Refereed article

EC Slipher's Mars Expeditions to South Africa

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Abstract. From 1939 to 1956, EC Slipher of Lowell Observatory in Flagstaff, Arizona carried out three separate astronomical expeditions to South Africa. Each of these was specifically designed to make photographic and visual observations of the planet Mars during favourable oppositions. In total, Slipher captured more than 60 000 images on film, in addition to making countless visual observations. His important observations gave much new insight about the atmospheric and surficial features of the red planet, including atmospheric belts, dark markings, polar ice caps and the putative canals.

Keyword: history of astronomy

EC Slipher and Mars

By 1939, after more than thirty years observing and photographing Mars, Earl Carl (EC) Slipher (Figure 1) of Lowell Observatory in Flagstaff, Arizona, had established himself as one of the world's preeminent Mars observers. That year, Mars would be especially well situated for study, as it was nearing opposition. Even better, the opposition would happen when Mars was near perihelion, its closest approach to the Sun. These perihelic oppositions, which occur every 15-17 years, usually take place from July through September, when Mars is generally in Aquarius or Capricornus. (This type of opposition took place in 2003, when Mars was less than 56 million kilometers from Earth, its closest approach in thousands of years.) Unfortunately, this means that for observers in the Northern Hemisphere, the planet is too low in

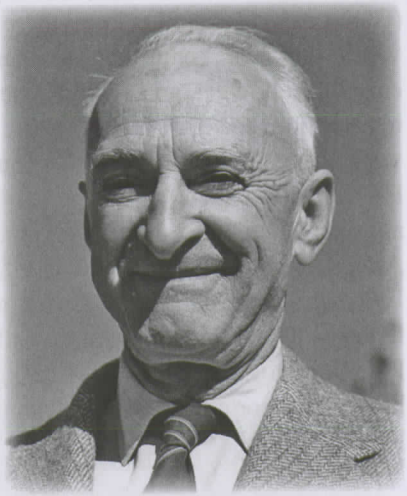

Figure 1. Earl Carl (EC) Slipher, 1883-1964, photo taken 1954. (Lowell Observatory Archives)

Figure 2. Aerial view of Lamont-Hussey Observatory and surrounding game reserve, 1954. (Lowell Observatory Archives)

the sky, well below the celestial equator. This makes observing less than ideal, due to both increased atmospheric distortion and the reduced amount of time the object would is viewable during any given observing session.

To solve these observing problems, Slipher followed the suggestion of Observatory assistant James Edson and organized an expedition to the Southern Hemisphere (Giclas n.d.: 51-52, 57). From there Mars would be near zenith during meridian crossing, allowing potentially better seeing and longer observing sessions. This would be Slipher's second Southern Hemisphere expedition to study Mars, as he had accompanied David Todd of Amherst College to Alianza, Chili for the 1907 Mars opposition. The earlier expedition was financed by Percival Lowell, and 13 000 photographs were taken using Amherst's transported 18-inch refractor (Hoyt 1976: 189-190).

For the 1939 opposition, Slipher made arrangements with HD Curtis of the University of Michigan to use that university's 27½-inch refractor, the then-largest refracting telescope in the Southern Hemisphere. This telescope was located at the Lamont-Hussey Observatory in Bloemfontein, South Africa, under the direct supervision of Richard Rossiter, an astronomer specializing in double star research.

Lamont-Hussey Observatory

Owned by the University of Michigan, the Lamont-Hussey Observatory was built in Bloemfontein in 1928 on a game reserve atop Naval Hill. Located at an elevation of 1 490 meters, its primary intended function was for the study of double stars. During the ensuing 24-year program, which was carried out mainly by Rossiter, 29 157 measures were taken and 7 638 new pairs (7 368 numbered, 270 noted) were discovered (Rossiter 1955).

The Lamont-Hussey telescope had an inverted 27½-inch objective lens of Schott glass and then ground and figured by the McDowell optical firm. It had a focal length of approximately 40 feet (12.2m) and was housed in a 56-ton, 56-foot (17m)

diameter hemispherical dome made of structural steel covered with 18-guage Armco iron. Using blueprints of the 27½-inch telescope that Slipher had acquired earlier, Lowell staff in Arizona either built or modified all of the cameras, filters, lenses, and other equipment that would be used on the telescope for the Mars studies (Slipher EC 1955; Slipher EC n.d.b; Rossiter 1955).

Bloemfontein

Bloemfontein had become a well-known centre for the study of astronomy in the Southern Hemisphere. In addition to the Lamont-Hussey Observatory, the Boyden Station of Harvard College was just 19 kilometers away. This proximity was especially convenient for Slipher, as he had permission to use Boyden's instrument shop when the need arose (Slipher 1940a). Bloemfontein is also relatively near the sites of two of the twentieth century's greatest scientific discoveries. About 540 kilometers to the south is East London, where in 1938 Marjorie Courtenay-Latimer rocked the world of zoology. Carrying out her duties as curator at the East London Museum, she was looking through a ton and a half of sharks and other fish that a trawler had pulled up and spotted an unusual specimen that she had never seen before. This remarkable find turned out to be the first known example of a living coelacanth, a fish thought to have gone extinct tens of millions of years ago.

Northwest of Bloemfontein is Taung, where in 1924 Raymond Dart, then a professor at the University of Witwatersrand in Johannesburg, came across two-million-year-old fossil bones of a non-human

Figure 3. Zebras grazing near Lamont-Hussey Observatory, 1954. (Lowell Observatory Archives)

Figure 4. Cartoon from a newspaper, probably *The Friend*, indicating rainy conditions during the early stages of the 1939 observing run. EC Slipher is characterized sitting on the left. (Lowell Observatory Archives)

hominid baby. Based on this important find, he introduced a new species, *Australopithecus africanus* (literally, the southern ape from Africa) which eventually helped redirect the search for human origins from locales such as Europe, Java and China to Africa.

1939 Expedition to Bloemfontein

At 13h00 on 27 May 1939, Slipher and his wife Bess left Flagstaff for New York City. From there, they sailed aboard the *Aquitania* to Southampton, England, where they boarded another ship, the *Athlone Castle*, to South Africa. They stayed at Fort Drury Apartment House (Giclas 1982: 73; collection of receipts and notes in Lowell Observatory Archives). Upon arrival, Slipher spent some time familiarizing himself with the 27½-inch telescope and associated equipment. Additionally, problems such as a short circuit, lost motion in the clock drive and impractical slow motion devices had to be overcome (Slipher EC n.d.b).

Observations began soon after Slipher's arrival in South Africa on 24 June, continued through the opposition in late July (when Mars was within 58 million kilometers of Earth) and ended on 27 August (Slipher EC 1940a). Despite initial winds that were strong enough to make the telescope sway (The Friend 1939c), and two unseasonably rainy periods (Slipher EC n.d.a: 2; Figure 4), Slipher made observations on 54 nights (Slipher EC 1940b). He obtained some 250 photographic plates with approximately 8 000 images (Slipher EC 1940a; Slipher EC 1940b).

Slipher estimated that he was able to photograph surface details 0.18" across (and perhaps even smaller), corresponding to about 50 kilometers on the surface (Millman 1940). Purportedly, the first colour images of Mars were captured (Rochester Democrat and Chronicle 1940; New York City Herald-Tribune 1939; The New York Times 1939). Interestingly, this coloured record of Mars was obtained around or directly on July 20 (New York City Herald-Tribune 1939), the same date on which, 37 years later, Viking 1 became the first spacecraft to safely land on the planet and, moreover, obtain pictures from its surface.

For Mars photographs (Figure 5), Slipher used two different, approximately 4-inch diameter, brass-tubed cameras (The Friend

1939b) and concentrated on regions of the spectrum ranging from 3 700 angstroms to 7 000 angstroms. One camera, which magnified images about 200 times, utilized a negative blue-correcting lens and an amplifying lens which produced images in blue light, revealing characteristics of the atmosphere. Most of these images were recorded on lantern-slide plates. The other camera utilized a negative-amplifying lens and magnified about 240 times. With the aid of Eastman Wratten filters, this camera produced photographs in green, yellow, orange, and red light, allowing details of the surface to be seen.

When carrying out astrophotography, Slipher typically fitted the cameras with double-slide plate carriages so that many images could be taken per plate. This would make better use of each plate (for his Mars photographs, he averaged 30 to 40 images per plate), and also meant that the observer would have to spend less time changing and developing plates. To capture the best images, Slipher looked through an auxiliary telescope and waited for moments of good seeing, then quickly snapped the shutter (Slipher EC 1962:62; Slipher EC 1955).

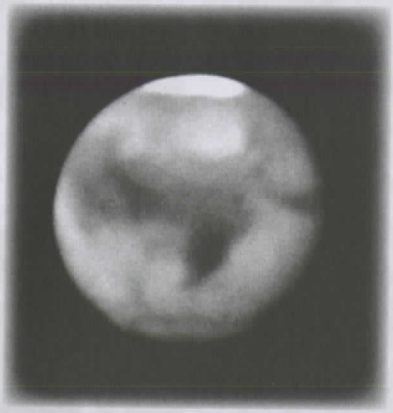

Figure 5. Photograph of Mars made by EC Slipher using the Lamont-Hussey Telescope, 1939. (Lowell Observatory Archives)

The images were recorded on photographic plates designed by the Eastman Kodak Company. Two different emulsions were used - the 103 type emulsion resulted in fast exposures, ranging from 1/5 to 1/2 second, while the III type emulsion was slower but finer-grained, resulting in exposures of 3/4 to 3 seconds (Slipher EC 1940b). Upon loading a plate, Slipher gently brushed it with a camel hair brush to remove dust particles that could ruin the photographs (Slipher EC n.d.b).

In addition to the photographs, Slipher also made visual observations and drawings. These were necessary in order to catch the quickly passing moments of better seeing that couldn't be captured with a camera. For these visual observations, he added a separate eyepiece carriage, with micrometer, to the telescope (Slipher EC n.d.b). To supplement Slipher's research, his co-workers back in Arizona used the 24-inch Clark refractor to observe and gather spectra, and the 42-inch reflector to take radiometric measurements of Mars (Slipher VM 1939). Since Flagstaff and Bloemfontein are separated by nearly 140 degrees of longitude, this also meant that Mars could be observed nearly continuously, as long as terrestrial weather permitted.

Slipher reported discovering various atmospheric phenomena, changes in the polar ice caps (the Martian southern hemisphere was in spring, and Slipher observed the shrinking of the southern ice cap throughout his observing run) and other surface details. However, many newspaper accounts focused on Slipher's discoveries that had direct implications for possible Martian life. By this time, most scientists discounted the likelihood of intelligent life on Mars, but did believe that plant life existed there. Slipher's new findings, such as green patches on the Martian surface, a new putative canal, and changes in the Martian surface, seemed to prove the existence of vegetation (New York Herald Tribune 1940; The Friend 1939a; New York World-Telegram 1939; New York City Herald-Tribune 1939).

After completing work at Lamont-Hussey in August of 1939, Slipher hoped to make observations using the 26½-inch Grubb refractor at the Union Observatory in Johannesburg. However, his cameras couldn't easily be adapted to that telescope and he made only visual observations. By this time, Mars was well past opposition, so further work probably would not have added significantly to the observations already made (Slipher EC n.d.a). Besides, the start of World War II made overseas travel dangerous. Because of this, the Sliphers bypassed England on their trip home, sailing aboard the steamer *Brastagi* from South Africa directly back to the United States (New York World-Telegram 1939; collection of receipts and notes, Lowell Observatory Archives).

Reflecting the widespread preoccupation with war, one newspaper made the sober observation: "Because of its red colour Mars was taken from earliest antiquity to be the planet of war. The earth, on the other hand, would appear to an observer on Mars as a blue planet, colour of peace. Which goes to show that the Martian, if he existed, would be just as wrong about the earth as the inhabitants of earth are about Mars" (July 23, 1939 New York Times).

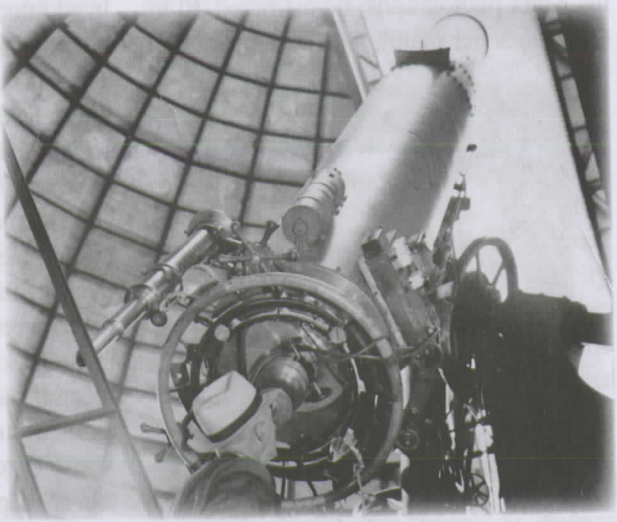

Figure 6. EC Slipher looking through eyepiece of Lamont-Hussey Telescope, 1954. (Lowell Observatory Archives)

Not long after Slipher returned home, he began receiving numerous requests to use his photographs, especially the colour ones, in various periodicals such as Life Magazine, Colliers, and Scientific Monthly (Manthorp 1940; Chenery 1940; Moulton 1940). He was also invited to present his findings at various professional and public meetings and even had a request from the Project Globes Company of Rochester to use his material as the basis for a model globe of Mars (Fairbanks 1939; Bennot n.d.; Slipher VM 1940).

1954 National Geographic-Lowell Observatory Expedition

Largely due to the success of his 1939 expedition, Slipher returned to South Africa for the 1954 opposition. On 2 July the planet was within 64 million kilometers of the Earth (Slipher EC 1955). The National Geographic Society agreed to cosponsor the trip, thus creating the National Geographic Society-Lowell Observatory Expedition.

On 26 March 1954 Slipher and his wife received yellow fever shots in Phoenix, Arizona and the next day boarded a plane for their journey back to Bloemfontein (Giclas n.d.: 103). This, of course, was much faster than the ships they travelled aboard in 1939, taking only 38 flying hours to reach their destination. Unlike the 1939 expedition when Slipher came alone, this time he was assisted in observations by amateur astronomer AP Fitzgerald of Ireland. A local crew was also on hand to help with the operation of the telescope and dome – they included Petrus Franzsen, TJ Adendorff and Everet Steyn (Slipher EC 1955).

The $4 000 awarded by the National Geographic Society in 1954 allowed Slipher to design better planetary cameras, which were built at Lowell Observatory by AV Brodie and Warren Jewett (Giclas n.d.: 102-103). A camera configuration with a focal length of 66 meters was used (Sinton 1955), an increase from the typical 46-54 meter focal length typically used in earlier Mars images taken by Lowell astronomers. With this arrangement, exposure times were faster than in 1939, ranging from 1/25 to 1/15 second for plates with Eastman 103 emulsion (1/5 to 1/2 second in 1939), and 1/3 to 1½ seconds for plates with Eastman III emulsion (3/4 to 3 seconds in 1939). This configuration was also used by Slipher at Lamont-Hussey during the 1956 opposition, resulting in a Mars disk diameter of about 8 mm (Slipher EC 1962: 57).

The grant money from National Geographic was also used to help pay for the maintenance of the Lamont-Hussey Telescope, which had been out of commission for 15 months. When Slipher arrived at the observatory he discovered pigeons nesting in the dome. He used a pellet gun to scare away the birds and cleaned the telescope, which was covered with pigeon droppings (The Friend 1954). Electrical repairs also had to be made, as a lightning strike had knocked out the electrical circuits. As it turned out, Slipher had plenty

of time to take care of these details, since the cameras and other equipment that were supposed to be shipped in February were still sitting in storage in New York (Slipher EC 1955).

Eventually the equipment was sent and Slipher started making observations on 12 May, continuing through the opposition on 24 June and ending on 16 September. During this 128-day period, only four or five nights were clouded out. The skies were so exceptional that from 16 June to 16 September, a total of 93 consecutive days, Slipher photographed Mars every night. He made approximately 20 000 exposures, while during the same period, 6 000 exposures were obtained at Flagstaff (Slipher EC 1962: 61).

International Mars Committee

Significant for the 1954 and 1956 oppositions was the establishment in 1953 of the International Mars Committee (IMC). Slipher was instrumental in establishing this worldwide network of Mars observers that in 1954 included astronomers from seven observatories worldwide. Member observatories were Bosscha in Java, Eva Peron in Argentina, Helwan in Egypt, Kodaikanal in India, Lamont-Hussey in South Africa, Lowell in the United States and Pic du Midi in France. Additionally, 10 other observatories in the United States, New Zealand, Australia, Japan, and South Africa cooperated with the IMC. These observatories were not formal members of the IMC, but all had similar Mars observing programs and contributed observations to the IMC (Sinton 1955; Slipher EC 1962: 64).

By having member observatories at different latitudes spread around the world and using refracting telescopes with similar plates, filters and enlarging lenses, the IMC made continuous Mars observations under fairly comparable conditions (Sinton 1955; Slipher EC 1962: 64). This worldwide coordination of Mars observing was very successful and later helped lead to the establishment of the International Planetary Patrol (Slipher EC 1962).

Figure 7. EC Slipher and assistant AP Fitzgerald examining photographic plates with multiple Mars images, 1954. (Lowell Observatory Archives)

The 1956 Expedition

By 1956, Slipher had become a bit of a Mars celebrity. In April of that year, Walt Disney Productions came to Lowell Observatory in Arizona to gather footage for a documentary *Man and Mars*. The

film featured Wernher von Braun and others talking about the history of Mars observations, current scientific theories about Mars and other interesting titbits. EC Slipher also took part and discussed the upcoming 10 September opposition, at which time Mars would only be 57 million kilometers away (Giclas n.d.; Walt Disney Productions 1956). The program aired in September, but Slipher did not see it because in June he had returned to Bloemfontein for another six month observing expedition. This time he was accompanied by Paul Wild of the University of Bern, Switzerland, later quite a distinguished astronomer in his own right (Seitzer 2007).

For the 1956 expedition National Geographic awarded a $12 000 grant, which largely helped pay maintenance costs for keeping the observatory open (Giclas n.d.). Despite a large Martian dust cloud that covered most of the planet for almost three weeks, Slipher collected 37 000 images of Mars, while his colleagues in Flagstaff obtained 11 000 exposures (Slipher EC 1962: 57). The weather in South Africa again proved good for Slipher and he carried out observations on 180 consecutive nights (Hall 1972; Slipher EC 1962).

While observations were still made visually and with photographic plates (Figure 8), television equipment was now used to gather images (Figure 9). Expedition members Somes-Charlton and Barth used image orthicon tubes (a type of vacuum tube used in television cameras from the 1940s to 1960s; Figure 10) made by the Pye company in England, to photograph Mars (Slipher EC 1962: 60). Originally used for fluoroscopic x-ray work at Johns Hopkins University, this system was adapted for observing the 1954 Mars opposition on Lowell Observatory's 24-inch Clark Telescope by Lowell Director Albert Wilson and Ralph Sturm of Johns Hopkins (Sinton 1955).

Though earlier reports gave much promise for this method of photography (even projecting that "... with some improvements, in 1956 it will yield photographs of the elaborate canal system") (Sinton 1955), Slipher reported uninspiring results, with

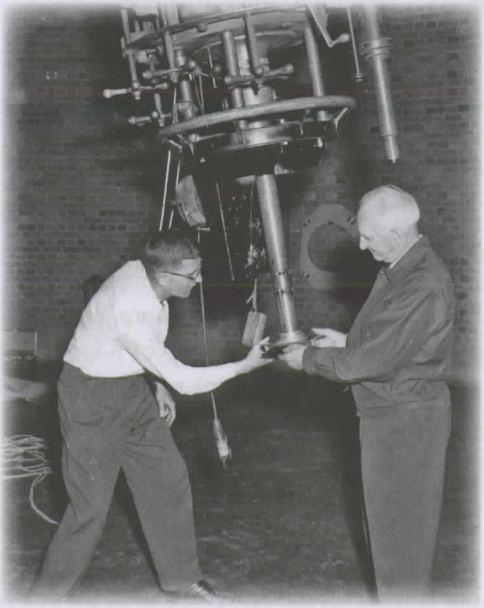

Figure 8. EC Slipher and unidentified assistant loading photographic glass plates into camera, 1956. (Lowell Observatory Archives)

Figure 9. Television equipment used with the Lamont-Hussey Telescope, 1956. (Lowell Observatory Archives)

a less than 2:1 gain in exposure time and worse definition than traditional photographic methods (Slipher EC 1962: 60).

As an aside, the nickname of the image orthicon tube was "immy". In the late 1940s, America's Academy of Television Arts and Sciences created an award for outstanding television programming and acting. "Immy" was later feminized to "Emmy" (thought to be more appropriate to go with their statuette of a winged woman holding an atom) and the Emmy Awards were born. (Parker n.d.)

End of an Era

The 1956 expedition would be the last Slipher made to South Africa. The Lamont Hussey Observatory was used for double star research and occasional planetary photography in ensuing years, but closed in 1974. The optics were removed and returned to the University of Michigan the following year (ASSA Bloemfontein Centre 2004), while the telescope tube and other equipment was removed from the dome and, until recently, relegated to a patch of weeds near a hangar at the Erlichpark Fire Station in Bloemfontein. Since 2002/2003, the equipment has been stored inside the hangar. Two planetary cameras used by Slipher, likely for the 1954 and 1956 expeditions, were found near the elephant cages of the nearby city zoo. The building was given to the City Council of Bloemfontein and converted into a theatre (Van Jaarsvelt 2002; ASSA Bloemfontein Centre 2004).

In his three trips to South Africa, EC Slipher gathered some of the best images of Mars taken up to that point. He discovered many atmospheric features including atmospheric belts and detected the emergence and migration of dark markings, including one that covered a 322 000 square kilometer region. Slipher also measured the advance and retreat of polar ice caps and recorded the position and extent of the putative canals and

oases (Hall 1972; Slipher EC 1940a: p. 104-109; Hall 1972).

Today, Slipher's South Africa observations are often forgotten or overlooked, much like the observatory he used. But thanks to the efforts of astronomical historians such as Patrick Seitzer, Willie Koorts, Gerrit Penning, Braam van Zyl, Matie Hoffman, and Dawie van Jaarsveldt, this lost chapter in the history of astronomy is seeing new light. Perhaps, in the future, money might be raised to establish a permanent exhibit at the old observatory. Though the Lamont-Hussey Telescope is likely to prove unusable for any future observing, it would be a marvellous educational display and serve as a monument to the historic work of EC Slipher and others.

Figure 10. Unidentified operators using image orthicon tube assembly attached to Lamont-Hussey Telescope, 1956. (Lowell Observatory Archives)

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