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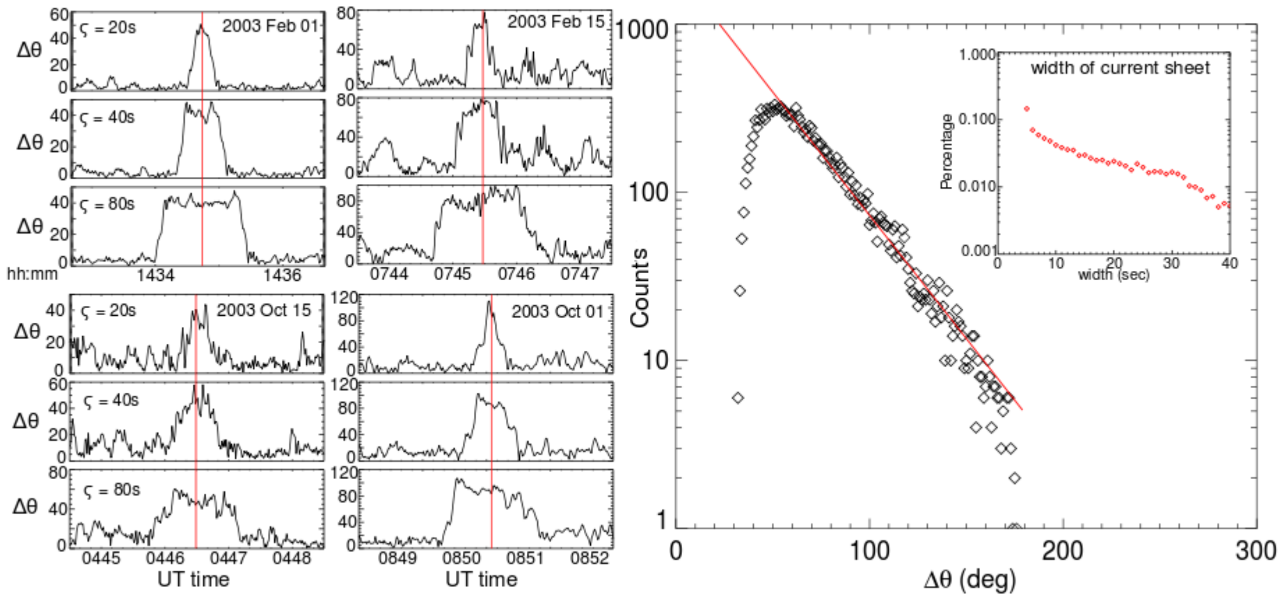
# Current Sheets as Intermittent Structures: ACE/MAG Observations

Current sheets are common structures in the solar wind and are a significant source of solar wind MHD turbulence intermittency. In a collisionless plasma such as the solar wind, intermittency arises because fluctuations of the magnetic field and fluid velocity are not scale invariant as conjectured by the Kolmogorov (1941) theory. Roughly speaking, intermittency reflects how turbulence is unevenly distributed in space. In the solar wind, current sheets are signified by a sudden change of magnetic field direction in a small distance (or a short duration at the spacecraft).




Numerical simulations (Chang et al. 2004, Zhou et al. 2004) have shown that current sheets can arise from non-linear interactions of MHD turbulence. However, recently Borovsky (2008, 2009) has argued that these structures may represent the magnetic walls of flux tubes that separate solar wind plasma into distinct bundles and that the flux tubes are relic structures originating from the boundaries of super-granules on the surface of the Sun.

The analysis of Borovsky did not identify individual current sheets and their physical properties. Li (2008) developed a method that allows identification of individual current sheets. Using this method with high-time-resolution magnetic field data from ACE/MAG, we analyzed magnetic field data for all of 2003 and identified 15410 current sheets. Four examples of these structures are shown above in the left panels. The essence of the method is to examine the angle between the vector magnetic field at time t, B(t) and at time (t + $\zeta$), B(t + $\zeta$), as well as the $\zeta$ dependence. In doing so, a current sheet will present itself as an isosceles trapezoid or triangle as illustrated in the left panels above. In all panels, three $\zeta$ values are considered and the red vertical line is the location of the center of the current sheets. The width of the current sheet is the difference in length of the bottom and upper segment of the trapezoid. Another property of a current sheet is its deflection angle -- the angle between the average magnetic field directions across the current sheet. As shown in the right panel above, the deflection angle has an exponential distribution ~ $\exp(-\Delta\theta/\theta_o)$, with $\theta_o = 29°$. The width of individual current sheets is also distributed exponentially (see the inset), although not as nicely as the deflection angle. In the scenario proposed by Borovsky, the deflection angle can be thought of as the relative change of the directions between adjacent flux tubes and the width of the current sheet is a rough measure of the transition layer (the width also depends on the relative orientation between the solar-wind speed and the flux tube direction). However, our method does not make assumptions about the origin of these current sheets. Whatever their origin, our method provides a nice tool to study physical properties of these structures.

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