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Behaviour of Hα and H Ca II Emission Lines in a Prominence Before and During its Dynamic "Disparition Brusque"

M. S. Madjarska and V. N. Dermendjiev
Institute of Astronomy, 72 Trakia Blvd., 1784 Sofia, Bulgaria

Z. Mouradian
Observatoire Paris-Meudon, DASOP, URA 326, 92195 Meudon, France

P. Kotrč
Astronomical Institute of the Czech AS, 25165 Ondřejov Observatory, Czech Republic

Abstract. Hα and H Ca II emission lines in a limb quiescent prominence (QP) undergoing destabilization are studied. The temperature, line-of-sight velocity and micro-turbulence are obtained in one of the prominence legs, just before and during the prominence activation.

1. Introduction

On August 3, 1992 at the solar East limb ($\phi = -16°$, $1 = 90°$), a prominence was registered by the Multicamera Flare Spectrograph (MFS) of the Ondrejov Observatory (described in Valniček et al. 1959). The prominence was observed in two series, from 13:25:45 to 13:30:15 UT and from 14:22:55 to 14:33:35 UT. The registration was made by all cameras of the MFS in different slit positions on the prominence body. During the first series of observations the prominence behaved as a quiescent one, whereas in the second one as a dynamic "disparition brusque" (DB). According to Solar Geophysical Data (1993) the activation started at 13:50 UT and finished at 17:05 UT, so that we have observations covering the late QP phase and the chance to follow the start of the destabilization and eruption. In this paper we present preliminary results concerning the basic plasma parameters in a prominence leg, just before and during the DB process.

2. Observational Material

During the first series of observations, which lasted 4m 30sec, 6 registrations were made in different slit positions. At 14:22:55 UT the observations were renewed and 10 spectrograms more were taken in different slit positions.

The spectrograms cover five spectral regions including the following emission lines – Hα, D3 He, Hβ, Hγ, H and K Ca II. The height of the slit is 50 mm which corresponds to 627,125 km and the working width is 0.0534 mm ≈

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669 km. The focal image of the Sun has a mean diameter of 125.6 mm. In the different spectral regions, 1 mm of the vertical scale corresponds to 17.3 arc sec on the solar disc. The dispersion is in order of 1 Å/mm. The exposure time for the first series is 5 sec and for the second series is 6 sec.

3. Image Processing

The observational material was processed on the Joyce Loebl microdensitometer at the National Astronomical Observatory – Rozhen. The two-dimensional scans were taken with a diaphragm of 25×25 μ^2 and a step of 25 μ in both directions. The obtained spectra were corrected for ghosts as well as for scattered light.

4. Prominence Plasma Parameters

To study the physical conditions in the prominence at certain times of its quiescent and DB phases, we compared the slit positions of both series of observations. Two of them, in the south prominence leg (at 13:25:45 UT and 14:22:55 UT), nearly coincided. The location of the slit was almost perpendicular to the prominence leg which permitted us to follow velocity and temperature changes along the leg's cross section.

The line-of-sight velocity was determined by the equation

$$v_r = c\frac{\lambda - \lambda_0}{\lambda_0}$$

where c is the velocity of light, λ_0 is the real wavelength and λ is the registered one. The obtained results (Figure 1) show that just before the eruption (dashed line) in the periphery of the prominence leg $v_r > 0$, whereas in the central region $v_r < 0$, where v_r is in the range of –5 to 5 km s^{-1}. During the DB phase (continuous line) we determined $v_r = -14$ km s^{-1} for the left edge of the prominence leg, whereas in the central part and right edge the velocity did not change significantly.

In addition to thermal effects, the atoms possess a non-thermal velocity component (micro-turbulence) that influences the line profile and gives rise to the total Doppler width (Tandberg-Hanssen 1995), expressed by

$$\Delta\lambda_D = \frac{\lambda}{c}\sqrt{\frac{2kT}{m} + \xi_t^2}.$$

Both velocities could be separated by comparing the width of two spectral lines from atoms of different weight. We compute the temperature using Hα and H Ca II lines arising in the same portion of prominence volume by the formulae

$$T = 1.95 \times 10^{12}\left(\frac{1}{\mu_1} - \frac{1}{\mu_2}\right)^{-1}\left[\left(\frac{\Delta\lambda_{D_1}}{\lambda_1}\right) - \left(\frac{\Delta\lambda_{D_2}}{\lambda_2}\right)\right]^2,$$

where μ_1 and μ_2 are the atomic weights for Hα and H Ca II, respectively. The

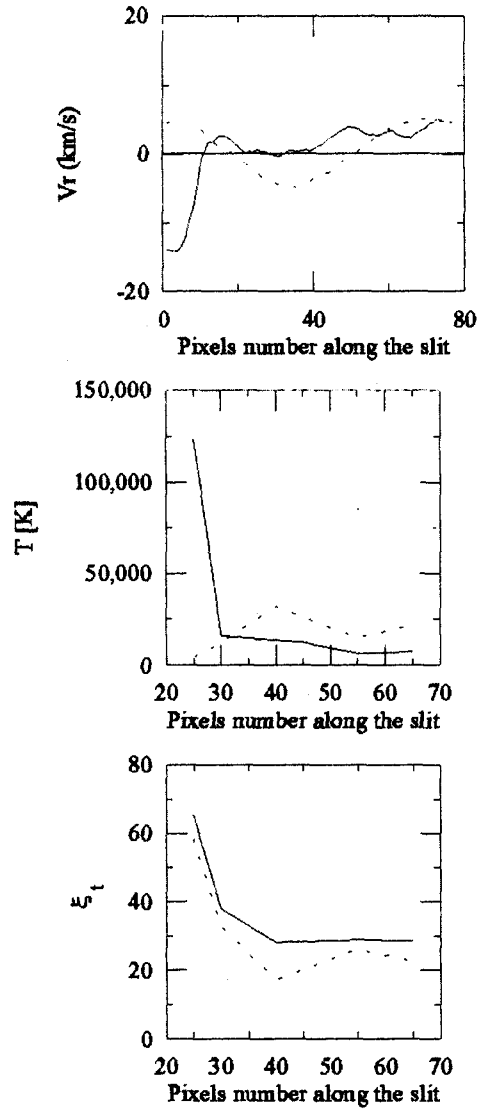

Figure 1. The line-of-sight velocity (top), temperature (middle) and micro-turbulence (bottom) during the QP (dashed line) and active phase (continuous line).

micro-turbulence was determined by the equation (Jefferies and Orrall, 1962),

$$\xi_t = \left(c^2 \frac{\Delta\lambda^2}{\lambda^2} - \frac{2kT}{m} \right)^{1/2}$$

where k is the Boltzmann constant and m is the mass of unit atomic weight.

It is interesting to note that in the central part of the prominence leg, during the QP phase, ξ_t decreases (Figure 1, bottom). On the other hand the temperature (Figure 1, middle) slightly increases. Without additional observational information it is difficult to interpret the obtained results. One of the possible suppositions is that there was a slight down flow of hotter material. Such a downflow will increase to certain degree the horizontal (parallel to the disk) oscillations leading to the observed increase of $| v_r |$ (Figure 1, top).

5. Conclusion

The scenario sketched in this paper from these preliminary results is rather attractive. However, it needs further verification based on the entire series of registered emission lines.

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