Electron acceleration at the Earth's quasi-perpendicular bow shock: MMS observation

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Electrons can be accelerated to non-thermal energies (> 1 keV) at interplanetary shocks and the Earth's bow shock. While simulation studies have proposed various mechanisms, the precise mechanism of electron acceleration remains unclear. Here we show, based on the ultra high-time resolution measurements by MMS, that electrons form a power-law energy spectrum at and around the shock ramp region. The signatures of non-thermal electrons are modulated by the periodic variations of the shock internal structure at the time scale of roughly ion gyro period. In an event of high Mach number (~11) quasi-perpendicular shock crossing (shock angle ~ 80 degrees), we found that there exists an upper energy-limit (cutoff) in the power-law spectrum at ~10 keV and that the electron gyro-radius of this energy is roughly equal to the local ion inertial length, consistent with the idea of acceleration within the narrow shock ramp region. In this presentation, we will further discuss possible mechanisms of electron acceleration by, for example, gradient B drift and stochastic processes via waves.

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