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Electron heating via microturbulence ocurring in the front of supercritical quasiperpendicular shocks

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In supercritical shocks, as well known, a certain fraction of the incoming ions are reflected at the steep magnetic ramp, stream across the magnetic field and accumulate to form the foot. The simultaneous presence of beams of incoming and reflected ions, and incoming electrons leads to a microturbulence driven by their relative drifts. The waves easiest to excite are in the electron cyclotron frequency range and generated by the electron cyclotron drift instability [1]. Several Bernstein harmonics can be unstable, their number being directly proportional to the drift of the reflected ion beam versus the electrons. The number of harmonics and their level of intensity is limited, however, linearly by the ion beam's temperature and nonlinearly by resonance broadening [2].

Electromagnetic PIC simulations restricted to the foot region are performed to investigate the nonlinear characteristics of this microturbulence. The simulations, which are designed to provide a high spatial resolution, are characterized by a large mass ratio value and a large ratio of electron plasma to cyclotron frequency. While first, high cyclotron harmonics develop in good agreement with linear dispersion properties, subsequently a nonlinear dynamics similar to the inverse cascade takes place whereby the spectral power shifts toward lower k-modes to eventually accumulate on the first harmonic branch with frequency Ω_{ce}. We discuss the role played by resonance broadening in this inverse cascade and show that the latter phase is characterized by the development of a magnetic component to the spectrum and exhibits a significant energy transfer from the reflected ion beam to the electrons, which experience a marked increase in their temperature.

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