The Solar Wind as a Laboratory for the Study of Magnetofluid Turbulence

The solar wind is the Sun's exosphere. As the solar atmosphere expands into interplanetary space, it is accelerated and heated. Data from spacecraft located throughout the heliosphere have revealed that this exosphere has velocities of several hundred kilometers/sec, densities at Earth orbit of about 5 particles/cm^3, and an entrained magnetic field that at Earth orbit that is about 5 10^{-5} Gauss. A fascinating feature of this magnetized plasma, which is a gas containing both charged particles and magnetic field, is that the magnetic field fluctuates in a way that is highly reminiscent of "Alfvén waves", first defined by Hannes Alfvén in 1942. Such waves have the defining property that the fluctuating magnetic fields are aligned with fluctuations in the velocity of the plasma and that, when properly normalized, the fluctuations have equal magnitudes. The observed alignment is not perfect and the resulting mismatch leads to a variety of complex interactions. In many respects, the flow patterns appear to be an example of fully developed magnetofluid turbulence. Recently, the dissipation range of this turbulence has been revealed by Search Coil magnetometer data from the four Cluster spacecraft. This tutorial will describe some of the properties of the large-scale and small-scale turbulence.