BOSTON UNIVERSITY

SPACE PHYSICS SEMINAR

Paul Song

UMass Lowell

A Model of the Chromosphere: Heating, Structures, and Convection

Thursday, February 14, 2013
725 Commonwealth Ave.
Refreshments at 3:30pm in CAS 500
Talk begins at 4:00pm in CAS 502

Abstract:

We propose a model of local convection in the chromosphere, with scale size of supergranules. The strong heating required in order to balance the radiative losses in the chromosphere is provided by strong damping, through plasma-neutral collisions, of Alfvén waves that are driven by motions below the photosphere. On the basis of a self-consistent plasma-neutral-electromagnetic one-dimensional model, we derive the vertical profile of wave spectrum and power by a novel method, including the damping effect neglected in previous treatments. The high-frequency portion of the source power spectrum is strongly damped at lower altitudes, whereas the lower-frequency perturbations are nearly undamped and can be observed in the corona and above. As a result, the waves observed above the corona constitute only a fraction of those at the photosphere and, contrary to supposition in some earlier Alfvén-wave-damping models, their power does not represent the energy input. Calculated from parameters of a semi-empirical model for quiet-Sun conditions, the mechanism can generate sufficient heat to account for the radiative losses in the atmosphere, with most of the heat deposited at lower altitudes. When the magnetic field strength varies horizontally, the heating is likewise horizontally nonuniform. Since radiative loss is a strong function of temperature, the equilibrium temperature corresponding to local thermal balance between heating and radiation can be reached rapidly. Regions of stronger heating thus maintain higher temperatures and vice versa. The resulting uneven distribution of temperature drives chromospheric convection, which produces a temperature minimum in the chromosphere near 600 km altitude and distorts the magnetic field to create a funnel-canopy-shaped magnetic geometry, with a strong field highly concentrated into small areas in the lower chromosphere and a relatively uniform field in the upper chromosphere. The formation of the transition region, corona, and spicules will be discussed.