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How Does Collisionless Magnetic Reconnection Work in the Presence of a Guide Magnetic Field?

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The dissipation mechanism of guide field 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 2.5 and three-dimensional PIC simulations of guide-field magnetic reconnection. We will show that diffusion region scale sizes in moderate and large guide field cases are determined by electron Larmor radii, and that analytical estimates of diffusion region dimensions need to include description of the heat flux tensor. The dominant electron dissipation process appears to be based on thermal electron inertia, expressed through nongyrotropic electron pressure tensors. We will argue that this process remains viable in three dimensions by means of a detailed comparison of high resolution particle-in-cell simulations.