The Electron Diffusion Region: Forces and Currents

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The dissipation mechanism of magnetic reconnection remains a subject of intense scientific interest. On one hand, one set of recent studies have shown that particle inertia-based processes, which include thermal and bulk inertial effects, provide the reconnection electric field in the diffusion region. On the other hand, a second set of studies emphasizes the role of wave-particle interactions in providing anomalous resistivity in the diffusion region. In this presentation, we present analytical theory results, as well as PIC simulations of guide-field magnetic reconnection. We will show that the thermal electron inertia-based dissipation mechanism, expressed through nongyrotropic electron pressure tensors, remains viable in three dimensions. We will demonstrate the thermal inertia effect through studies of electron distribution functions. Furthermore, we will show that the reconnection electric field provides a transient acceleration on particles traversing the inner reconnection region. This inertial effect can be described as a diffusion-like term of the current density, which matches key features of electron distribution functions.