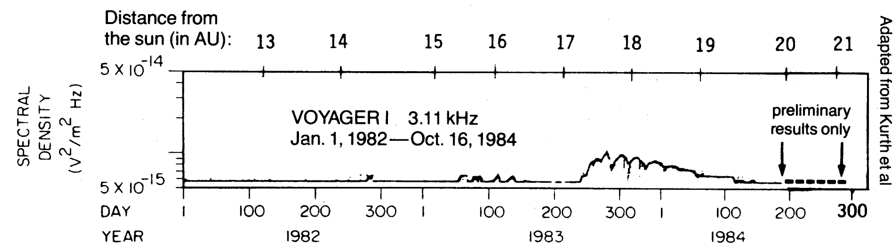
A message from the heliopause?

On June 13, 1983, the Pioneer 10 spacecraft became the first man-made object to get farther from the sun than all nine of the known planets (SN: 6/11/83, p. 373), and soon Pioneer 11 as well as Voyagers 1 and 2 will do the same. Beyond them all, however, is a still more distant frontier: the heliopause, the vast "bubble," or boundary, where the sun's magnetic field interacts with the "interstellar medium." As to the nature of the heliopause, there are so far only theories. But now the two Voyager probes, outbound following their encounters with Jupiter and Saturn, have picked up radio signals that a group of scientists thinks may be the first evidence of the heliopause ever detected.

The spacecraft are certainly not there yet, and except for radio tracking of their trajectories, the only actual data showing that they are even approaching it have been their measurements of a gradual rise, year after year, in the number of galactic cosmic rays. In the spaces among the stars, the cosmic-ray "flux" is presumed to be relatively constant, but keeping them away from the sun itself (as with other stars) is the constant outpouring of particles and magnetic fields called the solar wind. Farther out in the solar wind, therefore, the number of cosmic rays is greater, and where the solar wind has vanished completely, the cosmic ray count will presumably level off.

The researchers speculate that what the Voyagers have recorded are radio waves caused by electrons that are accelerated through a "plasma" of charged particles, setting up oscillations that make the plasma act, in effect, as a transmitter. A key element of the idea, however, notes William S. Kurth of the University of Iowa in Iowa City, lies in the nature of just what accelerates those electrons. In what would be a much smaller-scale example of the same phenomenon, the solar wind collides at supersonic speed with *earth's* magnetic field, setting up a shock wave that, indeed, accelerates electrons that have been detected (along with the resulting radio waves) by various spacecraft. But is there such a shock wave along the heliopause at all to trigger the Voyagers' "evidence"? Or are the signals from elsewhere?

James A. Van Allen of the University of Iowa says, for example, that the helio*sphere* — the sun's magnetic field — appears to move through the interstellar medium at far less than supersonic speeds, too slowly to produce a shock. On the other hand, Frederick L. Scarf of TRW Inc. in Redondo Beach, Calif. (a colleague of Kurth's in the heliopause suggestion, being published in the Nov. 1 NATURE), notes that the solar wind's collision with the interstellar medium may well be



Readings from Voyager 1's plasma-wave detector as it heads out of the solar system may represent the first emissions ever detected coming in from the boundary of the sun's magnetic field. (Dashed line adds early analysis of data through Oct. 16.)

supersonic, just as it is with the magnetic field of earth. The two Voyagers, when they get there, should be able to answer the question.

But when will that be? Among other question marks is that no one knows how far away the heliopause actually is. Voyager 1, which is in better condition than its twin to record the specific signals that have caused all the interest, is now about 22 astronomical units (AU) from the sun (1 AU, the mean distance between the earth and the sun, is about 150 million kilometers). Various researchers have estimated that the heliopause may be anywhere from 50 to 100 AU out, and those wide-ranging figures all come from scientists who have taken into account the measured increases in cosmic rays at greater distances from the sun.

Kurth and his colleagues (Scarf, Donald A. Gurnett from U. of Iowa and Robert L. Poynter from Jet Propulsion Laboratory in Pasadena, Calif.) base their estimate not on cosmic-ray fluxes at all, but on their proposed mechanism for how the emissions detected by the Voyagers may be generated. If it is correct, they predict, the heliopause should lie somewhere on the low end of the range proposed from the cosmic-ray data, possibly as close as 46 AU — where Voyager 1 will be in 1991 — or even closer. But the Kurth group's method has its uncertainties too.

Furthermore, the researchers point out, it is not actually certain that the emissions were caused by the heliopause at all. "What we've really discovered," says Kurth, "is only a radio emission that we didn't know before. We haven't established its source." Another possibility, for example, could be that radiation trapped in the "tail" of the magnetic field of Jupiter travels down the tail until it gets to where the solar wind's density is low enough for the radiation to spread out toward the spacecraft. But that idea, too, has its problems, as do possible sources at Saturn, Uranus and even yet-unidentified places *beyond* the heliopause.

Radio emissions notwithstanding, the heliopause is out there, the edge of the whole electromagnetic domain of the sun. The sun's gravitational influence extends thousands of AU farther still, but the heliopause is likely to be the most remote solar system boundary accessible to measuring devices sent from earth for lifetimes to come. And four spacecraft are on their way for a look. *—J. Eberhart*

Substance P proposed as arthritis factor

Substance P is a short protein that evidently wears several hats. It is purported to transmit signals from nerve to nerve, as well as regulate the strength of signals sent via other neurotransmitters (SN: 6/27/81, p. 407). And now it's been assigned a role in arthritis, as a possible link between the nervous system and the immune system. As such, it would present a target for intervention.

Arthritis is thought of primarily as an immune system disease, but it has some quirky nervous system associations. Rheumatoid arthritis, which normally strikes bilaterally, hits only the unaffected sides of stroke victims. And arthritis flare-ups are sparked by stress.

Substance P may be the nervous system-immune system link, causing or exacerbating the inflammation present in arthritic joints, say researchers from the University of California at San Francisco (UCSF) and Massachusetts General Hospital in Boston. "The severity of arthritis can be attributed, at least in part, to actions of substance P in the affected joint," they report in the Nov. 2 SCIENCE.

In tests on rats with experimentally induced arthritis, they found that joints most prone to arthritis have more substance P-releasing nerves and higher concentrations of the protein than less affected joints. In addition, substance P injections make the arthritis worse.

"It follows that attempts to [somehow] diminish substance P levels in these joints may prove effective in reducing the inflammation and tissue destruction," the researchers report.

There are receptors for substance P on immune system cells, notes Jon D. Levine, one of the UCSF researchers involved in the study, and substance P could be working by stimulating inflammation in arthritic joints. "It could be directly affecting the function of cells of the immune system or it could be by some other method of action," he says. *— J. Silberner*