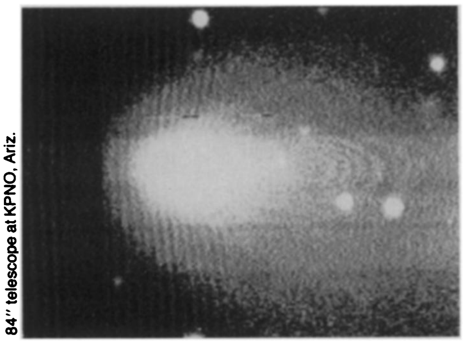
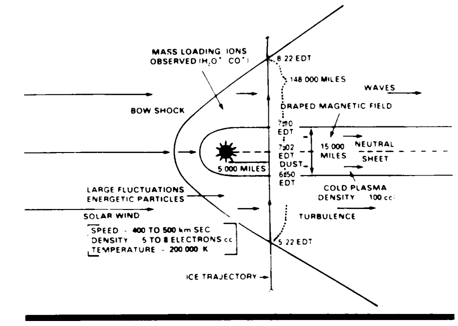
SCIENCE NEWS of the week

First to a Comet: 'A Long, Wonderful Night'

The first visit to a comet by a man-made object resulted last week from a cleverly designed and remarkably complex series of maneuvers carried out by a spacecraft originally created — and used — for a totally different purpose, studying the sun. The comet mission's intricacies had been widely publicized, including the fact that the U.S.-built probe would reach a comet called Giacobini-Zinner six months before a group of Soviet, European and Japanese craft was due at Comet Halley. Less mentioned, however, was the worth of the science that the little U.S. probe, called the International Cometary Explorer (ICE), would be able to perform when it arrived, carrying no cameras, nothing designed to study a comet's dust. But when the encounter was finished, Edward Smith of Jet Propulsion Laboratory in Pasadena, Calif., was not atypical of the mission's scientists in dubbing it "an unqualified success."



84" telescope at KPNO, Ariz.



adapted from NASA

Comet Giacobini-Zinner on Sept. 11, seen from earth and probed (diagram) by ICE.

Early on the morning of Sept. 11, at about 46,000 miles an hour, ICE hurtled toward the comet, aimed to pass through the comet's tail about 5,000 miles "downstream" from the icy nucleus. A major question was whether the craft, or at least its power-generating solar panels, would be damaged by dust streaming back from the nucleus as it was released from the vaporizing ice. But ICE survived virtually unscathed. The result was valuable information for officials of the various Halley-bound missions, whose craft will not arrive until next March but who followed the encounter from the ICE control center at NASA's Goddard Space Flight Center in Greenbelt, Md.

Lacking formal dust detectors, ICE nonetheless offered at least five possible indicators — only one of which appeared initially to show any dust at all. A plasma-wave detector operated by Frederick L. Scarf of TRW Systems in Redondo Beach, Calif., recorded pulses believed to represent little ionized clouds formed by dust particles vaporizing as they hit the spacecraft. The pulses seemed after very preliminary analysis to be occurring only about once a second, and other symptoms such as wobbling of the spacecraft or degradation of its solar panels were completely absent.

Some scientists had thought that with no cameras, the blind spacecraft's first awareness of Giacobini-Zinner might be its detection of radio waves possibly generated in the comet's tail. But Jean-Louis Steinberg of the Paris Observatory reported "no evidence of any radio emission before we reached the comet."

Instead, the honor went to an instrument that project scientist Tycho von Rosenvinge of Goddard says was once rated least likely to make a contribution among the seven sensors to be used during the encounter. A particle detector in the charge of Robert Hynds of Imperial College, London, it first spotted the signs when ICE was still about a million kilometers from its goal.

"What we really expected to see," says Hynds, "was some very low-energy particles, possibly very close to the tail of the comet — I suppose you might say we expected to see a very pale imitation of the earth's magnetosphere. And what actually happened was a considerable surprise." Beginning hours before the encounter, the instrument detected the presence of highly energetic ions, and the readings continued afterward for an even longer time. "When it was proposed to send ICE to a comet," Hynds admits, "I must say that, like Dr. Steinberg, I had some doubts as to the merit [of undertaking] the operation. I'm very glad they were overcome."

Hynds's findings may also be of particular interest to the mentors of the various Halley missions. His instrument was picking up signs of Giacobini-Zinner's presence over a span of more than 42 hours — representing a domain "far bigger than any of us expected," says Scarf — and one or more of the Halley craft may be limited in the time during which all their instruments can operate at once. The reason, on the other hand, has been the anticipated need to depend on battery power in case the solar panels are damaged, and ICE's solar panels showed no power reduction at all.

One surprise lay in ICE's answer to whether a comet would have a magnetic "bow shock," formed where the comet blocks the incoming, supersonic flow of ionized gases called the solar wind. Advance speculation ranged from "yes" to "no," but ICE initially appeared to show evidence of both possibilities. During the approach to the comet, Scarf's instrument detected high-frequency electrostatic waves of the sort familiar from spacecraft studies of planets such as Jupiter and Saturn, where bow shocks are clearly present.

On the other hand, Smith's magnetometer failed to show what in the case of such planets would be a clear-cut jump in the strength of the magnetic field. "We don't see evidence for a bow shock," he said after the encounter. The emissions recorded by Scarf, some of which were audible over loudspeakers as a sort of gentle gurgle, at first intensified as expected, but then failed to climax in a pronounced "whomp!" as ICE penetrated the region where the shock wave may have been.

Samuel Bame of Los Alamos (N.M.) National Laboratory (whose electrostatic analyzer had also detected the comet hours in advance) also got readings near the presumed shock region — but instead of a clear "signature," he says, "we saw something very different from what we see when we go through a shock." Instead, he describes a region of great turbulence in the electrons his sensor was measuring. Says Bame, "I don't know whether it should be called a shock at all."

As for what the comet is actually made of, Keith Ogilve of Goddard was not particularly surprised at his early results. "We confirmed the conventional wisdom that the 'water group' [ions such as H_2O^+ and H_3O^+, with mass numbers of 18 and 19] would be the most common ionic group that we would see. We believe that there is probably CO^+ there [carbon monoxide, a probable part of an observed concentration of ions with mass numbers of 28 to 32]."

Another concentration was observed in ions of mass numbers 23 and 24, yet to be interpreted, but Ogilve was pleased after a mere glance at his data by how well his instrument performed. Prior to the Giacobini-Zinner encounter, Ogilve later told SCIENCE NEWS, he was worried that if the solar wind started moving too rapidly, it might accelerate the ions until they were beyond the device's measuring capability. Instead, he says, "we couldn't have done better if we'd known about it [the solar wind velocity] in advance." During ICE's three-plus-hour trip across the comet's tail, the instrument completed seven sweeps through its full mass-measurement range, the first direct samplings of a comet's composition.

Before and during ICE's encounter, attempts were also made to observe Giacobini-Zinner from at least three other spacecraft at widely differing locations: the International Ultraviolet Explorer circling the earth,the Pioneer Venus Orbiter (PVO) around Venus, and the latest member of the fleet bound for Comet Halley, Japan's Planet A, launched on Aug. 18. All (except ICE itself) were equipped to record Giacobini-Zinner's ultraviolet hydrogen emissions, promising measurements of how much water was actually coming off the comet due to the sun's heat.

The emissions appeared about twice as bright as expected, says Ian Stewart of the University of Colorado in Boulder, in charge of PVO's ultraviolet spectrometer. Combined with the data from ICE, he says, the result will be the first set of quantitative measurements linking a comet's sublimation (ice vaporization) rate with the ion densities and structure in its tail. The PVO instrument was able to monitor the comet for 10 hours, resulting in especially noise-free measurements and encompassing the whole span of ICE's visit.

There are no comet "experts"—far too little is known for anyone to merit such a term, even after ICE's pioneering visit. But according to John C. Brandt, chief of Goddard's Laboratory for Astronomy and Solar Physics, "our concept of cometary physics has fundamentally changed as of Sept. 11, 1985." Added Scarf after the encounter, "It's been a long, wonderful night."

—*J. Eberhart*

Giant telescope begun

Construction of what will be the world's largest telescope began with a groundbreaking ceremony Sept. 12 on the summit of Mauna Kea on the island of Hawaii. The instrument, to be known as the W.M. Keck Telescope, will have a mirror 10 meters in diameter. The world's largest telescope now is a 6-meter mirror in the Soviet Union.

The Keck telescope will have a radically new design. Its mirror will be built of smaller segments, each with independent support and positioning control. (Manufacture of a monolithic 10-meter mirror is considered impractical.) The design is largely by astronomers of the University of California. The California Association for Research in Astronomy, which represents the University of California and California Institute of Technology, will build the new telescope. The cost of construction, about $87 million, will be supplied by Caltech in Pasadena, mainly from a grant by the Keck Foundation of Los Angeles. The 13,000-foot Mauna Kea offers some of the best astronomical seeing in the world. Housing several other telescopes, its summit is fast becoming an astronomers' acropolis. □

Viral close-up: In from the cold

The enemy might not yet be ours, but now we know what it looks like: Scientists have generated the first three-dimensional, atomic-scale model of a cold virus. The virus's structure makes development of a conventional vaccine unlikely, says research head Michael G. Rossmann of Purdue University in West Lafayette, Ind., but it does suggest other ways to prevent colds.

The collaborative effort between scientists at Purdue and the University of Wisconsin in Madison was reported in the Sept. 12 NATURE. It is the first three-dimensional description of a virus that infects animals.

The virus depicted, one of more than 80 members of the cold virus family, looks like a 20-sided soccer ball; within the ball is an RNA core. Each triangular face is made of protein and has hills and a valley. Within each valley, Rossmann believes, is the apparatus with which the virus grabs on to a host cell; the ridges are the sites recognized by the host's immune system.

This shape makes the cold virus a survivor and is a major roadblock to a vaccine. The constantly exposed ridges are constantly changing, allowing viral descendants to sneak unrecognized past an immune system primed to recognize previous versions of the virus. And antibodies can't fit into the valleys in which the stable receptors reside.

But the fight is far from lost. "We might be able to do something with the [host cell] receptor," says Rossmann. "The virus has to be able to infect the host." If something can be found to cover the host cell receptor, he suggests, infection could be prevented.

In a commentary in the same issue of NATURE, Don C. Wiley of Harvard University cites the viral description as "a *tour de force* of modern X-ray crystallography." It is, he notes, "certainly nothing to sneeze at."

Wiley suggests three approaches to a cold preventive. Like Rossmann, he proposes blocking the host cell receptor; his other suggestions concern the virus's protein coat. The virus has to get undressed—lose its shell — to enter the cell, and understanding the structural changes involved may suggest a way to block the disrobing, he says. In order to leave a cell following replication and infect another cell, the virus has to assemble a new coat; a better understanding of this process could provide information necessary to keep viruses from getting dressed.

The researchers marshaled Purdue's Cyber 205 supercomputer and Cornell University's high-energy synchrotron in their attack on the virus. They hit crystallized cold viruses (SN: 3/12/83, p. 165) with X-rays from the synchrotron and studied the diffraction patterns with the computer; the resulting map has a margin of error of about one-half angstrom. Approximately 6 million pieces of data were considered. Doing the calculations without a supercomputer could have taken 10 years instead of a month, Rossmann estimates. He says the same procedure could be used to study the AIDS virus, provided it can be crystallized.

The structure, the researchers note, is remarkably similar to those of previously described plant viruses and suggests a common evolutionary history.

— *J. Silberner*

Visa controls for supercomputer access

The Reagan administration appears determined to keep Soviet-bloc and Chinese researchers away from U.S. supercomputers. "It's fairly clear that there will probably be some kind of restrictions on access to supercomputers," says Charles H. Herz, general counsel for the National Science Foundation (NSF), reporting last week to the DOD-University Forum Working Group on Export Controls.

Department of Defense (DOD) officials argue that "high-end computing" is essential for many military and intelligence applications. Access to supercomputers like the Cray-2 could help the Soviet Union build its own machines and show Soviet researchers how to use them effectively. What's needed are "wise and prudent measures" that one would apply to any expensive piece of equipment, says George Menas of DOD's Strategic Trade Directorate. This can be achieved "without intruding on academic freedom," he says.

The debate focuses on four university supercomputing centers established earlier this year by NSF (SN: 7/20/85, p. 36). Recent discussions between NSF and the Department of State, which is responsible for coming up with a supercomputer access policy, indicate that visa restrictions are the favored control method. Visas for visitors from proscribed countries would clearly indicate whether the named visitor is allowed access to a supercomputer.

This approach, says Herz, takes the university out of the business of being an enforcer. However, federal officials hope that university personnel will voluntarily and informally cooperate by reporting individuals who violate the terms of their visas. Eventually, similar controls may be instituted for all U.S. supercomputer installations.

—*I. Peterson*