Turbulent Plasma and Astrophysical Shocks in Solar-Terrestrial Physics

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Applications are invited from ambitious and self-motivated candidates to study turbulent astrophysical plasma and its interaction with quasi-parallel shocks. Upstream regions of quasi-parallel astrophysical shocks are among the most complex plasma systems. The multi-scale collective plasma dynamics mediates energy dissipation and isotropy in these regions. The principles which underpin this behavior, represent the most generic plasma processes: strong turbulence, Fermi acceleration, shock reformation and a number of instabilities. A full 3.5 year STFC (Science & Technology Facilities Council) studentship (fees and maintenance at standard research council rates) is available for UK and EU students. Candidates should hold or expect to hold a high 2.1 or 1st (or equivalent) in Physics or related subject area. The PhD will be undertaken within the Department of Physics at the University of Warwick, at the Centre for Fusion, Space and Astrophysics.

The project will focuses on key physical processes upstream of the quasi-parallel collisionless shocks: linear and nonlinear large amplitude magnetic fluctuations and their relation to the observed particle spectra, and bulk plasma heating caused by the nonlinear stages of kinetic instabilities. Specific objectives include quantifying the relation between particle distributions and the power in magnetic perturbations of different types, exploring the role of nonlinear waves in the plasma dynamics of the quasi-parallel foreshocks and understanding how unstable tails of the particle distribution couple to its core. We aim to progress current understanding of quasi-linear and nonlinear dynamics of these systems, using data analysis of multi-spacecraft observations and numerical simulations. Advanced multi-point data analysis techniques will be applied to in-situ measurements of the terrestrial foreshock from Cluster and MMS missions. Single-point observations of shocks in the inner solar wind from the Parker solar mission will also be used. Two-dimensional numerical simulations of the quasi-parallel shock will be used to understand the nonlinear phase of the observed plasma instabilities, such as these driven by the temperature anisotropies.

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