PROJECT 10073 RECORD

1. DATE - TIME GROUP	2. LOCATION
October 65	Northern Hemisphere
3. SOURCE Multiple	10. CONCLUSION Comet (IKEYA-SEKI)
4. NUMBER OF OBJECTS One	See case file
5. LENGTH OF OBSERVATION N/A	11. BRIEF SUMMARY AND ANALYSIS
6. TYPE OF OBSERVATION Ground-Visual	
7. COURSE Stationary	
8. PHOTOS ☒ Yes ☐ No	
9. PHYSICAL EVIDENCE ☐ Yes ☒ No	

FORM
FTD SEP 63 0-329 (TDE) Previous editions of this form may be used.

Early-Morning Rising Necessary

Newly-Sighted Comet Visible Here

The newly-discovered Ikeya-Seki comet, named for two Japanese astronomers who first sighted it Sept. 18, has been sighted and photographed by a Wright-Patterson Air Force base aerospace engineer.

Harold Schuetz, of 1095 Boston court, Xenia, photographed the comet with a Polariod camera mounted on a tripod on the roof of his home.

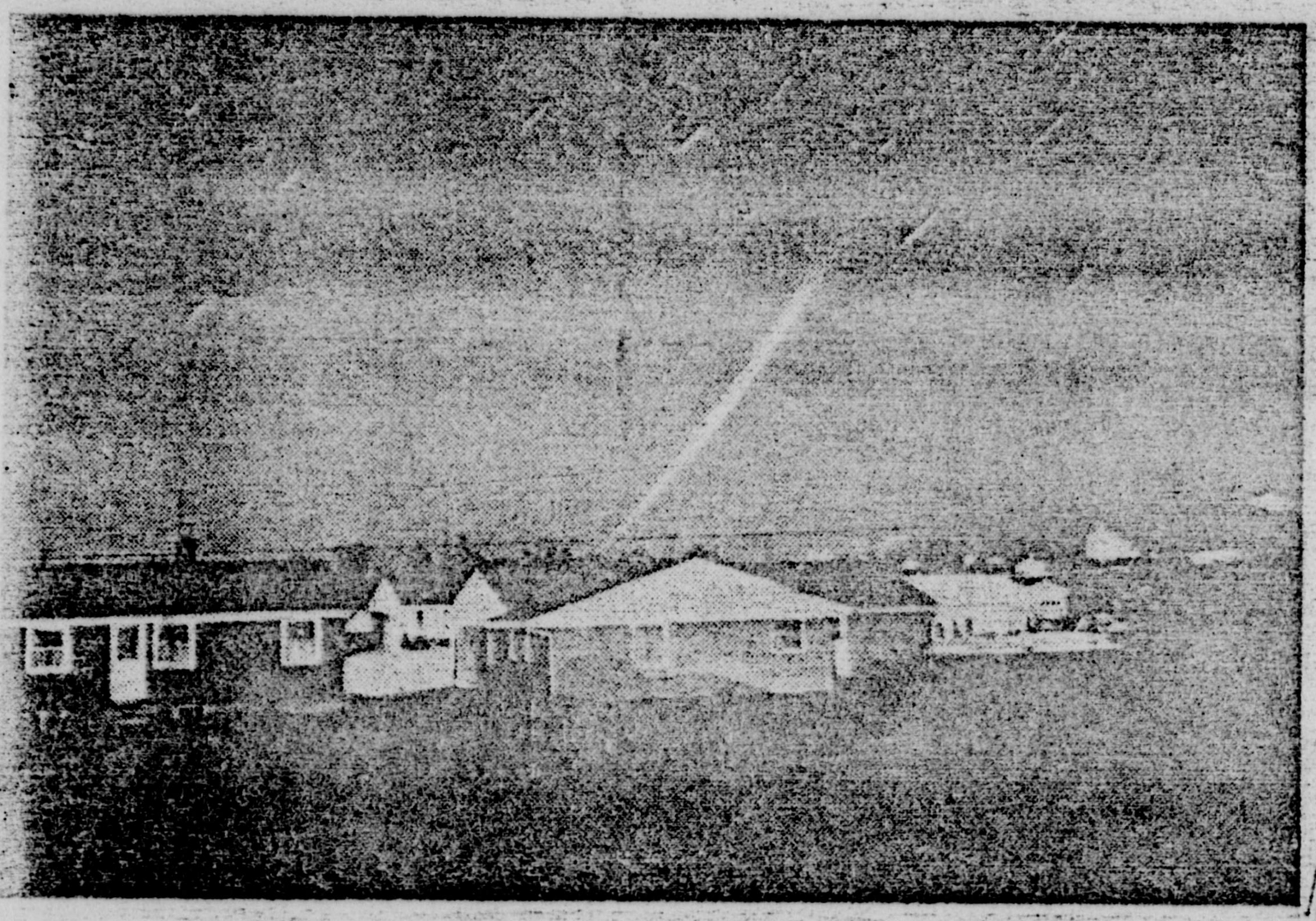
He said yesterday the comet is visible on the eastern horizon from about 5:15 a.m. to 5:45 a.m. each morning and should be visible through the end of this month.

Schuetz suggested city residents would need to drive out of the city and be at an elevated location to sight the comet, but he added that residents of Dayton area suburbs may be able to see the comet from their homes.

The last comet visible to the naked eye was sighted in 1954, he said, and "The World Alanac" says that barring any other unexpected event, such as the appearance of the Ikeya-Seki comet, the next visible comet will be Halley's which will be seen in 1986.

Schuetz, an amateur astronomer, said no one knows now when the Ikeya-Seki comet will be seen again. This will depend on its orbit, he explained, predicting it won't reappear in his lifetime.

Harold Schuetz
... Sights comet



Comet At Xenia

Termed by astronomers the most spectacular comet seen on earth in more than 80 years, the Ikeya-Seki comet is shown here as photographed by Harold Schuetz from the roof of his home at 1095 Boston Court, Xenia. The flecks of light throughout the sky are the paths of stars recorded in this time exposure which was taken at about 5:30 a. m.

MEMO FOR THE RECORD

Mrs. [redacted] called 20 Oct 65 regarding the comet which supposedly can be seen at the present time. Sgt. Moody said that it is difficult to be seen because of the weather. It is also difficult to see without binoculars. Sgt. Moody suggested that she call again Friday about 10 o'clock.

Comet Ikeya-Seki

FAVORABLY PLACED observers on October 20-21 viewed a comet so brilliant that it could be seen with the naked eye in broad daylight, if the sun was hidden behind the side of a house or even an outstretched hand. This beautiful phenomenon is rare: the most recent daylight comets had been 1927 IX, 1910 I, 1901 I, and the great comets of 1882, 1843, and 1811.

Many more professional and amateur astronomers viewed Comet Ikeya-Seki in the dawn skies of late September and October as a fuzzy patch that brightened noticeably from day to day. And after perihelion passage on October 21st, the comet's tail became three-quarters of the earth-sun distance in length. It was seen curving upward from the southeastern horizon during morning twilight.

At observatories around the world, the great comet of 1965 gave an eagerly awaited opportunity to apply new and more powerful methods of observation. In this issue, Brian G. Marsden tells of this work by professional astronomers. His account supplements the description on page 284 in November of the comet's discovery and early observational history.

Also in this issue is a portfolio of photographs of Ikeya-Seki during the fortnight after perihelion passage. But the amount of observational material reported to SKY AND TELESCOPE is so great that much of it must be reserved for our January number. That is scheduled to contain a roundup of amateur reports.

During December, Comet Ikeya-Seki will be visible with small telescopes in the southern sky in the middle hours of night, as it travels from Antlia through northern Vela into Puppis. However, the strong southerly declination will hamper viewing from most of the United States.

The following positions have been computed at the Smithsonian Astrophysical Observatory from the orbital elements by L. E. Cunningham (page 332). Given here for 0^h Universal time at five-day intervals are the comet's right ascension and declination (1950 coordinates), and probable magnitude:

November 21, $11^h\,03^m.4$, $-29°\,55'$, 6.4; **26**, $10^h\,42^m.7$, $-32°\,27'$, 6.8.

December 1, $10^h\,20^m.1$, $-34°\,42'$, 7.2; **6**, $9^h\,55^m.5$, $-36°\,35'$, 7.6; **11**, $9^h\,29^m.0$, $-37°\,59'$, 7.9; **16**, $9^h\,01^m.2$, $-38°\,48'$, 8.2; **21**, $8^h\,33^m.3$, $-38°\,59'$, 8.5; **26**, $8^h\,06^m.1$, $-38°\,31'$, 8.8; **31**, $7^h\,40^m.8$, $-37°\,30'$, 9.1.

During December, the distance of Comet Ikeya-Seki from us increases from 98 to 112 million miles, while its distance from the sun grows from 121 to 174 million.

So far, the path around the sun followed by Comet Ikeya-Seki has been quite close to a parabola, but deviations begin to indicate that it is in fact a very elongated ellipse.

The motion of Comet Ikeya-Seki within 67 minutes is evident in these daytime pictures taken October 21st in Japan, at Tokyo Observatory's Norikura solar station, 9,400 feet high. The sun is behind the 0°.57-diameter black disk, which is here fringed by scattered sunlight (not the corona). North is up, east to the left. The tail lagged far behind the comet-sun line, because the comet's velocity was much greater than that of outflow along the tail. F. Moriyama and six co-workers took these pictures at 2:20 UT (left) and 3:27 with a 4.7-inch f/12.5 coronagraph in 4700-6000-angstrom light. In sending these pictures, Tokyo director H. Hirose writes: "Observers at the corona station noticed at 3:50 that the comet head was disintegrating, and at 4:37 was divided into three parts, one far brighter than the others."

The Great Comet of 1965

BRIAN G. MARSDEN, *Smithsonian Astrophysical Observatory*

"A SCIENTISTS' COMET" was how comet expert Fred L. Whipple described Ikeya-Seki as we viewed it together by full daylight in one of Harvard Observatory's telescopes on the hazy afternoon of October 20th. Reports had been coming in to us all day of fruitless predawn vigils by people looking for the comet's tail, but on the other hand of new and important scientific observations.

Although a great disappointment to most of the general public as it neared the sun in October, Ikeya-Seki put on a spectacular display for amateur and professional astronomers. So far, its general behavior has been so similar to that of the great comet of 1882 that it is unlikely its performance is now over. Even in December, Comet 1965f may be a very striking object in the morning sky, for Southern Hemisphere observers at least.

As told on page 284 of last month's issue, the comet was discovered on September 18th by two Japanese amateurs as an 8th-magnitude nebulous object in Hydra. Ever since September 30th, when it became definite that a new member of the famous group of "sun-grazing" comets had been found, excitement has been increasing. Scientists planned rocket launches, arranged jet flights, and made observing the comet part of the intended Gemini 6 mission. It was also hoped that significant new findings would result from ground-based observations, both of the general appearance of the comet and of its spectrum over as large a range of wavelengths as modern technology permits.

The reason 1965f was expected to become a spectacular object was its small perihelion distance. The activity shown by a comet increases very sharply as it nears the sun; for example, brightness typically varies as the inverse fourth power (approximately) of heliocentric distance. And as the orbital elements by L. E. Cunningham that are cited here imply, Comet Ikeya-Seki was to pass only 290,000 miles from the sun's surface on October 21st at 4:15 Universal time (4:23 as seen from Earth).

Prior to passage of the comet through perihelion, the Smithsonian Astrophysical Observatory received about 100 reports from its worldwide chain of observing stations, which are equipped with the large, short-focus Baker-Nunn cameras normally used for tracking artificial satellites. Their photographs should provide useful photometric information about the comet, as well as data on the motions of particles in its tail. These reports indicated that 1965f was brightening in accord with expectation, and that the empirical inverse-fourth-power rule seemed to be obeyed, even when the comet was only a few million miles from the sun.

On the morning of October 3rd (local date), the staff of the Smithsonian station at Woomera, Australia, noted that the tail was 4° long; three days later it had grown to 8°. The early photographs showed a typical "gas" tail with characteristic straight streamers.

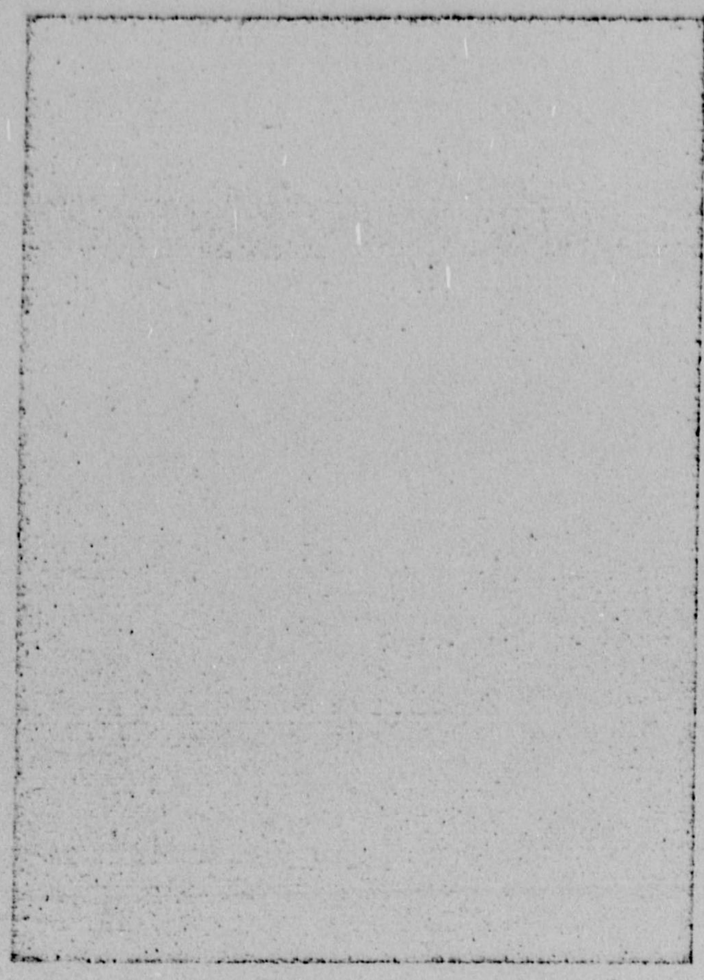
During the second week of October, the head of Comet 1965f was large, very bright, and almost round on shorter exposures, such as those taken at Lick Observatory by S. Vasilevskis and E. Harlan, at the Mexican National Observatory by M. Mendez, and at Table Mountain Observatory in California by C. Capen and J. Young.

But as the comet approached the sun, it became increasingly difficult to observe,

ORBITAL ELEMENTS OF COMET 1965f

Time of perihelion (T)	1965 Oct. 21.17767 ET
Longitude of ascending node (Ω)	345°.924
Node to perihelion (ω)	68°.686
Inclination (i)	144°.395
Perihelion distance (q)	0.0077759 a.u.

The angular elements are referred to the equator and equinox of 1950. From calculations by L. E. Cunningham, Boschner Observatory, in *Circular 1933* of the International Astronomical Union based on observations on September 22, October 1 and 7.



For this 41-minute exposure on October 6th, C. Capen and J. Young at Table Mountain Observatory used a telephoto lens of 250-mm. focal length.

especially from the Northern Hemisphere. Even in the southern continents, morning twilight masked most of the tail, and on October 18th, just 80 hours before perihelion passage, Woomera astronomers could see no tail at all, though the head was as bright as magnitude zero.

On October 20th, although haze prevented observations without a telescope in the eastern United States, Ikeya-Seki was a conspicuous object with the naked eye or binoculars in broad daylight at many locations in the southwestern states and across the Pacific Ocean.

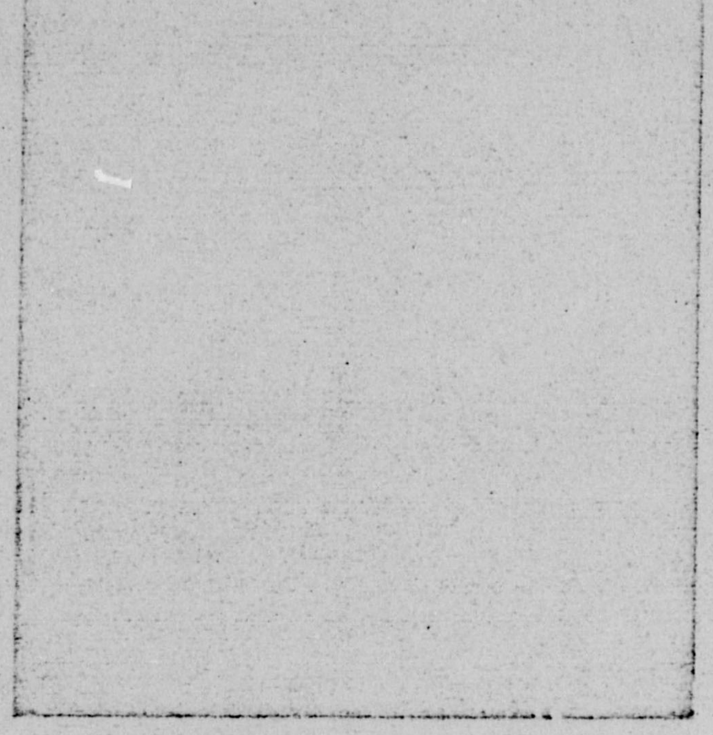
At McDonald Observatory in Texas, the comet was easily seen with the naked eye at noon (18:00 UT), when only 2° from the sun. G. de Vaucouleurs writes that in binoculars "the appearance . . . was reminiscent of the descriptions of the daytime comets of 1882 and 1927: a very bright nucleus and silvery tail of 1° to 2° visible length." He estimated the total visual magnitude of the head as —10, about one magnitude brighter than had been predicted.

Just half an hour later, Norbert Roth and Darrell Fernald saw the comet from the Smithsonian station at Organ Pass, New Mexico. Approximately 1° long and slightly curved, the tail seemed of about the same brightness as the 25½-day-old moon visible at the time.

At Kitt Peak National Observatory in Arizona, Stephen Maran observed with 16 x 50 binoculars from within the shadow of a 24-inch black disk erected to hide the sun. "The most splendid thing I have ever seen," he notes. From a distance of 125 feet behind the disk he successfully photographed the comet with an Exakta camera mounted on a Questar telescope. Comet 1965f was clearly visible with the unaided eye all day at the U. S. Naval Observatory's station in Flagstaff, Arizona. There, H. Ables, J. Christy, H. Guetter, and J. Priser were able to photograph it with the 61-inch astrometric reflector. At 0:00 UT (of October 21st) Elizabeth Roemer judged the head to be magnitude —10 or —11; the nucleus was stellar and the 2° tail showed marked curvature.

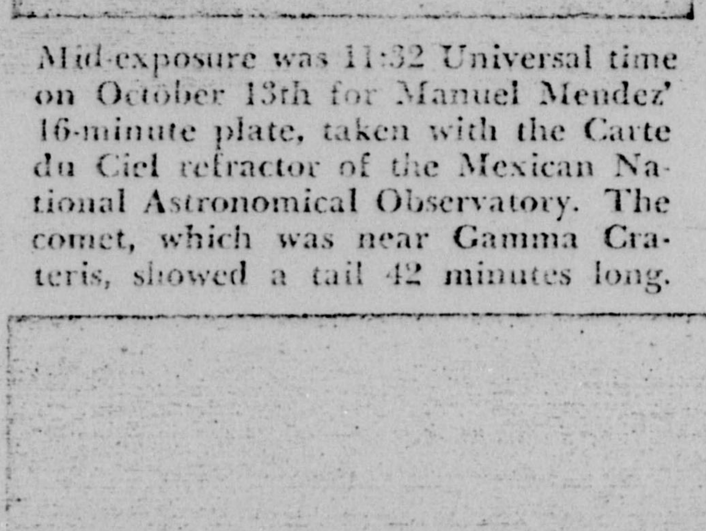
That same afternoon, though he could not see the comet without binoculars, G. Van Biesbroeck in Honolulu noted the tail's curvature; considerable development had taken place since morning. Ikeya-Seki was a striking object from the California Institute of Technology's campus in Pasadena.

In Japan the comet was described as "10 times brighter than the full moon."

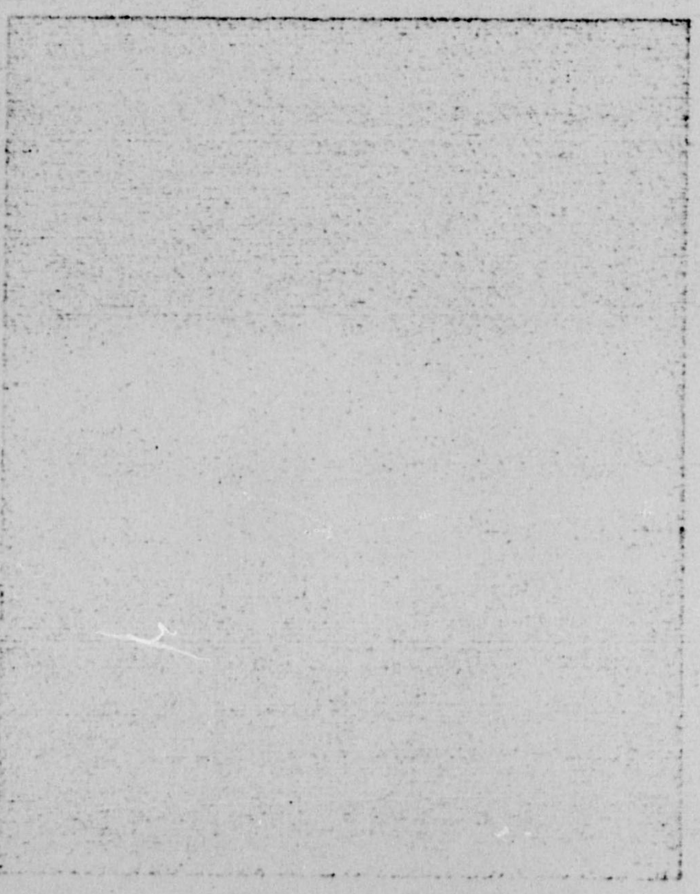


Delicate tail structure is visible in this 20-minute exposure on October 7th with the 40-inch reflector at Flagstaff, Arizona. Official U. S. Navy photograph by Elizabeth Roemer.

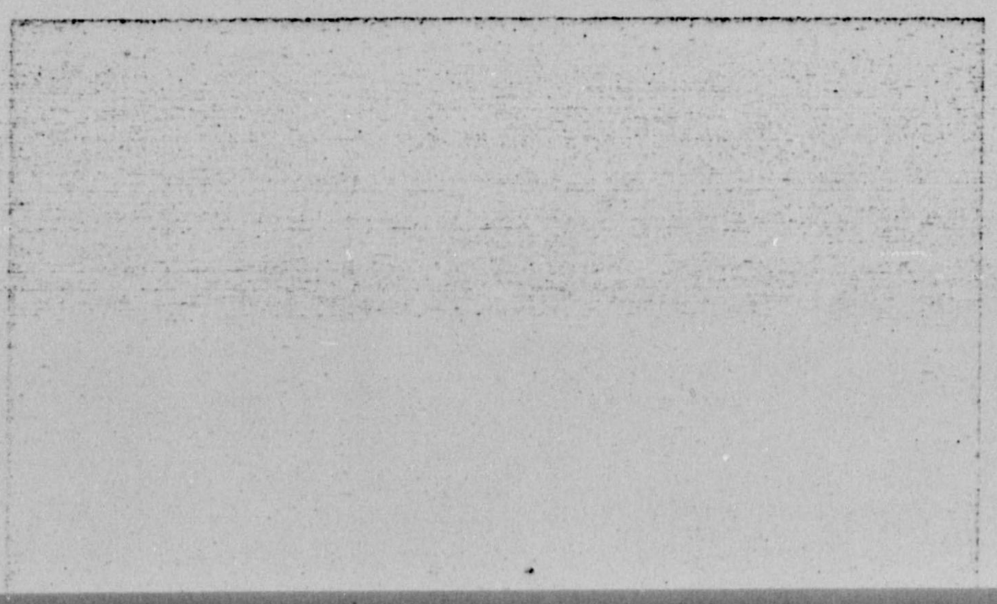
At 3:50 UT on October 21st, only half an hour before perihelion passage, a "disruption" of the comet was observed from the Mount Norikura coronagraph station



Mid-exposure was 11:32 Universal time on October 13th for Manuel Mendez' 16-minute plate, taken with the Carte du Ciel refractor of the Mexican National Astronomical Observatory. The comet, which was near Gamma Crateris, showed a tail 42 minutes long.



Just 4½ days before perihelion passage, Comet 1965f appeared as magnitude +0.2 to A. A. Page at Brisbane, Australia. On October 16th, 18:10 UT, he and Mrs. Page made this 2-minute exposure with an f/5.6 lens of 180-mm.



Left: The comet on October 11th (left) and 14th. For these short exposures, Messrs. Capen and Young used a 6-inch f/15 refractor, at the Table Mountain Observatory of Jet Propulsion Laboratory, near Wrightwood, California. By the time of the second picture, Comet 1965f was 36 million miles from the sun.

With his unaided eye, David Meisel made these daylight sketches from Flagstaff, Arizona, as the great comet approached perihelion. The drawing at left was made October 20th at 21:00 UT, the other two hours later. He saw about 2¼ degrees of tail and a coma two minutes of arc (or less) in diameter.

of Tokyo Observatory. See picture caption page 332.

Few observations have been reported during the following few hours; this is believed to be due to generally cloudy conditions. Clear skies in Prague, however, did allow astronomers there to pick up the comet with the unaided eye shortly after sunrise. According to L. E. Cunningham's calculation, the comet should have passed within a quarter-minute of arc of the solar disk at 5:25 UT.

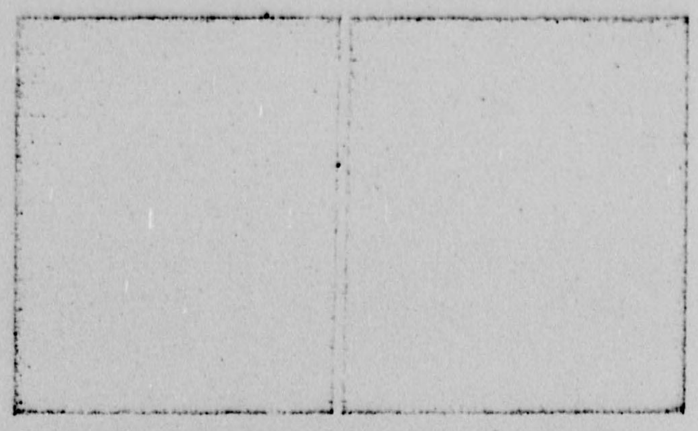
That morning in France (9:00 UT on October 21st), Haute Provence Observatory reported the tail was only one minute of arc long. A few hours later at Bochum Observatory, West Germany, the daylight comet was estimated as of magnitude —6 or —7. A similar estimate was made in Cambridge, Massachusetts, at 9:00 a.m. Eastern standard time (14:00 UT), when only the bare beginning of a tail was visible.

In the clearer skies of the western United States, 1965f was again a naked-eye object on October 21st. At about 17:00 UT, McDonald Observatory astronomers judged the magnitude as —8, and took black-and-white and color photographs through the finders of both the 82-inch and 36-inch reflectors. Extensive observations in broad daylight have been reported from Organ Pass, Flagstaff, and Table Mountain.

Telescopic daytime viewing was also possible on October 22nd, when the comet's magnitude was estimated as zero at 17:15 UT from Lowell Observatory, and as —2 three hours later from McDonald.

The earliest observation in the dawn sky following perihelion passage was made at the Pretoria, South Africa, Moonwatch station on October 23rd, and the next morning a 5° tail was visible there with the naked eye. On October 25th at the Smithsonian station in Arequipa, Peru, a tail 20° long and 3° wide at its extremity tapered out from a head of magnitude —2.

Contrast the preperihelion aspect at left (October 20th, 22:01 UT) with the postperihelion one above (October 21, 15:36 UT). Observers at Sacramento Peak Observatory, where these red-light pictures were taken with the 16-inch coronagraph, noted that the tail was reduced in brightness after perihelion. Linagraph Shell Burst film was used for these 1/50-second exposures.

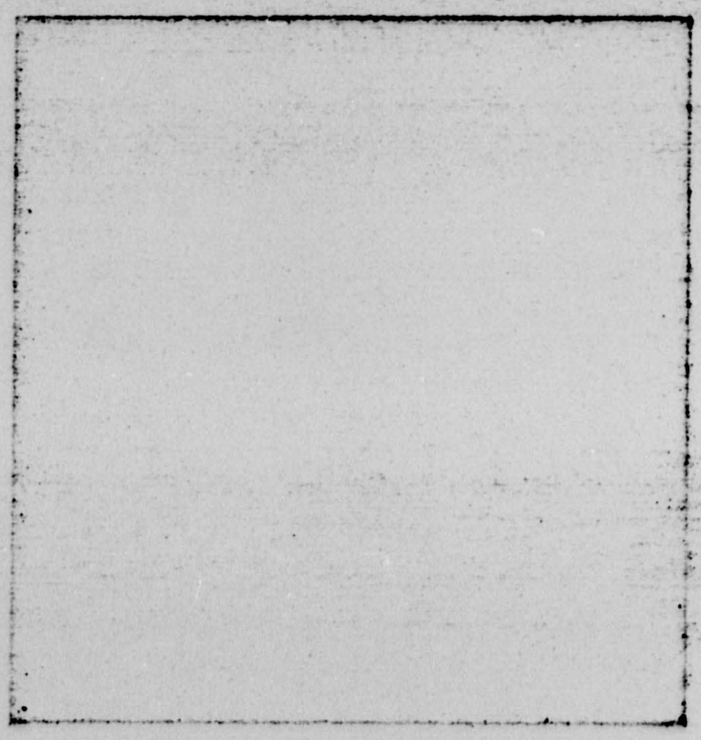


Daytime drawings by Gerard de Vaucouleurs at McDonald Observatory. Right: October 20, 22:30 UT with the 10-inch finder of the 82-inch reflector. Left: October 21st, 16:00 with the 4-inch finder of the 36-inch telescope.

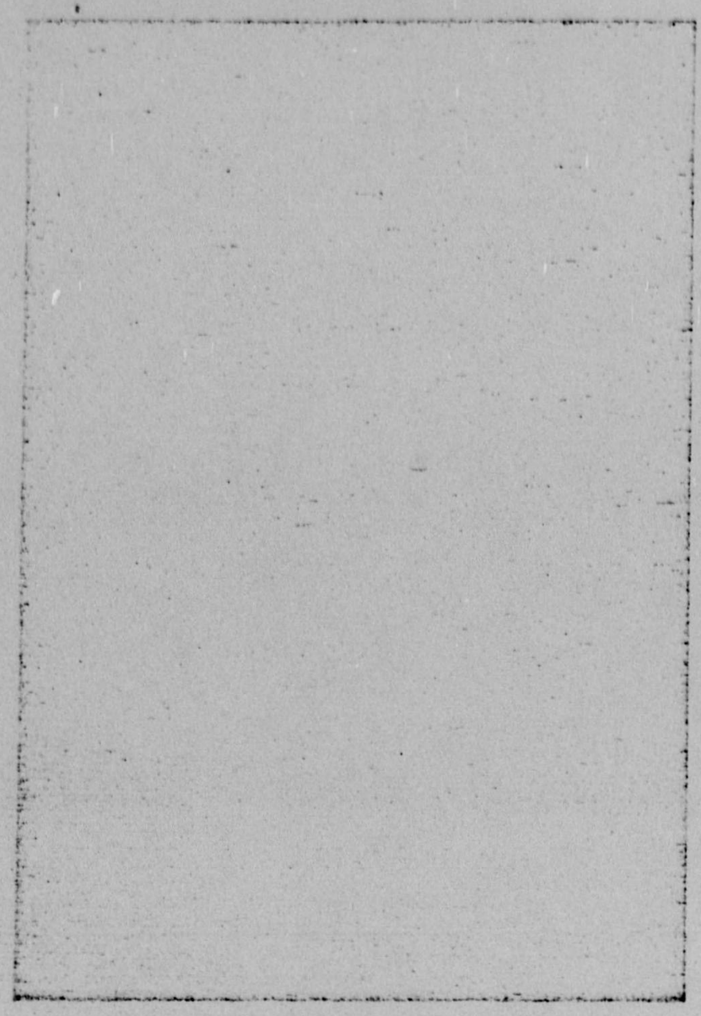
Swirls in the tail were noted on the 27th at Organ Pass and in Florida. By the 29th, the tail was readily noticeable an hour or so before sunrise in the climatically less favored New England states, but in the encroaching dawn the head could not be seen without binoculars or a telescope. During the first week of November the comet became more easily visible as it moved away from the sun. The "dust" tail was about 30° in length (corresponding to 70 million miles).

The nucleus had become double, Howard Pohn found on November 4th with the 30-inch f/15 reflector at the Astrogeology Department of the U. S. Geological Survey, Flagstaff, Arizona. He observed visually and photographically a second nuclear condensation, situated about 14 seconds of arc up the tail spine from the first, and about 1¾ magnitudes fainter than it. The following morning, the magnitude difference was only ¾ and the separation 16 seconds; if the second nucleus was really in the tail spine, the distance between the two would have been 8,000 miles.

A possible third condensation was suspected, twice as far away as the second, and more than three magnitudes fainter than the first. Other astronomers reported additional nuclei, probably transient in



On October 21st at 18:17 UT, H. Ables and L. Christy secured this 13-second exposure with the U. S. Navy's 61-inch astrometric reflector at Flagstaff. Note the lyre-shaped tail, also well shown in



The comet's nucleus appeared elongated on November 5th (top) and definitely split the next day. The five-minute exposure on the 5th began at 13:14 UT, the one-minute one on the 6th at 13:25. C. Capen and J. Young used the 6-inch Table Mountain f/15 refractor.

nature. In the case of Comet 1882 II, one month after perihelion passage, five separate condensations were seen along a 40-second arc. (See a picture of them in February, 1960, SKY AND TELESCOPE, page 204.)

To professional astronomers, Comet Ikeya-Seki provided a very welcome opportunity to observe the spectrum of a great comet at a small heliocentric distance. The last comparable chance was in 1882, when spectroscopic techniques and interpretations were both very primitive.

In the visual spectrum of an average comet, the most conspicuous features are three bright bands—the Swan bands, due to the diatomic carbon molecule, C_2. Most comets also show a pronounced continuous spectrum, often with superimposed dark lines that match the solar absorption spectrum.

Photography of cometary spectra began in 1881, leading to the observation of new bands toward the violet. These included features due to triatomic carbon (C_3), cyanogen (CN), and the CH radical. Then, in Comet 1882 I the sodium D lines (at 5896 and 5890 angstroms) were observed in emission, and these have since been recognized as a normal feature of comets at relatively small distances from the sun.

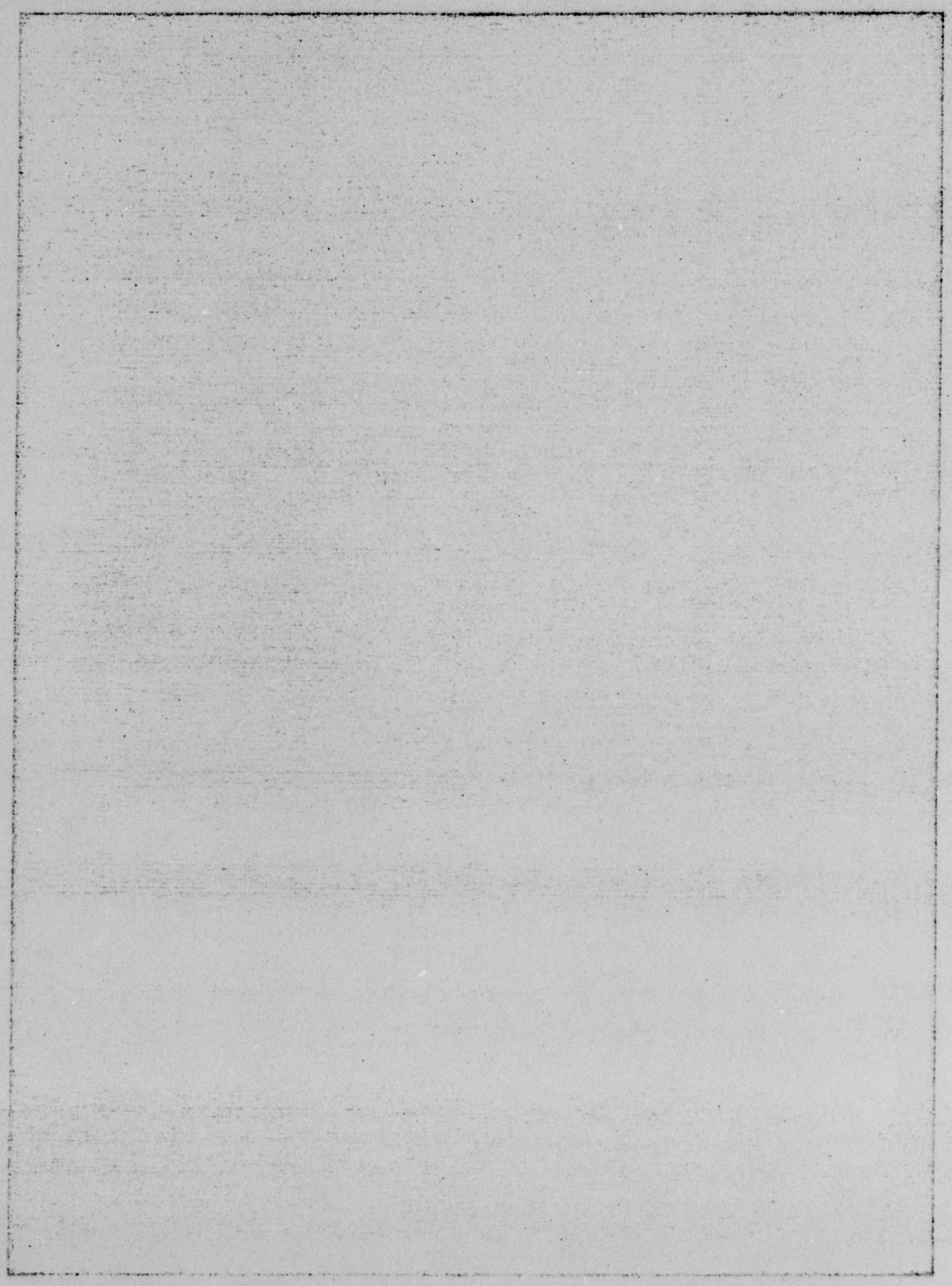
On September 18, 1882, the first spectroscopic observation of a comet in daylight was made by Ralph Copeland and J. G. Lohse, with a visual spectroscope attached to the 15-inch refractor of Dunecht Observatory, in Scotland. They viewed the Great Comet 1882 II, already mentioned as a member of the sun-grazing family that includes 1965f, less than 18 hours after perihelion.

Copeland and Lohse saw the D lines immediately, red-shifted from their normal wavelengths by the comet's velocity of recession. The Swan bands were very weak, but a number of additional bright lines could be seen in the green and orange. The Dunecht observers thought that most of these lines were due to iron, with some possibly from titanium and calcium.

For eight decades this report of additional bright lines has been controversial. In 1927, the Russian astronomer S. V. Orlov rediscussed the Copeland-Lohse observations, and agreed that the green lines were probably of iron, but he hesitated to identify the others. Many astronomers did not believe the observations, mainly because similar lines were never found in subsequent comets. But then, no later comet was observed so close to the sun, until now.

In an article published early in 1965, the well-known Belgian expert on cometary spectra, Polydore Swings, expressed his belief that lines of calcium and other elements would eventually be found in comets of very small perihelion distance. His hopes have been quickly realized!

On the morning of October 20, 1965, A. D. Thackeray at Radcliffe Observatory, in South Africa, obtained spectrograms of the nucleus of Comet Ikeya-Seki, then only eight million miles from the sun. These showed bright lines of neutral iron, and also the H and K lines of ionized calcium. (Copeland and Lohse could not have detected the H and K lines, which are outside the visual range



The comet over Maui, Hawaii, at about 15:00 UT on October 28th. A 35-mm. camera was used for a one-minute exposure by personnel of the Baker-Nunn tracking station of the Smithsonian Astrophysical Observatory. Probably an artificial satellite made the trail at upper right.

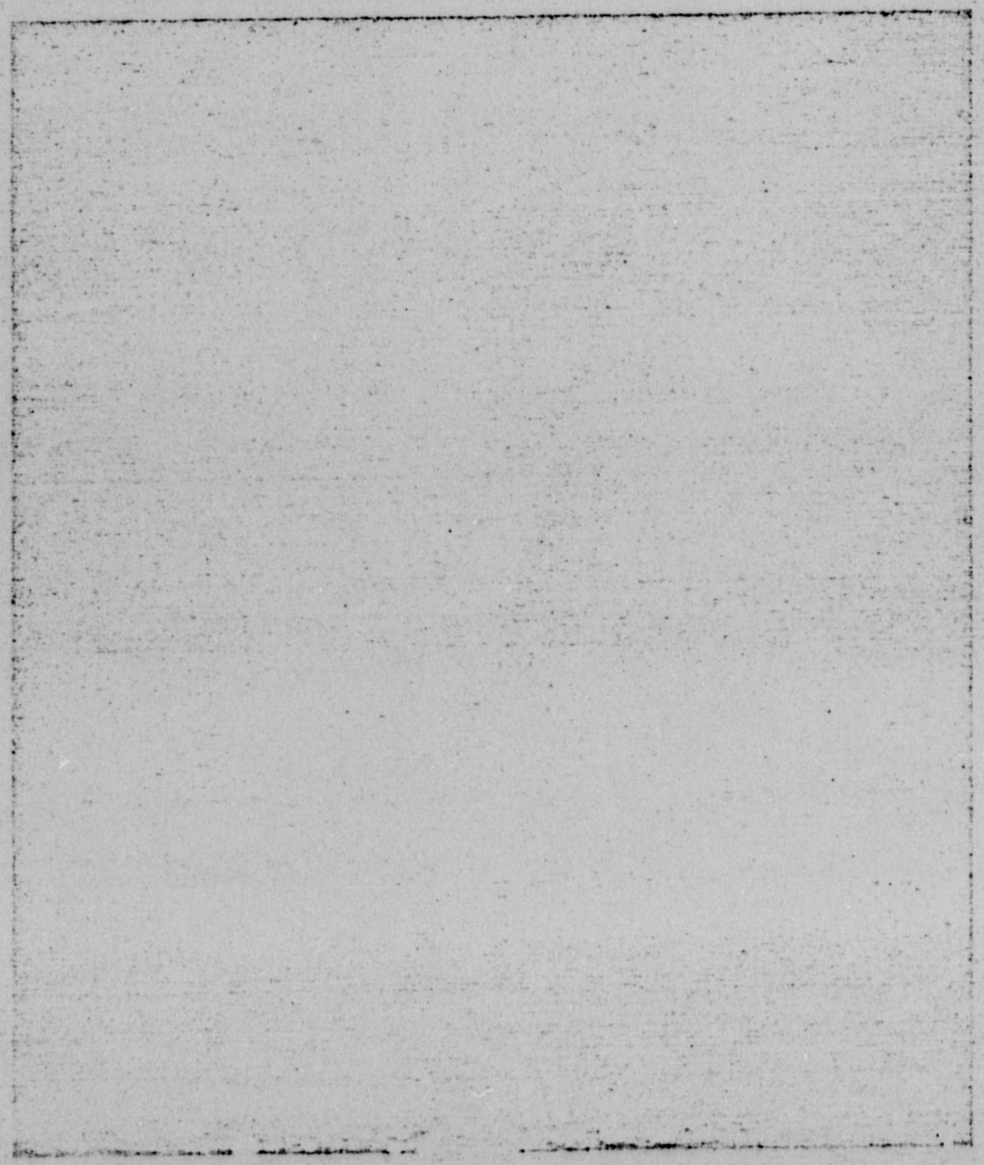
This unusual photograph of Comet Ikeya-Seki (1965f) was taken by Alan McClure on the morning of November 1, 1965. It is an 11-minute exposure begun at 12:43 Universal time. Well seen here on a large scale are the small head and the structure in the tail near it. At that time, the comet was about 51 million miles from the sun and 98 million from the earth. On this reproduction one inch equals about 0.93 degree. The picture was taken from the 8,800-foot level on Mount Pinos in California. Mr. McClure used an f/5 Zeiss aerial lens of 5½ inches aperture and a panchromatic emulsion.

Photographs of Comet Ikeya-Seki

These five pages of Comet Ikeya-Seki photographs record its changing appearance during the two weeks following perihelion passage on October 21st. However, only a small sample of the pictures that continue to arrive at SKY AND TELESCOPE *can be included here.*

Above: On October 26th, only five days after perihelion passage, Comet 1965f was observed to have a 17-degree tail, from Table Mountain Observatory in California, operated by the Jet Propulsion Laboratory. J. Young and C. Capen started this 18-minute exposure at 12:41 UT, with a 135-mm. telephoto lens. The comet appeared to them about magnitude zero.

Left: Note the spine in the tail in Mr. Capen's Table Mountain picture on October 27th (13:00-13:04 UT), taken with a 6-inch f/15 refractor.



Above: American amateur J. Ruiz obtained this picture while visiting Tonantzintla Observatory in Mexico. The tail rose nearly vertically at his latitude of 19 degrees north. This exposure is one minute at f/2.8.

Right: On October 28th, R. B. Minton, observing from a place 15 miles east of El Paso, Texas, recorded 20 degrees of tail on a 10-minute exposure with an f/7

Above: A starlike coma supporting a wide curving tail is captured in this picture by Eugene A. Harlan, Mount Hamilton, California. He took it at 13:06 UT, October 29th, when Ikeya-Seki was 41 million miles from the sun and 97 million from the earth. In this reproduction, one inch equals about 3.4 degrees. Note the central bright core of the tail (also well shown in the photograph at upper right), which was brightest where the diagonal streamers begin. The pair of bright stars near the head are (left) Eta and Delta Corvi. Mr. Harlan used a small Schmidt camera for this two-minute exposure.

Above right: Taken at 12:00 UT, only an hour before Mr. Harlan's picture, this one by Glenn W. Shaw shows almost imperceptible motion of the comet. The El Paso, Texas, observer used a Nikkorex-F camera with an f/2.5 lens of 205-mm. focus for this 20-second exposure.

Right: In the northern part of the nation, the comet was more difficult to see. On October 30th, Richard Davis of Scituate, Massachusetts, took this five-minute exposure at 9:50 UT. He used an f/2.5 Aero-Ektar lens.

Above: At Las Cruces, New Mexico, Gordon Solberg, Jr., used a reversed Moonwatch telescope (his f/2.8 camera lens held next to the objective) to obtain this picture of the comet and the zodiacal light below Leo. The 10-minute exposure on October 31st was started at 11:51 UT.

Right: Alan McClure's record on November 1st from 12:43 to 12:54 UT. At his site on Mount Pinos, he used an f/3.8 Zeiss lens of 10 inches focal length.

Below: October 31st large- and small-scale views by Evered Kreimer, Scottsdale, Arizona. At left, with a 135-mm. f/4 lens, the four-minute exposure began at 12:35 UT; at right, 55-mm. f/5.6, six minutes exposure at 12:20 UT.

Above: Photographs on the mornings of October 31st (left), by Bradford A. Smith, and November 1st (right) by Tamie A. Smith. They both work at New Mexico State University Observatory. The bright star near the head is Gamma Corvi. At that time the comet was moving 1½ degrees southwest per day. K. Ikeya's last comet discovery (1964f) passed near this same spot in the sky in mid-August, 1964.

Above: This is a 15-second exposure by Walter A. Feibelman, Pittsburgh, Pennsylvania. He took it on the morning of November 1st from the sixth floor of an apartment building. A 35-mm. Leica camera was used at f/2.

Left: Sherman W. Schultz of St. Paul, Minnesota, took this picture on the morning of October 28th. His Aero-