Multiscale Processes in Earth's Bow Shock and Foreshock

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Both shock waves and their upstream foreshock regions involve coupling of multiple physical processes from micro-scales to macroscales. Micro-scale physics includes the time-varying magnetic overshoots and 3D structures of reforming and timestationary shocks, electron reflection and acceleration at shocks, growth of Langmuir waves in the foreshock, and the linear or nonlinear conversion of Langmuir energy into radio emission at multiples of the electron plasma frequency f_p. Intermediate scale physics includes the development of ripples on the shock surface with scales of order those characteristic of ambient upstream turbulence or the decorrelation length of the upstream magnetic field, as well as scattering of the radio emission by density irregularities. Macro-scale physics includes 3D spatiotemporal variations of the plasma and the shock motion, as well as the properties throughout the macroscopic foreshock of energetic electrons, Langmuir waves, and radio emission associated with individual shock ripples or shock reformation events. Brief reviews are given here of existing observations, simulations, and theoretical models for shock reformation, electron reflection and energisation, Langmuir eigenstates and wave and radio emission for Earth's bow shock - foreshock system. This growth, includes detailed comparisons between theory and STEREO spacecraft data, which agree reasonably well, of the strength of Langmuir waves as a function of distance from the bow shock. New evidence is also provided that the Uranian bow shock was reforming during Voyager 2's inbound shock crossing. Outstanding issues and current research activities will be identified, including applications to type II solar radio bursts.

Keywords: shocks; foreshocks; electron acceleration; electron beams; Langmuir waves; Langmuir eigenstates; radio emission, STEREO spacecraft, simulations, theory).