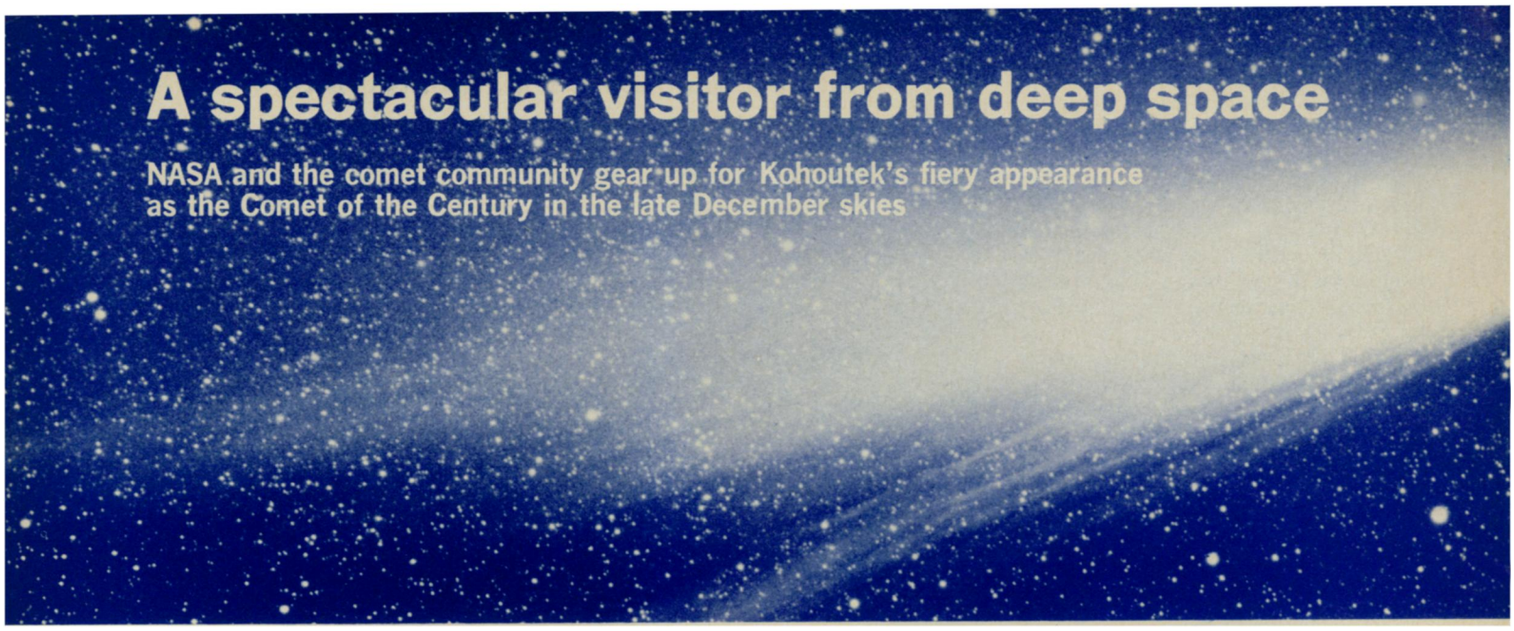


A spectacular visitor from deep space

NASA and the comet community gear up for Kohoutek's fiery appearance as the Comet of the Century in the late December skies

by Everly Driscoll

In that silent, icy realm between the outer edges of the solar system and the nearest stars, swarms of comets probably orbit the sun. Occasionally a star perturbs the comets. A pull from the star causes some of the comets to escape the solar system. Others are pulled toward the center of the solar system.

Thus the comet Kohoutek (SN: 4/14/73, p. 237) may have begun its journey—a trip that will take it four times closer to the sun than the recent bright comet Bennett and in broad view of the earth in late December and early January. The closer to the sun, the brighter a comet glows.

"It could be the Comet of the Century," says Brian Marsden of the Smithsonian Astrophysical Observatory. Marsden has calculated the comet's orbit and estimates its closest approach to the sun (perihelion) to be 13 million miles.

Kohoutek, observed under comparable conditions, should be twice as bright as Bennett, says Marsden, and much more spectacular than Halley's comet, due for an appearance again in 1986.

The new comet was discovered by Lubos Kohoutek of the Hamburg Observatory on two plates exposed March 7. (He later found the comet on an earlier plate exposed in late January.) In March the comet was a nebulous, diffuse object of the 16th magnitude. It could be seen moving west-northwest against the background of the constellation Hydra 440 million miles from the sun, or 4.7 astronomical units. (One astronomical unit is the distance from the earth to the sun, 93 million miles.) On July 2 it was 3.36 a.u., still between the orbits of Jupiter and Mars.

Kohoutek will move to the north of the ecliptic Dec. 27 and will be at perihelion the next day. The magnitude could be as bright as minus 5 to minus 10 and the comet may be visible to the naked eye in broad daylight. However, its proximity to the sun will make it difficult to see. Early in January the comet will appear in the southwestern sky after sunset and if it is as bright as expected and has a long tail, it should be spectacular as early as Dec. 30. "Those people who see a comet on their way to New Year's Eve parties shouldn't worry," says Stephen P. Maran, head of Operation Kohoutek at NASA. "It is those who see it when they are returning home who should worry." (The comet will set below the horizon in the early evening, he explains.)

There will be a full moon on Jan. 8 which could interfere with the viewing of Kohoutek. The most convenient time to observe it might thus be from Jan. 10 to Jan. 20 when the moon is out of the way. The comet will be 30 degrees from the sun as it moves away from and to the north of the sun. It will be closest to the earth (75 million miles) on Jan. 15.

"Discovery of such a potentially fine comet more than nine months before perihelion is quite unprecedented," says Marsden. "It may never happen again that such a long lead time is available for planning observations of a comet passing so close to the sun."

To make the most of the comet and the forewarning, NASA established Operation Kohoutek under the direction of Maran, an enthusiastic young scientist formerly of the Kitt Peak National Observatory and now at the Goddard Space Flight Center. "The project will be a coordinated program to use all the means at NASA's disposal for studying the comet," says Maran. So, Kohoutek may be not only the most spectacular comet of the century but also the most intensively studied comet to date.

At first NASA investigated the possibility of sending a spacecraft to intercept the comet. "But with the time available to assemble a payload," says Maran, "we could not guarantee we could make good quality scientific measurements." (Norman Ness of Goddard has proposed a 1977 Explorer mission to the comet Grigg-Skjellerup.)

What is feasible, says Maran, is the use of existing satellites such as the Orbiting Solar Observatory (OSO 7), the Orbiting Astronomical Observatory (Copernicus), and perhaps the new Mariner-Venus-Mercury spacecraft that will be launched Nov. 3 (SN: 6/30/73, p. 422). NASA is also considering rocket launches and flights of high-altitude aircraft to make observations from above much of the earth's atmosphere.

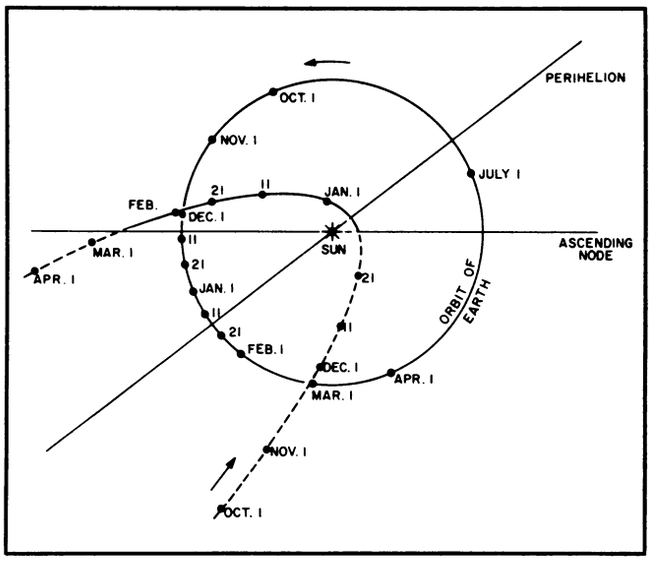
But the most exciting prospect to the comet community is the possible use of the Skylab. Skylab is equipped with the most sophisticated array of telescopes ever orbited. They would be able to photograph the comet over a broad range of the electromagnetic spectrum.

When the comet is approaching and receding from the sun, for example, the scientists, in Maran's phrase, could make "very good use" of the ultraviolet spectrograph designed by scientist-astronaut Karl Henize. When the comet is at perihelion, the key instruments would be those on the Apollo Telescope Mount. The white-light coronagraph, designed by Robert MacQueen, would block out the sunlight and allow the comet to be photographed. Richard Tousey's extreme ultraviolet spectrograph would also be used. Another exciting possibility is real-time transmission of video pictures of the comet near the sun from the Skylab.

"I am very hopeful this can be done," says Maran. But he stresses that the decision to use Skylab with its manned crew will have to await further study

Alan McClure/Calif.

Kohoutek should be twice as bright as Bennett, the 1970 comet (left). Kohoutek's orbit (right) will take it four times closer to the sun than Bennett's.



Marsden/Smithsonian

of the rescheduling implications.

NASA is also studying the use of such aircraft as the C-141 at the Ames Research Center in California (SN: 5/12/73, p. 307). Infrared studies of the comet could verify the observations made several years ago of silicates in comet dust. Ames also has Lear Jets that can be equipped with remote sensing instruments.

The ground-based observation network will be complex and worldwide. The New Mexico Institute of Mining and Technology in cooperation with NASA is rushing to completion a special cometary observatory atop South Baldy in New Mexico. The observatory will have two domes with different telescopes. The main instrument will be a Schmidt camera that has been specially designed for studying comet tails. The second will be a conventional 16-inch reflector for photographing the comet through different filters.

The International Astronomical Union's Commission on the Physics of Comets is also planning a program of observation.

Maran hopes studies will determine the source molecule of the hydrogen atoms discovered in the huge clouds surrounding comet heads. Scientists think it is probably water. Astronomers would also like to see what atoms show up in the spectrum when the comet is close to the sun. Sodium, for example, has been observed in previous comets. Observations of the Lyman alpha radiation of hydrogen with ultraviolet space sensors might reveal the temperature, density and motion of the gas in the vast cloud around the comet.

No one knows for sure where comets come from, but recent calculations done by Marsden and Zdenek Sekanina at the Smithsonian tend to confirm and refine the work of Jan H. Oort, a Dutch astrophysicist. In 1950, Oort postulated that comets originate from a cloud (now known as Oort's cloud) containing 200 billion or so comets. The total mass of the comets would only be 10 to 100 times the mass of earth. The comet cloud could extend as far as 150,000 a.u., or a substantial distance to the nearest stars. The comets' orbits are apparently influenced both by stars and by the planets of the solar system. There seems to be a remarkable piling up of the comets around 50,000 a.u., says Marsden. "Something has shaped their orbits very accurately sometime during the last few million years."

Comets consist of a nucleus probably only a few miles across and rarely more than 15 miles across. A good comet such as Kohoutek could have a mass of a trillion tons or more, says Marsden. The nucleus probably consists of ices such as water, methane and ammonia, and dust particles (bits of all the elements). Some scientists think hydrocarbons or even more complex molecules might be present.

As comets get within 100 million to 200 million miles of the sun, the heat from solar radiation vaporizes the water ice and releases and diffuses the dust. Material from the nucleus expands into the coma. Typical diameters of comas have been from 10,000 to 50,000 miles across. The coma itself expands into an enormous hydrogen cloud detectable only with ultraviolet space sensors. The dust in the nucleus is liberated and blown into the coma and tail.

There are two kinds of tails—straight, narrow, blue tails and curved, broad, yellow tails. Comets may have none, one or both. The blue tail results from the emission of light by the carbon monoxide ions. Its direction is the result of interaction with the solar wind. The yellow, curved tails are the result of dust reflecting sunlight. The released dust eventually goes into orbit around the sun. Tail particles are pushed by radiation pressure away from the sun. Some have been as long as 50 million to 100 million miles or more.

Comets can have short-period orbits generally between three and nine years. Others have periods of a few tens to hundreds of years. Kohoutek is a long-period comet. Its orbital period is at least 10,000 years and probably longer, says Marsden.

How comets originated and how long they have been where they are are questions subject to debate. No easy answers appear in sight. Oort at one time thought the comets originated in the asteroid belt and were thrown out by Jupiter. Now the general consensus, says Marsden, is that the comets originated near the orbit of Neptune between 20 and 50 a.u.

Fred Whipple has suggested that perhaps Neptune and Uranus are made up of tiny comets. Once these planets formed, they would have enough mass to push the other comets out. Alternatively, A. G. W. Cameron suggests that while the solar nebula itself was condensing, satellite disks around the nebula were also condensing. Comet-sized bodies could have formed in these disks.

"If indeed comets were formed at Neptune and beyond," says Maran, "long-period comets such as Kohoutek may be our last remaining hope of finding samples of the primordial solar system material." Long-term comets have not spent a lot of time in the inner solar system being modified by solar radiation and the solar wind (as have meteorites). "We had hoped the moon would yield such material, but studies show that lunar processes modified the rocks."

"Comets may be our last chance." □