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Behavior of Compressed Plasmas in Magnetic Fields

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Plasma in the earth's magnetosphere is subjected to compression during geomagnetically active periods and relaxation in subsequent quiet times. Repeated compression and relaxation is the origin of much of the plasma dynamics and intermittency in the near-earth environment. An observable manifestation of compression is the thinning of the plasma sheet resulting in magnetic reconnection when the solar wind mass, energy, and momentum floods into the magnetosphere culminating in the spectacular auroral display. This phenomenon is rich in physics at all scale sizes, which are causally interconnected. This poses a formidable challenge in accurately modeling the physics. The large-scale processes are fluid-like and are reasonably well captured in the global magnetohydrodynamic (MHD) models, but those in the smaller scales responsible for dissipation and relaxation that feed back to the larger scale dynamics are often in the kinetic regime. The self-consistent generation of the small-scale processes and their feedback to the global plasma dynamics remains to be fully explored. Plasma compression can lead to the generation of electromagnetic fields that distort the particle orbits and introduce new features beyond the purview of the MHD frameworks, such as ambipolar electric fields, unequal plasma drifts and currents among species, strong spatial and velocity gradients in gyroscale layers separating plasmas of different characteristics, etc. These boundary layers are regions of intense activity characterized by emissions that are measurable. We study the behavior of such compressed plasmas and discuss the relaxation mechanisms to understand their measurable signatures as well as their feedback to influence the global scale plasma evolution.