2.5 The Structure of Transition Region Loops

S.K. Antiochos (Stanford University)

We propose a model for the Solar Transition Region in which the bulk of the material at lower temperatures, T < 10^4 K, is contained in cool loops. The structure of such loops is discussed and compared to the usual coronal loop models. Temperature, density and pressure profiles are calculated. The physical differences between the coronal and the cool models are discussed. We also investigate the effects of gravity and spatial variations of the heating rate on the plasma structure. Finally, the implications of these results for UV observations of the Solar Transition Region are discussed.

2.6 Modeling the Solar Chromosphere With Submillimeter Limb Brightness Profiles

C. Lindsey, L. Herrmans (U. of Hawaii, Inst. for Astronomy)

We use submillimeter brightness profiles of the solar limb to model the solar chromosphere independent of gravitational-hydrostatic equilibrium. Limb brightness profiles determined by Lindsey et al. at 30, 50, 100 and 200 µm were used as a basis to vertically perturb the chromospheric models of Vernerza, Avrett and Loeser (VAL).

The longer-wavelength profiles showed a somewhat brighter limb, consistent with the 6000 K temperature plateau of the middle chromosphere of the VAL models. However, the profiles of hundreds of kilometers higher than predicted for the unperturbed VAL. This is corrected by nearly doubling the physical thickness of all layers above the temperature minimum. The temperature of each layer is left unchanged, while the density is adjusted (decreased) to correct the vertical optical depth of the chromosphere.

2.7 Spicule Dynamics: Long Time Behavior

A.C. Sterling and J.V. Hollweg (University of New Hampshire)

We extend the spicule model of Hollweg (1982) by investigating its long-time behavior. In that model, spicule-like structures result from the non-linear evolution of a wave train which develops from a quasi-linear impulse at the base of intense magnetic flux tubes. At long times, these structures approach a new state of hydrostatic equilibrium. Roughly speaking, the new equilibrium consists of three layers: i) nearly undisturbed chromospheric gas below some 1300 km; ii) shock-heated chromospheric gas above 1300 km, which we identify with the spicules; iii) nearly undisturbed coronal gas at greater heights. The terminal height of the intermediate layer is proportional to the initial energy input. For a typical case, we find the steady state spicule-like structure to have a temperature T = 6.4 x 10^4 K, density n = 10^10 g cm^-3, and a height h = 1.6 x 10^6 km. The new equilibrium may be ripe for further heating to UV-emitting temperatures, as in Sterling and Hollweg (1984). However, the present work emphasizes dynamics - radiative losses and non-shock heat input are not included.


2.8 Umbral Oscillations: Correlation of Amplitudes Between Two Chromospheric Heights

B. W. Lites (HAO/NCAR) ¹, NSO/Sunspot

Measurements of umbral oscillations have been made using the Vacuum Tower Telescope and echelle spectrograph of the National Solar Observatory/Sunspot. Spectra were obtained in two lines (Fe I 1543 and Ca II 8498) covering the entire umbra of 7 sunspots, for durations of up to 85 minutes. Correlation of the oscillatory amplitude within the 5-minute band in Fe I with the amplitude in the 3-minute band in Ca II indicates that 3-minute umbral oscillations affect regions where the 5-minute oscillations are strong. This observation suggests that the umbral oscillations are not driven by nonlinear wave interactions of the 5-minute modes with the chromospheric cavity resonating at 3 minutes. At each frequency within the 3-minute band, these umbras show a good correlation of oscillatory amplitudes with umbral position at the two heights measured. Within one umbral fluxtube, the relationship between the amplitudes at these two heights varies with frequency. At a given frequency, the relationship differs in distinct umbral fluxtube. These two observations show: 1) within an umbral element, the chromospheric structure is fairly uniform, 2) chromospheric structure differs between fluxtubes, and 3) fluctuations in the driving source (in the photosphere), not in chromospheric structure, are responsible for temporal changes in amplitude and frequency of the umbral chromospheric oscillations.

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2.9 Sunspot Umbra Oscillations in the Photosphere and Low Chromosphere

J. H. Thomas (U. Rochester) and B. W. Lites (HAO/NCAR)

Velocity oscillations in sunspot umbrae were measured simultaneously in two spectral lines, one formed in the low photosphere and the other formed in the low chromosphere, just above the temperature minimum. The power spectrum of velocity in each spectral line shows the presence of both 3-minute and 5-minute oscillations. The coherence spectrum and phase spectrum between the velocities in the two lines show that the 3-minute umbral oscillation has the character of a coherent, vertically standing wave in the photosphere. Also, the kinetic energy density of the 3-minute oscillation is found to be at least five times greater in the low photosphere than in the low chromosphere. These results indicate that the fundamental 3-minute umbral oscillation is caused by a photospheric resonance rather than a chromospheric resonance. Multiple peaks in the power spectrum of chromospheric oscillation at periods near 3 minutes may be caused by the additional effect of a chromospheric resonance. The umbral 3-minute oscillations are coherent between the two heights with a small, positive phase difference between the low photosphere and low chromosphere, much the same as in the quiet Sun. A negative phase difference at frequencies around 2 mHz suggests the presence of gravity waves in the umbrella.

2.10 On the Broad-Band Circular Polarization Signature of Sunspots

A. Skumanich, B. W. Lites (HAO/NCAR) ²

We consider the transfer of Stokes parameters in a model sunspot based on a Schuster-Temescy (ST) representation of field lines as constructed by Landman and Finn, Solar Phys., 63, 221 (1979). The basic equations include magneto-optical birefringence following the conventions of Landi Degl'Innocenti, Astr. and Ap., 45, 269 (1975). The effects of velocity, field and thermal gradients as well as the role of magneto-optical birefringence, are explored. It is found that a circular polarization and photometric observables of Hensel and Kemp, Solar Phys., 93, 289 (1984) can be explained only if birefringence is included and require a dilating velocity field. An accelerating outflow stronger in the penumbra than in the umbra satisfies the observations.

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