

Across the Solar System

While astronauts stay home, unmanned probes will survey planets, asteroids and comets

by Jonathan Eberhart

Huge metal floats, bobbing through the Venusian sky. A map-making tour of the rings of Saturn. A rendezvous with an asteroid. Live television close-ups of a comet.

In the first 17 years of the Space Age, inaugurated by Sputnik 1 on Oct. 4, 1957, man lifted his horizons to the moon. In the next 17, U.S. astronauts will be confined to the space shuttle's orbits around the earth. The Lewises and Clarks will be robots—unmanned, automated space probes bound for all but the absolute farthest reaches of the solar system.

NASA is already well along in planning a skyfull of missions to visit every one of the sun's captive worlds save Pluto. Some will simply fly past their targets; others will settle into orbits around them, land on their surfaces, and even gather samples and return them to earth. Some will visit the tiny moons of the outer worlds, the craggy outposts of the asteroid belt and a variety of comets.

There is even the possibility of a flight that will deliberately avoid the planets by as wide a margin as possible, hunting for an area in the solar system's vicinity that resembles as closely as possible the vast reaches of interstellar space. Launched in 1988, it would be sent to find out what kinds of particles and fields populate the "empty" space that is undisturbed by the presence of planetary bodies.

This ambitious program will get right to the heart of the matter this fall with the launch of the first of two Helios probes that will give man his first close look at the sun. From barely 28 million miles out, closer even than Mercury (where daytime temperatures



NASA

The fabled rings of Saturn, 170,000 miles across, may be visited in the 1980's.

can melt lead), Helios 1 will be instrumented to study conditions ranging from the solar wind to cosmic rays to the residue of past comets. Solar physicists, still flushed with the sun-watching success of Skylab, will then have another close look through the eyes of Helios 2 in 1976. NASA is also considering a 1979-80 flight out of the plane of the ecliptic that would orbit the sun at a high latitude, possibly even crossing over its poles if a solar-powered electric propulsion system can be developed to provide a sustained push.

Plans for flights to Mercury could change when Mariner 10 makes the first flight past the planet on March 29, but the space agency's studies so far envision only a single pair of orbiters, both to be launched in 1987. In hopes of getting a really close look (Mariner 10 is planned to miss the planet by about 621 miles), one of them will be put into a long ellipse that gets as close as 110 miles, but then swings out to more than 13,000 miles so that Mercury's gravity will not pull the spacecraft down after only a few revolutions. The other probe will go into a circular orbit about 270 miles high, better suited for mapping the surface by television, infrared sensors and other instruments.

The center of attention, however, will be Venus. The cloud-wrapped world has already been investigated by more spacecraft than any planet but earth, but with each new look it becomes more enticing. NASA is weighing the chances for up to 12 Venus probes in as many years, beginning with a pair launched in 1978 that would eject clusters of soft-landing capsules into the atmosphere from as

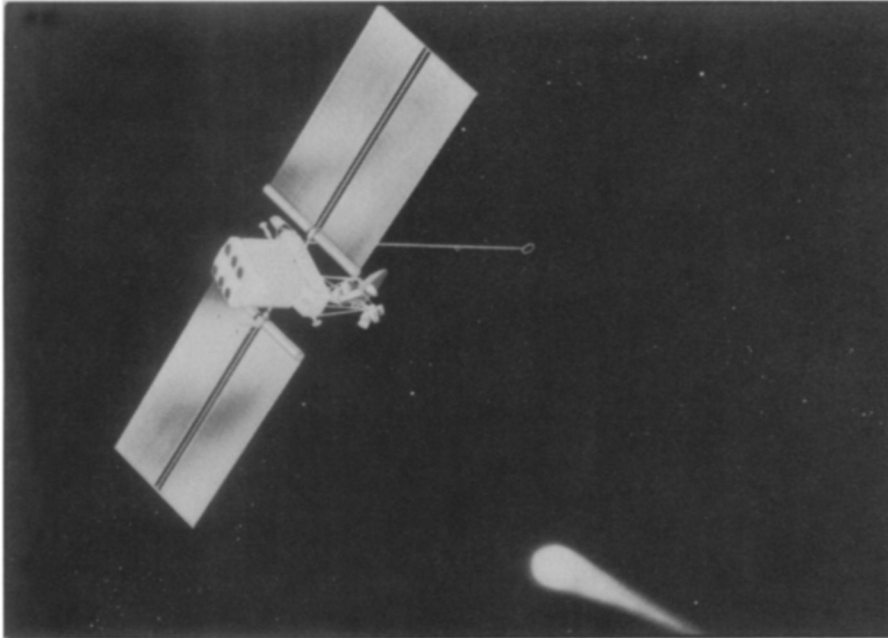
low as 80 miles. Two orbiters may be sent in 1983 to map the vapor-shrouded surface by radar, a tool that has proven useful for the task even from earth (SN: 8/4/73, p. 72).

One of the most exotic missions on NASA's tentative timeline is a 1985 plan for a pair of 15-foot metal floats to be turned loose in the dense Venusian atmosphere, armed with radar, laser altimeters and other devices to chart turbulence, winds and major circulation patterns as they bob about.

Four years later, at long last, the United States may send its first full-scale spacecraft to land on Venus' surface. (The 1978 capsules may survive their landing, says John Naugle, NASA associate administrator for Space Sciences, but the mission calls for them only to study the atmosphere all the way down.) The Large Lander will weigh in at an instrument-packed 3,700 pounds, about 50 percent more than the largest of the Soviet Venera probes that have already accomplished the task. It will carry TV cameras to study surface features as small as a few centimeters, along with devices to monitor seismic disturbances, weather and other phenomena.

Next out from the sun is earth, with its moon. NASA has not abandoned the moon, but it will be at least 1979 before a U.S. spacecraft visits it again, initially one in a path that will carry it over the poles only 60 miles above the surface. For an even closer scan the orbiter will in turn launch a tiny "sub-satellite," such as that carried by Apollo 16, whose lifetime could be as short as a few weeks or months.

A pair of Rovers, robot versions of the moonmobiles in which Apollo



NASA

A TV camera sent past Halley's comet may show earthlings what Kohoutek wasn't.

astronauts toured the terrain, may go in 1987 and 1988, followed by a satellite known as Halo. Halo is a communications satellite, to be placed in a fixed position 35,000 miles above the moon's far side, where it will be held by a unique balance of the gravitational attraction of the sun, moon and earth. Its sole occupation will be to relay communications between earth and a pair of complex craft that will land on the moon, explore the surface, gather samples, return to their landing site and take off again, bringing the samples home.

A Mars-bound flight that could turn out to be one of the most important events in history is already in the works. A pair of probes called Viking will be launched next year to land on the Martian surface, instrumented to look for the first concrete signs of extraterrestrial life. Another is tentatively set for 1979, to be followed five years later by two attempts to bring back samples of the surface.

In 1990 and 1991, the years when samples may be brought back by remote control from earth's moon, similar missions may also be launched to Deimos or Phobos, the moons of Mars, giving planetologists a chance to broaden their knowledge of natural satellites and their role in the solar system's evolution.

Between the orbits of Mars and Jupiter lies the famous asteroid belt. The largest of the asteroids, Ceres, is only about 470 miles across, and most are craggy, irregular chunks only a few miles through. (Pioneer 10 last year indicated that fears of a dense crowd of much tinier boulders, capable of shooting down any spacecraft that tried to get through them, seemed to be

groundless. It detected little if any increase in space dust compared with the rest of interplanetary space, perhaps because the large chunks sweep it up.) NASA hopes in 1986 to send a probe close by one of the larger asteroids, partly in hopes of finding out whether and when a supposed former planet was shattered by some ancient cataclysm to form the belt.

Jupiter has been visited once, by Pioneer 10, and Pioneer 11, already on its way, will repeat the feat in December. Most of NASA's planned future Jupiter flights will simply be zipping by the giant planet—taking a look on the way, of course—bound for still more distant worlds. There are no plans to try to brave the planet's crushing atmosphere to land on the surface, but in 1981 two spacecraft may be sent to study it from an orbit as close as about 90,000 miles. Then in 1984, two more could be aimed to actually pass through the atmosphere, probing the cloud structure with its weird bands of color moving at widely different speeds and perhaps getting a good look at last at the Great Red Spot. Still later—1990 and 1991 seem to be the Years of the Moons—probes may be sent to land on Ganymede or Io, Jovian moons which both show signs of having at least rarified atmospheres. Because of the power needed to combat Jupiter's mighty gravitational pull, however, such a moon landing would require a nuclear-powered rocket, a project presently on the shelf for financial reasons.

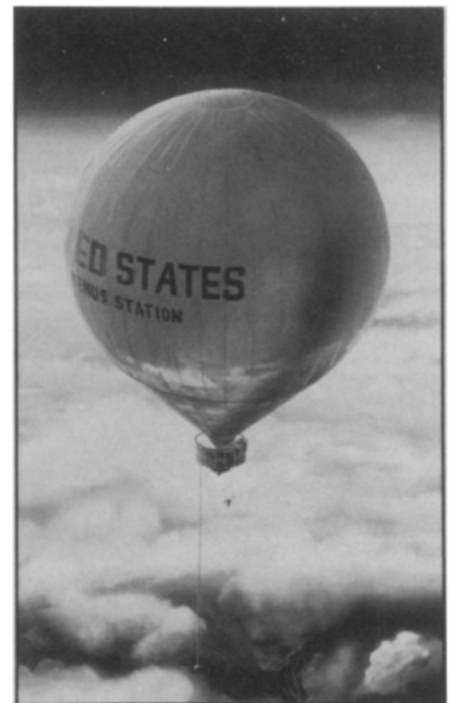
Ringed Saturn is certainly the showpiece of the solar system. Pioneer 11 will probably take the first look after swinging by Jupiter, followed by a larger Mariner spacecraft, three times

as heavy, launched in 1977 to visit Jupiter, Saturn and Saturn's moon Titan as well. A 1980 shot may dump a capsule into Saturn's atmosphere. The real spectacular, however, is a 1985 plan for a pair of spacecraft that would orbit the planet in a small ellipse that would carry them right through the rings themselves. Astronomers differ on whether the icy chunks comprising the rings would be likely to wipe out a passing spacecraft, so the results from the preceding flights will be critical. And again, sometime in the 1990's, there may be a mission to Titan, whose atmosphere some astronomers believe to be even thicker than that of Mars.

Beyond Saturn, planetologists are still very much in the dark. Uranus, innermost of those last three worlds, never gets closer than about 1.6 billion miles to earth, more than 17 times the distance from earth to the sun. Several Uranus probes are being considered, one of which, to be launched in 1986, would swing on by to distant Neptune, a journey from earth of almost seven years. (Keeping the flight even that short depends first on developing what NASA calls a "disposable tug," a full-scale rocket that would send the probe on its way from the space shuttle's orbit around the earth.)

Pluto will have to wait. It is just too far away (never less than about 2.8 billion miles), too little understood (one theory says it's an escaped moon of Neptune) and too demanding on propulsion technology, says NASA, for scientists even to judge whether it would be worth the expense.

(Continued on page 167)



Martin-Marietta

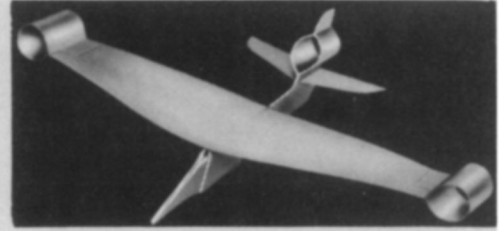
Balloons may hover in Venus' clouds.

(Continued from page 163)

Besides planets, moons and asteroids, there are comets in the tentative target plans. The big one, of course, is Halley's, due back by the earth in 1986. Astronomers are fairly confident that it won't be a visual fizzle like Kohoutek, and NASA's idea is a probe that would study its nucleus, coma (the vast hydrogen cloud, visible only by ultraviolet light, that extends tens of thousands of miles into space), visible halo and tail, with television as well as other instruments, from as close as 5,500 miles to the nucleus itself. A shot to Comet Encke may be launched in 1981 to fly only 55 miles away, an awesome prospect as well as valuable preparation for Halley's.

Budgets fluctuate. Public and Congressional opinion vary. It is possible that few or many of these missions may not survive the press of economic priorities. But all are being considered, some with possible European cooperation; many have been developed right down to the actual launch day. Though there is likely to be some sacrificing and corner-cutting, such as making single-probe missions out of double ones, says NASA Director James Fletcher, by the beginning of the 1990's, man's search for knowledge will have nearly covered the planetary domain of his home star. □

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