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Investigation of the Low Latitude Boundary Layer (LLBL) in Mercury's Magnetosphere Using MESSENGER Data

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A comprehensive analysis of Mercury's Low-Latitude Boundary Layer (LLBL) has been studied using MESSENGER observations from 11 March 2011 to 30 April 2015. LLBL events were classified into three distinct categories based on energy dispersion trends: increasing, decreasing, and unclear cases. The results indicate significant differences in plasma transport mechanisms, energy evolution, and spatial distribution. Increasing cases are characterized by a continuous energy transition from the magnetosheath to the magnetosphere, suggesting efficient plasma penetration. In contrast, decreasing cases exhibit discontinuous energy transitions at the LLBL-magnetosphere boundary. Proton density, temperature, and pitch angle distributions further differentiate these LLBL types. Statistical analysis reveals a strong dependence on interplanetary magnetic field (IMF) orientation, with a majority of LLBLs occurring under northward IMF conditions, especially for flank dawn and dusk. Dawn-dusk asymmetry is also evident, with increasing cases dominating the dawnside and decreasing cases prevailing on the duskside. LLBL formation mechanisms vary across spatial regions. Future observations from BepiColombo's MSA instrument are expected to refine our understanding of Mercury's LLBL dynamics.

Astrophysics Field

Space physics

Author: WANG, Xue (Laboratoire de Physique des Plasmas, Ecole Polytechnique)

Co-auteurs: Dr SAHRAOUI, Fouad (Laboratoire de Physique des Plasmas, Ecole Polytechnique); Dr HADID, Lina (Laboratoire de Physique des Plasmas); Dr AIZAWA, Sae (Laboratoire de Physique des Plasmas, Ecole Polytechnique)

Orateur: WANG, Xue (Laboratoire de Physique des Plasmas, Ecole Polytechnique)

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