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Solar wind speed and rotational shear at coronal hole boundaries and streamer stalks, impacts on magnetic field inversions

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The solar wind is frequently perturbed by transient structures (magnetic folds, jets, waves and flux-ropes) that propagate away from the Sun over a large range of heliocentric distances. Parker Solar Probe has detected a large number of these at small heliocentric distances, together with surprisingly large solar wind rotation rates. Sun-to-spacecraft connectivity analysis shows that a large fraction of the corresponding solar wind flows were formed and accelerated in the vicinity of polar coronal hole boundaries.

We show via global MHD simulations that coronal rotation is highly structured in proximity to those boundary regions, in agreement with SoHO/UVCS synoptic observations and possibly with future Solar Orbiter/Metis campaigns. Enhanced poloidal and toroidal flow shear and magnetic field gradients also develop on such boundaries, and some regions can develop field-aligned and/or transverse vorticity. Some of these wind shears are noticeable tens of solar radii away from the surface, and therefore have a potential impact on the propagation of such magnetic perturbations across extended heights in the solar wind. We conclude that these regions of persistent shears are undoubtedly sources of complex solar wind structures, and suggest that they can trigger instabilities capable of creating magnetic field reversals detected in-situ in the heliosphere.

Our simulations furthermore indicate that the spatial structure of the solar wind shear will become more complex as the solar cycle progresses, with strong and extended shears appearing at heliographic latitudes that will be probed by Solar Orbiter in the near future.

Student poster?

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