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DYNAMICAL FINE STRUCTURE OF FILAMENTS AND PROMINENCES

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OBSERVATIONS

We observed a quiescent prominence on the east limb of the Sun, on June 7, 1988 (Mein P. et al 1990) and a quiescent filament (N 5, W 5) on June 17, 1986 (Schmieder et al 1991). These two observations are made with the Multichannel Subtractive Double Pass spectrograph of the turret dome refractor of the Pic du Midi Observatory, providing simultaneous 2D pictures in 9 channels for H_α .

STATISTICAL MODELS

Fig I shows the geometrical model of the filamentary structure for the filament. For the prominence, see Mein et al, 1990 .
The filament (or the prominence) is supposed to consist of a lot of "threads" with the same temperature T, the same source function S, the same optical thickness τ, with different velocities. Each observed pixel mixes n_1 lines (because of the seeing and of the size of the pixel) of n_2 (on the same line of sight) "threads".

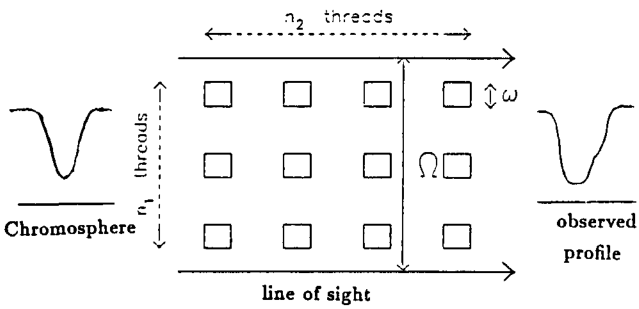

Figure I Geometrical model of the filament.

We compute the line profile assuming that each thread i has a velocity v_i: for the filament v_i is a vertical velocity; for the prominence, it is an horizontal velocity. We calculate the profile with T, $\epsilon = \omega/\Omega$, τ and S as parameters.
The velocity of the thread i of the prominence is $v_i = v_1 + v_2$ (v_1, constant for all the threads of the pixel, is deduced from a gaussian distribution $(0, \sigma_0)$; v_2 is a random velocity with a gaussian distribution (v_1, σ_1)).
For the filament, the velocity v_i of the thread i is deduced from a gaussian distribution $(0, \sigma)$.
In the case of the filament, the profile of H_α is given by:

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$$i_t(\lambda) = I_{ch.}(\lambda)(1 - n_1\epsilon) + \epsilon \sum_1^{n_1} (I_{ch.}(\lambda) e^{-\sum_1^{n_2} \tau_i(\lambda)} + S(1 - e^{-\sum_1^{n_2} \tau_i(\lambda)}))$$

$I_{ch.}(\lambda)$ is the chromospheric profile below the filament.

$$\tau_i(\lambda) = \tau_0 \times exp - \left[\left(\frac{\lambda_0 - \lambda + v_i \lambda_0 / c}{W_D}\right)^2\right]$$

$$W_D = \frac{\lambda_0}{c}\sqrt{2kT/M}$$

For the prominence $I_{ch.}(\lambda) = 0$.

OBSERVATIONS OF FILAMENT AND PROMINENCE.

In the prominence, we measure the following quantities:
I_{max} (maximum value of the profile $I(\lambda)$), V (velocities at $\pm$ 0.41 Å) and W (line width).
Then, we calculate the statistical values S_v(standard deviation of the velocities of the whole prominence) and S_w (standard deviation of W) as functions of I_{max} (Mein P. et al 1990).
In the filament, we measure I_{min} (minimum value of the profile $I(\lambda)$), I_1 (value of the profile at $\pm$ 0.25 Å) and V (velocity at $\pm$ 0.25 Å).
Then, we calculate: S_v = standard deviation of the velocities of the whole filament and S_I = standard deviation of I_1; as functions of I_{min}.
The fig II shows the observations for the filament.

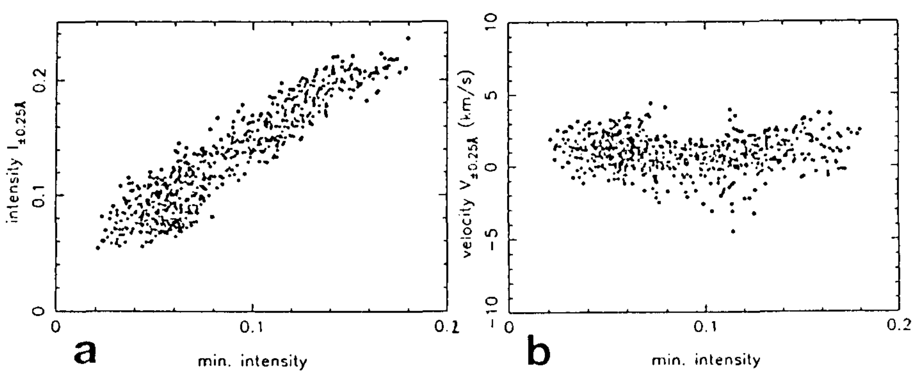

Figure II Observed values for the filament.
(a) I_1 versus I_{min}, (b) V versus I_{min}

BEST FIT BETWEEN OBSERVATIONS AND SIMULATIONS.

We simulate 5000 H_α profiles and we calculate the same statistical values as the observed ones. By trial and error we deduce the best fit. Fig III shows this fit

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for the filament.

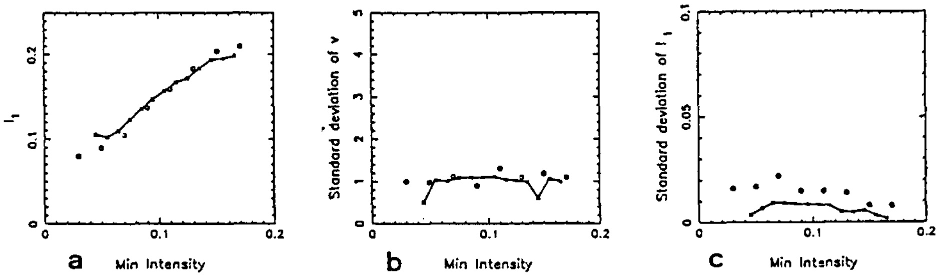

Figure III Comparison between simulations (full lines) and observations(circles) for the filament:(a)I_1, (b)S_v (c)S_I versus I_{min}

The best fit is obtained for $T=$ 8500 K, S=0.05 (unit= continuum intensity at disk center) , $\tau_0 = 0.2$, σ = 7.2 km/s, $\epsilon = 1$ and $n_1 = 1$.
We find $2 < n_2 < 15$.
For the prominence we introduce two cases corresponding to the edges and to the center of the filament (Mein P. et al 1990). The results are practicaly the same as for the filament, expect the edges where we introduce σ_0 = 6.5km/s and σ_1 = 7.5 km/s.

CONCLUSION.

The results of the filament are similar to the results of the prominence, showing a similar behaviour of vertical and horizontal velocities.
The fitting for the standard deviation of intensity is not so good as the other results. Perhaps the dicrepancy is due to the fluctuations of the background.

ACKNOWLEDGMENTS

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REFERENCES

Mein P., Mein N., 1990, Sol. Phys. **136**, 317.

Schmieder B., Raadu M. A., Wiik J.E. 1991, Astron. Astrophys. **252**, 353.