

**The Relationship Between Discontinuities and Alfvén Waves
As Functions of Radial Distance and Latitude: Ulysses**

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We examine the normalized rate of occurrence of discontinuities as Ulysses travels from 1 to 5 AU and then to high heliospheric latitudes. High discontinuity occurrence rates are found in two regions of interplanetary space: in stream-stream interaction regions and in Alfvénic wave intervals typically associated with the trailing portions of high speed streams. For the latter case, the discontinuity rate remains high even as the Alfvén wave amplitude declines. The relationship between discontinuities and Alfvén waves becomes particularly clear at high latitudes. As Ulysses enters a high-speed stream from a polar coronal hole, the field is characterized by continuous Alfvén waves with $\delta B/B \approx 1 - 2\%$. The discontinuity rate is ~ 15 (Yday, approximately 2-3 times higher than that found in the ecliptic plane at 1 AU. We have also examined the detailed relationship between these discontinuities and Alfvén waves. We find that at times the discontinuities are an integral part of the Alfvén waves, comprising $\sim 180^\circ$ phase rotations and the slow rotating part of the Alfvén waves, the return $\sim 180^\circ$ phase rotations. We argue that these nonlinear Alfvén waves have been steepened and the discontinuities represent the steepened edges.

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