Voyagers traverse asteroid belt

Voyager 1, only the third spacecraft ever to be sent into the asteroid belt beyond the orbit of Mars, has emerged safely from the belt's outer edge on the way to Jupiter, and Voyager 2 is expected to be "in the clear" by late October. The previous probes to make — and survive — the trek were Pioneers 10 and 11, which were also on their way to encounters with the giant planet.

The result within the Voyager project, however, does not seem to be the unclenching of whitened knuckles or the release of long-held breaths, so much as the pleased acceptance of confirmation of what was already suspected: that the asteroid belt is a relatively benign environment for passing space probes, rather than living up to old ideas of a debris-strewn minefield of the solar system.

Even before the two Pioneers blazed the trail, in fact, the planners of those missions were optimistic, citing earth-based calculations and observations of such phenomena as slight sky-brightenings due to sunlight reflected from small particles in space. To further evaluate the numbers and sizes of particles, the Pioneers each carried an array of sealed, gas-filled cells in which punctures by dust-sized grains could be detected by drops in the gas pressure, while larger particles were monitored by small telescopes that recorded the changing sky-brightness in their field of view. The tiniest particles — from about a thousandth of a millimeter to a millimeter across — could not damage the spacecraft, but they could be used in calculating the population of larger chunks.

The key evidence, of course, was that both Pioneers survived, a result which, for all the pre-launch optimism, was not a foregone conclusion. The flight data further showed that the littlest particles measured (about 0.001 mm) actually got *fewer* in number with increasing distance from the sun. Those of about 0.01 to 0.1 mm stayed about the same, with essentially no measurable increase in the belt. The 0.1 to 1.0 mm particles rose to perhaps three times their near-earth numbers in the belt. The larger chunks were rare indeed: Pioneer 10, for example, saw only seven particles from 15 to 150 mm across in their more than 200 million km trip across the belt. "From a hazardous particle point of view," says one NASA summary, "there appeared to be no asteroid belt."

The two Voyager spacecraft, in fact, carry no small-meteoroid detectors at all, though the designers did make some changes to be on the safe side. Some movable louvers were re-oriented, an exposed radiator panel was protectively sandwiched, and some thermal "blanket" material was given an extra outer layer to break up possible small impacting particles.

The really big particles — the full-fledged asteroids, from one to hundreds of kilometers across — are hardly considered a problem at all, since they are millions of kilometers apart and can mostly be tracked by telescope from earth. Voyager scientists were disappointed prior to the launches, in fact, when revised data showed that neither spacecraft would be going close enough to the asteroid 92 Undina to take its picture.

Even with the probes on their way, says Voyager mission planning manager Charles E. Kohlhase, a computer check was made to see if any known asteroids might be within range of some of the instruments aboard, even if the distances were too great for photography. The brightest, with an apparent visual magnitude of about 6.5 to 7.5, was indeed Undina, Kohlhase says, but Voyager 1 came no closer than 16.8 million km on May 28, and Voyager 2 got only slightly nearer — 14.68 million km — on June 22.

One attempt was almost made. The computer check showed that asteroid 212 Medea, about 84 km across and visible as a magnitude 9.2 object, would come within 15.87 million km of Voyager 1 on April 6, making it a possible candidate for photometric and polarized-light studies. The "encounter sequence" of instructions was actually drawn up — a months-long procedure — and even transmitted to the spacecraft's on-board computer. But then, with barely six weeks to go, the movable "scan platform" carrying the instruments stuck during a test, and the plan was abandoned. The problem has now apparently passed — but so has Medea.

More and more mass: Universe is closing

You can't find an empty spot any more. Relatively, that is. Astronomical discoveries are showing that no place in the universe seems to be truly empty. First they found that galaxies are pervaded by clouds of gas. Then they found gas between galaxies, gas clouds pervading whole clusters of galaxies. Now it's gas between the clusters, in the last of the old open range, so to speak.

A huge cloud of gas that pervades two distant clusters of galaxies in the constellation Aries, called Abell 401 and 399, and the space between and beyond them has been found by X-ray observing equipment on the satellite HEAO-1. The finding is being presented this week at the meeting of the American Astronomical Society's High Energy Astrophysics Division in San Diego by Melville P. Ulmer of Northwestern University and R. Kinzer, R. G. Cruddace, K. Wood, W. Evans, E. T. Byram, T. A. Chubb and Herbert Friedman of the Naval Research Laboratory.

The gas was discovered by its X-ray emissions, and its extracluster character is attested to by the finding that the peak X-ray brightness comes from a point in the space between Abell 401 and Abell 399. A lunar occultation was used to determine that datum. The moon's position has been well charted for centuries, and, as it moves across the sky, the location of its leading edge is more accurately known than the pointing of the X-ray equipment on HEAO-1 — or of many telescopes on earth, for that matter. As the moon's edge passed in front of Abell 401 and 399, it cut off one part of the X-ray flux after another. At the moment it cut off the peak of the X-rays it was known to be positioned between two clusters.

One purpose for studies of this kind is to try to settle the question whether the universe is open or closed. An open universe would expand endlessly, to what end nobody really knows. A closed universe would someday stop expanding and begin to collapse back. To close the universe requires a force of gravity in the universe strong enough to stop the expansion. That requires a certain amount of mass in the universe to provide the force.

Observing the visible stars, astronomers have calculated that the total they can see would account for only 10 percent of the needed mass. A closed universe seems to many minds tidier than an open one, and so the problem has tended to become one of "missing mass." Various suggestions have been made, but gas clouds are now more seen as the thing. To quote Friedman: "The new X-ray evidence places most of the 'missing' mass in primordial gas, left over from the epoch of galaxy formation." In the present observation the mass of the cloud can be calculated (from the X-ray brightness) at 10^{12} times the sun's mass. If all the clusters in the universe are similarly equipped, it indicates a closed universe. □

Soviet Venus probe

The last month of 1978 will be a busy one at Venus. The U.S. Pioneer Venus orbiter will enter its elliptical path around the cloud-shrouded planet on December 4, and five days later four Pioneer Venus probes (plus the instrumented "bus" that carried them from earth) will enter the planet's atmosphere and take readings all the way down to the surface. But there's more. On September 9, an unmanned Soviet spacecraft was launched toward a Venus rendezvous that is also due in December. Initial Soviet accounts did not specify the nature of the spacecraft, called Venera 11, through they did mention the intent to carry out solar-wind, ultraviolet, cosmic-ray, gamma-ray and "Roentgen-ray" studies "in the vicinity of Venus." Past Soviet Venus missions have included "flybys," orbiters and landers, and there have been proposals for sending balloon-like probes that could float at different altitudes in the planet's atmosphere. □