A SURGE IN THE CHROMOSPHERE AND THE TRANSITION REGION: VELOCITIES AND MICROTURBULENCE

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ABSTRACT

Simultaneous observations of a surge in Hα and C IV are analysed in terms of Doppler velocities and "microturbulence". The behaviour of both quantities suggests strong velocity shears with small spatial scales.

1. Observations

Simultaneous observations of a surge in active region AR 2701 were obtained on Oct.2, 1980 with the Ultraviolet Spectrograph and Polarimeter (UVSP) instrument onboard the Solar Maximum Mission (SMM) satellite (1548 Å C IV line) and the Multichannel Subtractive Double Pass (MSDP) spectrograph of the Meudon Solar Tower (Hα). Instrumentation and data processing have been detailed, and Doppler velocity measurements have been investigated in a previous publication (B. Schmieder et al., 1983). The main conclusions were that cold and hot material follow parallel lines of force in the same channel, and that a pressure gradient may drive the surge in the initial phase . In this poster, we extend the analysis to "microturbulence" determination, in order to investigate the behaviour of velocity shears along the line of sight, especially in the final phase when the free-fall is the dominating mechanism.

2. CIV Analysis : Double Doppler Determination

In each point of the field (1' x 1') the UVSP observed 4 intensity values in the line profile, almost simultaneously :

$I(\lambda_{b1})$ with $\lambda_{b1} = \lambda_o + 0.05 - 0.15\,Å$
$I(\lambda_{b2})$ with $\lambda_{b2} = \lambda_o - 0.05 - 0.15\,Å$
$I(\lambda_{r1})$ with $\lambda_{r1} = \lambda_o + 0.05 + 0.15\,Å$
$I(\lambda_{r2})$ with $\lambda_{r2} = \lambda_o - 0.05 + 0.15\,Å$

The two quantities : $RV1 = \frac{I(\lambda_{b1})-I(\lambda_{r1})}{I(\lambda_{b1})+I(\lambda_{r1})}$ and $RV2 = \frac{I(\lambda_{b2})-I(\lambda_{r2})}{I(\lambda_{b2})+I(\lambda_{r2})}$

are related to the line-width $W = \frac{\lambda_o}{c}\sqrt{\xi^2 + \frac{2kT}{m}}$

by equations which are detailed in a paper by G.Simon et al.(1982). The "microturbulence" ξ is calculated by assuming a temperature T around 10^5 K for the CIV ejecta.

3. Hα analysis : 1^{st} order differential cloud model

Surges appear as "clouds" imbedded in the corona, transparent to the Hα radiation. They seem to be relevant to the well known "cloud model" suggested by Beckers (1964). However, the strong horizontal gradients in brightness which characterize active regions, especially in the Hα radiation, prevent an easy determination of any reference chromospheric background. We propose to use a "differential" version, as developped in a paper by P. Mein et al., (1988). The Hα profile I_P, observed in the line of sight P'P, is compared to the profile I_R observed at a neighbouring line of sight R'R (fig. 1a). If Q is such that the optical depth P'Q equals the optical depth R'R, the following equations can be written in the standard notation :

$$I_Q \quad I_R \qquad\qquad C_1 = \frac{I_P - I_Q}{I_Q} = \left(\frac{S}{I_Q} - 1\right)\left(1 - e^{-\delta\tau}\right)$$

$$\delta\tau \quad \delta\tau_0 e^{\left(\frac{\lambda - \lambda_0 - V\lambda_0/c}{W}\right)^2} \qquad\qquad W = \frac{\lambda_0}{c}\sqrt{\xi^2 + \frac{2kT}{m}}$$

The source-function S is fitted so as to obtain a gaussian shape of the optical depth $\delta\tau$ (fig.1b).

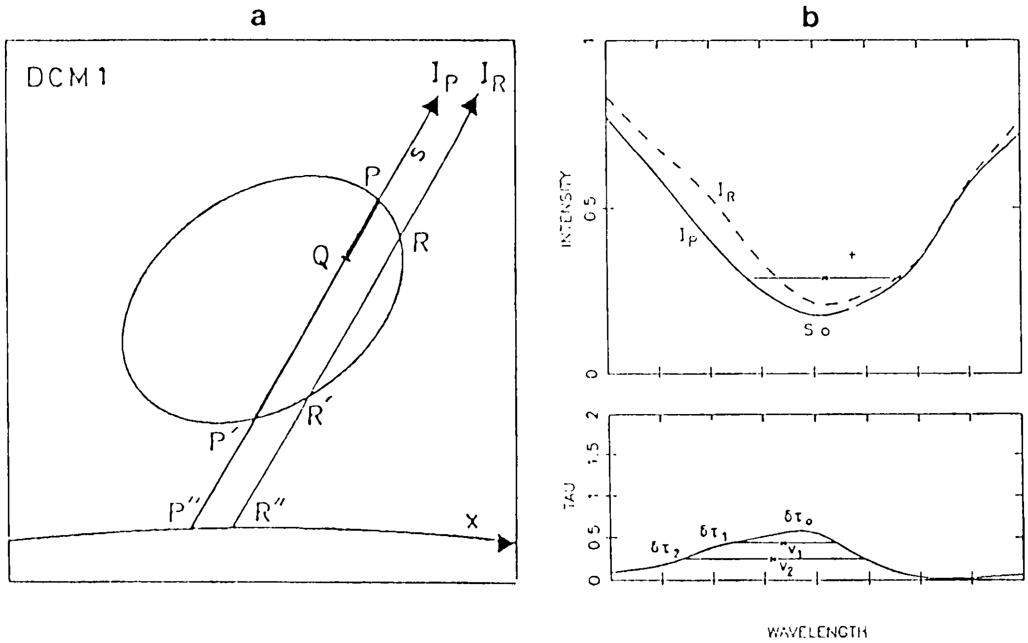

Fig.1 a) Cut of the "cloud" and lines of sight under study, in the case of "1^{st} order Differential Cloud Model".
b) Example of observed Hα profiles and corresponding $\delta\tau$-profile.

This method is most efficient near the edges of absorbing structures, where large differences I_P - I_Q correspond to small background fluctuations (differences between radiations emerging from P" and R"). The temperature of Hα ejecta is assumed to be 2×10^4 K in the microturbulence calculation.

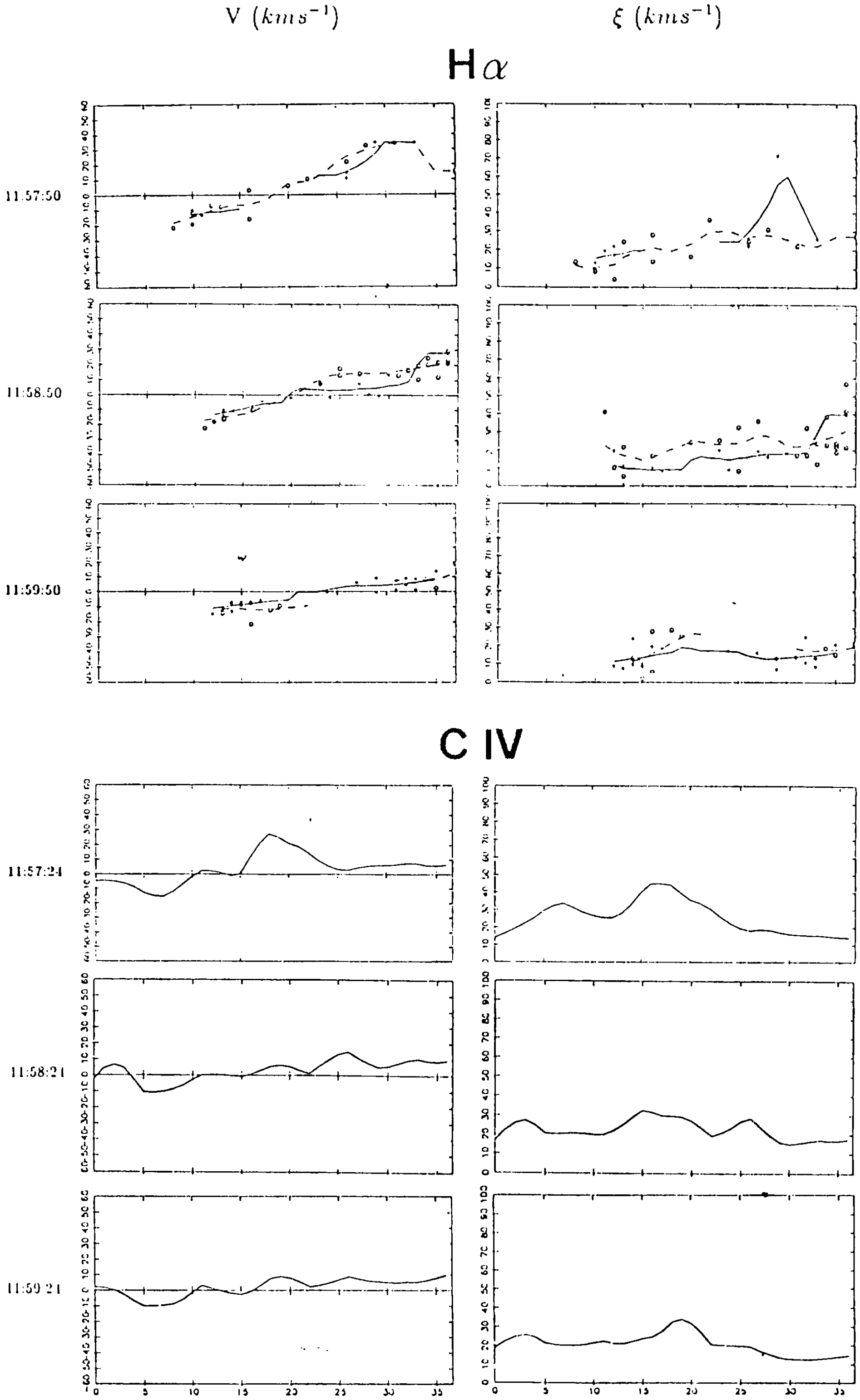

Fig.2 Velocity and "microturbulence" along the surge in Hα and C IV ; times are indicated for each observation.

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4. Results

Figure 2 shows the velocity V and the "microturbulence" ξ, observed between 11:57 and 11:59 UT in Hα and C IV. Cuts AB along the surge (36" long) are superimposed on both lines. Note that velocities are always downward near the foot A of the surge, and upward near the top B, during this final phase of the event.
We note also that the velocities have similar values in cool and hot material although the gradient from A to B seems higher as seen in Hα (-20 to +25 km s^{-1}) than in C IV (-10 to +10 km s^{-1}). The "microturbulence" is very high in both cases and decreases with time from 30 to 15 km s^{-1}.

5. Conclusion

The decrease with time of the "microturbulence" can be explained tentatively by the presence of velocity shears. Indeed, flows along different magnetic lines of force are independent, and fast material reaches higher levels than slow material, so that the free-fall leads to a global elongation of the surge in time. During this elongation, the velocity range decreases along each individual line of sight, as shown in a numerical simulation detailed in a poster by N. Mein et al. (1988).
The ξ values exceed the sound velocity, especially in the case of Hα. This suggests that the responsible mechanism should not be hydrodynamic microturbulence, but possibly Alfven waves or shears (as already mentioned). In any case, since the ξ values exceed also the differences between V-values in Hα and C IV, we conclude that the dimension of small scale velocity fields seems to be smaller than the distance between trajectories of Hα and C IV ejecta.

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