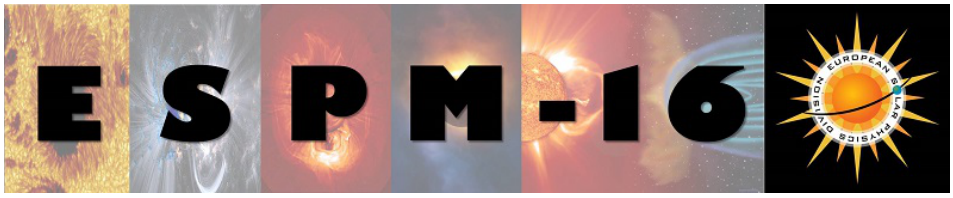

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Flux tubes and energetic particles in Parker Solar Probe orbit 5: magnetic helicity–PVI method and IS⊙IS observations

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Plasma turbulence can be viewed as a magnetic landscape populated by large- and small-scale coherent structures, consisting notionally of magnetic flux tubes and their boundaries. Such structures exist over a wide range of scales and exhibit diverse morphology and plasma properties. Interactions of particles with turbulence may involve temporary trapping in, as well as exclusion from, certain regions of space; generally controlled by the topology and connectivity of the magnetic field. In some cases, such as SEP "dropouts", the influence of the magnetic structure is dramatic; in other cases, it is more subtle, as in edge effects in SEP confinement. With Parker Solar Probe now closer to the sun than any previous mission, novel opportunities are available for examination of the relationship between magnetic flux structures and energetic particle populations.

We present a synergistic use of the magnetic helicity-partial variance of increments (PVI) technique paired with IS⊙IS observations of energetic particles (EPs). The filtered magnetic helicity detects large-scale helical flux tubes while the PVI identifies their boundaries, thus giving a multi-scale finer description of the structures. The correlation with EP fluxes show direct observational evidence of the modulation provided by flux tubes.

We find that helical flux tubes, accompanied by bounding large-PVI patches, act as hard boundaries that inhibit EP transport either confining populations within the helical field, or excluding them from entering it.

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