

Project Details

ROSES ID: NNH09ZDA001N

Selection Year: 2010

Program Element: Focused Science Topic

Topic: Plasma Neutral Gas Coupling

Project Title:

Modeling Effects of Ion-Neutral Coupling on Reconnection and Flux Emergence in the Chromosphere

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Summary:

Objectives:

The chromosphere is a relatively poorly understood, partially ionized region of the solar atmosphere, but it is critical for understanding the corona as all solar magnetic field emerges from the convection zone through this region. Understanding reconnection events, such as spicules, chromospheric jets and Ellerman bombs, is now believed to be important for understanding chromospheric and coronal dynamics and heating. Some of these dynamic phenomena are closely related to the emergence of magnetic flux from beneath the solar surface. Our previous works are the only studies to date that have included some of the effects of ion-neutral coupling in the chromosphere in numerical models of flux emergence. However, ion-neutral coupling is believed to play a role in both reconnection and flux emergence in the chromosphere.

The goal of this proposal is to develop numerical models of these phenomena that self-consistently include the coupling of ionized and neutral plasma. We will identify the role of ion-neutral coupling on flux emergence and magnetic reconnection, and quantify its role in not only the dynamics and heating of the chromosphere but also on the state of the coronal magnetic field.

Methods:

Flux emergence, magnetic reconnection, and dynamics/heating in the solar chromosphere will be simulated in 2D, for the first time, using a two-fluid (plasma+neutrals) numerical model, HiFi. Single-fluid, 3D simulations including prominent ion-neutral effects will be conducted using the MHD code Lare3D. Simulation results of flux emergence and reconnection will be compared to both theoretical models and H-alpha, UV and EUV observations of the chromosphere.

Significance to NASA:

This program will develop first-principles, self-consistent models of chromospheric events such as Flux emergence, chromospheric jets, Ellerman bombs and Spicules that can be compared to current observations. These models will help the solar community understand the role of ion-neutral coupling in chromospheric heating, and on the state of the magnetic field in the chromosphere and corona. Through collaboration with the other Science Focus Teams, we will also improve understanding of the role of ion-neutral coupling in the ionosphere.

Publication References:

Summary: no summary

Reference: Leake, James E.; Lukin, Vyacheslav S.; Linton, Mark G.; Meier, Eric T.; (2012), Multi-fluid Simulations of Chromospheric Magnetic Reconnection in a Weakly Ionized Reacting Plasma, The Astrophysical Journal, Volume 760, Issue 2, article id. 109, 12 pp, doi: 10.1088/0004-637X/760/2/109

Summary: no summary

Reference: Leake, James E.; Lukin, Vyacheslav S.; Linton, Mark G.; (2013), Magnetic reconnection in a weakly ionized plasma, Physics of Plasmas, Volume 20, Issue 6, article id. 061202 12 pp, doi: 10.1063/1.4811140