Particle Energization Associated With Foreshock Transients: Results From a Hybrid-Vlasov Simulation and MMS Observations

Souhail Dahani*[1], Lucile Turc[1], Shi Tao[1], Veera Lipsanen[1], Jonas Suni[1], Yann Pfau-Kempf[1], Minna Palmroth[1,2], Gershman Daniel[3], Roy Torbert[4,5], and Jim Burch[6]

[1]Department of Physics, University of Helsinki – Finland
[2]Finnish Meteorological Institute – Finland
[3]NASA Goddard Space Flight Center – United States
[4]University of New Hampshire – United States
[5]Southwest Research Institute [San Antonio] – United States
[6]Southwest Research Institute, San Antonio, TX, USA – United States

Abstract

The interaction of solar wind discontinuities with reflected solar wind particles upstream of Earth's bow shock leads to the formation of large scale transient phenomena such as Foreshock Bubbles (FBs) and hot flow anomalies. These transient phenomena play an important role in accelerating and energizing plasma and could have global impacts on the near-Earth environment. Direct derivations from the Vlasov-Maxwell equation provide the equations that describe the temporal evolution of the kinetic and thermal energy. In this ongoing study, we investigate the behavior of the fluid energy terms that directly affect the evolution of the kinetic and thermal energy associated with these transients, with a particular focus on FBs. Specifically, we analyze the behavior of these energy terms in different sub-regions of the FB, including its core, sheath, and the shock created by its expansion at different stages in the lifetime of an FB. We employ a 2D global hybrid-Vlasov simulation performed with the Vlasiator model and compare the numerical results with FBs observed by the Magnetospheric MultiScale (MMS) mission. We discuss the role of FBs in accelerating, heating the plasma and producing or annihilating magnetic energy.

*Speaker