Project Details

ROSES ID: NNH05ZDA001N
Selection Year: 2006
Program Element: Focused Science Topic

Topic: Solar wind plasma entry and transport in the magnetosphere

Project Title:
Theory and Hybrid Simulations of Transport due to Kinetic Alfven Waves at the Magnetopause

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Summary:
Recent observations have placed observational constraints on plasma entry mechanisms for northward IMF conditions when the plasma sheet cools and densifies. In particular, both in situ and remote observations have found dawn-dusk asymmetries in the density and temperature of the ion populations, and in situ particle distributions show perpendicular ion heating of low energy ions on the dawnside associated with strong compressional wave activity in the magnetosheath. It is the purpose of this proposal to examine transport processes that would occur due to kinetic and nonlinear interactions associated with the large amplitude, low frequency waves that are nearly always observed near the magnetopause in the context of these observational constraints. We would address the following scientific questions: (a) What is the nature of the low frequency wave activity and how does it regulate plasma entry into the magnetosphere, (b) What are the observational signatures expected from these transport processes?, and (c) How do the observational signatures compare with simulation and theory?

We will use a combined theoretical and computational approach to understand how kinetic Alfven waves develop near the magnetopause and contribute to transport. We will obtain wave solutions near the magnetopause using the kinetic-fluid model (that include finite Larmor

radius effects and wave particle interactions) that we will use to understand transport and heating at the magnetopause using methods of nonlinear dynamics. We will compare these results with hybrid simulations in a simplified slab geometry to understand the nonlinear aspects of low-frequency MHD waves at the magnetopause. Using this insight, we will perform and interpret three-dimensional hybrid simulations in a realistic magnetospheric geometry. We will examine the dependence of transport on solar wind conditions and the location along the magnetopause where particle entry occurs. We will compare our theoretical models with observations of wave activity, particle distributions, and global asymmetries.

This project is directly relevant to the Living with a Star Targeted Research and Technology program Focused Science Topic area (c) Solar Wind Plasma Entry and Transport in the magnetosphere because we will address the means by which plasma crosses the magnetopause and we will quantify the amount of solar wind entering the magnetosphere due to low frequency kinetic Alfven wave activity and identify where it enters along the boundary. This proposal is also relevant to NASA's national research objectives to explore the dynamic earth system because we will have improved understanding of space environmental conditions and their causes which will increase capabilities for space flight and exploration.

Publication References:

Summary: no summary

Reference: Lin, Y.; Johnson, J. R.; Wang, X. Y.; (2010), Hybrid simulation of mode conversion at the magnetopause, Journal of Geophysical Research, Volume 115, Issue A4, CiteID A04208, doi: 10.1029/2009JA014524