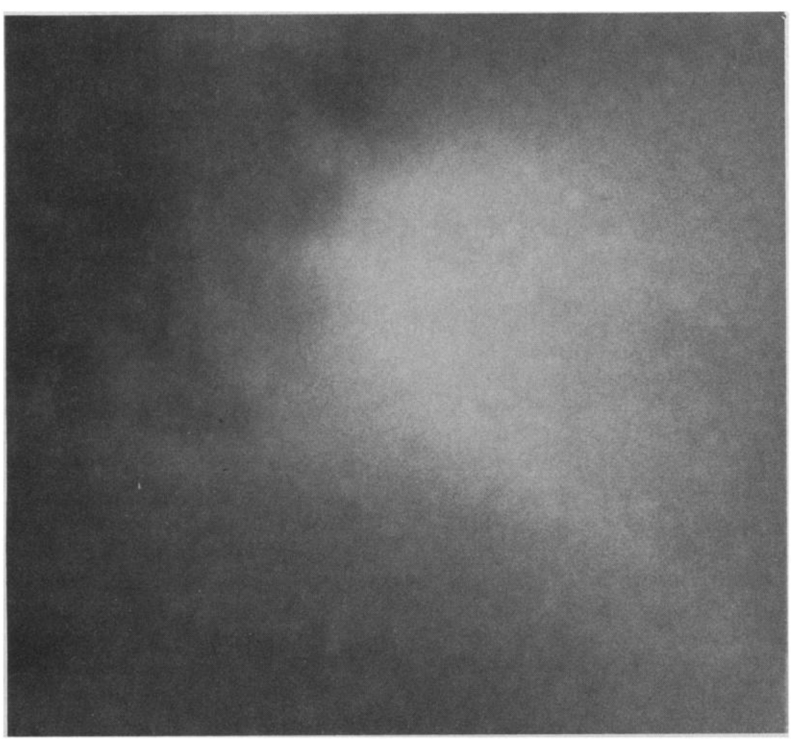
The New Look of Halley Is Black and Lumpy

The closeup view from the Giotto spacecraft that was recently released reveals a hill and craters spewing dust jets

COMET Halley began fading sharply in mid-April, but not before the audacious Giotto spacecraft had swooped in for a close look at the cosmic hunk of ice during its most blustery spouting of gas and dust. The large size of the nucleus, twice that expected, and dark surface were immediately apparent, but Giotto researchers have only recently released some of their best pictures and detailed descriptions of the nucleus and its jets.

From Giotto's view, the nucleus is oblong, 15 kilometers by at least 7 kilometers and perhaps as many as 10 kilometers. A sphere having the same surface area would have a diameter of about 11 kilometers, almost twice as large and eight times as massive as assumed. The potato-shaped nucleus falls far short of spherical perfection in other ways as well. A hill on the night side reaches high enough to have caught the first rays of the morning sun. The dark edge of the nucleus silhouetted against bright dust is scalloped by slopes of 15° and less that have heights of several hundred meters.

Bumpiness seems to be the primary characteristic of the surface of the nucleus. Although reluctant to use terms connoting underlying causes, Giotto team members often speak of a cratered terrain. One clear example of a familiar, crater-like feature, 1.5 kilometers in diameter, appears between the two main jets in an unreleased image. But meteorites are not likely to have created these craters. The localized jetting of dust and gas, forming cometary volcanoes of a sort, seems a more appropriate mechanism. In some of its more guarded language in the 15 May issue of ***Nature***, where early Halley encounter results appear, the team discusses narrow jets of dust spewing from five to seven "roughly circular structures" about 0.5 kilometer in diameter in "scalloped areas" spanning about 3 kilometers. The crisscrossing jets merge to form the single major jet at the north tip of the nucleus. Taken together, the source areas of the nucleus's seven jets, all of which are on the sunlit side, have the surface area of a 4-kilometer sphere. That is in the size range predicted for Halley some years ago.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One of Giotto's best. *From a distance of 4910 kilometers, the Giotto camera caught the northern tip of the nucleus. Five to seven small, narrow jets, apparently issuing from small depressions, form the major jet seen here.*

The dust jets are at the center of a polite controversy over whether either of the Soviet VEGA spacecraft saw anything of Halley's nucleus. The Giotto camera team is doubtful. Their camera had a side view from as little as 2000 kilometers away. The VEGA cameras returned their best pictures looking straight down on the sunlit side, into the jets, from 8000 kilometers or more. After considering the problems of imaging the black nuclear surface under a haze of dust, the Giotto team concludes that their analysis "leads to the surface being virtually invisible if viewed through larger amounts of dust, as for instance from the sub-solar side." In fact, the team claims that, despite the arrival of their spacecraft 3 days after the last VEGA, "for the first time it has been possible to detect the nucleus of a comet unambiguously."

Plasma physicists, who had little new or startling to report at the encounters, now have at least one anomalous phenomenon to ponder. Konstantin Gringauz of the Space Research Institute in Moscow and his colleagues on the plasma instrument package team report that, instead of the 4000 to 5000 kilometers of space about the nucleus expected to be dominated by cometary ions, the comet's sphere of influence extends 150,000 kilometers to what they dub the "cometopause." Across a boundary about 10,000 kilometers wide at that distance, the VEGA instruments stopped detecting the protons of the solar wind and began detecting only the heavy, slow-moving ions of the comet. How the cometary ions could be so successful in fending off the solar wind remains unknown.

There was also confirmation of some predictions from plasma theory. In contrast to some of the results from the flyby last September of Comet Giacobini-Zinner by the International Cometary Explorer, the solar wind does seem to slow first in front of Halley at a bow shock rather than at a broader, less abrupt bow wave, even along the flanks of the comet. There is also evidence of critical ionization occurring, according to S. Klimov of the Space Research Institute and his colleagues on the low-frequency plasma wave detector team. Critical ionization, a phenomenon predicted in 1954 by Hannes Alfvén in the absence of any observational evidence, is a means of producing new charged particles in which neutral molecules passing through a plasma above a minimum relative velocity become ionized. ■ RICHARD A. KERR