Space Science Seminar
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Magnetic Cavities in the Solar Wind as Natural Tokamaks

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Host: Dr. Gary Zank (sponsored by CSPAR)

Recent studies of particle acceleration in the heliosphere have revealed a new mechanism that can energize particles up to several MeV/nuc locally in the solar wind. It has been found that stream-stream interactions as well as the heliospheric current sheet – stream interactions produce huge magnetic cavities, which resemble tokamaks in terms of solving the confinement problem. Such cavities are usually filled with dynamical small-scale magnetic islands (SMIs) with a typical width of ~0.01AU or less, which are produced by magnetic reconnection at strong current sheets representing the borders of magnetic cavities. SMIs experience compression and merging due to dynamics of the entire system, which leads to trapping and re-acceleration of energetic particles in the confined region via stochastic acceleration mechanism (Zank et al. ApJ, 2014, 2015; le Roux et al. ApJ, 2015, 2016). Since SMIs cannot escape, acceleration of energetic particles occurs in the most effective way. As a result, crossings of magnetic cavities are associated with unusual variations in the energetic particle flux up to 1-2 MeV/nuc near the Earth's orbit. These energetic particle flux enhancements called "atypical energetic particle events" (AEPEs) are observed at timescales from ~1/2 hour to several hours, sometimes, against the background of classical solar energetic particle events or before/after energetic particle enhancements associated with corotating interaction regions, but mostly in the relatively quiet solar wind (Khabarova et al. 2015, 2016, Khabarova & Zank, 2017). AEPEs associated with SMIs and magnetic cavities can be as dangerous to astronauts and spacecraft equipment as well-known solar energetic particle (SEP) events, since AEPEs possess similar characteristics.

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