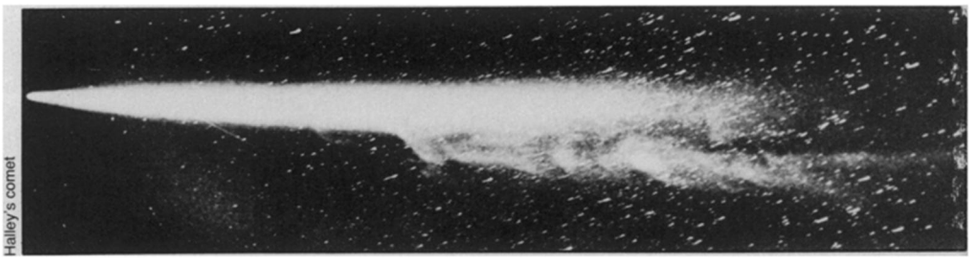
Space: A Push for the Primitives


Halley's comet

"Anyone who's optimistic about the U.S. planetary program," a U.S. space researcher recently quipped bitterly, "works for the Russians." Only a single new interplanetary mission — the Galileo orbiter and probe of Jupiter — is now in the works at the National Aeronautics and Space Administration, in contrast with the last decade of discovery, and even Galileo still gets threatened at various stages in the annual budget process. In such a climate, it may seem like blind faith indeed to be laying out strategy for major new explorations in the future, yet just such a step has now been taken. Its objectives, in fact, are what some might characterize as the lesser objects in the solar system — comets, asteroids, meteorites and even space dust.

The strategists are collectively known as COMPLEX, the COMmittee on Planetary and Lunar EXploration of the National Research Council's Space Science Board. The group is the only independent, non-NASA body formally charged with advising the space agency on the scientific questions to be addressed by its planetary probes, and its motivation is more than blind faith. Years of planning go into deciding what instruments such probes will carry, but before those decisions determine the limits of a spacecraft's capabilities, the U.S. planetary program's philosophy has long been to see first which questions are the essential ones, while choices can still be made. Such appraisals, all the more critical if space probes are to be fewer and farther between, are COMPLEX's job.

The group has taken a three-pronged approach to the solar system. In 1975, COMPLEX issued a report of recommendations regarding the outer planets — giant Jupiter, Saturn, Uranus and Neptune. More recently, it set forth proposed strategy for the rocky inner planets (SN: 1/13/79, p. 22), grouping the "terrestrial triad" of earth, Mars and Venus ahead of Mercury and earth's moon. But the solar system's major worlds do not hold all the answers. Overlooked in such a limited view are numerous other objects which, while smaller and mostly less spectacular, may hold the keys to the origin of the whole system — the cauldron from which the planets came. These are the system's "primitive" objects, the focus of the remaining third of the COMPLEX trilogy and the subjects of its latest report.

• Comets: Commonly thought to consist of a mixture of dust and ices or snows, comet nuclei are believed to contain condensates that may represent the earliest stages of the pre-solar nebula. "Through $4\frac{1}{2}$ aeons in deep-freeze at the fringes of the solar system," says the report, "comet nuclei have preserved volatile-rich materials and structures that would normally be transitory in our part of the solar system." The document recommends a number of specific detailed measurements that it feels should be made ("abundances of all atmospheric species with molecular weights in the range of 1-150 and which are present at relative concentrations by number in excess of 0.1 percent of the total") of the chosen comets' nuclei, dust, atmospheres and solar-wind interactions. In addition, however, although COMPLEX maintains that its role is to propose important questions rather than specific missions, the report asserts that answering the questions will require "rendezvous-mode investigations" — meaning a spacecraft that can match speeds with a comet and cruise beside it for long periods of time, rather than just streaking past on a ballistic trajectory. Before the report was even written, a rendezvous mission to comet Halley had failed to win budget approval, and a Halley flyby that would go on to rendezvous with a different comet also fell by the way. If a rendezvous is to take place, it is likely to be with a "lesser" comet than Halley, though it is at least conceivable that one of the various countries planning Halley flybys could use the occasion to eject an instrumented probe toward the nucleus. NASA had such a plan in its now-rejected two-comet mission, but COMPLEX notes that "the science objectives can be met during the next decade without undertaking to land on or penetrate a comet nucleus." Thinking of subsequent decades, however, the group suggests precursory studies for bringing a sample of a comet back to earth.

• Asteroids: These "seem to constitute an ordered assemblage of primitive planetesimals and their fragments in which there is preserved important information about the structure of the proto-planetary nebula and the processes that produced the planetary bodies of the solar system," notes the report. Also, "unlike comets, most asteroids probably condensed and accreted from the ... nebula somewhere near their current locations with respect to the planets." Some, in fact, may be better repositories of primitive, low-temperature materials even than short-period comets, which repeatedly approach the sun. COMPLEX again maintains that the necessary studies will require rendezvous missions, and with not just one, but a sufficient number of asteroid types to let researchers extrapolate their data to the wide variety in the general asteroid population. Research, says the report, should also be addressed to the possibilities of landing on selected asteroids.

• Meteorites: It has become more relevant than ever that meteorites deliver themselves to earth without the need for spacecraft, and state-of-the-art studies for several years have been contributing to theories of conditions before the solar system even formed. COMPLEX urges support for a "vigorous" program of laboratory and theoretical investigations. "To realize the full promise of meteorite research," says the report, "it is necessary to maintain laboratory capabilities at the highest level of evolving technology and to encourage the development of even more sophisticated analytical methods."

• Interplanetary dust: Possibly representing all the above sources and more in micron-sized chunks, spacedust is recommended by COMPLEX as a "high-priority" subject for "earth-orbital science." That involves the space shuttle, of whose problems (which could also limit the launchable weight of deep-space probes) COMPLEX urges "every effort" at solution.□

Saturn: Pinning down the spin

For years, the rotation period of Saturn was known only approximately, calculated from earth-based observations of a handful of features in the planet's cloud tops and made more difficult by the fact that the clouds move at different speeds at different latitudes. Early this year, a true, "internal" period was determined for the first time, using non-thermal radio emissions detected from Saturn by the two Voyager spacecraft. Now the accuracy of that measurement has been improved by 75 percent, with the calculated period becoming slightly shorter in the process.

With only 40 days of data to go on (the