SCIENCE NEWS OF THE WEEK

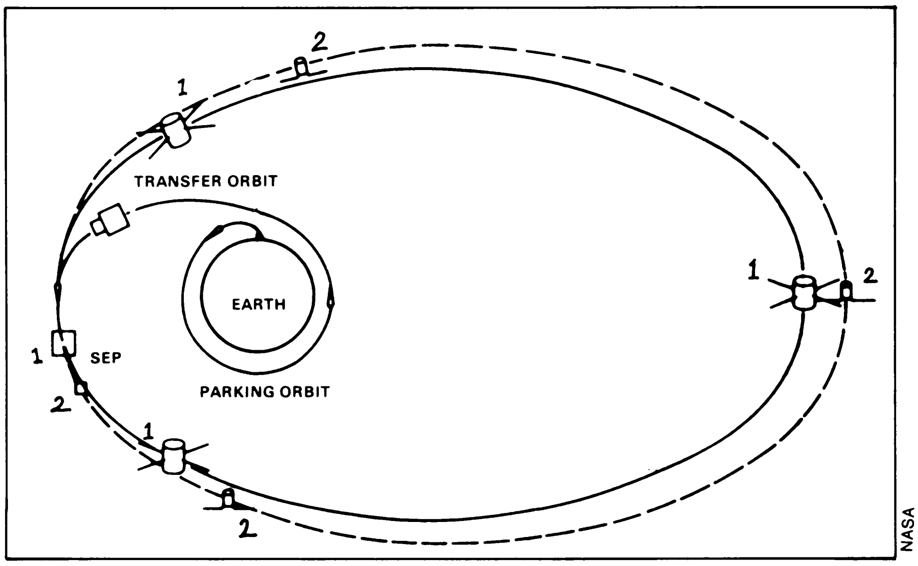
ISEE: Staking Out Earth's Magnetosphere

It's all in one's point of view. An oft-cited Peace Corps-style exam question is a picture caption asking, "Is this glass of water half empty or half full?" The same question can be posed in the study of the earth's magnetic field, which is now receiving worldwide emphasis as a result of the International Magnetospheric Study. Earth's magnetosphere can be looked at as a region filled with charged particles and other phenomena whose travels and behavior patterns are controlled by the planet's magnetic lines of force. But it is also possible—and equally relevant—to see the magnetosphere as a region from which certain outside influences, notably the solar wind, are *excluded*.

As with the water glass, both views are valid. The magnetosphere holds the solar wind at bay, but it also accepts contributions from it, such as the particles that comprise a substantial portion of the planet's trapped-radiation belts. In addition, the solar wind helps to define the field's shape, producing the long wake, or magnetotail, that stretches out "behind" the earth away from the sun. The shape and internal structure of the field are known in considerable detail. Less certain, however, is how the interior of the field responds to specific disturbances from the sun. In other words, we see the results, but how do they get that way?

On Oct. 22, a pair of satellites were launched as the beginnings of a three-satellite family designed specifically to find out. The probes are orbiting the earth in nearly identical, highly elliptical paths that range from as close as 280 kilometers to the planet out to more than 138,000 km. The elongated orbits mean that the satellites can not only study near-earth effects, but also pass through the bow shock where the solar wind collides with the magnetosphere on the planet's sunward side, and make excursions well down the length of the magnetotail on the side of earth away from the sun.

While these two probes are monitoring the behavior of the magnetosphere, the third satellite, to be launched next July, will be working much more closely to the sun, observing the solar perturbations that produce the near-earth effects. To keep the third satellite on the sun-earth line, it will be stationed about 1.5 million km from earth at a "libration point" where the gravitational attraction of the sun will be exactly balanced by the combination of the earth's gravity and the centrifugal force on the satellite. Actually, it will not be right *at* the libration point, but will circle around it (orbiting the sun-earth line) on a radius long enough to place it outside the disk of the sun as seen from earth; this is so the sun's own radio noise will not cause interference in the data being received from the satellite.



Two satellites from one launch provide complementary views of magnetosphere.

The three satellites are known as International Sun-Earth Explorers (or ISEEs) 1, 2 and 3. The larger of the two satellites launched last week, ISEE-1, was built by the National Aeronautics and Space Administration, while ISEE-2 was provided by the European Space Agency. In their similar orbits, the two probes essentially will be travelling one behind the other, with the distance between them varying between hundreds and thousands of kilometers so that they can study magnetospheric phenomena over a range of sizes. The carefully calculated orbit (the differences between the two are trivial) had to satisfy several scientific requirements: It had to produce a maximum number of bow-shock crossings, some of them early in the mission, as well as some crossings of the region known as the "neutral sheet" in the magnetotail. In addition, the orbit had to be stable enough to hold up for a mission of at least three years, and it had to be such that the satellites would not be blocked from the sun by the earth for more than six hours at a time.

ISEE-3, which will also be provided by NASA, will have its own unique orbital demands. It will be the first spacecraft intended to reside at a libration point (other libration points have been proposed as sites for possible future space "colonies"), and its interference-avoiding "halo orbit" will have to be large enough to allow for solar flares. (It would be ironic if radio interference created by such an event drowned out the satellite's data on the same event.) Furthermore, the halo will have to be adjusted from time to time so that its plane stays perpendicular to the earth-sun line.

Heavily instrumented to monitor particles, fields, plasmas, X-rays, cosmic rays, magnetic fields, radio waves and other phenomena, the ISEE satellites are thus equipped to address questions that were more difficult or impossible to answer using probes in less-coordinated orbits. As detected by a single satellite, for example, a sudden change in the number of high-energy particles may indeed have originated with some event on the sun, but it may also be nothing more than particles somehow released from earth's own radiation belts. Or the problem may be compounded if the particles have been deflected or changed by an encounter with the bow shock. The two earth-orbiting ISEEs, observing from different points in essentially the same orbit and with similar instrumentation, should be able to eliminate some of the ambiguities, and the addition of ISEE-3 promises an even better chance by identifying the solar events before they even get to earth.

Understanding of the earth's magnetic field has grown rapidly from its paltry state of 20 years ago, which, not coincidentally, is just about how long ago the first man-made satellites began going aloft to take their measurements. But there is still a lot to learn, even in areas that are supposedly well in hand. It was this year, for example, that researchers reported the discovery (SN: 6/11/77, p. 378) that a substantial portion of the trapped particles in earth's radiation belts come not from the sun, but from the earth's own atmosphere.

Nearly 50 satellites, including the ISEEs, are involved in the International Magnetospheric Study (SN: 1/3/76, p. 6), a 40-nation, multi-year effort with 7 overall areas of research and more than 1,000 individual scientific projects. □