

‘So much for fame!’: The Story of Lewis Swift

Peter T. Wlasuk FRAS

Department of Physics, Florida International University, University Park, Miami, FL 33199

(Received 1996 May 7)

SUMMARY

Between 1862 and 1899, Lewis Swift discovered no fewer than 13 comets, making him one of the most prolific comet discoverers of all time. Swift was a farmer and hardware store owner by trade, whose first telescope was a homemade 3-inch refractor with a Spencer objective. His first comet discovery, 1862III, known popularly as Comet Swift–Tuttle, is the source of the famous Perseid meteor shower. All but one of Swift’s comets were discovered with a $4\frac{1}{2}$ -inch Fitz–Clark refractor. In 1882, Swift became a ‘professional’ astronomer, heading the Warner Observatory at Rochester, NY, using a 16-inch Clark refractor, then the fourth largest in the United States, to survey the heavens for new nebulae. Swift eventually found more than 1200 objects, ranking him third behind only the Herschels in this category, and first among American observers. In 1893, Swift relocated his 16-inch telescope to Echo Mountain in California, where he spent the remainder of his career at the Lowe Observatory. Today, the 16-inch Clark is used as a teaching instrument by Santa Clara University. The whereabouts of Swift’s 3- and $4\frac{1}{2}$ -inch refractors are unknown.

In 1991 August and again the following year, amateur astronomers around the world were surprised by the intensity of the Perseid meteors (1), the best-known and one of the most reliable of the ‘annual’ meteor showers. The enhanced Perseid activity gave new hope to predictions that the parent comet of the shower, Swift–Tuttle, would return later in 1992 (2). However, the orbit of Swift–Tuttle, also known as Comet 1862III, was not well known, as the comet had not been observed since its original apparition, and predictions that it would return in 1981 had failed to materialize, so there was no small amount of doubt that this ‘dirty snowball’ would visit our neighbourhood again in 1992. Then, on 1992 September 26, a Japanese amateur named Tsuruhiko Kiuchi recovered Swift–Tuttle using 150-mm binoculars (3).

By the late autumn of 1992, Swift–Tuttle became a respectably bright, if not spectacular, object (see Fig. 1) which was intensively studied by both amateur and professional astronomers. By mid-November, the comet was about as bright as a 5th-magnitude star and sported a 2° gas tail and a shorter dust tail (4). In Naples, Florida, USA, more than 2000 people showed up at a star party organized by the Everglades Astronomical Society to observe this celestial visitor (5)! During the 1992 apparition, the orbit of the comet was refined, and astronomers initially estimated that Swift–Tuttle had a 1-in-10000 chance of colliding with Earth at its next return, scheduled for the year 2126 (6). The *New York Times* even ran an article headlined ‘Scientists Ponder Saving Planet from Earth-Bound Comet’ (7)! Some astronomers also predicted a Perseid ‘meteor storm’ in 1993, owing to the debris left by the comet (8); although the ‘storm’ did not materialize, some observers saw as many as 200 meteors per hour, with many ‘fireballs’ (9).

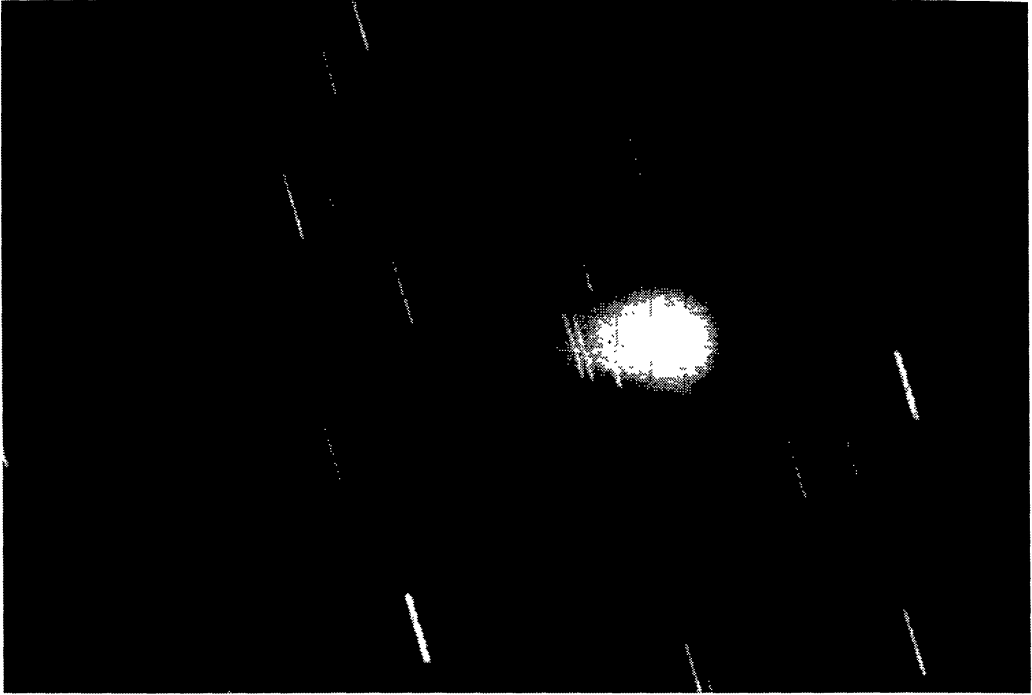


FIG. 1. Periodic Comet Swift-Tuttle (1862III) as photographed by Michael Stecker on 1992 November 27. Photo courtesy Michael Stecker.

Despite the great excitement created by Comet Swift-Tuttle among both astronomers and laypersons, few people know very much about the man who first discovered this object during the days of America's War Between the States. That man was Lewis Swift, and his story is a quaint reminder of a bygone era when the line between amateur and professional astronomers was blurred, and great discoveries could still be made using relatively simple telescopes.

SWIFT'S EARLY YEARS

Swift was born on 1820 February 29 in rural Monroe County, New York, on his family's farm. His father, also named Lewis Swift, had been a general in the Revolutionary War, and was descended from William Swift, who came to Massachusetts from England in 1630 (I). To get his family through the long, harsh winters of upstate New York (when no farming could be done), General Swift set up a large workshop to make farming implements, obtaining several patents for new inventions, which often won prizes at the State Fair. Young Lewis displayed a mechanical ingenuity while helping his father, an ingenuity that he would apply many times during his astronomic career.

As far as anyone can tell, Lewis Swift's first encounter with astronomy occurred in 1833, the year of the great Leonid Meteor Storm. Blessed with dark rural skies unpolluted by the yet-to-be-invented incandescent light, Lewis was awestruck by the storm. 1833 was also the year that young Lewis had a serious accident on the farm, which fractured his hip, leaving him lame. For several years, owing to 'the inadequate surgery of the day' (II), Lewis

was unable to walk without crutches, and he henceforth had a pronounced limp. The accident ‘proved a blessing in disguise’, however, as ‘incapacitated for farm work, he gained time for study’ (12). In 1835, Lewis matriculated at the Clarkson Academy in western New York, where he received a well-rounded liberal arts education. Swift’s fine academic record at the Academy was an early indicator of his persevering nature, for travelling the 4-mile round-trip to and from the school on crutches was no easy feat. He preferred his science courses over other subjects, and was very impressed by Halley’s Comet during its 1835 apparition.

During the 1840s, after graduating from Clarkson, Lewis satisfied both his love of things scientific and his wanderlust by travelling throughout the midwestern United States and Canada, giving lectures and demonstrations on electricity, magnetism and the telegraph. It was at this time that Swift observed the Great March Comet of 1843, a sungrazer which attained a total magnitude of about -7 (13), bright enough to be observed in broad daylight even when it was only 1° from the Sun’s limb! The tail of this comet stretched over a 40° swath of sky – no wonder that Swift eventually felt himself drawn to astronomical studies. Swift reported ‘The comet’s broad tail reached from the horizon to the very middle of the heavens; the sight dazzled me’ (14).

THE HARDWARE STORE ASTRONOMER

Lewis married Lucretia Hunt in 1850, and the next year opened a hardware store in his bride’s hometown of Hunt’s Corners, Cortland County, New York. By this time, Swift had given up farming, but his interest in science was just beginning to flower. After inventing a microscope that employed a calcium light to project views of slide-mounted specimens on to a screen, Swift embarked on another lecture tour, playing to large audiences. Lewis purchased his first two astronomy books in 1855 – Burritt’s *Atlas Designed to Illustrate the Geography of the Heavens*, and *The Practical Astronomer* by Thomas Dick. Religion had always been an important part of Swift’s life, and he enjoyed Dick’s mixture of theology and astronomy; following instructions in Dick’s book, he made his first telescope, a 3-inch refractor with a hand-fashioned brass mount. Swift purchased the objective for this instrument from the Spencer Optical Company for \$5.00 (15). Although known mostly for their microscopes, Spencer did produce a few fine telescopes and objectives during the mid-to-late 1800s. Using the 3-inch and Burritt’s *Atlas*, Swift began what he described as a systematic survey of the heavens.

Swift was further inspired to pursue his astronomic work after attending two series of lectures in 1857 and 1858 at the Atheneum Library in nearby Rochester, New York, given by Ormsby Mitchel, the director of Cincinnati Observatory who would go on to win fame in the War Between the States as a Union general. Also in 1858, after the 3-inch Spencer was accidentally broken, Swift decided to upgrade his equipment by purchasing a $4\frac{1}{2}$ -inch $f/10$ ‘comet seeker’ from the famous American optical craftsman Henry Fitz. By today’s standards, this telescope would not be considered ideal for comet sweeping, but $f/10$ was a fairly ‘fast’ focal ratio for telescopes of that period. To accommodate his new telescope, Swift built his first observatory,

consisting of ‘a conical revolving dome covered with canvas’ (16). Almost immediately after taking delivery of the comet seeker, Lewis had a disappointing experience that has been repeated by countless amateur astronomers down through the years – he reported the ‘discovery’ of Donati’s Comet, only to find out that several other astronomers had already spotted this object. None the less, this ‘near miss’ convinced Swift that he, too, could discover comets, and he wrote up his observations of the Donati comet for the 1858 November 12 *Astronomical Journal*.

SWIFT’S FIRST AND MOST FAMOUS COMET

In 1862, just as the War Between the States was heating up, Swift’s wife died, and he and his children relocated to the small town of Marathon, New York, where he continued to run his hardware store. The Swift property in Marathon was surrounded by trees, and he realized that finding comets required unobstructed horizons, so he built the first of several ‘rooftop observatories’. In Swift’s own words,

I cut a hole through the gable of my barn to crawl through, and built a platform on which to observe. My first stroke of luck was the discovery of the famous comet of 1862III...(17)

Swift’s discovery of Comet 1862III was entirely by accident, and it generated no small amount of controversy within the astronomical community. At the time of his discovery, Swift was a subscriber to *The New York Times*. In the 1862 July 15 edition of that newspaper, Swift read of the discovery of a comet ‘north east of the north star moving very fast’. As Swift later recounted,

I told the people of the village...of its discovery, and that to-night I am going to try to find it. As soon as it was dark, I took my comet-seeker to a neighbor’s back yard and in less than five minutes I ran across a beautiful comet apparently north east of the north star, which I took for granted, as everybody would, that it was the comet I was searching for...The next night I expected a long search for it, as the *Times* did not state in which direction it was moving, and a near-by barn obstructed much of my view in a northeast direction. Pointing, the telescope the next night to the place of the comet on the previous evening, the comet was not seen, but was in a moment found near by, having moved but little, which surprised me, but still no suspicion was entertained that it was another comet. Some three or four days after the same paper announced that another comet was discovered northeast of the north star by Tuttle. No one can realize my surprise at the announcement! (18)

With the help of Professor G.W.Hough of the Dudley Observatory in Albany, New York, things were eventually sorted out and Swift was credited as the co-discoverer of the comet, along with Harvard’s Horace Tuttle. In 1866, Giovanni Schiaparelli announced that Comet 1862III travelled in an orbit virtually identical to the orbit of the Perseid meteor stream, and, in later years, both Tuttle and Swift tried to claim sole credit for the momentous discovery. The controversy was debated in the pages of the American journal *Popular Astronomy*, including one article (19) in which Swift complained that, despite his being listed as the sole discoverer of Comet 1862III in *The Annual of Scientific Discovery* for 1862 and Chambers’ cometary catalogue, many astronomers had taken to calling it ‘Tuttle’s Comet’. Swift ended this article with the lament, ‘So much for fame.’



FIG. 2. Comet and nebula discoverer Lewis Swift, *c.* 1885, with his second wife Caroline Topping Swift, and their son Edward, who, years later, discovered his own comet from California. This, and all other photos, unless otherwise indicated, courtesy Fran Biddy, Strassenburgh Planetarium.

THE TOTAL SOLAR ECLIPSE OF 1869

Two years after the discovery of his first, and most famous, comet, Lewis Swift married Caroline Topping of Long Island, New York (see Fig. 2). In 1867, Swift was privileged to witness a second Leonid meteor storm (the Leonids peaked in Europe the previous year). His account of the shooting stars that he observed on the morning of 1867 November 14 included a fascinating description of an exploding Leonid:

During the display I counted 896 shooting stars. How many I lost in a cessation of twenty minutes I cannot know. Many were bright and left visible trains in their wake, but only one was seen long enough to determine accurately the direction of its motion. This exploded near the southern limit of Cancer, and disappeared near its northern boundary; its visibility lasted for, at least, twenty minutes. Its changes of form were very numerous and interesting, resembling, at times, several capital letters of the alphabet, sometimes like U, then S, but more frequently like N. Its motion was very slow exactly north, nearly over my zenith. About five minutes before its final disappearance, it centrally transited Praesepe and, while in transit, not a trace of the meteoric debris was visible. After gathering itself into a globular mass, it disappeared some 5° or 8° north of Praesepe. (20)

During these years, Swift maintained his friendship with the astronomers at Dudley, and in 1869 travelled to Mattoon, Illinois, as part of the Dudley expedition to observe the total solar eclipse. Swift eloquently described Bailey's beads and prominences which he observed during the eclipse:

A little to the right of the point of contact were five lunar mountains ... looking like the straight edge of a saw, whose teeth were worn to bluntness ... The instant I saw those lunar mountains, the thought occurred to me, that if, as is generally supposed, Bailey's

beads are caused by the sun being seen between them, then they ought to be seen more conspicuously in that vicinity; and I found by observation that my conjecture was fully realized ... A short time before the appearance of Bailey's beads, I saw that never-to-be-forgotten protuberance, sitting in queenly beauty on the crest of the sun ... At the instant of totality, seven or eight protuberances of indescribable beauty and splendor were seen ... The internal structure of the great protuberance ... looked like a ship, with her hull, masts, spars, etc. painted red, and the ropes painted black ... (21)

THE CIDER MILL OBSERVATORY

Swift barely missed discovering his second comet in 1871; the next year, he moved to Rochester, New York, a thriving city of 80000 on Lake Ontario, and expanded his hardware business. His first home was on Jones Street, but the Swifts shortly acquired a modest house on Ambrose Street, farther away from the glare of downtown Rochester's gas lights. Lewis tried to observe from his backyard, but an abundance of nearby trees and houses made for poor horizons – a serious handicap for the dedicated comet hunter. He therefore eagerly accepted the invitation of Daniel W. Powers, a local businessman, to observe from the roof of his Powers Block tower, but this was downtown, again too near the glow of gas lights. Eventually, Swift set up his telescope upon the estate of former Congressman Lewis Selye, in an elevated area north of the city known as Lake View Park.

Two years later, Swift became the first American astronomer to observe Coggia's Comet, which he showed to throngs of eager Rochesterians at Lake View Park. Actually, Swift at first thought that he was the discoverer of Coggia's Comet, and a local newspaper erroneously credited him with the accomplishment. As recounted by one historian, 'A man who had perhaps bought a pump handle or a buggy whip from Swift's hardware store on State Street early that year could not escape a shock of surprise when he opened his *Democrat & Chronicle* on July 15 and read that the same Lewis Swift had just discovered a comet' (22). It was at this time that the local press discovered that they had something of a local sensation in Lewis Swift, and he was soon hailed as 'The People's Astronomer' for his willingness to hold public star parties and give free lectures. In 1875, Swift accepted the University of Rochester's invitation to lecture on 'The Wonders of the Moon'. He also began writing popular articles on astronomical topics, including a sceptical critique of the theory that life existed on Mars. In a later paper on the so-called *canali* of the Red Planet, Swift opined that these were merely an artefact of 'persistence of vision ... reported by the users of inferior telescopes' (23).

Bausch & Lomb hired Swift as an optical consultant in 1876, and he enjoyed the distinction of inspecting and testing the very first telescope crafted by that firm, commissioned for a leading merchant of the area named Aaron Erickson. In that same year Swift organized a very successful 'public Perseid watch' from which many valuable data were collected, and embarked on a lecture tour for the Northwestern Lyceum Bureau. The next year saw 'The People's Astronomer' set up a small observatory on a platform atop the roof of Duffy's Cider Mill, on White Street near the Genesee River in Rochester. Icy weather often compelled Swift to crawl 100 ft across the cider mill's slanted roof on hands and knees. What's more, the low height of the

$4\frac{1}{2}$ -inch's mount obligated Swift to spend many hours observing from a prone position, separated from the roof of the cider mill by only a small throw rug. In winter, Swift regarded a sturdy blanket as an 'observing necessity'. The famed American astronomer Edward Emerson Barnard described the cider mill observatory:

The access to this bleak place of observation... was had only by climbing over several lower roofs and up a rickety wooden ladder – a process hazardous enough to one with sound limbs, but doubly so to him because of his lameness. The tube and stand [of the $4\frac{1}{2}$ -inch] were left on the roof, but the object glass and eyepieces were carried back and forth in a basket, and it was by this means that a fall broke the flint lens of the $4\frac{1}{2}$ -inch.

(24)

The broken flint element was quickly replaced by the Alvan Clark & Sons firm at a cost of \$100.00. The Clark optics proved superior, and Swift soon discovered his second comet – 1877III, for which he was awarded a gold medal by the Imperial Academy of Science in Vienna. These were clearly exciting times for The People's Astronomer, and, each time a new comet was suspected, a stirring chain of events would unfold:

Checking himself on such occasions, Swift would study his object again to make sure there was no mistake; if satisfied, he would rush down the ladders and catch a horsecar into the city where a telegram could be dispatched to the Dudley observatory in Albany, later to the observatory in Vienna. The next hours were always impatient ones for Swift and his friends, awaiting confirmation of his discovery. (25)

Swift credited his successful comet hunting with the $4\frac{1}{2}$ -inch to a revolutionary eyepiece (26) especially designed for that purpose by a local optician named Ernst Gundlach. After Swift explained the need for the widest possible field of view, Gundlach, after much experimentation, devised a nine-element eyepiece (unheard of in its time), giving a flat but very wide (about 3°) field of view (27). Comets were not the only objects that interested Swift. While taking a break from comet hunting on the night of 1877 December 12, he observed an unusually fine display of Geminid meteors with his naked eye. And, realizing that the sky contained many faint nebulae that could be confused with comets, Swift began plotting nebulae, including some that were hitherto uncatalogued, on his Burrit's *Atlas*. This pastime, in the time-honoured tradition of Charles Messier and other comet hunters, would eventually consume most of the Rochester astronomer's energies.

SWIFT 'DISCOVERS' VULCAN

1878 marked the most controversial year of Lewis Swift's astronomical career. After finding Comet 1878I, for which he was awarded a second gold medal, he made some valuable measurements of the transit of Venus, assisted by his friend William Rebasz, a local watch maker who had been inspired by Swift to construct two homemade telescopes of his own. Then, in late July, Swift journeyed to Denver, Colorado, as a member of the University of Chicago's total solar eclipse expedition. On his journey west, Swift joined the Chicago astronomers at the Dearborn Observatory, which featured an $18\frac{1}{2}$ -inch Clark telescope, and a group from Princeton University who were transporting, with great effort, a $9\frac{1}{2}$ -inch refractor to the eclipse site (28).

Many respected astronomers of the day had theorized that a putative intra-Mercurial planet, dubbed 'Vulcan', could be seen during a total eclipse if one knew just where to look. The existence of Vulcan had first been postulated by the Frenchman, Urbain Le Verrier, in 1859 to provide 'missing' Newtonian gravitational perturbations which would, it was hoped, account for the progression of Mercury's perihelion point (29). Swift spent much of his observing time during the 1878 July 29 eclipse sweeping the area of sky near the limb of the Sun. After considerable effort, he spotted 'two stars, about 3° S.W. of [the] Sun, apparently of 5th magnitude some 12' apart, pointing towards [the] Sun.' (30) Later, Swift 'recalculated' the distance between the stars as 8 arcmin instead of 12 arcmin, and was able to identify one of the stars as Theta Cancrī. The other star, Swift concluded, was an intra-Mercurial planet 'beyond all question, for on the morning of the [August] 10th... I saw Theta robbed of the companion I saw during the eclipsed Sun.' (31)

Swift's 'discovery' of Vulcan was taken quite seriously for some time thereafter, as many astronomers were impressed by supposedly 'corroborating' observations made by Professor J.C. Watson (University of Michigan), whose observing station had been located at Rawlins, Wyoming. Newspapers across the country rushed to report this fantastic find; typical is the following account, taken from the pages of the *Chicago Tribune*:

First in the order of popular interest, if not in a scientific sense, is the alleged discovery of Vulcan. After many years of speculation and watching and waiting, during which prominent astronomers have changed front more than once from disbelief to belief and back to disbelief again in his existence, he has been seen by two astronomers separated by a distance of several hundred miles, Prof. Watson, of Ann Arbor, Mich., well known as a discoverer of minor planets and Lewis Swift, of Rochester, N.Y., almost equally well known as a discoverer of new comets. Watson saw him... as a star of little less than the fourth magnitude... and Swift saw two stars... the star Theta in Cancer... is situated very nearly in that position... One of the objects... seen by Swift was the fixed star... and there seems to be no escape from the conclusion that the other object near it is either the long-sought for planet, or at least a 'piece of him'. (32)

Of course, Swift and Watson's 'discovery' was never confirmed, and the need for an intra-Mercurial planet to explain the precession of Mercury's perihelion evaporated with the advent of Einstein's theory of general relativity, published in 1916. In the meantime, however, The People's Astronomer received a hero's welcome, and one Rochester newspaper blared 'BRAVO! For Rochester's Astronomer/Prof. Swift Discovers 'Vulcan', The New Planet' (33). After his triumphant return from the expedition, Swift was more in demand than ever as a speaker, and he gave a series of well-attended talks on 'Marvels of Astronomy'.

SWIFT BECOMES A 'FELLOW'

1879 proved to be a turning point in Lewis Swift's astronomical life. After discovering Comet 1879II in June near the Perseus double cluster, the Imperial Academy awarded him a third gold medal. Two additional honours followed – Swift was elected a Fellow of the Royal Astronomical Society on 1879 April 9, and received an honorary doctoral degree from the University of Rochester. Swift was extremely proud of his election as a Fellow of the

RAS, and he always signed his article by-lines with the title 'FRAS'. In later years, Swift immensely enjoyed his membership of the newly formed (in 1890) British Astronomical Association, which had many members keenly interested in the comets which had fascinated him for his entire life.

Lewis Swift's many cometary discoveries made him particularly famous in America, and his exploits even inspired occasional satire, as witness this excerpt from an article appearing in the *New York World*, titled 'An Unauthorized Astronomer':

We think it is time for somebody to sit down upon Lewis Swift, of Rochester... a sort of bushwacking astronomer who has had the impertinence to discover two comets... He has no lofty tower nor fifty-three foot tube nor four-ton speculum. He keeps a small hardware shop, and when he ought to be asleep recruiting his strength for the labor of tinkering pots and pans he probably ascends to his back attic and observes the sky out of some old home-made telescope. Doubtless his skill in the hardware business has enabled him to patch together a few length of stovepipe for a tube, and he perhaps has been able to hoist the instrument on an old bedpost... and point it at the astonished stars. Now is such a thing to be tolerated when there are observatories built all over the country, furnished with magnificent telescopes mounted after the most approved fashion, and controlled by genuine astronomers whose sole business is to watch the sky? There is only a limited number of comets and things, and what right has a fellow like Lewis Swift to put his attic observatory into competition with authorized institutions and take away gold medals, for finding what other observers would be sure to discover sooner or later if they were allowed a little leisure in the hunt? A fellow of this kind will stop at nothing. (34)

Swift enjoyed applying his scientific mind to worldly questions, and at one point took time out from his hardware business and astronomical researches to prove (or so he thought) that a pitched baseball, contrary to popular belief, could not really 'curve'. The National League, baseball's first true major league, had started play in 1876; in 1863 'Candy' Cummings had introduced a new way of pitching the baseball which he called the curveball. Baseball was quite popular in Rochester, and a debate arose among the area's baseball fans as to the genuineness of the curveball phenomenon. After declaring that, in his opinion, the curveball was nothing more than an optical illusion, Professor Swift, as he was now called, agreed to stand in as the batter to prove his point. The startled astronomer quickly recanted his opinion (35) after almost being hit on the head by one of the pitcher's 'illusions'!

THE WARNER OBSERVATORY

The most important event of 1879 for Lewis Swift, however, was his chance introduction to Hulbert Harrington Warner, a Rochester millionaire who made his fortune selling iron safes and 'Safe Liver Pills'. Warner aspired to be a philanthropist, but he could not decide exactly how his money should be spent. After meeting Swift, Warner resolved to build an astronomical observatory that would bear his name; Warner offered to pay for the observatory grounds and building, and to set up a fund from which Swift would be paid an annual stipend, and further offered to match, dollar for dollar, any funds that Swift could raise himself among the people of Rochester to pay for the telescope itself. Swift set to work in 1880 raising funds for the telescope, which was originally designed as a 7-inch refractor.

That year he found his fifth comet, 1880IV. This comet turned out to be a recovery of Tempel's Comet of 1869, which astronomers thought had been lost. It was also at this time that the American Association for the Advancement of Science elected Swift as a Fellow.

Professor Swift was extremely busy in 1882, dividing his time between fundraising for the new telescope, which was very enthusiastically greeted by Rochesterians, and continuing his comet searches from the roof of Duffy's Cider Mill. After raising \$12 500.00 in 'subscriptions', Swift realized that a much larger telescope than originally planned could be acquired – one could say that Swift and Warner suffered from what today's amateur astronomers colloquially call 'aperture fever'! Plans were drawn up for a 16-inch behemoth, and Warner bought a beautiful piece of property on East Avenue near Arnold Park for the observatory, just down the street from the house of George Eastman, founder of the Eastman–Kodak Company. Warner also set aside the princely sum of \$100 000.00 for the observatory building and astronomer's quarters. Somehow, during all of this excitement, Swift found time to discover two more comets 1881III and 1881VIII, for which he was awarded the Lalande Prize by the French Academy of Sciences, consisting of a silver medal and 540 francs. The 'secondary tail' of Comet 1881III was 55° long, the longest secondary tail on record at that time (36).

Also in 1882, several of Swift's friends, who had been inspired by him to take up their own amateur astronomical studies, formed the Rochester Academy of Sciences Astronomy Section, but strangely Swift never joined the organization. In fact, this was a pattern that would hold throughout Swift's life – he never had much to do with the well-regarded University of Rochester, despite the honorary PhD that institution awarded him. While he enjoyed giving public lectures and star parties, Swift declined to ally himself with institutions or large scientific organizations, although he did have a few close friends who were astronomers, including E.E. Barnard.

Construction of the Warner Observatory began in earnest in 1882. The observatory buildings were fashioned from white sandstone obtained from Lockport, New York, about 60 miles west of Rochester. The dome, 31 ft in diameter, consisted of a ribbed framework of pine and oak, covered with galvanized steel. The total weight of the dome, what sat elegantly atop a rounded, four-storey tower, was about 3 tons. Great care was taken in designing the tracks on which the dome revolved, so that Professor Swift, who was already in his early sixties, could move it by hand with little effort. Of the dome, Swift remarked:

Hitherto nearly every principle of mechanical construction has been violated in the building of observatory domes, and they have been made as weighty as possible, under the delusive idea that if heavy they must needs be strong. Another prevalent error that has obtained is that powerful steam or gas motors are necessary to rotate them. To revolve the Warner dome, pulling or pushing – depending on the direction desired – on a perpendicular arm of tough oak, attached to the ring is all that is required... I have seen this dome completely revolved by the hand of a boy of seventeen in 47 seconds, and, pulling with the middle finger of one hand, in 70 seconds... The estimated weight of the dome is 3 tons, while the weight of the Harvard Observatory dome (same size) is 14 tons. (37)

Swift himself was in charge of procuring the telescope, and he travelled to Cambridge, Massachusetts, to place an order with the renowned optical firm

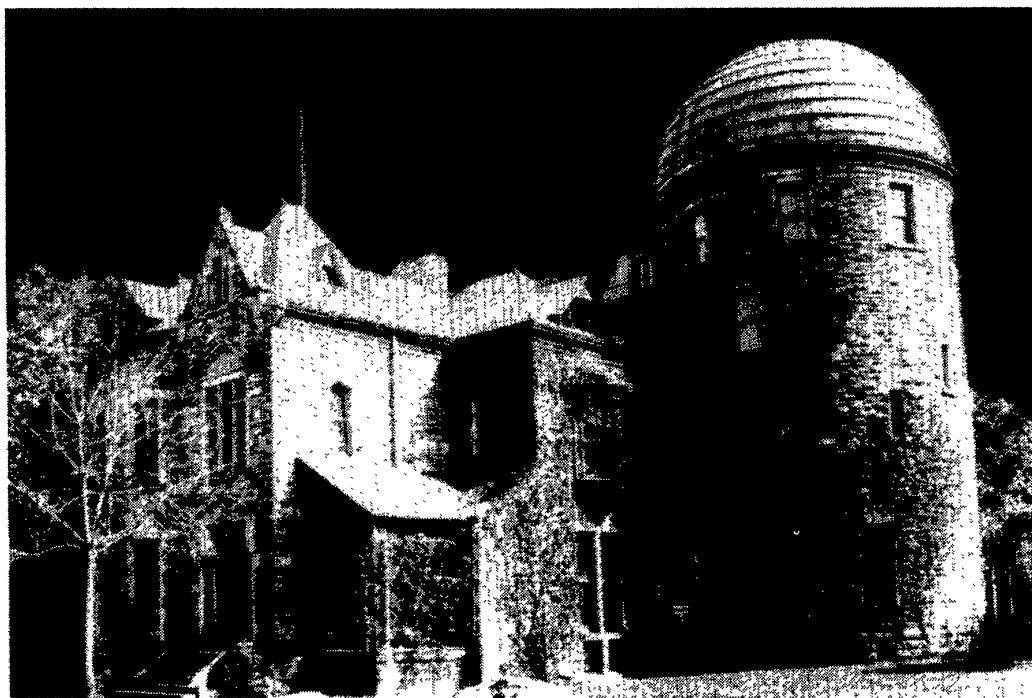


FIG. 3. The H.H. Warner Observatory on East Avenue in Rochester, New York, c. 1888.

of Alvan Clark & Son. During this trip, Swift attended a meeting of the American Association for the Advancement of Science where he met other leading astronomers of the day, and visited several New England observatories to determine what equipment and library materials the Warner Observatory would need. The glass for the 16-inch objective was obtained from Birmingham, England, but it developed several defects during grinding and had to be replaced with a second blank. Swift returned to Cambridge on several occasions, to be able to witness the several stages of grinding and polishing the great lens. When finished, the object glass had a focal length of 22 ft; the crown and flint elements were $3\frac{1}{2}$ inches apart. The highest power eyepiece used with the telescope gave a magnification of about $2000\times$. The Clarks mounted the great lens in a steel tube, 14 inches in diameter at the eye end and 18 inches in the middle and at the objective end. The tube was carried by a massive equatorial mount, having a declination circle 28 inches in diameter. The tube carried a $3\frac{1}{4}$ -inch refractor as a finderscope (38).

In November of 1882, the Warner Observatory was ready for installation of the 16-inch refractor, and young Alvan G. Clark personally accompanied the telescope from Cambridge and supervised its erection. The mount was set in a sturdy 'double pier'. The first pier was conical, 20 ft in diameter at its base, tapering to a diameter of 9 ft at its top, which was level with the floor of the observing room – in other words, this part of the pier lay beneath the floor of the dome. The second part of the pier, the part visible from the observing room, was rectangular in shape, upon which the equatorial head was installed. As if this were not sufficient, the two piers were separated by a great capstone, 9 ft wide and weighing 8 tons! Needless to say, Swift always found the 16-inch Clark to be 'rock steady'. Warner even paid for the



FIG. 4. Lewis Swift seated in the observer's chair at the Warner Observatory, c. 1890. Note the large brass spectroscope resting on the ornately covered table at centre.

installation of an elevator 'outside the tower to avoid any vibration of the instruments'.

The rest of the observatory was no less magnificent (see Fig. 3). Warner's own mansion was regarded as the most opulent in the city, so it was not so surprising that 'earlier plans for a modest home and observatory had been revised to give the Professor a stone residence of generous proportions' (39). The interior of the observatory was nicely furnished, including a large, sturdy observing chair constructed by Swift himself. The observatory also featured a first-class astronomical library, and local philanthropists donated funds to acquire various excessory equipment, including a sidereal clock, a filar micrometer also made by the Clarks, a customized 'Bond Spring Governor' clock drive for the 16-inch, and an Alvan Clark & Sons spectroscope which cost \$1000.00 (40) (see Figs 4 and 5). The spectroscope was donated by Hiram Sibley, one of the promoters for the Western Union Telegraph Company. Perhaps one of the more interesting features of the 16-inch was its 'automatic right ascension circle', invented by the renowned American double star cataloguer Sherburne Wesley Burnham, about which Swift commented:

I have spent much time and money in its improvement, and have finally succeeded in bringing it to a degree of perfection unanticipated by either the original inventor or myself... A 15 inch circle of bronze graduated to minutes of time, and read by verniers to 5s., ... is mounted on a short spindle attached (on a level with the eye) to the north side of the pier, close above the sidereal clock, and carries a grooved iron pulley about a foot in diameter. This, by a small pliant braided cord of fine brass wires, is connected with a similar pulley attached to the polar axis. A weighted rider presses on the cord, which maintains the same degree of tension under all temperatures... the sidereal clock



FIG. 5. Another view of Swift in the Warner Observatory dome, showing almost the entire 16-inch Alvan Clark refractor which was the showpiece of the observatory.

simply controlling the velocity of the verniers... Above and to the left of the circle is seen a bottle of shot attached to a metallic cord wound around the shaft on which the verniers revolve. This takes up all lost motion caused by the cogs in the clock train... With this arrangement, the approximate R.A. of a new object is quickly obtained... (41).

Anticipating the opening of the Warner Observatory, Lewis Swift closed his hardware store in 1882; he was now a full-time professional astronomer, despite the fact that he never received an advanced degree in the subject. Not surprisingly, Swift had no trouble finding eager volunteer assistants to help operate the magnificent Clark, which required the efforts of two people pulling on ropes to slew the telescope into position. Swift's son Edward and William Rebasz were his chief helpers.

TRADING COMETS FOR NEBULAE

In 1883, the Warner Observatory enjoyed its first full year of operation. Lewis Swift found another comet – 1883I – but this would be his last until 1889. Although the $4\frac{1}{2}$ -inch Fitz-Clark was still used by the venerable astronomer for casual observing, the principal mission of the Warner Observatory was to add to the lists of nebulae compiled by the Herschels and others. These lists were assembled into the *New General Catalogue* by the

Danish astronomer John Ludwig Emil Dreyer in 1888. By 1895, so many new nebulae had been found that Dreyer was obliged to publish a supplemental *Index Catalogue*, followed by a *Second Index Catalogue* in 1908. Swift had first become interested in nebulae while sweeping for comets from the roof of Duffy's Cider Mill, but, unlike Messier who regarded nebulae as mere nuisance objects, Swift believed that they were deserving of serious study in their own right. As Swift explained in the introduction to the *History and Work of the Warner Observatory*:

The Warner Observatory is distinctively a private institution built for the purpose of original discovery rather than the ordinary routine work of most other observatories. The desire of its founder was that the great telescope...be used in such work; so, selecting as my principal field of labor, the discovery of new nebulae, which, since the death of the Herschels and of D'Arrest, had been much neglected, and to which work the quest for faint comets had well trained my eye (an important factor), and also because of its congeniality to my taste (another influential consideration), on July 9, 1883, a thorough and systematic search was inaugurated for this class of objects, which were popularly supposed to have been exhausted... (42)

During his cider mill observatory years, Swift had realized that discovering objects that were not already catalogued by the Herschels would require a fairly large aperture, leading him to recommend to Warner that a 16-inch telescope be commissioned instead of the originally planned 7-inch. When the Warner Observatory opened, it boasted the fourth largest telescope in the United States at that time (only the US Naval Observatory's 26-inch Clark refractor, Princeton's brand-new 23-inch telescope, and the Dearborn instrument were larger), and the largest in a 'private' facility.

Despite the fact that Swift devoted much effort during the first 2 years of the Warner Observatory's operation to finding new nebulae, he did not abandon his personal goal of making astronomy understandable to the citizens of Rochester, and the 16-inch Clark was used for free public 'open nights' every Tuesday and Thursday, from 8 p.m. to 10 p.m. On other days, visitors were admitted to the observatory after buying a 25¢ ticket at Warner's patent medicine store on St Paul Street in downtown Rochester. Wednesdays and Sundays were reserved strictly for research. Warner and Swift regarded the public observing sessions as an opportunity to show gratitude to the many enthusiastic citizens who had provided financial and other support for the observatory. Hulbert Warner's observatory soon became a major tourist attraction, and the state legislature exempted it from taxation in recognition of the facility's public service. One newspaperman who was given a personal tour of the facility described what it was like to visit the Warner Observatory in its heyday:

One evening recently the writer proceeded to the Warner Observatory on East Avenue. Walking up the three flights of stairs leading to the dome he found the head of the institution, Dr. Lewis Swift, in the work room. The intense heat did not interfere with the astronomer's activity. Clouds prevented him from watching the heavens and he was busy on a new mechanical device. It was evident that he still finds time to exert the inventive skill which has been one of the elements contributing most to his success in scientific investigation. The visitor was warmly welcomed, and after being led to the observing room enjoyed a talk on nebulae, a subject to which the doctor is now paying much attention. Truly the charming room, commanding a view of land and sky on every side, with the magnificent telescope rising up to the roof, makes one feel that he is in a favored spot for study and reflection. There is one other thing which may

impress the visitor at the observatory – the earnestness of the astronomer in speaking of the science to which he is so entirely devoted. (43)

In 1884, the city of Rochester celebrated its centennial, and, as part of the festivities, Lewis Swift was asked by the local press to make an ‘astronomical forecast’. In response to this somewhat unusual request, the Professor predicted that astronomers would shortly discover a trans-Neptunian planet (44). Of course, Swift was almost half a century early, if somewhat prescient, in making this bold statement.

After Swift published his first two catalogues (45) of newly discovered nebulae in 1885, containing about 200 objects, he caught the attention of Sir John Herschel, with whom he established a lively correspondence. At about this time Swift began to write popular articles for the American journal *The Sidereal Messenger*. Swift later wrote for that publication’s successors, *Astronomy & Astrophysics* (not to be confused with the modern European journal for professional astronomers) and *Popular Astronomy*.

In 1886, Lewis Swift published catalogues 3–5 (46) of his new nebulae, the brightest of which he plotted on his old Burrit’s *Atlas*, and Dreyer incorporated these objects into his *NGC*. Most of Swift’s nebulae lists appeared in the *Monthly Notices of the Royal Astronomical Society* and in *Astronomische Nachrichten*. The following year produced Swift’s sixth list of nebulae (47), and also the only two books that the Rochester astronomer ever authored. The first, titled *Simple Lessons in Astronomy* (48), was a compilation of 50 weekly newspaper articles explaining various aspects of astronomy for the layperson, which originally appeared in the Rochester *Union & Advertiser*. In the early chapters of this book, the author shared his excitement at revealing the secrets of the heavens:

There is no purer satisfaction experienced than that felt in devoting a portion of one’s life to the enlargement of ideas and the promulgation of truth... To space there is no end, there can be none. As far as the great telescopes carry us, it is filled with worlds typical of every kind of vastness, immensity, infinity, omnipotence, eternity. (49)

The second book, *History and Work of the Warner Observatory* (50), contained many interesting descriptions of the facility’s equipment, as well as notes and sketches of nebulae and comets, Swift’s collected nebulae catalogues and a section devoted to ‘The Warner Prize Essays’. In 1881 Hulbert Warner had decided to establish his own prize for the discovery of comets, consisting of a gold medal and a \$200 cash award to any American credited with being the first to find one of these celestial interlopers, up to a maximum of five prizes per year. If fewer than five prizes were awarded in any one year, the amounts of the prizes would be increased so that they totalled \$1000 for that year. Ironically, after Swift turned his attention towards nebulae, most of the Warner Prizes were won by William R. Brooks of the Red House Observatory in nearby Phelps, New York. After a naked-eye comet overwhelmed Warner with 3000 claims for his prize, he decided to ‘break the tie’ with an essay contest, with the winner decided by Swift himself.

Between 1888 and 1890, Swift published nebulae catalogues 7, 8 and 9 (51), and found time to discover comet 1889VI. This comet, once feared lost, was accidentally recovered in 1973 by Tom Gehrels of Palomar Observatory

while searching for Apollo-type asteroids (52). Gehrels' observations showed that this comet has a period of about 9 yr.

BARNARD AND LICK OBSERVATORY

During March of 1889, Lewis Swift travelled to California to use the new \$700 000 Lick observatory's massive 36-inch Clark refractor. While at Lick, he became good friends with the brilliant astronomer Edward Emerson Barnard, the friendship emanating largely from the mutual respect that they had for each other's considerable talents as visual observers. Swift was extremely impressed, not only with the Lick facility, but also by California's favourable climate. Swift had spent his entire astronomical life in the 'snow-belt' of Upstate New York, hardly an ideal place for stargazing, causing him to remark, 'No one knows how much I suffered. Night after night I have lain out in the snow and cold. If I hadn't had an iron constitution, I never could have stood it' (53). Perhaps that is why The People's Astronomer was rarely seen without a woollen observing cap upon his head! Amusingly, on another occasion when he was obviously feeling more cheerful about his plight, Swift commented:

There was compensation for the time spent in the clear night air. Health was improved while the mind was satisfied. One engaged in absorbing astronomical work does not feel the cold. Devotion to a telescope is one of the best prescriptions for continued healthfulness. It has been said that night air is injurious, but my long vigils on the Duffy cider mill proved to me that night air is agreeable. (54)

THE DEMISE OF THE WARNER OBSERVATORY

None the less, by 1892, Swift was ready to move west, for a variety of reasons. Construction of the new Third Presbyterian Church began that year, right next to the Warner Observatory, creating a controversy (55) that excited the local media. The steeple of the church blocked much of the 16-inch's view of the heavens, causing Warner to complain bitterly:

...the building of the church...has...ruined the Observatory...and I consider the position of the Third Presbyterian Church people...as very unfair. I do not think that any institution like the church has the right to locate on any street, and place its building in such a way as to injure any man's property, especially a public institution like the Warner Observatory. (56)

Although Swift was somewhat more diplomatic than Warner, he too found this development discouraging, compounding problems caused by the poor weather and light pollution of 'The Flour City'. Swift told a reporter:

...the Third Church would certainly shut off much of the Western horizon. If Mr. Warner decides to abandon the observatory, I hope it will not be located again in Rochester. The climate here is too damp, and the sky is too often cloudy for successful observation. The electric lights of the city also interfere greatly with my view. I would like to have the observatory placed in Arizona or New Mexico where I would have the benefit of several degrees more of latitude to work in and would also have 365 cloudless nights out of every year. (57)

It is perhaps surprising to us today, who tend to think of light pollution as a problem of recent origin, that astronomers of Swift's day also had to contend with this anathema. In fact, however, by 1893, Rochester's electric

lights were already wreaking havoc with Swift's nebulae searches, causing him to comment;

The vast number of electric street lights entirely surrounding the Observatory, from a few rods to three miles distant, has so ruined the work of the discovery or observation of nebulae that, practically, it has been abandoned. When the ground is covered with snow and the trees denuded of their leaves, the sky illumination almost equals that from a gibbous Moon. (58)

Warner tried to persuade the church to build elsewhere, and even offered to deed the church officials alternative real estate. This generous offer was rebuffed, however, causing Warner to retaliate by giving a vacant lot that he owned next to the observatory to the rival St John's Episcopal Church! Warner defiantly announced 'It is my expectation in the near future to erect another Warner Observatory in some other city, and I hope that I shall be able to select a city where a society or any set of people will look upon it with pride' (59). However, this was not to be, as Warner's patent medicine business began to fail, causing Swift to travel west again, this time at the invitation of Westminster College, near Denver, Colorado.

Westminster made Swift an attractive offer to join its faculty and head its observatory. It is not clear whether Westminster was more interested in Swift or in the 16-inch Clark, considering that the college 'observatory' lacked a telescope; Swift would be required to transplant the 16-inch from Warner Observatory to Westminster as his part of the bargain, which he agreed to do. Warner quickly discovered Swift's plans and forbade him from removing the Clark refractor, ostensibly because the instrument belonged to the people of Rochester whose donations had paid for it. Westminster immediately rescinded its offer. To placate Swift, who was becoming increasingly agitated, Warner paid for him to take another trip out west, this time to receive a bronze comet medal from the fledgling Astronomical Society of the Pacific. This trip only strengthened Swift's resolve to move west, especially after he again visited Barnard at Lick, who encouraged him to relocate.

Back in Rochester, Swift compiled his tenth catalogue of nebulae (60), and follow this up with the discovery of perhaps his most spectacular comet, 1892I, the brightest seen by northern hemisphere observers since 1882. This comet, which was the tenth to be discovered by Swift, first appeared as a 4th-magnitude blur in Sagittarius; 1892I brightened to 3rd magnitude and developed a 20° tail (61). Photographs of the tail showed eight 'tail rays'. Barnard and W.H.Pickering both photographed the remarkable tail of this comet, and their photographs confirmed what visual observers had noticed – that the tail 'underwent rapid and marked changes' (62). Unfortunately, Comet 1892I has an elliptical orbit with a period of 23000 yr!

THE T.S.LOWE OBSERVATORY

The final blow to the Warner Observatory was dealt by the great financial panic of 1893, as a result of which Warner's business completely collapsed. Warner, no longer able to support himself in the style to which he had become accustomed, and unable to pay for the upkeep of his observatory or Swift's salary, vacated his great mansion and moved to Minnesota, where he retired 'to an obscure old age' (63). Swift had never amassed any substantial

assets himself, and the demise of his benefactor left him facing the possibility that he would have to abandon astronomy altogether. Swift again journeyed to California, this time to negotiate with Professor Thaddeus Lowe, who was building a new observatory on Echo Mountain, in the Sierra Madre range outside Pasadena. Although it is not clear how the two met, it is clear that Lowe was in many ways like Warner, but more colourful. Originally from New Hampshire, Lowe had been a pioneering balloonist during the War Between the States, conducting reconnaissance for the Union forces. In the post-bellum years, he developed many successful industrial processes, including a way of making artificial ice and a new system for manufacturing coke (coal, not the drink!). These inventions made Lowe a very wealthy man, allowing him to indulge other intellectual interests.

Lowe had originally planned to build his observatory on Mount Wilson, but chose instead Echo Mountain after concluding that it would be too difficult and costly, owing to the steep ascent, to build at the former location. The observatory was only part of a resort developed on the mountain by Lowe which included two luxurious hotels, and various ‘amusement centres’, including a museum, a zoo, and horseback riding trails (64). Visitors accessed the Echo Mountain resort by a rather unique mode of transportation – an inclined electric railway running through the Rubio Canyon to the summit of the mountains, at an elevation of 3700 ft.

After considering invitations from many other institutions in Texas, New Mexico, Arizona, California, Colorado, Missouri, Iowa and Nebraska, Swift agreed to join Lowe’s enterprise. One of the reasons for Swift’s decision no doubt was his ‘desire to locate farther south, as between the equator and 38° of north latitude there lies a belt encircling the globe on which no large telescope has ever been used’ (65). It is rather humorous to realize that, in light of what we know today of Los Angeles, a major inducement for Swift to relocate there was that city’s absence of smog. How times change!

Swift arrived at Echo Mountain in 1893, moving into Echo Mountain House, located a quarter of a mile from the site of the new observatory, with his wife and youngest son, Edward. The citizens of Pasadena welcomed Swift and his family with a huge reception at which the 73-year-old astronomer was dubbed the ‘Columbus of the Skies’ and given a large wooden key to the city (66). By 1894, construction of the Lowe Observatory was completed and the 16-inch was installed in its new home. Swift had quietly dismantled the telescope at the Warner Observatory and loaded it on to a boxcar in the middle of the night with the assistance of some of his closest friends, fearing that the Rochester citizenry would attempt to thwart the removal of ‘their telescope’. However, with Warner’s financial downfall, no one in Rochester was prepared to keep up the 10-year-old observatory, and there was very little negative public reaction once it was realized that both Swift and the 16-inch were gone. In fact, in later years, Swift returned to Rochester on many occasions, and was always warmly received wherever he went. Ironically, during these visits Swift often worshipped at the same Third Presbyterian Church that had contributed to the demise of the Warner Observatory, and he had no qualms about giving to the church’s coffers!

LIFE ON ECHO MOUNTAIN

Lewis Swift's first year at Echo Mountain was an exciting one. His son Edward, who was his father's chief assistant, discovered Comet 1894IV, which turned out to be a recovery of de Vico's Comet of 1844. This fact was not realized until 1963, when Brian Marsden, then a graduate student at Yale University, used a computer to correlate the observations of this object (67). When Edward Swift recovered the comet, its magnitude was only 13, attesting to the quality of the 16-inch Clark and the dark skies of Echo mountain. Ironically, Edward found his comet while searching for new nebulae with the 16-inch Clark at the same time that his father was sweeping the skies outside the dome with the venerable comet seeker!

Lewis Swift wrote a very enthusiastic article on his new observatory for *Popular Astronomy*, wherein he described the observing conditions and some of the interesting objects visible from the site:

...the Pacific Ocean [is] plainly in sight, though 35 miles away...The principal advantage...this location has...is the extraordinary number of clear nights...It is the most southern observatory in the United States...approximately $34^{\circ} 20'$ or about 9° south of the Warner Observatory...This difference of 9° imparts a strange appearance to the celestial vault, especially the elevation of the southern constellation[s], and the depression of the pole star, which seems much out of place.

Every clear night I see the beautiful 1st magnitude star Canopus... But few people in the United States have ever seen this star. Gamma Crucis, the northernmost star of the Southern Cross, just grazes the horizon when on the meridian, refraction, and my elevation enabling it to be seen. My low latitude also allows observations of many of Sir John Herschel's and Dunlap's southern nebulae and I find the descriptions of several incomplete and often erroneous.

That grandest of all visible clusters, Omega Centauri...is plainly visible at a good elevation. In comparison with this, 13 Messier in Hercules is a tame affair...it is about $20'$ in diameter, and as round as the Sun. In that small space there are many thousand stars from the 13th to the 15th magnitude, suns every one, no doubt doing the same service as our Sun, warming, lighting, guiding and fertilizing a system of planets where people no doubt are dwelling the same as here. (68)

Swift would remain at Lowe Observatory until failing eyesight forced his retirement in 1901. In 1895, the College of Los Angeles (now called the University of Southern California) aggressively tried to lure Swift and his telescope away from Echo Mountain, but the ageing astronomer rejected this offer, content in his still relatively new home. During those happy years he found three more comets, bringing his total to 13, and added about 300 nebulae to his lists (69), many of these being 'southern' objects that had been invisible to him at the latitude of Rochester. During his career, Swift found 1248 previously uncatalogued nebulae. Although, like most nebula hunters of his day, Swift lacked a deeper understanding of what he was seeing, some of his observations were accompanied by remarkable insight. For example, Swift correctly described the Rosette nebula in Monoceros as an expanding cloud of gas, and characterized edge-on galaxies as follows:

Near some of Sir John Herschel's southern nebulae I have discovered several overlooked by him, notably one between G.C. 4863 and 4865, in [the] field with the latter. It is very faint, very small [and] exceedingly elongated to a ray five times as long as broad. I am surprised at his failure to see it. Such exceedingly long thin nebulae are undoubtedly of the shape of a double convex lens of long focus, with its longer diameter in the direction of the line of sight. (70)

ACCIDENTAL COMETS

One of Swift's last comet discoveries, 1895II, was made accidentally while trying to confirm the position and magnitude of the last nebula discovered by him at the Warner Observatory. In his own words:

My own discovery of a comet in 1895 was a strange one. Among my newly discovered nebulae in Rochester, N.Y. was one whose place, owing to the breaking of the driving clock cord, I could not at the time accurately determine, so, one morning, setting the telescope by the circles, I put my eye to the glass and lo! a new comet was in the field. It is not easily possible to think of anything more fortuitous than that. It is as if a blind man were to fire a gun into the air and bring down a bird. (71).

Swift even succeeded in delivering comet discoveries on request, much as the American baseball icon Babe Ruth was purported to hit home runs to satisfy the wishes of small children. Writing many years later for *Popular Astronomy*, Swift recounted 'a personal family incident' in which his son prayed for a comet:

One of my young sons, a little boy of five or six years, in saying his evening prayer one Saturday night, omitted his week old petition for a velocipede, because he thought Sunday not the proper day for its bringing, and substituted for this request a prayer that God would help papa to find a comet that night, and his faith certainly was strengthened by the announcement next morning that a comet had been discovered while he had slept. (72)

Despite Swift's occasional lucky discoveries, most of his comet finds were the results of tireless work. His favourite motto was 'One cannot discover comets lying in bed' (73). Sometimes he would sweep the western skies just after sunset, go to bed, and awaken before dawn to sweep the eastern skies before sunrise. On other occasions, he would work from dusk to dawn without stopping. During these long sessions, the bearded astronomer fortified himself simply by occasionally sipping water from a large pitcher placed nightly on his observing desk. Typical of his exhaustive observing regimen is Swift's description of the days preceding his discovery of Comet 1878I:

I had searched from nightfall to dawn for four consecutive nights, until, weary indeed with watching, I would sleep and dream and waken and gaze alternately. (74)

On 1896 April 14, Swift found his twelfth comet just below the Pleiades (75). In 1897, the Royal Astronomical Society awarded Swift its first Jackson-Gwilt gold medal in recognition of his many discoveries of comets and nebulae. Two years later, he made his final comet discovery, 1899I, a sixth-magnitude object in Eridanus, the nucleus of which fissioned into two fragments (76). In 1901, Swift observed the third fine display of Leonid meteors during his lifetime, quite an accomplishment considering the fact that this shower peaks every 33 years.

RETIREMENT AND REQUIEM

Unfortunately, by the turn of the century Swift's astronomical career was clearly in its twilight. In 1900 February, a savage wildfire, always a threat in Southern California, nearly destroyed the Lowe Observatory, causing Swift tragically to lose 'many articles and papers of value' (77). Soon after, Swift's

eyesight failed and, at age 81, he reluctantly decided to retire from Echo Mountain. For the next 3 years, Swift remained in California, helping to plan the construction of the new observatory on Mount Wilson, at an elevation of 6500 ft. In 1904 he returned to Marathon, New York, to live with his daughter. Upon his retirement, Lewis Swift wrote a farewell essay for *Popular Astronomy* which he wistfully titled 'Ups and Downs, and Here and There of an Astronomer' (78). He concluded this bittersweet piece with the following advice:

Those who have followed me through this checkered digest will see that what I have accomplished under discouraging difficulties, has been the offspring of perseverance, the details of which I have written for the amateur to follow where unfathomable mysteries in the heavens still await him to solve, only hoping that he can say as do I, that sometimes 'Though bitter has been the bud, Yet sweet has been the flower'. (79)

In 1910, despite poor eyesight, the retired astronomer observed Halley's Comet for the second time of his life. It had been Swift's 'absorbing desire to see again the celestial streamer which first fired his imagination and challenged his ambition when a farmboy of 15 years' (80). A newspaper in Cortland, New York, reported that 'the old man was so overjoyed at the sight that he sank to the ground unable to control his emotion' (81). Sadly, on New Year's Day, 1913, Swift suffered a stroke and 4 days later died in Marathon, New York, where he was buried in the village cemetery. Swift was eulogized by several of the great astronomers of the day, including his longtime friend Barnard, who wrote:

Swift was of a genial and happy disposition. He was generous to the struggling amateur and was always liberal with help and with advice to those who were striving to gain a footing in the science of astronomy. (82)

By all accounts, Lewis Swift had been devoted to living a virtuous life. Swift himself credited his longevity to abstaining from tobacco and liquor, and prided himself on 'never using one swear word' (83). He was a devout Christian who avidly read the Bible with a magnifying glass he always carried with him, and Swift's essays often cited celestial wonders as testimony to God's greatness. His personality was well summed up by a local historian, who noted that:

Nature was to Swift an open book ... He was an indefatigable watchman, keeping vigil night after night while the world would sleep. (84)

SWIFT'S LEGACY

What became of Swift's observatories and instruments? After sitting vacant for nearly 40 years, in 1931 the once-great but now cobwebbed Warner Observatory was razed to make room for an apartment building (85). Today, only the decorative stone gate of the Warner Observatory survives, and it is very doubtful that passers-by know what it signifies. After Swift retired from Echo Mountain, he was succeeded by Edgar Lucien Larkin, a very capable astronomer who had previously been in charge of the Knox College Observatory in Galesburg, Illinois. Unfortunately, Thaddeus Lowe had lost much of his fortune in the depression of 1895, and in 1902 the Pacific Electric Railway Company bought the inclined railroad and the observatory. Lowe, like Swift, died in 1913. In 1905 December, another

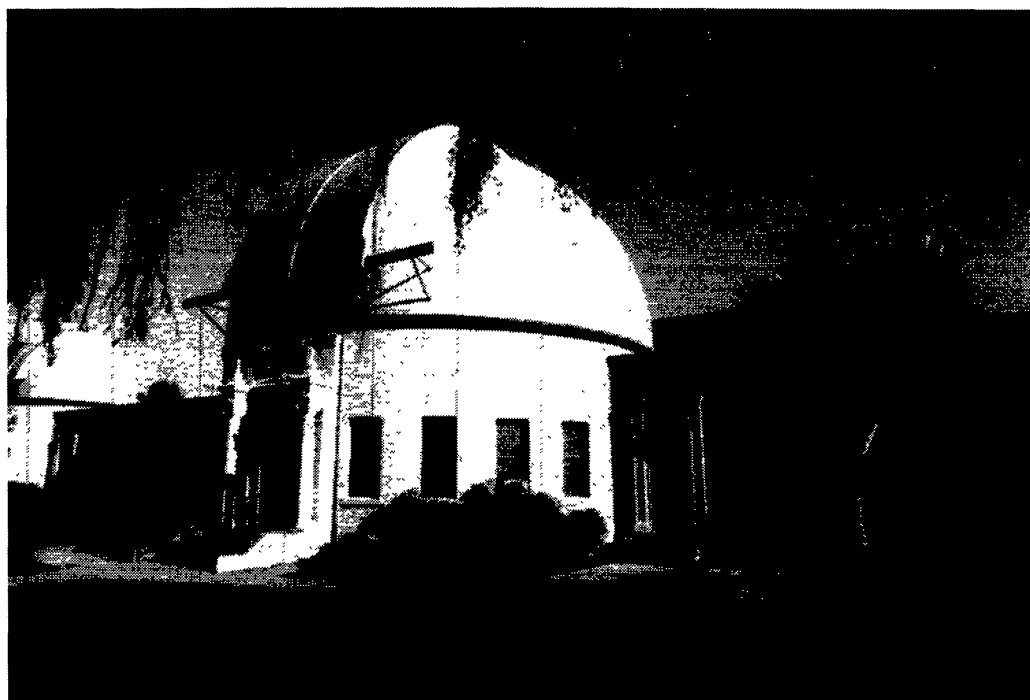


FIG. 6. The current home of Swift's 16-inch Clark refractor, the immaculate Ricard Observatory of Santa Clara University. Photo courtesy Bill Johanson, Santa Clara University Department of Physics.

wildfire, much worse than the one in 1900, destroyed all of the buildings on Echo Mountain except for the observatory. The objective of the 16-inch Clark had to be rescued by removing it from the tube and lowering it into a water tank until the fire subsided (86). Although William H. Pickering used the 16-inch to study the Moon and the Galilean satellites of Jupiter, Lowe Observatory was mostly used for public observing until 1928, when the observatory building was levelled by a violent windstorm. During the storm, debris from the observatory building crushed the tube of the 16-inch, almost cutting it in two. Amazingly, the objective again survived.

Lowe Observatory was never rebuilt, and the 16-inch Clark, in damaged condition, was placed into storage by the Pacific Electric Railway Company until it was sold in 1941 to Santa Clara University for \$2000. For many years the refractor was used by Father Jerome Ricard, a Jesuit professor at Santa Clara who was a proponent of the once-popular theory that sunspots affected the weather on Earth. After Father Ricard's death, the telescope fell into disuse, until in 1991 students at Santa Clara obtained approval to renovate the historic instrument (87). In 1993, Santa Clara's Ricard Memorial Observatory began using the beautifully refurbished 16-inch for an undergraduate class in observational astronomy, 111 years after it was first installed at the Warner Observatory (see Fig. 6). Fittingly, in August of that year, the Perseid meteor shower put on a fine show following the return of Lewis Swift's most famous comet.

Although the history of the 16-inch Clark is fairly well documented, the whereabouts of Swift's $4\frac{1}{2}$ -inch comet seeker and his observing notebooks are not. Swift apparently kept the comet seeker after leaving Echo Mountain; he

remarked in later years that he had disposed ‘of my entire equipment, except the comet seeker, which my children forbade me to sell’ (88). A 1940 article (89) in *The Sky* claimed that one of Swift’s ‘portable refractors’ had ‘recently turned up in the possession of some members of the Rochester Astronomy Club’, noting further that ‘A former owner had parted with it for about a tenth of its value to buy his auto license!’ Since Swift’s 3-inch was the only other ‘portable refractor’ he owned, and that instrument was broken by Swift early in his career, it may well be that the telescope unearthed by the Rochester astronomers was the comet seeker. However, today none of the present members of that society knows the whereabouts of that instrument. (90).

Swift told interviewers in his later years that he gave his observing notebooks that survived the 1900 Echo Mountain fire to his son Edward, but what happened to them after that may forever remain a mystery. Interestingly, Swift’s family donated some of the mechanical devices used in his early itinerant lectures to Cornell University’s Division of Regional History.

Lewis Swift was one of the last of his kind – an amateur astronomer who, by availing himself of wealthy patrons, was able to convert his avocation into a vocation. It is rather surprising that his name is not better recognized today, especially since his discoveries of nebulae were exceeded only by the Herschels. Perhaps Swift’s lament ‘So much for fame’ anticipated his own subsequent obscurity. Nevertheless, as one gazes through his beautiful 16-inch Clark refractor today, it is almost impossible for the observer to avoid wishing that, just for a little while, he or she could transport themselves back to a long-gone era and spend some time chatting with ‘The People’s Astronomer’.

ACKNOWLEDGEMENTS

The author wishes to extend his heartfelt thanks to the following persons for their invaluable assistance, without which this paper would not have materialized: Judy Bausch, Librarian, Yerkes Observatory; Francis C. Biddy, Producer/Astronomer, Strasenburgh Planetarium; Kenneth J. Brown, Rochester Academy of Sciences, Astronomy Section; Vikki DiMatteo, Monroe County Historian’s Office; Charles Gulker, amateur astronomer; Dr Dorrit Hoffleit, Senior Research Astronomer, Ret., Yale University; Dr William Johanson, Physics Chair, Santa Clara University; Joe LaVigne, Staff Astronomer, Calusa Nature Center Planetarium; William Pezzaglia, Physics Department, Santa Clara University; Michael Saladyga, Librarian, American Association of Variable Star Observers; James Spano, amateur astronomer; and John Chumack, Ronald Kohl, Paul Roques and Michael Stecker, astrophotographers of Comet Swift-Tuttle.

REFERENCES

- (1) MacRobert, A.M., 1992. *Sky Telesc.*, **84**, August, 185; Marsden, B. G., 1993, *Sky Telesc.*, **85**, January, 17.
- (2) Bortle, J.E., 1992. *Sky Telesc.*, **84**, August, 220.
- (3) IAU Circ. 5620; IAU Circ. 5621.

- (4) For a comprehensive summary of amateur observations of Comet Swift–Tuttle during its 1992 apparition, see Mobberley, M.P., 1994. *J. Br. Astron. Assoc.*, **104**, 11.
- (5) *Naples Daily News*, 1992. November 16, p. 3A.
- (6) *New York Times*, 1992. November 3, p. C1.
- (7) *Ibid.*
- (8) Rao, J., 1993. *Sky Telesc.*, **86**, August, 43.
- (9) Lunsford, R.D., 1994. *Journal of the Lunar and Planetary Observers*, **37**, 120–126.
- (10) Bates, R. & McKelvey, B., 1947. ‘Lewis Swift: The Rochester Astronomer’, *Rochester History*, **9**, January, 1, 3.
- (11) *Ibid.*
- (12) *Ibid.*
- (13) Kronk, G.W., 1984. *Comets: A Descriptive Catalogue*. Enslow, Hillside, NJ, pp. 35–36.
- (14) Watson, W., 1984. ‘The People’s Astronomer’, *Upstate Magazine*, January 15, 7.
- (15) Swift, L., 1901. *Pop. Astron.*, **9**, 476.
- (16) *Ibid.*, p. 477.
- (17) *Ibid.*
- (18) Swift, L., 1898. *Pop. Astron.*, **6**, 417.
- (19) *Ibid.*
- (20) Swift, L., 1890. *The Sidereal Messenger*, **9**, 472.
- (21) Swift, L., 1869. *Ann. Dudley Obs.*, **2**, 312, 314–315.
- (22) Bates, R. & McKelvey, B. (ref. 10), pp. 1–2.
- (23) Swift, L., 1897. *Pop. Astron.*, **4**, 138, 140–141.
- (24) Barnard, E.E., 1913. *Astron. Nachr.*, **194**, 136.
- (25) Bates, R. & McKelvey, B. (ref. 10), p. 8.
- (26) Maine, H.C., c. 1910. ‘Astronomical Discoveries in Rochester’, etc., *The Union & Advertiser*, Rochester; miscellaneous observing notes of Swift.
- (27) *Ibid.*
- (28) Bates, R. & McKelvey, B. (ref. 10), p. 9.
- (29) Strom, R.G., 1987. *Mercury: The Elusive Planet*. Smithsonian, Washington, DC, pp. 55–56.
- (30) Swift, L., 1876, *Washington Observations*, App. III, 229.
- (31) *Ibid.* Swift and Watson’s ‘discovery’ of Vulcan is recounted in numerous late nineteenth century sources, including Chambers, G.F., 1889. *A Handbook of Descriptive and Practical Astronomy, Book One*, 4th edn. Clarendon Press, Oxford, pp. 82–85; and Newcomb, S. & Holden, E., 1887. *Astronomy for High Schools and Colleges*, 6th edn. Henry Holt, NY, pp. 322–325.
- (32) Article in *Chicago Tribune*, reprinted in unidentified newspaper article, c. 1878.
- (33) Unidentified newspaper article, c. 1878.
- (34) Article in *New York World*, c. 1878 August.
- (35) Bates, R. & McKelvey, B. (ref. 10), p. 10.
- (36) Chambers, G.F., 1909. *The Story of the Comets*. The Clarendon Press, Oxford, p. 23.
- (37) Swift, L., 1887. *History and Work of the Warner Observatory*. Democrat & Chronicle Book, & Job Print, Rochester, pp. 5–6.
- (38) *Ibid.*
- (39) Bates, R. & McKelvey, B., (ref. 10), p. 12.
- (40) Swift, L., *History and Work*, etc. (ref. 37), pp. 7, 10.
- (41) Swift, L., *History and Work*, etc. (ref. 37), p. 8.
- (42) Swift, L., *History and Work*, etc. (ref. 37), p. 5.
- (43) Unidentified newspaper article, c. 1883.
- (44) Bidby, F.C., 1984. ‘Lewis Swift and the Astronomy Tradition in Rochester’, unpublished manuscript, p. 8.
- (45) Swift, L., 1885. *Astron. Nachr.*, **112**, 2683; **113**, 2707.
- (46) Swift, L., 1886. *Astron. Nachr.*, **115**, 2746 and 2752; **116**, 2763.
- (47) Swift, L., 1887. *Astron. Nachr.*, **117**, 2798–2799.
- (48) Swift, L., 1887, *Simple Lessons in Astronomy*, *Union & Advertiser*, Rochester.
- (49) *Ibid.*
- (50) Swift, L., *History and Work*, etc. (ref. 37).
- (51) Swift, L., 1888. *Astron. Nachr.*, **120**, 2859; Swift, L., 1889. *Astron. Nachr.*, **122**, 2918; Swift, L., 1890. *Astron. Nachr.*, **126**, 3004.
- (52) Kronk, G.W., *Comets*, etc. (ref. 13), p. 303–304.

- (53) Watson, W., 'The People's Astronomer' (ref. 14), p. 9.
- (54) Maine, H. C., *Astronomical Discoveries in Rochester* (ref. 26).
- (55) Biddy, F. C., 'Lewis Swift', etc. (ref. 44), p. 9; unidentified newspaper article, c. 1890.
- (56) Ibid.
- (57) Ibid.
- (58) Swift, L., 1893. *Astron. Astrophys.*, **12**, 380.
- (59) Unidentified newspaper article, c. 1890.
- (60) Swift, L., 1892. *Astron. Nachr.*, **129**, 3094.
- (61) Kronk, G.W., *Comets*, etc. (ref. 13), p. 84; Chambers, G.F., *The Story of the Comets* (ref. 36), p. 29.
- (62) Clerke, A. M., 1908. *A Popular History of Astronomy During the Nineteenth Century*. A. & C. Black, London, p. 368.
- (63) Bates, R. & McKelvey, B. (ref. 10), p. 20.
- (64) Ashbrook, J., 1972. 'Lewis Swift and the Lowe Observatory', *Sky Telesc.*, **43**, 364–366; Ashbrook, J., 1984. 'Lewis Swift and the Lives of a 16-inch Refractor', *The Astronomical Scrapbook*. Cambridge University Press, London, pp. 71–78; Perrine, C.D., 1895. 'The Lowe Observatory', *Publ. Astron., Soc. Pac.*, **7**, 47. For a detailed description of Lowe's Echo Mountain resort, see Seims, C., 1976. *Mount Lowe – The Railway in the Clouds*. Golden West, San Marino, CA.
- (65) Swift, L., 1893. *Astron. Astrophys.* **12**, 380.
- (66) Bates, R. & McKelvey, B. (ref. 10), p. 18.
- (67) Kronk, G.W., *Comets*, etc. (ref. 13), pp. 239–240.
- (68) Swift, L., 1896. 'The Lowe Observatory', *Pop. Astron.*, **3**, 465–467.
- (69) Swift, L., 1898. *Astron. Nachr.*, **147**, 3517; Swift, L., 1899. *Mon. Not. R. astr. Soc.*, **59**, 568; Swift, L. 1898. *Pop. Astron.*, **5**, 426–429 and **6**, 18–20, 400.
- (70) Swift, L., 'The Lowe Observatory' (ref. 68), p. 467.
- (71) Swift, L., 1897. 'Accident Comets', *Pop. Astron.* **4**, 138, 139.
- (72) Ibid., p. 140.
- (73) Bates, R., 1940. 'The Story of Lewis Swift', *The Sky*, **4**, 7.
- (74) Ibid., p. 139.
- (75) Kronk, G.W., *Comets*, etc. (ref. 13), p. 89.
- (76) Ibid., p. 93.
- (77) Swift, L., 1901. 'Ups and Downs, and Here and There of an Astronomer', *Pop. Astron.*, **9**, 476–479.
- (78) Ibid.
- (79) Ibid., p. 479.
- (80) Unidentified newspaper article, c. 1910.
- (81) Ibid.
- (82) Barnard, E.E., 1913. *Astron. Nachr.*, **194**, 136.
- (83) Watson, W., 'The People's Astronomer' (ref. 14), p. 9.
- (84) McIntosh, W.H., 1877. *The History of Monroe County, 1788–1877*. Everts, Ensign & Everts, Philadelphia.
- (85) Watson, W., 'The People's Astronomer' (ref. 14), p. 9. However, long-time residents of Rochester dispute this, as they have no recollection of an apartment building at this location. The area is now an open lawn.
- (86) Ashbrook, J., 'Lewis Swift and the Lives of a 16-inch Refractor' (ref. 64), p. 77.
- (87) Spaight, T., 1991. *Sky & Telesc.*, **82**, December, 670–671.
- (88) Swift, L., 'Ups and Downs', etc. (ref. 77), p. 479.
- (89) Bates, R., 'The Story of Lewis Swift' (ref. 73).
- (90) Miscellaneous conversations and correspondence, including correspondence dated 1994 June 15 from K. Brown to the author.