Encounters with Comet Halley: The new view begins to emerge

The international family of five spacecraft that encountered Comet Halley in March would "rewrite the textbooks," many researchers said, and this week saw the publication of the first detailed notes for the job. Thirty-eight scientific papers, some with more than 30 authors, appear in the May 15 NATURE, summarizing initial results from the most elaborate space "flyby" ever mounted.

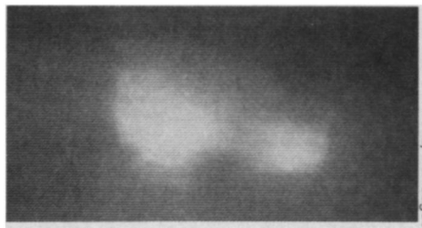
Together, the two Soviet, one European and two Japanese craft photographed the comet, sampled its dust and gases, and measured its electromagnetic properties (SN: 3/22/86, p. 180), revealing, among other findings, that comets are even less understood than had been thought.

The nucleus of Comet Halley, far from being an ordinary ball, is an irregular, "potato-shaped" object, in the words of scientists with the Soviet Vega spacecraft team. Its double-lobed shape, resembling a large lump with a smaller lump bulging out of one side, measures about 14 by 7.5 by 7.5 kilometers, according to the Vega analysis. A similar result came from Europe's Giotto craft, which took its last pictures of the comet from only 1,703 km away. Giotto actually got to within about 605 km, but an apparent glitch in the spacecraft power system ended its observations about 12 seconds earlier.

The nucleus looked extremely dark, reflecting only about 4 percent of the sunlight striking it. The Vega and Giotto groups both conclude that the largely icy nucleus – more than 80 percent of the material coming from it is water vapor – is covered with a thin layer of nonvolatile material, through which numerous bright outbursts often emerged. "If the ice were not protected by an insulating crust on the surface," writes the Giotto group, "then the total gas and dust production would be about an order of magnitude higher than observed."

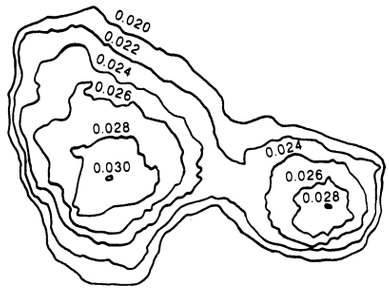
The close-up photos show striking details, all of which are hidden from earth-based observers by the glare of reflected light. One "large bundle of jets," for example, is reported by the Giotto group to have its origin near the nucleus's northern end, where there are "scalloped features resembling craters, each of which appears to be the source of a narrow jet." Study of some of the images, the team reports, indicates that surface features seen "in profile" appear to have slopes of no more than about 15°, suggesting a "rough 'crater-type' terrain" in which features measuring 1 km or less in extent can be identified.

Determining the comet's composition was a major goal of the encounters, not just for the study of Comet Halley but also because many researchers have long felt that comets may represent samples of some of the most primitive material in the solar system. Most of the dust particles were found to be rich in hydrogen, carbon, nitrogen and oxygen, for example, "suggesting the validity of models that describe cometary dust as including organic material," according to one Giotto report.

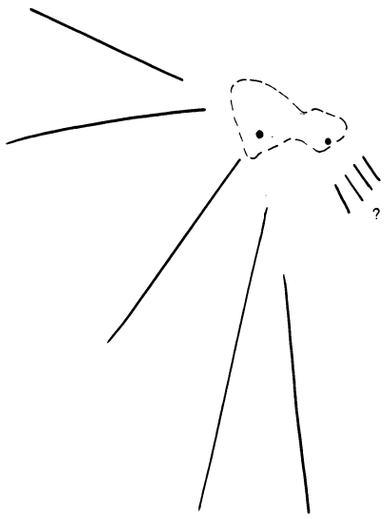


Illustrations: NATURE/R. Z. Sagdeev et al.

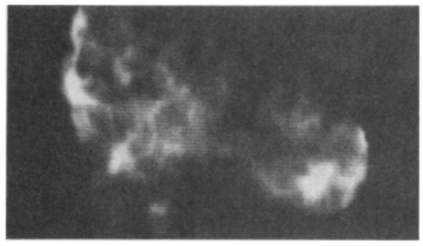
Comet Halley's irregular, double-lobed nucleus, photographed on March 9 by Vega 2 from 8,030 km away, 1.5 seconds before the spacecraft's closest approach.



Brightness contours of the above image.



Five jetlike bursts from the nucleus, and a possible region of lesser activity, observed in the photo's outer portion (not shown).



The nucleus's solid shape is brought out by computer processing that compensates for differing brightness distributions at and around the nuclear region. Further processing may add topographic detail, possibly leading to reconstruction of the nucleus in three dimensions.

Similar material has also been proposed by some researchers to be a major component of a class of meteorites known as carbonaceous chondrites, and may also account for the surface appearance of such dark solar system objects as the rings of Uranus and the dark portions of Saturn's moon Iapetus. Indeed, one Vega team notes, "it is reasonable to assume that all of this material is carbonaceous in composition." On the other hand, says one Giotto report, mass spectrometer measurements suggest that the cometary particles are "only roughly similar" to a variety of carbonaceous chondrites known as type C1, which some scientists think may be the type most likely to represent unaltered, primitive solar-system material.

A new finding about the comet, reported by researchers with Japan's Sakigake spacecraft, was the discovery that it seems to be emitting radio waves. First detected as far as 10 million km away, the signals showed their maximum intensity at the craft's closest approach, "indicating that the emissions are intimately related to the comet." Several different emission patterns were detected, collectively termed "cometary kilometric radiation" and ranging from intense, sporadic bursts of broad-band noise to continuously rising and falling tones. Though the mechanisms that produce such emissions will – like virtually every other aspect of the encounters – require much additional study, the Sakigake team infers that the signals result from "moving shock or bow waves in the coma region of the comet, due to time-dependent variations in the solar wind."

Vast amounts of study lie ahead for all of the Halley-encounter scientists, ranging from the nature of the solar wind's interaction with the comet (the presence or absence of a conventional "bow shock" may be too easy an answer) to the results of additional computer-processing of the spacecraft photos. NASA hopes, meanwhile, to start developing a visit to another comet, this time for an extended look in the 1990s. Rewriting the textbooks will not be easy. *– J. Eberhart*