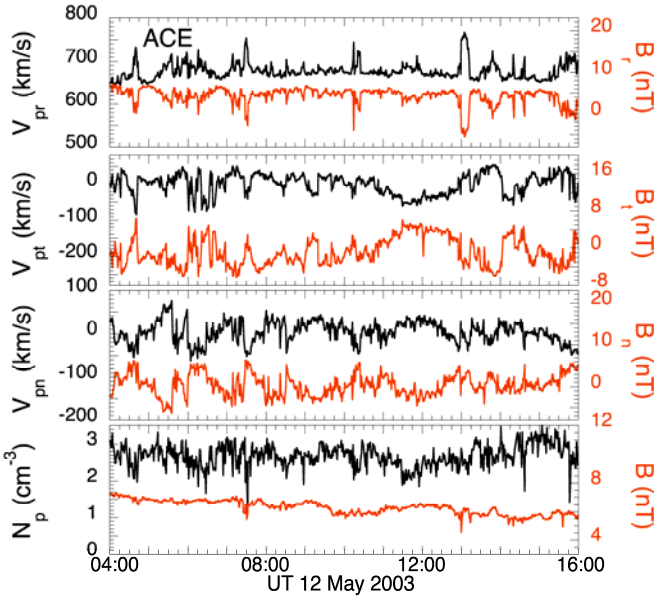
ACE News #121 – April 10, 2009
A One-Sided Aspect of Alfvénic Fluctuations in the Solar Wind



Observations by the plasma and magnetic field experiments on ACE have revealed a characteristic one-sided aspect of Alfvénic fluctuations in the solar wind that has not previously been reported. Alfvénic fluctuations fill much of the solar wind and are characterized by coupled changes in the magnetic field and flow velocity vectors, ***B*** and ***V***, respectively. Previous analyses have revealed that the fluctuations propagate predominantly away from the Sun along ***B***, suggesting that they are largely the evolved remnants of fluctuations that originate inside the point where the solar wind flow becomes super-Alfvénic. The fluctuations are thought to contribute substantially to the heating and acceleration of the wind. The figure above shows plasma and magnetic field data from ACE in heliocentric r, t, n coordinates obtained when the spacecraft was within the core of a high-speed stream from a coronal hole. Throughout the 12-hr interval shown the fluctuations in all components of ***V*** and ***B*** were strongly anti-correlated, while the proton density and the field magnitude were relatively constant. In contrast to the fluctuations in the t and n components, which appear to be random, the fluctuations in V_r and B_r appear as one-sided pulses of variable duration relative to slowly varying base values. This one-sided aspect of the r-component of the fluctuations is characteristic when B_r is the dominant component of the underlying magnetic field. Similarly, we find that when B_t is the dominant component of the underlying field, the fluctuations in the t-components of ***B*** and ***V*** are one-sided relative to slowly varying base values (not shown here). The one-sided pulses in V_r (V_t) are always positive (negative) when B_r (B_t) is the dominant underlying field component independent of the sign of the base B_r (B_t) value.

The one-sided aspect of the fluctuations is a natural consequence of the transverse nature of Alfvénic fluctuations in which |***B***| is ~ constant. If one considers the simple case of an underlying radial field directed outward from (inward toward) the Sun, fluctuations in either or both of the transverse field components necessarily force B_r to become less positive (less negative) so as to keep |***B***| ~ constant. In either case, the outward-propagating fluctuations also must produce increases in V_r relative to an underlying base value since changes in ***V*** and ***B*** are anti-correlated (correlated) for Alfvénic fluctuations propagating parallel (anti-parallel) to ***B***. A similar situation prevails for the t-components of ***V*** and ***B*** if the underlying field direction is transverse to the radial direction in the solar equatorial plane. For more general orientations of the underlying **B** the situation is more complicated and the effect is more difficult to detect using data in r, t, n coordinates, although it must always be present. This one-sided aspect of Alfvénic fluctuations in the solar wind suggests that conclusions derived from statistical analyses of the fluctuations, including determinations of the field direction underlying them, that assume the fluctuations in all field components are relative to average values need to be re-examined.

Contributed by J. T. Gosling of the University of Colorado. Address comments or questions to jack.gosling@lasp.colorado.edu. For details see Gosling et al. ApJ, 695, L213-L216, 2009. *See http://www.srl.caltech.edu/ACE/ACENews_Archives.html for additional ACE News items.*