

## Solar system escape: How far is out?

What manmade object will win history's laurels as the first to leave the solar system, to escape the home star of its builders? Of the myriad spacecraft launched in the quarter-century of the Space Age, only four — two Pioneer probes and the two Voyagers — are truly outward bound, rather than locked in orbits around such hosts as the earth or even the sun itself. The first of them to depart the earth was Pioneer 10, which set out on March 2, 1972, later providing the first close look at Jupiter before heading off to parts truly unknown. And this week, at about 2 p.m. PDT on April 25, Pioneer 10 passed farther from the sun than Pluto, which is usually the most distant of the solar system's known worlds.

Usually, but not always. For unlike the other planets in their nearly circular paths, Pluto follows an orbit so elongated that, for about 21 years of its nearly 250-year trip around the sun, it is actually inside the orbit of Neptune. It is there now, making Neptune temporarily the outermost planet, and thus, in a sense, the "edge" of the solar system. Pioneer 10 will cross Neptune's orbit on June 13.

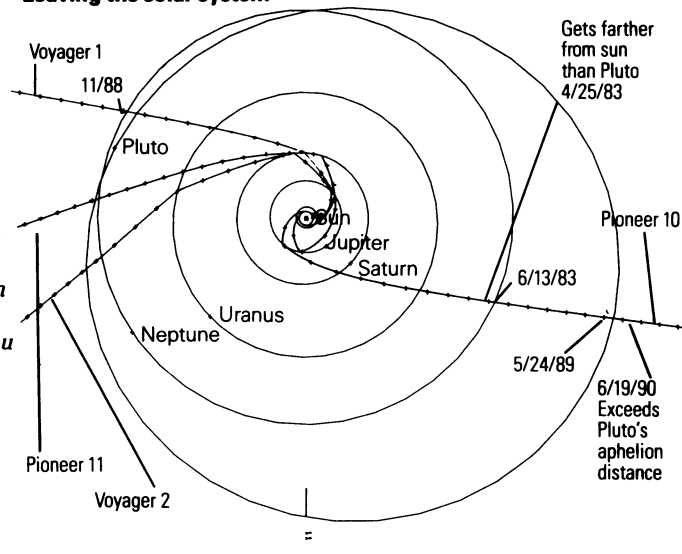
But is even that the edge? There is no official definition but there are plenty of unofficial ones from which to choose.

Although Pioneer 10 has exceeded Pluto's distance from the sun, for example, it has not crossed the planet's orbit, since the spacecraft is heading nearly away from Pluto itself, with the orbit's extended bulge far ahead of it. Thus, even with Neptune's orbit behind it, Pioneer 10 will not have crossed the orbits of all nine known planets. That honor will go to Voyager 1, which was launched five and a half years later, but on a course that will carry it in the direction of Pluto's inward excursion. It will not cross Pluto's orbit until late spring of 1988, but in November of that same year it will cross Neptune's as well, making it the first spacecraft to exit the nine planetary pathways.

On the other hand, one could still maintain that leaving the solar system as defined by the planets means exceeding the most distant planet's greatest distance from the sun, or aphelion. In that case, the advantage is again Pioneer 10's, thanks to its half-decade-long head start. It is also heading approximately in the direction of Pluto's orbital aphelion, but that is irrelevant, as is the fact that Pluto will be far around in its orbit when the spacecraft goes by. The point is that on about June 19, 1990, Pioneer 10's outbound journey will have carried it 7,375,174,991 kilometers from the sun, equal to Pluto's estimated aphelion distance (estimated, because the planet's orbital motion is imprecisely known), even though Pluto itself will not be that far away until about the year 2116.

*Four spacecraft are heading out of the solar system, with Pioneer 10 and Voyager 1 leading the way. Who will reach the edge first? It depends upon how you look at it.*

### Leaving the solar system



Robert J. Cesarone

A yet more remote "edge" could be defined as the heliopause, the boundary between the sun's magnetosphere and the interstellar "wind" through which the solar system is moving, like a vastly larger version of the interaction between earth's magnetic field and the solar wind. Its distance is unknown (guesstimates run as high as 20 billion km), and researchers are hoping that the four outbound probes will be able to signal their crossings by report-

ing the increased flux of cosmic rays expected to exist on the other side. Voyager 1 should be first, since its greater speed will by that time have made up for Pioneer 10's head start. It will also be helped by the fact that Pioneer 10 is headed down the solar magnetospheric "tail," with a longer path to follow before emerging from the heliopause.

Voyager 1 will also win if the edge is defined as the "Oort cloud," a region proposed by Dutch astronomer Jan Oort as the source of many long-period comets and variously estimated to be from about 6 trillion to 15 trillion km away. The comets, still weakly bound by the sun's gravity, would in a sense be part of the solar system, though the spacecraft may take 15,000 years or more to get there.

—J. Eberhart

## Foreign genes in plants

Normal petunia plants that produce a bacterial protein have been created by genetic engineering procedures. Monsanto Co. scientists and others recently announced that bacterial genes conferring antibiotic resistance had been transferred and functioned in plant cells growing in tissue culture. But at that time no plants had been regenerated from these cells (SN: 1/29/83, p. 68). Now scientists at Monsanto, in St. Louis, report they have produced several independent petunia plants that are completely normal in appearance, but pieces of the leaves can grow on media containing levels of antibiotic that normally would kill petunia cells.

Testing of genetically engineered plants has just been made simpler by a ruling of the Recombinant DNA Advisory Committee (RAC) of the National Institutes of Health. It applies to tests of a well-characterized gene inserted into a cultivated crop belonging to a genus containing no known noxious weeds, and to test areas isolated from other fields of the same crop. Under the new rule such tests require approval of the local Institutional Biosafety Committee and a small "plant working group" of RAC members. Previously for such testing researchers needed a formal exemption from the Committee's rules against deliberate release of recombinant organisms. □

## Soviet space docking fails

Three Soviet cosmonauts aboard their Soyuz T-8 spacecraft failed last week in an attempt to dock with the orbiting Salyut 7 space station, and returned safely to earth.

Soyuz T-8 was launched on April 20, carrying cosmonauts Vladimir G. Titov, Genady M. Strekalov and Alexander A. Serebrov in what Radio Moscow said would be "the first time that a piloted spacecraft will dock with such a huge space complex." The station's total weight was brought to about 40 tons last month with the addition of the unmanned Cosmos 1443 supply craft.

Western monitoring stations reported that the Soyuz and Salyut came within yards of each other, but never linked up. According to the Soviet news agency Tass, the docking was called off because the Soyuz strayed from its correct approach path to Salyut 7. The space station had previously served as home for two other cosmonauts during a mission lasting a record 211 days. □