20.05
The Formation and Support of Prominences in Magnetic Loops and Arcades

G. Van Hoven and Y. Mok (Univ. of California, Irvine), and J.F. Drake (Univ. of Maryland)

We report on some 1.5-D and 2-D numerical simulations of the nonlinear MHD evolution of the thermal-condensation instability in coronal magnetic structures. The models include radiation, thermal conduction and gravity, and deep chromospheres are provided. In the 1.5-D case we concentrate on the parallel propagation of temperature and density excitations, and of magnetic deflections due to gravity. The 2-D computations illustrate dynamic field-line length and bending effects, which both lead to and respond to nonlinear chromospheric-expansion and open-filament condensations. Each of these simulations demonstrates essential aspects of the formation and stable support of a levitated coronal prominence.

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20.06
Eruption of Solar Prominences

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Observations of erupting prominences indicate that they are imbedded in a helical magnetic field and that they tend to erupt upwards against the gravity force. Van Ballegooijen and Martens (Ap. J. 343, 971, 1989) have recently modeled the formation and eruption process by relying on photospheric flows to push magnetic field lines towards a neutral line where they reconnect. The reconnecting magnetic structure is stable and an eruption is inferred from the tendency of the axis of the magnetic field to rise as more and more of the confining arcade field reconnects. We modify this picture by allowing the photospheric flow to change its direction, thus creating a situation where the prominence becomes unstable at the top. The eruption, in our model, is therefore a consequence of a plasma instability. A simple exact solution will be shown.

20.07
Three-Dimensional Reconnection in Coronal Loops

H.R. Strauss (Courant Institute of Mathematical Sciences, New York University)

A numerical MHD simulation of three-dimensional driven reconnection in a model solar coronal magnetic flux tube is presented. Reconnection is driven by given velocity fields at the footpoints of the flux tube. After a short time, a velocity field develops in the flux tube having a stagnation line coinciding with a magnetic field line. An intense current forms along the stagnation line. This is the locus of strong magnetic field dissipation and field line reconnection. By projecting field lines onto planes transverse to the magnetic field, the topology of the reconnecting magnetic field can be seen to have a separatrix structure. Fluid elements are tracked in time to monitor field line reconnection. Fluid elements initially connected by magnetic field lines become widely separated from the field lines, if they are near the separatrix. This shows directly that reconnection takes place, and is closely related to the formation of a flow stagnation line and a current sheet. This work lends support to the idea that coronal heating is caused by reconnection driven by photospheric flows. It also shows how three-dimensional reconnection generalizes the more familiar two-dimensional concept of reconnection.

20.08
A Numerical Simulation of Atmospheric Responses Due to Emerging Flux From Sub-Photospheric Layers

S. T. Wu, M. T. Song, (CSPAR & ME/UAH) and E. Tandberg-Hansen, (SSL/MSC/NASA)

A numerical MHD simulation model to examine the dynamical responses due to emerging flux from subphotospheric layers is presented. In this model we chose, as the initial state, an arch filament for the magnetic field configuration together with a structured atmosphere. A magnetic flux is then introduced at the lower boundary. The simulation shows that this perturbation introduces a downward motion of the order of km s⁻¹ in the neighborhood of both leg and triggers an atmospheric gravity (i.e. Brunt-Väisälä frequency) wave which propagates outward. We suggest that these simulated results apply to brightness fluctuations observed in the photosphere.

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20.09
The Effect of the Kelvin-Helmholtz Instability on Photospheric Flows

J.T. Karpen, S.K. Antiochos, R.B. Dahlburg (NRL), and D.S. Spicer (NASA/GSFC)

The ceaseless motion of the photosphere is essential to a wide range of solar phenomena, from the formation of fluxules and the structure of the granulation network to coronal heating. Generally, strongly sheared flows have been observed down to the smallest resolved scales in Hα and continuum images. In general, sheared flows can be susceptible to the Kelvin-Helmholtz instability (KHI), which breaks down the ambient velocity patterns into smaller scale components with significant transverse structure. Any morphological alteration in the velocity field will be reflected in the magnetic field, due to the frozen-in condition. Because the footpoints of the coronal magnetic field move with the photospheric flows, the fine structure of the entire solar atmosphere can be affected. We have performed a series of hydrodynamic numerical simulations which investigate the nonlinear evolution of driven, subsonic velocity shears under a range of typical photospheric conditions. Here the hydrodynamic assumption is justified because the magnetic field is primarily perpendicular to the surface of the higher photosphere, thus affecting the characteristic time scales but not the qualitative behaviour of the instability. Our calculations were performed with our advanced pseudospectral Fourier-collation code, CRUNCH4D, which solves the 2D viscous-elastic, compressible, MHD equations. We used the series of simulations to investigate the effects of different initial velocity profiles, maximum speeds, and Reynolds numbers. Our calculations show that typical photospheric flows are indeed susceptible to the KHI, with rapid (ideal) growth rates. The implications of our results for magnetic structuring of the lower atmosphere and coronal heating will be discussed.

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20.10
A Dynamical Model for Heating of Coronal Loops

P. Beaufort, R. Coppi, and L. Golub (CIA)

A set of experimental new observations on the structure of solar corona (Golub et al. 1990, Nature 344, 842) is used as input to a theoretical model for magnetic field-related heating processes of the corona.

We argue that field-aligned currents are generated along coronal loops in this current sheaths by a skin-effect. We first consider ohmic heating involving anomalous electrical resistivity, and find that the very short lifetime of the corresponding configuration makes this heating mecha-