



MACHINE LEARNING FOR ASTROPHYSICS

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Analysis of Velocity Distribution Functions using the Gaussian Mixture Model

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Velocity distribution functions (VDFs) measured by the Magnetospheric Multiscale (MMS) mission are complex 3D datasets that can be represented as a superposition of multiple beams (Goldman et al., 2020). Recent papers (Dupuis et al., 2020; De Marco et al., 2023) proposed the use of the Gaussian Mixture Model (GMM) to identify different populations. The method is applied systematically to MMS data in the tail and in the day-side of the Earth's magnetosphere. The conclusion of the analysis is that the GMM is capable of detecting the presence of multiple beams within an overall distribution. The GMM can define reliably the complexity of a measured data-set in terms of the number of optimal beams provided by information theory criteria. The goal of the analysis is to differentiate between simple and more complex regions based on the VDF measured by MMS. In particular, complex shaped electron distributions, thus represented with a greater number of clusters, have been shown to be good indicators for processes of interest such as magnetic reconnection and turbulence (Shuster et al., 2014; Hoshino et al., 2001).

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