The observational evidence of electron mirror mode

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The mirror modes are fundamental process in space, and play important roles in solar physics, planetary, interplanetary, astrophysical and laboratory plasmas over the past half century. Although theoretical studies and numerical simulations further revealed their kinetic effects, they are generally regarded as magnetohydrodynamics (MHD) scale process. However, if the electron distribution is anisotropic, the electrons could become unstable and excite kinetic scale mirror modes to remove the free energy. This instability was presented for more than thirty years, but so far few unambiguous observational evidence has been found. In this study, we provide high-resolution Magnetospheric Multiscale (MMS) observations of electron mirror mode structures. These structures: (1) are train-like features similar to the MHD-scale mirror-mode; (2) are anti-correlation between electron and magnetic pressure; (3) satisfy electron trapping conditions and theoretical excitation of the mirror modes; (4) are “frozen” in the plasma flow frame. They were observed during the Corotating Interaction Region events (CIRs) near the Earth’s foreshock and its downstream turbulence, and could involve with the interaction between Earth’s magnetosphere and solar wind.