Particle Acceleration at the Earth's Bow Shock: recent results from MMS mission

M. I. Desai, J. L. Burch, S. A Fuselier, K. Genestreti, R. Torbert, R. E. Ergun, C. T. Russell, H, Wei, B. Giles, T. Phan, L-J. Chen, S. Wang, B. Mauk, and H. Lai

Abstract for Invited Talk submitted to Commission H; session: "Macro/Micro-Scale Kinetic Processes at Natural Boundary Layers in Terrestrial and Planetary Environments" at the XXXIInd General Assembly and Scientific Symposium of the International Union of Radio Science Montreal (Canada), 19 July-26, August 2017.
Conveners: B. Lembège, I. Shinohara and G. Lakhina

Collisionless shocks are a major producer of suprathermal and energetic particles throughout space and astrophysical plasma environments. Theoretical studies combined with in-situ observations during the space age have significantly advanced our understanding of how such shocks are formed, the manner in which they evolve and dissipate their energy, and the physical mechanisms by which they heat the local plasma and accelerate the energetic particles. Launched in March 2015, NASA's Magnetospheric Multiscale (MMS) mission has four spacecraft separated between ~10-40 km and equipped with identical state-of-the-art instruments that acquire magnetic and electric field, plasma wave, and particle data at unprecedented temporal resolution to study the fundamental physics of magnetic reconnection in the Earth's magnetosphere. Serendipitously, during Phase 1a, the MMS mission also encountered and crossed the Earth's bow shock more than ~300 times. In this paper, we combine and analyze the highest available time resolution MMS burst data during ~14 bow shock crossings from October 2015 through December 31, 2015 to shed new light on key open questions regarding the formation, evolution, dissipation, and seed particle injection and energization at collisionless shocks. In particular, we focus on the following two previously unexplored aspects of shock dissipation and particle acceleration: (1) the significance of electron-scale dissipation as evident from the properties of electron beams and associated electrostatic waves; and (2) the differences in how seed populations of different origins, e.g., solar wind He^{2+} and interstellar pickup He^{+} ions, are injected into the shock acceleration mechanisms at quasi-parallel and quasi-perpendicular shocks.