Nonlinear Mirror Mode Structures in Multi-dimensional Models

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The temperature anisotropy ($T_\perp/T_\parallel$>1) of ions in the magnetosheath drives the mirror instability. We performed two-dimensional (2D) and three-dimensional (3D) hybrid simulations in open boundary models to study the nonlinear mirror mode structures. In the open boundary systems, because of the propagation of EMIC waves, we can obtain the clearer non propagating mirror mode structures. We analyzed the relation between the mirror instability and the magnetic peaks and dips which are peculiar magnetic structures observed in the magnetosheath. In the 2D open boundary model, we obtain the clear magnetic dips at the nonlinear stage. The magnetic structures become larger in the parallel directions rather than the perpendicular directions. In the 3D model, on the other hand, the mirror instability makes the magnetic peaks structures with the same parameters. The cigar-like magnetic peak structures are formed because of the nonlinear evolution of mirror instability and the symmetric structure in the perpendicular directions. We also performed parametric analyses on the ion beta in both 2D and 3D models. We find that the magnetic peaks also arise in both 2D and 3D high beta case as shown in the Cluster observations. We find the MHD equilibrium between the particle pressure and the magnetic field of these magnetic structures. Integrating the equilibrium equation with the assumption of the magnetic dips, we find that the integrated pressure becomes larger as the spatial size of the magnetic dips becomes larger. Between the large scale magnetic dips which are made through the coalescence of the magnetic structures, the magnetic peak appears. Thus, the magnetic peaks are excited in high particle beta conditions.

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