SIMULATIONS AND MODELING OF NONLINEAR MIRROR MODES

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Magnetic structures in the form of pressure-balanced magnetic holes and humps with a size of a few ion Larmor radii, anticorrelated with density fluctuations, are often observed both in the solar wind and in planetary magnetosheaths, in regions characterized by anisotropic ion temperatures ($T_\perp > T_\|$) and a sufficiently high β. Such conditions can in particular be met under the effect of the plasma compression in front of the magnetopause. In order to understand the origin of these structures, high-resolution hybrid numerical simulations of the Vlasov-Maxwell (VM) equations using both Lagrangian (particle in cells) and Eulerian integration schemes are presented and compared with asymptotic and phenomenological models for the nonlinear mirror mode dynamics. It turns out that magnetic holes do not result from direct nonlinear saturation of the mirror instability that rather leads to magnetic humps. Nevertheless, both above and below threshold, there exist stable solutions of the VM equations in the form of large-amplitude magnetic holes. Special attention is paid to the skewness of the magnetic fluctuations (that is negative for holes and positive for humps) and its variation with the distance to threshold and the beta of the plasma. Furthermore, the long-time evolution of magnetic humps resulting from the mirror instability in an extended domain far enough from threshold may, when the beta of the plasma is not too large, eventually lead to the formation of magnetic holes.