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The Kinetic Scale Structure of the Low Latitude Boundary Layer: Initial MMS Results

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Since its launch in March of 2015, NASA's Magnetospheric Multiscale (MMS) mission has captured thousands of high resolution magnetopause crossings, routinely resolving the sub-Larmor radius structure of the magnetopause boundary layer for the first time. The primary goal of MMS is to understand the microphysics of magnetic reconnection, and it is well on its way to achieving this objective. However, MMS is also making routine measurements of the electron and ion gyroviscous and heat flux tensors with unprecedented resolution and accuracy. This opens up the possibility of directly observing the physical processes that facilitate momentum and energy transport across the magnetopause boundary layer under arbitrary conditions (e.g., magnetic field geometry and flow shear) far from the reconnection X line. Currently, our global magnetosphere fluid models (e.g., resistive or Hall MHD) do not include accurate descriptions of viscosity and heat flow, both of which are known to be critical players at the magnetopause (not just at the reconnection sites), and several groups are attempting to make progress on this difficult fluid closure problem. In this talk, we will address the fluid closure problem in the context of MMS observations of the Low Latitude Boundary Layer (LLBL), focusing on high resolution particle observations by the Fast Plasma Investigation (FPI). FPI electron bulk velocities are accurate enough to compute current density in both the high density magnetosheath and low density magnetosphere and have already revealed that the LLBL has a complex parallel current structure on the proton Larmor radius scale. We discuss the relationship between these parallel currents and the Hall electric field structures predicted by kinetic models. We also present first observations of the ion and electron gyroviscous and heat flux tensors in the LLBL and discuss implications for the fluid closure problem at Earth's magnetopause.