SUGGESTED INTERPRETATION OF THE CORRELATIONS
IN INTENSITY FLUCTUATIONS IN THE LINES Ca II
H AND K, MAGNESIUM b, AND HYDROGEN Hβ

(Research Note)

RICHARD N. THOMAS
Joint Institute for Laboratory Astrophysics, Boulder, Colo. 80302, U.S.A.

(Received 25 July, 1972)

In the preceding note, Evans and Catalano have found interesting behavior in the correlation between intensity fluctuations in the continuum and in the lines H and K of Ca II, H, and K, and Mg I, and hydrogen Hβ. In the first four lines, the correlation drops smoothly from ~0.9 near the continuum to negative values; followed by a rise to about zero at line center. For Hβ, the correlation is never negative, reaching zero at about 0.25 Å.

We suggest that this behavior reflects a combination of effects. First, the source-sink terms in the source-functions depend on different physical parameters in the two sets of lines. In addition, the line center regions are dominated by transfer effects at the top of the atmosphere.

For the Ca II and Mg I lines, the source-sink terms are collision-dominated, thus sensitive to the distribution of $T_e$ and $n_e$. Outside the line center then, the source-functions should reflect any local fluctuations in $T_e$ and $n_e$. If we make the plausible assumption that the total flux of energy is constant over the solar surface and that the continuum intensity reflects the radiative flux at lower levels, then any increase in radiative flux must be accompanied by a decrease in mechanical flux. For those portions of the lines which are chromospheric in origin, on the other hand, the local value of the source-function should reflect the dissipation of mechanical energy, which decreases if the mechanical energy flux decreases. Thus we should expect the observed negative correlation between behavior of the continuum (radiative flux) and behavior of the chromospheric component of the line source-function (mechanical flux).

In contrast to the Ca II and Mg lines, the source-sink terms for Hβ are dominated by photoionizations in the Balmer and Paschen continua, averaged over large areas of the solar surface. These source-sink terms should show negligible dependence on 'local' variations in radiative or mechanical flux at the photospheric level. According to a recent study by Gebbie and Steinitz (1972), 'mottling' in the Balmer lines should, rather, reflect effects of local velocity fields on the absorption coefficient in the scatter-term of the source function, thus show little correlation with events at the photospheric level. Thus the source-function for Hβ in the non LTE core of the line should be independent of that for the continuum; and the correlation between behavior of
Hβ and the continuum should drop rapidly toward line center. Such behavior is shown in Figure 3 of the cited paper, where the rapid drop in correlation begins at about 0.75 Å from the line center.

For all lines, when one reaches that part of the core corresponding to about one diffusion-scale from outer space, transfer effects at the boundary condition the intensity, and the features found in the central cores of both types of lines should show little correlation, positive or negative, with the lower level features of the continuum. The observations appear to confirm this.

If this interpretation is correct, it suggests that the magnitude of the intensity fluctuations, in different parts of the line, might be used as an empirical guide to the propagation-dissipation of the mechanical flux as a function of height. The high correlation Evans and Catalano find between features at 'corresponding wavelengths' in different lines fixes a common height scale, which frees the suggested empirical guide from too strong a dependence on the interpretation of a single line.

Acknowledgement

This work has been partially supported by the collaborative program between JILA and Sacramento Peak.

Reference