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Reconnection and temperature anisotropy in electron scale plasma turbulence

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We present results from 2.5D particle-in-cell (PIC) collisionless plasma simulations initialized to study the decay of turbulent fluctuations. A power-law cascade is created down to scales of order the electron gyro-radius, and reconnection operates at locations with appropriate X-point field line geometry. We work with physical mass ratios for electrons and protons, which limits our simulation to a size in-between ion and electron scales, and we therefore focus our results on an analysis of electron flows and temperatures.

We compare two different guide field geometries, one with an in-plane field and one with an out of plane field, to investigate the effects reconnection has on the turbulent cascade. We find that reconnection does not directly control the turbulence power spectrum and there are no significant electron temperature increases at the locations where it is occurring, but it does play an important role by relaxing the magnetic topology changes that are injected into short scales by the turbulent cascade. We identify and track reconnection events and find these display characteristic electron in-flows and out-flows, reminiscent of MHD reconnection. Reconnection sites are shown to generate dual peaked distributions in electron velocity space and therefore they act as sources of large temperature anisotropy at electron outflow regions.

Consequently reconnection regions may play a role in generating instabilities that allow the transfer of energy at smaller scales in the power spectrum. This work is of relevance to space and astrophysical systems which are often fully turbulent.