High-speed downstream jets: relevance to bow shock dynamics and their evolution throughout the magnetosheath

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Abstract

High-speed jets formed downstream of the Earth's bow shock are localized and transient dynamic pressure enhancements. Due to their properties, they can have an effect on Earth's magnetosphere, and they interact with background magnetosheath plasma. Jets have been connected to a variety of different effects, for example, magnetopause reconnection, excitation of ULF waves, and direct plasma penetration in the magnetosphere. While jets have been studied for several decades, their formation mechanism is still under debate. Several generation models have been proposed that include solar wind discontinuities, foreshock transients, non-stationarity of the shock (i.e., ripples/reformation) and many others.

In this work, we focus on the connection between magnetosheath jets and the Earth's bow shock. Specifically, we focus on observations of magnetosheath jets made by NASA's Magnetosphere Multiscale (MMS) mission. Due to the high-resolution measurements, we found evidence of shock reformation allowing solar wind plasma to be less compressed than the typical magnetosheath, allowing the formation of magnetosheath jets as a direct consequence of the shock's cyclic behaviour.

Moving on, we exhibit how jets evolve at the Earth's magnetosheath environment and how their velocity distribution functions (VDFs) can provide insight into their origin. Analyzing jets' VDFs highlights their kinetic nature and indicates the limitations of studying them from a full particle moment fluid picture.

Finally, we investigate aspects of non-Maxwelianity that jets exhibit, and discuss how future research could include multiscale investigation made by conjunctions of several missions that reside in the outer magnetospheric region such as Cluster, MMS and THEMIS.