MMS observations of sub-ion scale magnetic holes in the magnetosheath

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Magnetic holes (MHs), structure of an observable magnetic field magnitude decrease, have been widely observed in space plasma. Spatial size of the MHs ranged from tens to thousands of proton gyroradius (ρ i). In previous studies, these large magnetohydrodynamics (MHD) MHs were associated with mirror instabilities. In this study, we report a series of sub-ion scale magnetic holes in the terrestrial magnetosheath. The main characteristics are summarized below. 1. These structures have been observed in a scale of 10 ~ 20 ρ e (electron gyroradii) and lasted 0.1 ~ 0.3 s. 2. The magnetic field magnitude decreases along the background direction; distinctive electron dynamics features are observed, while no substantial deviations in ion data are seen. 3. An electron flow vortex is found perpendicular to the background magnetic field. 4. Electron diamagnetic drift contributes the calculated current density. 5. For the 90° pitch angle electrons, the flux is decreases between 34 eV to 66 eV and significantly increases between 109 eV to 1024 eV. 6. Electron magnetohydrodynamics (EMHD) soliton theory is considered as a possible generation mechanism.

Keywords: magnetic hole, sub-ion scale, vortex, diamagnetic drift , MMS, soliton

