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Electron heating scales in quasi-perpendicular shocks

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Collisionless shock waves are important for particle heating and acceleration in space. Electron heating at shocks is a combination of adiabatic heating due to large-scale electric and magnetic fields and scattering by high-frequency oscillations. Electron heating and scattering at the shock is still poorly understood but the scales at which heating happens can hint to which physical processes are taking place. Here, we study electron heating scales with the Magnetospheric Multiscale (MMS) spacecraft at Earth's quasi-perpendicular bow shock. We utilize the small tetrahedron formation and rapid plasma measurements of MMS to directly measure the electron temperature gradient inside the shock. From this, we reconstruct the electron temperature profile inside the shock ramps of a number of shock crossings with varying shock parameters. We find that most of the electron temperature increase takes place on a scale of tens of electron inertial lengths. Further, we investigate the electron distribution functions and attempt to disentangle the effects of the large-scale adiabatic heating and scattering by high-frequency waves.