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Particle Energization throughout the Heliosphere: Opportunities with IMAP

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Understanding the radiation environment at the Earth and beyond is one of the critical elements in our developing Space Weather capabilities and strategy. Furthermore, the energization of charged particles in a collisionless plasma remains one of the compelling unsolved yet universal problems in space physics and astrophysics. The proposed instrumentation of IMAP enables two critical goals: 1) real-time monitoring of the radiation and plasma environment as part of a Space Weather capability, and 2) making coordinated simultaneous measurements of all the basic plasma parameters needed to develop a comprehensive and detailed understanding of fundamental particle energization processes. Since the session addresses the "Physics of particle acceleration", we will survey briefly the critical open problems associated with particle acceleration during quiet and active solar wind periods. At least three elements will be discussed. 1) Dissipative processes in the quiet solar wind and at shock waves. For the former, we discuss emerging ideas about the dissipation of turbulence via structures such as flux ropes and their role in possibly energizing charged particles during quiet times, especially in the vicinity of the heliospheric current sheet. In the latter, reflected ions play an essential role in dissipative processes at both quasi-perpendicular and quasi-parallel shocks. This in turn has consequences for the energization of particles, the generation of turbulence upstream and downstream of the shock, and the importance of a pre-existing suprathermal ion population. 2) What is the role of pre-existing energetic particles versus injection from a background thermal population of charged particles in the context of diffusive shock acceleration? Does the pre-existing suprathermal particle population play a fundamental role in the dissipation processes governing heliospheric shock, as suggested by the case of the heliospheric termination shock and pickup ions? 3) What is the primary acceleration mechanism for electrons in the solar wind during both quiet and active solar wind periods? Apparently stable energetic electron power law distributions are observed for quiet periods. Does the observed kappa distribution function for electrons and the electron heat flux play an important role in generating energetic particle distributions during quiet times? The observed characteristics of energetic electrons in the vicinity of interplanetary shocks are frequently quite different from those predicted from classical diffusive shock acceleration. Is another mechanism at work? IMAPs ability to simultaneously measure energetic particles from energies as low as $\sim$2 keV, pickup ions, the interplanetary magnetic field, and thermal plasma distributions will provide important constraints on theory and modeling of particle energization throughout the heliosphere.