Nonlinear Magnetohydrodynamic Detonation of Solar Flares

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Linear instabilities are incapable of producing the Alfvénic growth rates observed in flare events. A new nonlinear mechanism—Detonation—provides a destabilization mechanism which becomes super-Alfvénic. In this scenario linear ballooning instability starts in a narrow region of the plasma and spreads nonlinearly to the metastable regions causing an explosive release of energy. Both analytic and numerical solar flare equilibria have been developed and their stability has been analyzed using the Detonation formalism. It is shown that these flare models are explosively unstable according to the Detonation mechanism in spite of the very low plasma beta. Further, we show that the instability occurs before any "loss of equilibria" condition is reached.

Non-LTE Radiative-hydrodynamic Models of Solar Flares

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We have modeled the dynamic response of the solar atmosphere to impulsive flare heating, using a modified version of the non-LTE radiative hydrodynamic code RADYN (Carlsson and Stein 1996). Our results show the response of the photosphere, chromosphere, transition region and corona to the input of flare energy in the form of a flux of non-thermal electrons. The X-ray irradiation of the lower atmosphere due to the heating of the corona is treated self-consistently. Non-LTE radiative effects of important optically thick Hydrogen, Helium, Calcium and Magnesium transitions are calculated in detail. The dynamic evolution and energetics of the flare atmosphere will be discussed for some typical examples of flare heating profiles.

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Global Sun Study: line broadening in the extended corona

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During the SOHO campaign dedicated to the Global Sun Study, the Ultraviolet Coronagraph Spectrometer (UVCS) has observed the corona at high spectral resolution (0.2 Å) in several coronal UV lines within 1.5 and 4 solar radii. A complete high resolution observation of the extended corona was obtained in 12 days during August-September 1996. The high spectral resolution observations were aimed to characterize thermal and non-thermal velocity fields along the line-of-sight through the study of the broadening of spectral lines. The major result we obtained is that open field line regions, where we expect the high-speed solar wind flow, are characterized by O VI 1032 and HI Ly α 1216 lines which are broader than in equatorial and mid-latitude streamers. The effect is much more evident in the O VI line. Furthermore, the broadening enhancement in open field line regions is increasing with distance from Sun center.

Evidence of untwisting magnetic fields in the Coronal Mass Ejections of June 7, 1996

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The Ultraviolet Coronagraph Spectrometer (UVCS) on board the SOHO satellite observed the first coronal mass ejection on June 7, 1996. The UVCS observed the coronal region between 1.5 to 3 Rs just after the passage of the mass ejection front in several ultraviolet emission lines. This region is characterized by an O VI 1032 bright feature which we presume magnetically connects the front of the coronal mass ejection to the solar surface. This structure is clearly characterized by a lower temperature (9 × 10^7 K) than in the surroundings (1.5 × 10^8 K) and by either circular or helical motions, which we suggest are evidence of untwisting magnetic fields in the erupted flux rope. The identified motions are characterized by line of sight velocities of the order of 30–50 km/sec, as derived by the Doppler shifts of the HI Ly α line.

Differential Emission Measures—Can we do more??

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Spectroscopic diagnosis of the temperature and density structure of hot optically thin plasmas from emission line intensities is usually described in terms of either: (a) spectroscopic mean electron temperatures \( T_e \), and electron densities \( n_e \) derived from line pairs whose ratios are predominantly ‘temperature sensitive’ (pair \( i,j \)) or ‘density sensitive’ (pair \( k,l \)); (b) an emission measure function \( DEM = \int T_e \, T \, dV \), in density, \( DEM = \int n_e \, dV \), or in both, \( DEM = \mu(n_e, T_e) \). We discuss the stability of the latter in the presence of atomic and data errors, and propose methods for obtaining the most reliable solution. Whilst showing that, mathematically speaking, the two methods are equivalent.

Studying the temporal behavior of the Evershed flow from SOHO/MDI

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We have investigated the temporal properties of the Evershed flow in an axisymmetric sunspot close to disk center, using full disk Doppler velocity data from the MDI instrument aboard SOHO. Plotting oscillation power as a function of position from the data we were able to see periodicities of the power ranging from 10 to 15 minutes in the center of the spot, as well as at the outer penumbral boundary; the strongest signal around 13 minutes. Assuming the Evershed flow is concentrated in magnetic flux tubes where fluid flow is closest to vertical around the umbra and at the footpoints beyond the penumbra, our results may suggest periodicity within the tubes on the order of 13 minutes.

P-Mode, Acoustic Emission and Surface Magnetic Fields

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It is well known that the solar \( p \)-mode power is reduced in magnetic regions. It has also been reported that the regions surrounding the strong magnetic field show excess emission in the frequency range 5.5 ≤ \( v \) ≤ 7.5 mHz. It is not clear whether the suppression is produced by direct modification of the \( p \)-mode eigenfunctions or due to changes in the spectral line formation process.

In this poster we investigate the reduction of Doppler velocity power in regions of strong magnetic field for several data sets taken with the MDI instrument aboard SOHO in the photospheric line Ni I 676.8 nm. We find that in the \( p \)-mode band, the Doppler velocity power is reduced in regions where the magnetic field is strong. In the frequency range 5.5 ≤ \( v \) ≤ 7.5 mHz, we see excess emission from areas surrounding the regions of strong magnetic field.

We carry out a similar analysis for 1991 South Pole continuum intensity data taken with the High-Degree Helioseismometer in the chromospheric line Ca II K 393 nm to examine whether this relationship between the \( p \)-modes, acoustic emission and the surface magnetic fields is seen at different heights in the solar atmosphere.