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Modeling Reconnection and Turbulence in the Magnetosphere on Kinetic Scales

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We consider magnetic turbulence using observations from the Magnetospheric Multiscale (MMS) mission on kinetic (ions and electron) scales, which are far shorter than the scales characteristic for description of plasma by magnetohydrodynamic (MHD) theory. We have shown that a break of the magnetic spectral exponent to about -5.5 agrees with the predictions of kinetic theory (-16/3), see Ref. [1]. It is worth noting that the unprecedented very high (millisecond) resolution of the magnetic field instrument allowed to grasp the mechanism of reconnection in the magnetotail on kinetic scales, Ref. [2]. As expected from numerical simulations, we have verified that when the field lines and plasma become decoupled a large reconnecting electric field related to the Hall current (1–10 mV/m) is responsible for fast reconnection in the ion diffusion region both at the magnetopause and in the magnetotail regions. Although inertial accelerating forces remain moderate (1–2 mV/m), the electric fields resulting from the divergence of the full electron pressure tensor provide the main contribution to the generalized Ohm's law at the neutral sheet (of the order of 10 mV/m), cf. [3]. This illustrates that when ions decouple electron physics dominates. The results obtained on kinetic scales may be useful for better understanding the physical mechanisms governing reconnection processes in various magnetized space and laboratory plasmas.

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