Cloud modeling of bright and dark features in Hα
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ABSTRACT
Chromospheric network when viewed in the shows bright and dark structures like fibrils. These fine structures usually called mottles are the key to understand the topology and energy balance of this solar regime. Bright and dark mottles form into two kind of groups, named rosette and chain. The mottles in a rossette spread radially outward from a bright center while in a chain they all point in the same direction.

In this work, we study the physical properties of bright and dark mottles in network, using the profile-scanning images taken with IBIS at the DST. Cloud modeling was applied to derive estimates of the mottle optical thickness, source function, Doppler width, and line of sight velocity. With these estimates more accurate parameters were determined: the number density of hydrogen atoms in levels $i$, total particle density, electron density, temperature, gas pressure, mass density. We compare the results with those obtained by various authors. It is concluded that bright and black network mottles have similar nature.

Time averaged parameter maps of Hα observations of quiet-region obtained with IBIS

Cloud parameters

In Match a quiet-sun network near disk center was observed in Hα with IBIS at the Dunn Solar Telescope at NGO/Sacramento Peak. The line was sampled at 64 spatial positions, at step intervals of 30″ in this a sequence of the 12 spectral scans at a cadence of 14 seconds. Line profiles were constructed for each pixel in the field of view (average as accurate).

Experimental

Model

Cloud modeling considers a feature as due to a cloud above a uniform atmosphere described by a reference background profile. The approach works well for optically thin structures and delivers estimates of the cloud optical thickness, the optical thickness at the line center, $\tau_0$, Doppler width $\Delta$V, and line-of-sight velocity $V_\lambda$, all assumed constant within the cloud along the line of sight. The observed contrast profiles are matched with theoretical contrast profiles (Backers, 1968).

The model parameters were determined by an iterative least square fitting procedure. For the selection of bright and dark features in network, masks were used for each spectral scan. Fig. 1 displays histograms of cloud parameters for bright and dark mottles. Table 1, 2 and 3 represent the mean values of the parameters with the standard deviations and the results of various authors. We can be seen from these tables there is an agreement between our work and the others except the optical thickness of bright mottles. The reason can be that Backers used a spectral profiles of bright mottles to estimate these parameters whereas we used $\nu$-profiles.

Results and Conclusion

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Different physical parameters such as $\lambda_0$, $\tau_0$, $\Delta$V, and $V_\lambda$ can be calculated by using cloud results. Fig. 2 shows the images of time-averaged physical parameters when taken into account all areas to which the cloud model iteration converged. The mean values of parameters for bright and dark mottles are given in Table 1. We also determined the same variables from VALD and VAL-F atmosphere models (Bouret et al., 2006) by using the averaged $\nu_0$ value calculated from observations see Table 5. We gave results of Tziropoulou and Schmidt (1997) and Tziropoulou and Tziropoulou (2006) in Table 5 to compare our results with them for dark mottles.

Furthermore, we found pressures of 0.1 and 1.2 kPa for dark and bright mottles, respectively. Heliot and Schmidt (2006) using non-LTE models have concluded that for low pressure structures such as dark mottles one can easily apply the classical cloud model assuming a constant source function and rather low opacity, while the high pressure solutions give much higher opacity and strongly non-constant source function. Some authors concluded that there is no perceptible difference between the dark and bright structures; their pressure and contrast probably depend on the amount of material injected into the flux tube and on the pressure-balance conditions inside. It can be clearly seen from our results of physical conditions inside the dark and bright features, given in Table 5, we also find no major differences between them.