Kohoutek, the Christmas Comet: Skylab Mission Expanded?

Brilliant comets have fascinated people for most of recorded history, but spectacular ones are scarce. Halley's comet was last seen in 1910, but a new giant comet, which is now between Mars and Jupiter is growing more luminous every day, and should be almost as bright as a full moon by the time it swings near the sun about 29 December. The new comet, named Kohoutek after the Czech astronomer who discovered it, is not only uncommonly bright, but it may also be unusually insulated from the rest of the solar system. It has probably been at the fringe of the solar system—a region one astronomer calls the deep freeze—for more than 10,000 years.

Because light from the new comet will be so intense, astronomers will have a rare chance to study it in great detail, and to raise questions too subtle to be answered by observations of fainter comets. At most of the world's large radio and optical telescopes extensive observations of Comet Kohoutek have already been scheduled, and the National Aeronautics and Space Administration (NASA) has established a special task force to help prepare for infrared, optical, and ultraviolet observations from aircraft and spacecraft, as well as ground observations. NASA briefly considered sending a spacecraft to intercept the comet, but found that even though Kohoutek was discovered when it was quite far away (*1*), too little time was available. However, the Orbiting Astronomical Observatory (OAO) will observe the comet in the months before and after its closest approach to the sun, and during the sun passage the Orbiting Solar Observatory (OSO), various sounding rockets, and possibly Skylab will be trained on the comet. Because of light scattering from the atmosphere, most ground-based telescopes are not capable of recording a comet as it makes a very close approach to the sun.

The original schedule for the third Skylab mission (designated SL-4) called for launch on 9 November 1973 and return on 4 January 1974. But because of troubles with the spacecraft and the mounting cost of ground support personnel (estimated at $1 million per day), the launch was moved up to October. Now, according to press spokesmen for NASA, the schedule is undecided, but at least one reporter has released information that the mission will either return to the original schedule or be extended to 90 days in duration, presumably so that Comet Kohoutek can be observed.

Although Kohoutek will actually come no closer to the edge of the sun than 30 solar radii, as viewed from the earth or Skylab it will appear to pass within 2 solar radii, in a region of the sky that solar coronagraphs were designed to observe. Coronagraphs on the ground may be able to observe Kohoutek, but those in space will have an enormous advantage, because the intensity of light scattered from the sky is expected to be about 100 times greater than the intensity of the comet (*2*). The field of view of the principal coronagraph aboard Skylab is annular, extending from 1½ to 6 solar radii, and a more modest coronagraph onboard could observe the comet out to 41 solar radii. The coronagraph aboard OSO-7, which is an older instrument with poorer resolution, could view the comet between 3 and 10 solar radii.

Only the coronagraph on Skylab could operate in its conventional mode while observing the comet, but several other instruments could be pointed at the comet by changing the attitude of the spacecraft. A scanning experiment, whose principal investigator is E. M. Reeves at Harvard College Observatory, could record images of the comet at various far-ultraviolet wavelengths (300 to 1300 Å), and a spectroheliograph, whose principal investigator is Richard Tousey of the Naval Research Laboratory, could produce photographic images at even shorter wavelengths (170 to 600 Å), where emission lines of ionized helium may be found. A high-dispersion ultraviolet spectrograph, which Tousey also implemented, could detect the expected H, O, and OH concentrations in the comet, with a good chance of finding new molecular species since Kohoutek will be so bright.

Comet Bennett, 16 April 1970. [NASA photograph]

Most of the observations of Kohoutek will probably be designed to establish what elements, radicals, and molecules are in the comet, and how their relative abundances and spatial distributions change as the comet grows. The species CN, NH, OH, C_2, C_3, CH, and CH_2 have all been found before in comets. They are highly reactive and are thought to be formed when so-called parent molecules are dissociated. At least three parents—CH_4, NH_3, and H_2O—are needed, but none of the proposed parents have been detected yet, probably because they do not absorb or emit light in the visible spectrum. Carbon monoxide and molecular nitrogen may well be found by observations in the ultraviolet, but methane, ammonia, and water could be more readily detected in infrared or longer-wavelength radiation, because they are characterized only by broad absorption features in the ultraviolet.

Features characteristic of ammonia and water could be detected in radio observations, and astronomers will be looking not only for these parent molecules, but also for more complex molecules similar to those found by radio observations of dark interstellar clouds. (No molecule with more than three atoms has been identified in a comet.) However, no one knows yet whether Comet Kohoutek is predominantly composed of gases or dust. By October, wide-dispersion spectral observations should indicate into which class of comets Kohoutek falls. If gas is abundant, searches for molecules should be fruitful. But if dust is abundant, infrared studies, looking for broad features rather than sharp lines, may reveal new information about the composition of the dust. For instance, are silicates as abundant in comets as many scientists think they are in interstellar clouds?

Some astronomers think that one of the most important studies of Kohoutek will be a detailed recording of the evolution of the comet. But Robert MacQueen of the High Altitude Observatory in Boulder, Colorado, points out that changes in the comet's tail near the sun may also be used to study the solar wind. Others will be looking for evidence of metals such as sodium and iron, which has shown up in other comets just before they reached the expected perihelion distance of Kohoutek.

The outstanding question about comets may not be solved by observing Kohoutek, however. The validity of the most comprehensive model of cometary behavior, in which F. L. Whipple likens a comet to a "dirty snowball," depends on whether or not comets have a solid nucleus. The nucleus of Kohoutek is expected to be about 20 or 30 km in diameter, far too small to resolve even with the best telescopes. Most astronomers think that a mission to a comet will be necessary to resolve this question, and some are already proposing a mission to intercept Comet Grigg-Skjellerup in 1977. But there is an outside chance that Richard Goldstein and his associates at the Jet Propulsion Laboratory, Pasadena, California, may prove the existence of a nucleus if they detect an echo when they try to bounce a radar signal off Kohoutek.

When Comet Kohoutek reappears after perihelion, plainly visible in the evening sky on 30 December, it should be a spectacular sight, stretching as far as 30° across the sky and shining almost as brightly as Mars. According to a theory of the origin of comets by J. Oort, Kohoutek may have been orbiting undisturbed beyond Pluto from the creation of the solar system until some fairly recent perturbation, in the last 10,000 years, sent it into its present course to the sun. If indeed Comet Kohoutek is making its first passage into the solar system, its glow may not only afford earth dwellers a spectacle that occurs once in a lifetime, but also provide astronomers with a view of the material from which the solar system was born.

—William D. Metz

Notes

1. The comet was discovered on 7 March 1973 by Luboš Kohoutek, with a 31-inch Schmidt telescope at the Hamburg Observatory, when it was about 5 astronomical units (A.U.) from the sun. At perihelion on 29 December 1973 it is expected to pass within 0.14 A.U. of the sun.
2. Estimates of the brightness of Comet Kohoutek at perihelion vary from magnitude -5 to -10. On the scale of solar brightness, the greater estimate (-10) corresponds to about 0.2×10^{-6}, while the scattered light from the sky even on a clear mountaintop has a brightness of 30×10^{-6} very near the sun (but decreases to 10^{-7} far away). Onboard Skylab, the brightness of the stray light in the white light coronagraph is 10^{-10} on the same scale.

Speaking of Science

Shortage of Primates?

Within 5 years investigators may have to breed all of the subhuman primates required for their research, according to William Goodwin of the Primate Research Centers Section, Division of Research Resources (DRR), National Institutes of Health, Bethesda, Maryland. Several species, including some already on the endangered species list compiled by the Department of the Interior, have been in short supply; now the availability of the common—and frequently used—rhesus monkey may be curtailed.

Since primates are not indigenous to North America, researchers in the United States have had to rely on imported animals. Most countries, however, have set export quotas to conserve their primate populations. India, the principal supplier of rhesus monkeys, has restricted the number exported worldwide to 65,000. Goodwin expects that the Indian government will soon reduce that figure to 30,000. The Institute of Laboratory Animal Resources (ILAR) of the National Academy of Sciences reported that researchers in the United States alone used almost that many rhesus monkeys—more than 26,500—in 1971.

The major problem is that the subhuman primates are losing their competition with the human primate. The situation of animals living in tropical forests is especially critical. These habitats are being converted to farmland in order to meet the food demands of growing populations or are being cut down for their hardwood timber. Unfortunately, many of the forest primates are both shy and unable to adapt to the altered environment; they prefer living in the wild to living in proximity with man.

Some species, such as the gorilla and the orangutan, are facing extinction. Of course, these are not typical laboratory animals, but the concern of primate specialists extends to the more commonly used species. Richard Thorington, curator of primates at the Smithsonian Institution, Washington, D.C., said that the survival of several species of Old and New World monkeys is threatened. These include the night monkey, which is imported from Colombia for research on malaria, and the stump-tailed macaque of Thailand. One investigator, who wanted to use the stump-tailed macaque for a long-term study of cardiac physiology, switched to another species when informed that the availability of the animals could not be guaranteed for the duration of the project. The chimpanzee is also becoming scarce. Once an animal has been placed on the endangered species list, this country may prohibit its importation.

Although research is not seriously handicapped at this time by a primate shortage, DRR has awarded a contract to ILAR to perform a survey of primate populations. This will be a worldwide primate census involving first an analysis of available data followed by the field studies needed to supply missing information. Very little is known about the status of the primate populations in such areas as Southeast Asia.

These surveys will identify those primates that will have to be bred in the United States to meet research requirements. Considering that more than 56,000 primates of all species were used in 1971, a substantial monkey business may result.—Jean L. Marx