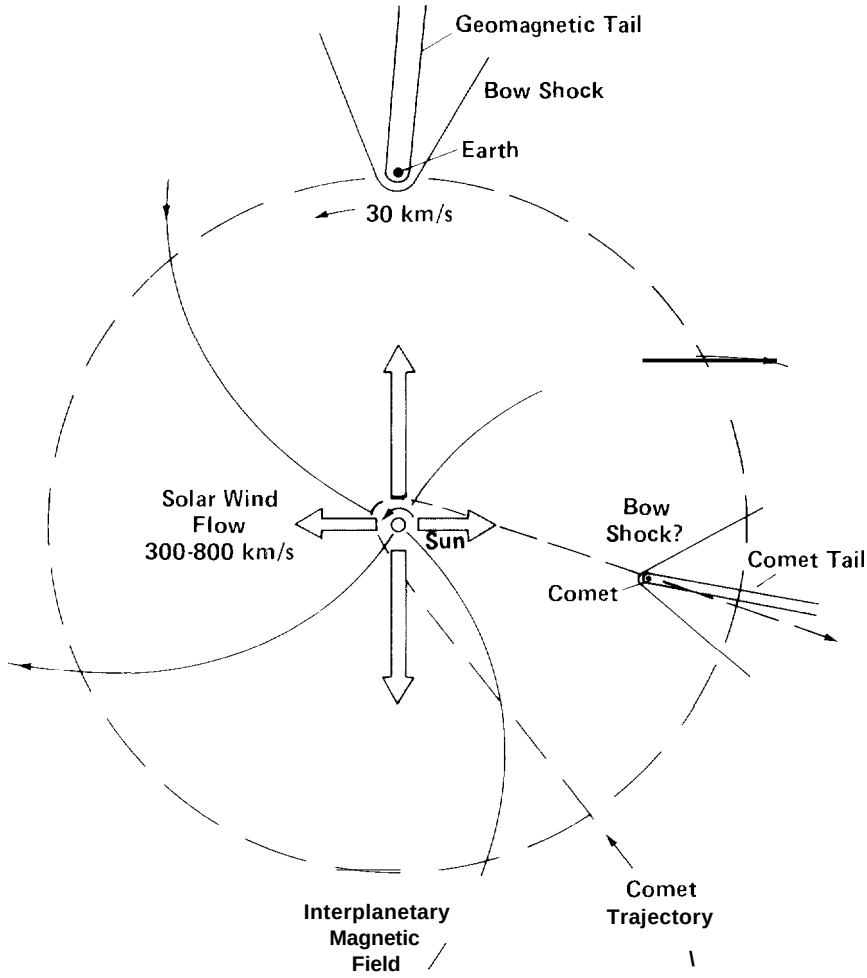
The Solar Wind

The sun's outer atmosphere, the corona, has been familiar to man for many centuries as the faint silvery glow surrounding the black disk of the moon during a total eclipse of the sun. Only in recent years, however, has man learned that the corona pervades the entire solar system as a wind of ionized gas, gusting outward from the sun at speeds that vary from 300 to 800 kilometers per second (see figure). This wind is a consequence of the million-degree temperature and the high thermal conductivity of the ionized coronal gas. These conditions produce such a high and extensive thermal pressure that even the enormous gravity of the sun is insufficient to contain the corona as a static, bound atmosphere.

As the solar wind rushes outward, it carries frozen within it a remnant of the sun's magnetic field. If the sun did not rotate, the resulting interplanetary magnetic field would be nearly radial. Solar rotation (once about every twenty-seven days as viewed from the earth) forces the interplanetary field into an Archimedean spiral (when viewed from above as shown in the figure). The polarity of the field, that is, whether it is directed away from or toward the sun, depends on the polarity of the field at the sun where the flow of plasma originates. Because the solar magnetic dipole is generally inclined significantly to the solar equator, the polarity of the solar wind field at earth tends to reverse sign two or more times per solar rotation.

The major constituents of the solar wind plasma are protons and electrons. Typical solar wind densities measured at the earth are about 10 particles per cubic centimeter, whereas typical field strengths are 5×10^{-5} gauss, By way of comparison, the particle density of the earth's atmosphere at sea level is about 3×10^{19} per cubic centimeter, and the earth's magnetic field strength at the poles is 0.6 gauss. Despite the dilute nature of the solar wind plasma and the weakness of the interplanetary field, the flow of the solar wind determines the overall shape of the earth's magnetosphere. Further, as observations from satellites have shown, the orientation of the interplanetary magnetic field controls the transfer of mass and energy from the solar wind to the magnetosphere, and this transfer is the cause of auroral disturbances and geomagnetic activity. ■



The solar system is filled with a supersonic solar wind Mowing nearly radially outward from the sun. Embedded in the flow is a remant of the solar magnetic field, which, however, is not radial but is bent into an Archimedean spiral by the rotation of the sun. The flow of the solar wind past the earth produces a stretching of the earth's magnetic field into a long, tail-like structure an the nightside and causes a detached bow shock to form on the dayside. This geomagnetic tail is similar in some respects to the ionic tail of a comet, which results from the interactions of the solar wind with gases emitted from the head of the cornet.