Investigation of magnetosheath jet kinetic structure and plasma moment derivation

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Abstract

Earth's bow shock consists of a highly complex plasma environment where several phenomena co-exist and interact with each other. One of the most energetic and intriguing phenomena is the magnetosheath jets, which are transient localized dynamic pressure enhancements. They have been associated to numerous foreshock and shock related dynamical phenomena and their effects are seen throughout the whole magnetosphere region. Jets can interact with the magnetopause and initiate reconnection, excite waves and even contribute to direct plasma penetration in the inner magnetosphere.

In this work, using Magnetosphere Multiscale (MMS), we investigate their structure by studying their velocity distribution functions (VDFs) and deriving partial plasma moments based on their configuration. We show how jets are inherently kinetic structures with very highly variable VDFs throughout their lifetime. By establishing different methodologies to derive partial moments for the jet population, we discover that the velocity, density, and temperature profiles are much more similar to SW-beams, providing vital information regarding jets' origin. Moreover, the properties we reveal have implications regarding the characterization and evolution of jets as they propagate towards the Earth.

Finally, we demonstrate the significance of a partial moment derivation to be made in future studies, and we discuss a series of implications originating from our methodology and results. Our results are eventually used to evaluate previous work and pave the way for future research to be done using a similar approach to the one we present.