5th Asia-Pacific Conference on Plasma Physics, 26 Sept-1Oct, 2021, Remote e-conference

# Structure and dynamics of compressed current sheets in the earth's magnetotail

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We use NASA Magnetospheric Multi-Scale (MMS) data to analyze the kinetic-scale structure and dynamics associated with compressed current sheets and how they affect magnetic reconnection. When a current sheet with a reversed magnetic field configuration is compressed down to kinetic scales during geomagnetically active periods, in situ observations show evidence of intense wave activity in the lower hybrid frequency range and substorm onset leading to magnetic reconnection. The waves are often assumed to be due to the density gradient driven lower hybrid drift (LHD) instability. However, the density gradient is mild where the waves peak, which cannot account for the strong correlation of the emissions with thinning current sheets. Laboratory experiments [1, 2] and theoretical studies [3-6] have shown that velocity-shear in the current sheet intensifies due to plasma compression and drives broadband turbulence peaking around the lower hybrid frequency. Nonetheless, velocity shear-driven waves have largely been overlooked in relation to compressed current sheets in the magnetotail despite evidence that they are present in current sheets and play important roles in ion heating, acceleration, transport, and other anomalous dissipation processes. We discuss recent MMS observations that show lower hybrid fluctuations that are well correlated with the E×B velocity shear. [7] Our analysis shows that a transverse electric field is localized to the region of the lower hybrid fluctuations and that the pressure gradient in this region is comparatively small, leading to the interpretation that compression of the current sheet and the resulting velocity shear is the underlying driving mechanism behind the fluctuations. Additionally, a new kinetic equilibrium model [4] shows that an ambipolar electric field forms self-consistently and intensifies as a large scale Harris current sheet is compressed. This produces velocity shear in the current sheet in the vicinity of the magnetic null, indicating that velocity shear-driven waves can arise in thinning current sheets and provide anomalous viscocity to trigger the magnetic reconnection process. In addition, the compression and the resulting ambipolar electric field also affects the distribution function, making it non-gyrotropic, which explains the observation of the crescent shaped distribution, temperature gradients, as well as the formation of substructures in the Harris current sheet such as embedded and bifurcated current sheets.

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