Magnetosheath Jets Close to the Bow Shock: Generation Mechanisms Using MMS Fast and Burst Data

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Abstract

Magnetosheath jets are found downstream of the Earth's bow shock. They are transient dynamic pressure enhancements usually attributed to both a density and a velocity increase. Jets have been associated with a variety of magnetospheric phenomena such as, magnetopause reconnection, ULF wave activity, energization of the outer radiation belt, aurora enhancement and direct plasma inflow to the magnetosphere. Moreover, jets appear to be a universal phenomenon possibly occurring in astrophysical or other planetary shocks.

These localized fast plasma flows are mainly found downstream of the quasi-parallel shock (regions where the angle between the IMF and the bow shock normal vector (θ_{Bn}) is less than 45 degrees). It is believed that the majority of them are generated at the shock by the interaction of the solar wind with the shock ripples. However, there have been many generation mechanism proposed for jets found downstream of the quasi-parallel bow shock but also of the quasi-perpendicular ($\Theta_{Bn} > 45$). Currently there is no consensus on how prominent or effective each mechanism is and is it still under debate if some of them exist.

In this work we briefly discuss the current theories describing the different origin mechanisms. Then, we show how statistical results from MMS mission (fast measurements) that have been associated to different mechanism support some of them. Furthermore, we present observations of high-resolution MMS (burst measurements) for jet structures found very close to the bow shock. We discuss different examples and the overall likelihood of existent formation mechanisms (e.g. bow shock ripples, foreshock transient events) and of newly proposed ones (e.g. magnetic reconnection, flux tubes). The initial results support the pre-existing theories while providing information about other effects that may contribute.