

Project Details

ROSES ID: NNH21ZDA001N-LWSTM

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Program Element: Data, Tools, & Methods

Project Title:

Vlasov Informed Super Resolution (VISR): A Deep Learning Approach for De-Aliasing Particle Data

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Summary:

Earth's magnetosphere is a complex system with plasma dynamics occurring on a vast range of spatial and temporal scales. Understanding how kinetic plasma dissipation processes shape the large scale structure and dynamics of the magnetosphere remains one of the great challenges of heliophysics. The community's effort to develop the next generation of predictively powerful global space weather models would benefit greatly from observations of plasma dissipation processes on millisecond time scales. NASA's Magnetospheric Multiscale (MMS) mission has paved the way for such observations, but important processes like turbulent dissipation and wave-particle interactions remain marginally resolved at best due to particle instrument aliasing.

We propose to develop a new tool for the heliophysics community -- Vlasov Informed Super Resolution (VISR) -- that uses deep learning to combine time-aliased particle data with the Vlasov equation to recover physically meaningful information below the energy sweep time scale. VISR will make use of Physics Informed Neural Networks (PINN), a recent development in deep learning that has shown promise for a wide range of applications. We will apply VISR to data collected by the Fast Plasma Investigation (FPI) on MMS. After prototyping and validating VISR on test data generated by analytic solutions of the Vlasov equation, we will scale up to production on the ADAPT GPU cluster at NASA-GSFC.

VISR will be made available to MMS team members at the MMS Science Data Center (SDC) no later than 18 months after the start date of the project. After an additional 6 month beta testing period, VISR will be made publicly available under an open source license at both the MMS SDC and an open github repository.

Publication References:

no references