Global 3D Hybrid simulations of the Super-Critical Bow-Shock behavior upon a Quasi-Perpendicular interaction with the Interplanetary Magnetic Field

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Résumé

We present an analysis of the terrestrial Bow-Shock behavior in supercritical regime when the interaction with the incoming Solar Wind occurs in a Quasi-Perpendicular configuration with respect to the normal direction at the nose. Past ad-hoc 2D simulations in a Quasi-Perpendicular interaction with planar shock-fronts have revealed the formation of ripples on the shock surface. Several kinetic mechanisms have been found to be a possible source of this rippling, indicating an highly kinetic nature. The presence of such ripples is also confirmed from satellite observations. However, to date there is no analyses for a realistic curved scenario.

From the hybrid simulation of a global 3D terrestial-like curved Bow-Shock interacting with highly Alfenic Mach number we have found that these ripples indeed appear more like elongated North-South structures extending for the entire Bow-Shock surface and propagating from the Bow-Shock nose outwards following the IMF orientation and directed towards the flanks with a constant velocity. Also, a spectral analysis showed that these structures hold a wavelength spanning between 1 to 20 pristine ion skin depths and beyond, confirming the values observed with different previous simulations and satellite observations.

In particular, an analysis of the ions phase-space along the nose normal direction revealed a clear signature of an ongoing shock-reformation across the Bow-Shock nose. We then believe that shock-reformation is one of the possible kinetic leading mechanisms to these structures: this process causes a recurring Bow-Shock surface back-and-forth movement, as a local oscillation that is later propagated along the Bow-Shock surface as a surface wave.

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