the observatory's longtime instrument maker, Stanley Sykes. Designed from the start for the planet search, the Lawrence Lowell telescope (Figure 5) produced highly defined star images over 14 x 17-inch plates. It could record 50,000 to 500,000 stars in a one-hour exposure. The plan was to photograph every field along the ecliptic, starting with the areas suggested by Percival Lowell, to repeat a few days later, and then to "blink" the plates in order to find objects that moved.

Blinking the plates was incredibly tedious work. Slipher hired 23-year-old high school graduate Clyde Tombaugh (Figure 6) to do it, and the rest is history.²

It is to Slipher's credit that Pluto is universally recognized as having been discovered by young Tombaugh. Had it been found at one of several other major observatories

²See, e.g., Hoyt (1980a)



Figure 6. Clyde Tombaugh at the blink comparator (courtesy LOA).

at the time, the director would have claimed credit. This is characteristic of Slipher's modesty.

It is to Slipher's discredit that, knowing that the Lowell Observatory lacked the expertise to compute the orbit of the newly-discovered planet, he delayed announcing the positions so that his former teacher, John A. Miller of Sproul Observatory, could come to Flagstaff and lead the computation of the first orbit. Three days after the public announcement of the discovery (itself held until Lowell's birthday), a telegram to the Trustee signed "Lowell Staff" reported (Lowell Staff 1930):

Impressed with vital importance to Observatory that our discovery announcement be followed soonest possible by best determined orbit our observations can give because orbit will demonstrate much about nature and status of new wanderer that we telegraphed Professor Miller Director Sproul observatory asking him come Flagstaff and help us work best possible orbit. Miller experienced with orbits loyal friend. Plans kept confidential.

Trustee Roger Putnam replied (Putnam 1930), "Frankly, I am very uncertain as to the ethics of when and what should be released, and will leave that to your judgment. I can't help feeling that having gotten the whole world stirred up, we have got to give them the information they want, but you know that sort of thing much better than I do."

Putnam was right, but Slipher delayed announcing more positions for four weeks while he and his colleague, C. O. Lampland, frantically worked their slide rules under Miller's direction until they had an orbit. This infuriated many in the astronomical community, such as the ace orbit-computers at Berkeley, who could have produced an orbit much more quickly (Giclas 1987). Slipher defended himself in a letter to the Trustee (Slipher 1930):



Figure 7. V. M. Slipher, C. O. Lampland, and E. C. Slipher in later years (courtesy LOA).

We have been severely criticised for not giving out positions that others might compute [sic] the orbit, and this will no doubt not stop for a while yet. However, unpleasant as that has been it seemed our clear duty to make use of our materials [sic] for the orbit as it was more useful to us than it could be made to others without still more delay. Of course others could have done the orbit quicker than we did it, but we did it as carefully as possible. To have followed the other policy would have meant a considerable sacrifice to the Observatory.

This is characteristic of Slipher's intense loyalty to Lowell Observatory and the memory of Percival Lowell.

5. The Doldrums, 1934–54

The year 1933, when he turned 58, was essentially the last year that Slipher published his own original research. His five-page article on "Spectra of the Night Sky, the Zodiacal Light, the Aurora, and the Cosmic Radiations of the Sky" appeared in the *Transactions of the American Geophysical Union* and was reprinted in the *Journal of the Royal Astronomical Society of Canada* (Slipher 1933a). It reports on many years of work, including the use of a newly-designed spectrograph to photograph the spectra of five regions of the sky at once. He gave the George Darwin Lecture to the Royal Astronomical Society after accepting the RAS Gold Medal that same year. The lecture was on spectroscopic studies of the planets and summed up his work, mostly completed long before (Slipher 1933b).

After that the Lowell Observatory slowly declined. For many years, three men – V. M., C. O. Lampland, and V. M.'s younger brother, E. C. Slipher (Figure 7) – dominated the observatory. Occasionally, a younger man, such as Henry Giclas in 1931, would be hired to a subordinate position, but the three senior astronomers jealously guarded the telescopes. All had been seriously wounded by the criticism from other astronomers, especially Lick Observatory directors W. W. Campbell and W. H. Wright, of work done at the Lowell Observatory. These eminent astronomers had developed an intense distaste for Percival Lowell and anything associated with him. Work coming

from Lowell's observatory was automatically suspect.³ V. M. had gotten into an exchange of criticisms with Campbell over his claim to have detected water on Mars in 1909, and after losing this battle he became even more reticent than he had been. He was very careful to check his work many times and to get repeated observations before going public. He devoted more and more time to his business affairs, and less to research. Meanwhile his brother, E. C., spent much of his time on politics, and Lampland puttered around without completing anything. V. M. published his last *Observatory Report* in 1933. It covered the years 1930–1932. The next to appear from the Lowell Observatory was for the years 1952–1954. Although signed by V. M., it was probably written by Albert G. Wilson, who was assistant director at the time. The most significant papers with Slipher's name on them after 1933 were of a totally different character from his other work. There were six of them, published in *Nature* and the *Physical Review*, and they contained astrophysical observations and theory far beyond Slipher's abilities.⁴ They were written by Arthur Adel, who had been hired in 1933 by the trustee over the opposition of the senior astronomers. Adel was to work at his alma mater, the University of Michigan, and do infrared studies that would relate Slipher's spectra to conditions on the planets. Adel built a 22.5-m long high pressure cell and put up to 40 atmospheres of carbon dioxide in it. Later he filled his tube with ammonia and methane. He was able to duplicate some of the spectra that Mt. Wilson astronomers had observed in Venus in 1932 and that V. M. had observed in Jupiter many years earlier. He did this entirely by himself in Ann Arbor for \$1000 per year, which even in 1933 was not much.

Adel used Slipher's published data but got nothing new from Slipher. Nevertheless, he put Slipher's name on the papers as co-author. In 1987 Adel told Robert Smith in an oral history interview (Adel 1987),

I had to do that, and neither he nor Lampland nor E. C. Slipher, none of them really knew what I was doing, had a real understanding of it. ... They didn't know anything about infrared spectroscopy. They didn't know anything about spectroscopy. They really didn't know anything about this work that I was doing, or the work I did in Ann Arbor.

When Adel was appointed to a lowly position in Flagstaff by the trustee, V. M. treated him very badly. And when Adel showed that the carbon dioxide bands in the spectrum of Venus could be photographed with the 24-inch refractor and thus could have been discovered by Slipher before they were found by Adams and Dunham at Mt. Wilson (Adams & Dunham 1932), he was barred from all the telescopes (Adel 1987).

According to Henry Giclas (Giclas 1987, 1990), Slipher resisted applying for grants and couldn't be bothered with the complications of payroll, social security, etc. Giclas was appointed executive secretary in 1953 and took over all the business affairs. Trustee Roger Putnam pushed for grants, and the first, from the Weather Bureau, was obtained in 1948 and included funds to measure the variation in the solar constant as well as meteorology of planetary atmospheres. Later this project was taken over by the Air Force. The appointment of Harold Johnson in July 1948, initially to work on the Weather Bureau project, was a turning point. Although very difficult to get along with and constantly complaining, he was a competent, energetic young scientist, and he

³Campbell did come to respect Slipher in later years, but by then Slipher's habits were set.

⁴See Adel & Slipher (1934a,b,c,d); Adel et al. (1935); Adel & Slipher (1935).



Figure 8. Albert G. Wilson and V. M. Slipher at Slipher's retirement party, 1955 (courtesy LOA).

accounted for nearly all of the Observatory's publications in the early 1950s. He quit and went to Yerkes after one year, but was hired back in August 1952 by the trustee over V. M.'s objections.

Slipher's last scientific publication was a brief abstract in 1939 announcing that he had re-observed Hubble's variable nebula, NGC 2261, and found that its spectrum had not changed since his observations of 1916–17 (Slipher 1939). He also wrote an occasional letter asserting his priority on something done long before.

6. Retirement, 1954–69

After Lampland died in December 1951, trustee Roger Putnam finally stepped in to make some changes. On the advice of John Duncan he selected 33-year-old Albert G. Wilson, who had been directing the National Geographic Palomar Sky Survey since completing his Ph.D. in mathematics at Caltech. It seems that the primary criterion for the appointment was that Wilson was acceptable to the Slipher brothers.

Wilson came as assistant director in 1953 and took over as director on V. M.'s 79th birthday, 11 November 1954, when the old man finally retired (Figure 8). Wilson's directorship was short and unhappy. After a rebellion from the younger astronomers, especially Harold Johnson and Henry Giclas, and the breakup of his marriage, he left in January 1957 and returned to California and a career in industry (Tenn 2007).

Slipher remained in Flagstaff although he moved off Mars Hill into one of his houses. His wife, Emma, died in 1961. Frances Wilson, the ex-wife of Slipher's successor, returned to Flagstaff and became Slipher's "private secretary and companion" according to Henry Giclas (Giclas 1990). V. M. Slipher died 8 November 1969, three days before he would have turned 94.

His will (Slipher 1967) stated that "During the latter years of my lifetime, FRANCES M. WILSON has devoted herself to my business affairs, and it is my desire

from my Estate to make provision for her.” He left her \$3000 per year for life, and he made her executrix of his estate. Aside from the endowment to support her he left his wealth to the V. M. Slipper Trust with a bank as trustee and Arthur Adel⁵ as Advisory Trustee. A portion of the income was to provide scholarships for worthy students pursuing scientific studies at Arizona’s three public universities. After that 50% of income went to the National Academy of Sciences for Astronomy. There was a great deal of property, including ranches and cattle.

7. Conclusion

Although he received prestigious awards in his lifetime, including the 1935 Bruce Medal of the Astronomical Society of the Pacific and the three mentioned in the obituary below, Slipper is probably underrated today. I gave a talk (Tenn 2005) at a meeting of the Historical Astronomy Division of the American Astronomical Society in 2006 titled “Why Does V. M. Slipper Get So Little Respect?” My current conclusion is that the most important reasons are

1. He needed Lowell to guide him, and Lowell’s early death left him unprepared to face the future. Although a skilled spectroscopist, he lacked the imagination to innovate.
2. The early criticism of Lowell and everyone around him made Slipper and his colleagues super-cautious about making any claims. They hesitated to publish until they were absolutely certain they were right. Fortunately, this happened a few times with V. M. His brother, E. C., would never have published had the trustee not forced him to. The result was a fine atlas of photographs of Mars. The third member of the Lowell staff, C. O. Lampland, did pioneering work in radiometry (infrared photometry), but hardly ever published. All three stayed too long, at least in part because there were no pensions until they were introduced by V. M.’s successor, Wilson, in the 1950s.
3. The Lowell Observatory’s poverty from the death of its founder in 1916 until after Slipper’s retirement precluded buying modern equipment that could compete with the Mt. Wilson and Lick Observatories in California and also led to Slipper turning much of his attention toward improving his personal finances.
4. He was not properly credited by Hubble for the Doppler shifts of galaxies that Hubble used so successfully in his key 1929 paper (Hubble 1929). All of the credit went to Hubble and Milton Humason. (Hubble did credit Slipper in later papers, starting in 1931.)

Slipper’s brief obituary in *Physics Today* (Anonymous 1970), which mentions only the discovery of Pluto among his accomplishments, makes this clear. It reads, in its entirety:

⁵The appointment of Adel to select the scholarship recipients and Adel’s service as a pallbearer at Slipper’s funeral are remarkable, considering that Adel was vehemently critical of how Slipper had mistreated him in the 1930s (Adel 1987). When I met Adel at the Lowell Observatory centennial in 1994 he was still resentful. Adel spent most of his life in Flagstaff, where he had a highly successful career at Northern Arizona University after World War II.

Vesto M. Slipher, director of the Lowell Observatory until 1952 [sic], died 8 Nov. at 93. Slipher had been at the observatory since 1901 and became director in 1926. He supervised work that led to the discovery in 1930 of Pluto. Among the honors received by Slipher were the Lalande Prize and gold medal of the Paris Academy of Sciences (1919), the Draper Medal of the National Academy of Sciences (1932) and the Royal Astronomical Society gold medal (1932).

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