High-speed Magnetosheath Jet Generation due to Shock Reformation

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Abstract

Magnetosheath jets are transient localized structures of enhanced dynamic pressure observed downstream of the Earth's bow shock. They may exhibit an increase of velocity reaching solar wind levels, while their density is typically much higher than typical magnetosheath and solar wind values. Jets have been associated to several magnetospheric effects such as, magnetopause reconnection, excitations of surface eigenmodes and even direct plasma penetration in the magnetosphere. While their exact origin is unknown, many mechanisms have been proposed. One of the most prominent explanations involves the interaction of solar wind with local inclinations of the bow shock (ripples) while others include solar wind discontinuities, and foreshock structures.

In this work, by using Magnetosphere Multiscale (MMS) we show in-situ observations of a super-magnetosonic magnetosheath jet being generated as a direct result of the bow shock reformation cycle. The observed jet origin appears to be the result of the dynamical evolution of the shock and the emergence of a spatially de-attached compressive magnetic structure that acts as a local shock front. Due to this, the solar wind particles are effectively transferred downstream without experiencing a strong interaction with the shock, which allows compressed high velocity plasma to be observed downstream of the bow shock.

The proposed mechanism does not require external phenomena (e.g., solar wind discontinuities) or specific configuration of the bow shock (e.g., ripples) to take place. On the contrary, it allows the magnetosheath jet phenomenon to directly originate from the dynamical evolution of the quasi-parallel collisionless shock.