return of an influenza virus to be detected, Palese says. Other new epidemics seemed to reflect shifts to viral surface proteins never before experienced by human populations.

Where was H1N1 hiding for 27 years? "We can rule out 27 years of normal passage in man," Palese says. He has observed that during transfer from person to person an influenza virus changes approximately 4 percent of its genetic material every 11 years or so. The 1977 virus is so similar to the 1950 variety that scientists say it probably was frozen. It is a matter of speculation whether the virus actually reemerged from someone's deep-freeze, as Maurice Hilleman of the Merck Institute for Therapeutic Research contends, or somehow was biologically carried along unchanged—perhaps as part of a person's or an animal's genetic material or in a non-infective form in immune-suppressed organ transplant patients. Friedrich Dienhardt of the University of Munich suggested facetiously at the symposium that an influenza-infected explorer fell into a glacier in 1950.

Beyond that gap in the influenza A virus's life history, H1N1 variations developed with normal rapidity during the 1977 epidemic, Palese and Young report. They analyzed ten of the 1977 viral strains from Eastern Asia and arranged them, according to their genetic differences, into an evolutionary scheme. They point out that the virus changed more in a 6-month period in 1977 than it did "frozen" from 1950 until its reemergence in 1977.

Because the body's defense system recognizes viruses by their surface components, it had been thought that a virus has the best survival potential if its surface proteins are altered. But variations recently found in almost all the influenza genes indicate that antibody attack is not the only force responsible for new strains. Palese speculates that a virus might have an advantage, especially early in an epidemic, if it contains proteins altered so that they can carry out more efficient viral replication inside human cells or they can increase the spread of the virus. "The influenza virus seems somewhat less stable than other viruses," Palese explains. In preliminary experiments, it accumulated more genetic changes during passage in laboratory tissue culture than did another RNA virus of comparable size.

Drastic as well as gradual genetic changes play a role in virus history. Scientists suspect that each pandemic virus either adopts genes from animal viruses or is a reemerged human virus that had not circulated for many years.

The interchange between the 1977 H1N1 and another influenza is the first documented recombination of viral genes in human disease. In 1977 two influenza A strains were in circulation simultaneously — the reemerged H1N1 and H3N2. Alan P. Kendal of the Center for Disease Control observed that some patients were infected with both viruses, and thus provided an opportunity for gene exchange between the viruses. In California in November 1978 a recombinant virus was isolated. In the December PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES Palese and Young report that the virus has four genes, including H and N, from its H1N1 parent and four genes from an H3N2 influenza.

Viruses of the H1N1 type collected in the United States later in 1978 and 1979 all consisted of the recombined genes, Palese says. Thus, he believes that the new virus has a survival advantage over the earlier H1N1 forms. Kendal, however, told SCIENCE NEWS that distribution of the recombinant virus is not uniform around the world. He says that in the United States and Japan most viruses were of that form last winter, but in Australia, India and the Caribbean the older, non-recombinant form still prevailed. "The recombinant viruses haven't clearly displaced non-recombinant H1N1," Kendal says. "We really have to wait and see whether in the future both viruses can survive."

A scarcity of influenza A outbreaks this winter so far leaves the scientists short of further data. Kendal points out, however, that the situation could change any day. Sir Charles Stuart-Harris of the University of Sheffield in England told reporters at the symposium that despite extensive analysis of past epidemics, virologists still have no power to predict what viruses will appear each year. □

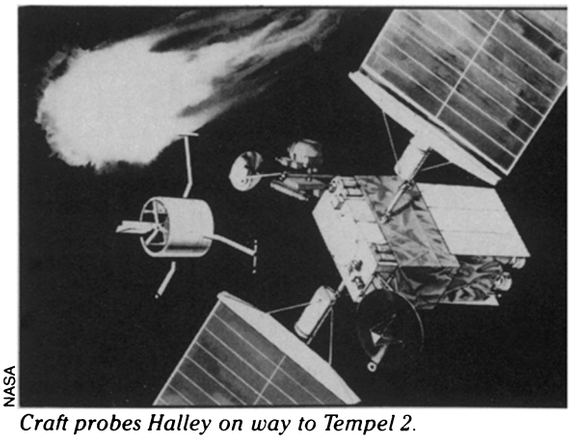
Comets in a storm: Tight money for space

Considerable furor has arisen out of concern among some scientists and others over the future of a proposed mission to send a spacecraft past Halley's comet on the way to a year-long, side-by-side cruise with comet Tempel 2. The crux of the matter is a new engine, the Solar Electric Propulsion System (SEPS), which would have to be developed for the vehicle in order to make the envisioned flight possible.

The mission's advocates consider it important because Halley is the only such large, active comet that will be an available target in this century, combined with the fact that the two-comet trajectory will yield — from the same launching — a chance for prolonged, intensive study of a comet nucleus. The spacecraft, which would have to be launched in 1985, would not need to appear in the National Aeronautics and Space Administration's budget until fiscal 1982, but the SEPS engine, requiring major technological development, would need a longer start. The proposed FY 1981 budget, now in the hands of congressional committees, left NASA's hands with a request for $20 million to begin the SEPS development. On the way to Capitol Hill, however, it made the obligatory detour through the Office of Management and Budget, and there the SEPS was deleted.

The result has been striking. Scientists call one another at night. National magazines and organizations such as the space-colony-oriented L-5 Society have mounted campaigns on the mission's behalf. At the House Subcommittee on Space Science and Applications, chairman Don Fuqua (D-Fla.) has received more than 200 letters on the subject, and, says a staffer, "I haven't seen any that are against." Calling the outpouring "surprising," he adds, "I do not recall any program in the last five years that has produced such a volume of mail."

Last week, Fuqua's subcommittee held a hearing on the science portion of the NASA budget request, which would include the



NASA

Craft probes Halley on way to Tempel 2.

SEPS. Of the testimony presented, the weakest regarding SEPS and the comet mission came from NASA itself, represented by Thomas A. Mutch, associate administrator for space science, whose spoken comments touched only briefly on the matter. His full, 33-page written statement contained just nine sentences about the comet mission, with a single reference to SEPS. (One observer suggested that Mutch's remarks might have been "muzzled," possibly because NASA is already receiving strong administration backing for substantial extra funding to help out the much-delayed space shuttle. NASA now envisions the shuttle's first orbital flight occurring as late as March of 1981.)

The other witnesses before the subcommittee took stronger stances. One possible alternative to the two-comet mission's requirement for prompt SEPS funding, for example, might be to drop the Halley flyby completely, leaving only the Tempel rendezvous (which scientists admit to be the more scientifically valid objective if a choice must be made). A.G.W. Cameron, chairman of the Space Science Board of the National Academy of Sciences, noted the view of the Board's lunar and planetary committee that "in view of the diversity of comets it is important that comparative measurements be made that

include objects in different stages of evolution." (Halley is considered a much "fresher" comet, having made fewer trips around the sun.)

It would be possible to accomplish many of the dual mission's objectives with two separately launched spacecraft, said Cornell's Joseph Veverka, who headed the NASA Comet Science Working Group, but "there is no justifiable reason for choosing such an approach. It offers no technical or scientific advantage. It does delay the expenditure of $15 million in FY 1981 funds [a revision of NASA's $20 million request], but ... we will have escalated the cost of carrying out the desired comet exploration program by at least $250 million." Existing approximate figures suggest that about $200 million of this would be for the second spacecraft, $40 million for its launching by the shuttle and $10 million for an additional upper-stage booster engine.

It is quite possible, Cameron and Veverka both believe, that NASA could start the development of SEPS with less than its initial $20 million request. A still more constraining option open to Congress would be to approve a budget bill giving NASA the option of reprograming some of its existing funds — if it could spare any. Next week, similar issues are likely to reemerge at a hearing on the Senate side.

The dual-comet mission, however, may face other problems as well. On the flight past Halley, the spacecraft is to jettison a probe that would go all the way to Halley's nucleus, but some sources are now worried that the European Space Agency, which was to have built the probe, may be about to back out of the deal in the face of the overall mission uncertainty. More recently, on the other hand, there have been signs that an individual European country may take on the job. But even if SEPS and the probe survive, NASA will next year have to battle for funds for the main mission spacecraft itself. □

The space race in manufacturing

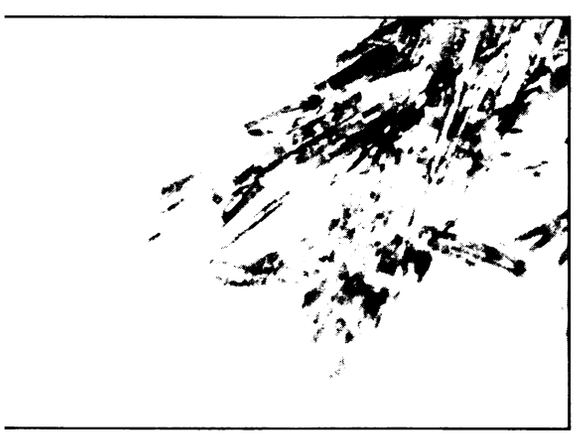
The Space Race once referred to the competition for getting something — anything — from the earth into orbit around it. It meant sending animals, then humans, then being first to the moon, and more recently it has covered orbiting weapons and the scientific prizes of planetary space probes. Already underway, however, are the preliminary heats of a race for yet another prize: the economic, technological and political gains from manufacturing in space. Whether the ultimate goals be space colonies, solar power satellites, better microcircuits or medical advances, the contestants are on their way. But the Comptroller General of the United States has just warned, in a report to the Senate Subcommittee on Science, Technology and Space, that America is already starting to look a bit winded.

After consulting "nearly 100 scientists, program managers, economists, industrialists and government officials ... in this country and in Europe," the report concludes that "only limited success can be expected in the next 20 years due to low funding and limited backing by the Administration and the Congress."

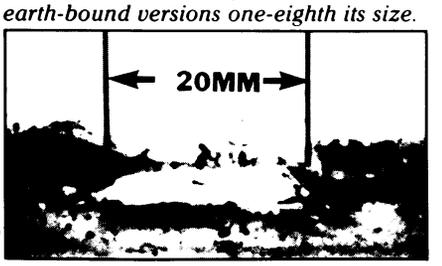
The report identifies four central problem areas:

- A need for greater U.S. industry participation, currently hobbled by such issues as government restrictions on the use of government-held patents.
- Technology transfer to the private sector, for which present programs must be revamped to emphasize commercial potential.
- Basic research in materials science, which will require greater government investment if industry is later to consider high, long-term investment. "Current funding levels," says the report, "assure very slow progress."
- International cooperation. "The U.S.' conservative approach does not compare favorably to the specific, long-term plans of ... the European Space Agency ... nor to the plans of the Soviet Union and Japan."

"Whether the United States is to maintain its world leadership role in materials science as well as other areas of space development depends largely upon events of the next 15 to 20 years," the document notes. "The opportunity to be the world leader in space is still available if we choose to exercise this option." □



Future space products could include large semiconductors such as the GeS crystal (below), made on Skylab, compared to earth-bound versions one-eighth its size.



NASA

Nuclear waste policy unveiled by Carter

Admitting that "past governmental efforts to manage radioactive wastes have not been technically adequate," President Jimmy Carter outlined for Congress on Tuesday Feb. 12 his plans for the nation's first "comprehensive" radioactive-waste management program. Born out of recommendations by a 14-agency federal review group (SN: 3/24/79, p. 183), the plan seeks generic solutions for the permanent disposal of all types of wastes from all types of sources. A draft of the plan detailing specific goals, research programs and timetables should be available for public and congressional review by year's end.

Among the more controversial aspects of the Carter proposal is termination of WIPP — the Waste Isolation Pilot Plant (SN: 7/21/79, p. 47) that was to have housed high-level radioactive transuranic wastes generated by the Defense Department. Though WIPP's underground salt caverns in Carlsbad, N.M., may provide adequate safety, its military role would have made it exempt from licensing requirements set by the Nuclear Regulatory Commission — something the President says runs counter to his policy. The Carlsbad site will remain a candidate, however, along with 10 or more others as a possible dump for high-level commercial wastes.

And in an attempt to stem growing local opposition to proposed waste sites, Carter has established a State Planning Council. It will permit local input on siting, licensing and management issues via a 14-member advisory panel to Congress and the Executive Department. □

Benzyl esters as a desickling drug

The crisis in sickle cell anemia arises when a person's abnormal hemoglobin molecules take on a sickled shape after giving up oxygen to tissues. As a result, the red blood cells housing the hemoglobin molecules become sickled as well and clog blood vessels, causing excruciating pain and tissue damage. There are several tactics one can take to prevent such crises: Keep hemoglobin molecules from sickling, keep red blood cells from sickling, or both. The problem is to find an antisickling drug, particularly one that attacks at the molecular level, which has minimal toxicity for the rest of the body and which is easy and inexpensive to give. Now a class of compounds called benzyl esters of amino acids looks as if it might fulfill these requirements at least on the basis of test-tube and animal studies.

In 1977, Alexander Rich of Massachusetts Institute of Technology in Cambridge, Mass., and his colleagues