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# Spectropolarimetric observations of filaments in H$\alpha$ and He $D_3$

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**Abstract.** Recordings of the full Stokes vector of filaments in the H$\alpha$ and He $D_3$ lines were obtained at the Gregory-Coudé telescope in Locarno with the polarimeter ZIMPOL. The aim was to perform preliminary studies to explore the presence of forward scattering polarization. The observations show linear polarization signatures, whose interpretation is still being investigated, although it appears likely that forward scattering is indeed involved.

## 1. Introduction

Transverse magnetic fields in solar filaments observed at disk center can generate linear polarization signatures through forward Hanle scattering. The diagnostic interest of this effect was pointed out by Trujillo Bueno (2001), and detected in filaments observed in the He 10830 Å line (Trujillo Bueno et al. 2002). To explore if forward Hanle scattering signals can be detected in filaments in H$\alpha$ and He $D_3$ we performed preliminary spectropolarimetric observations at IRSOL, choosing to observe quiet filaments near disk center. Here we just report the observational results, postponing the interpretation to a future work.

## 2. Observations

Observations were performed with the Gregory-Coudé telescope at IRSOL, using the Czerny-Turner spectrograph and the polarimeter ZIMPOL (Gandorfer 2004). 19 filaments measurements were performed in H$\alpha$ and 6 in He $D_3$. The polarimeter is adjusted in order to measure as positive $Q/I$ the linear polarization parallel to the spectrograph slit. For practical reasons it is convenient to define as positive $Q/I$ the linear polarization parallel to the local direction of the filament. Therefore the slit jaw-image was used to identify the orientation of the filament with respect to the slit. This could be accomplished by rotating the Stokes system numerically. To reach a good signal to noise ratio, exposures ranging from 10 minutes to 120 minutes (for He $D_3$ recordings) were needed. The automatic guiding system (Küveler et al. 1998) was used to compensate for the solar rotation.

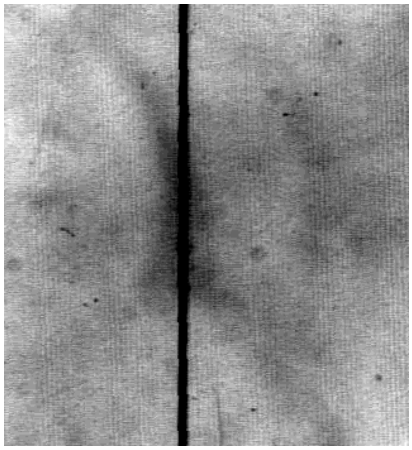

Figure 1. *Slit jaw Hα image. In this 95″ × 105″ recording we can see the filament observed at disk center and analyzed in Figure 2.*

## 3. Results

### 3.1. Results in H$\alpha$

Polarization signatures were found measuring filaments in H$\alpha$. The linear polarization parallel to the local filament direction, defined as $Q/I$, shows generally a peak at line center, while in $U/I$ peaks are located in the wings of the line.

The observation reported here was performed on March 18, 2005 at longitude 2° and latitude 11° starting at 08 UT and lasting about one hour. Figure 1 is a low resolution slit-jaw image of this filament, used to find its orientation with respect to the slit.

The results of this measurement are representative for most of the other H$\alpha$ observations of filaments.

Figure 2 shows the four Stokes images of a spectral interval around H$\alpha$. The darkest area in the line core in the intensity image is due to the filament. At the same place signatures in $Q/I$ and $U/I$ are detected. The $V/I$ image does not show any particular signal in the filament, just a small antisymmetric signal in the neighbourhood.

The vertical white lines drawn at 6563.6 Å mark the spatial interval (from 67″ to 94″) along which the Stokes profiles reported in Figure 3 are averaged. The two intensity profiles in Fig. 3 correspond to this interval in the filament (solid line) and to an interval from position 5″ to 30″ outside it (dot dashed line). The $Q/I$ and $U/I$ profiles show peaks, respectively at line center and in the wings, with amplitudes of order $10^{-3}$.

### 3.2. Results in He $D_3$

Observing filaments in He $D_3$, faint polarimetric signatures were found in the $10^{-4}$ range. Long exposure times are required to reach adequate signal-to-noise ratio.

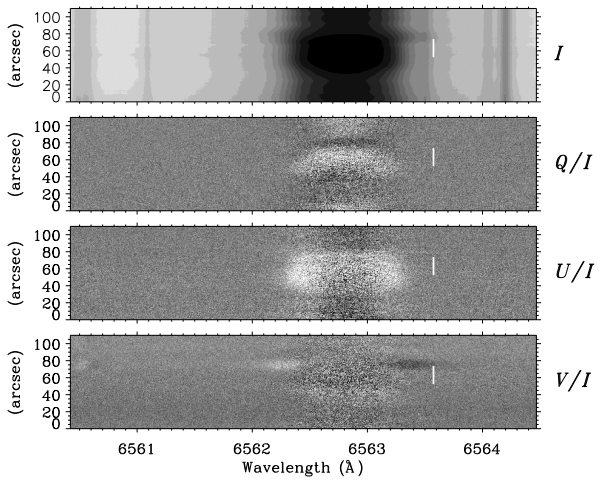


Figure 2. *Hα Stokes images of the region seen in Figure 1. The darker area in the intensity image comes from the observed filament. The nature of the linear polarization signatures seen in this filament and confirmed also in other filament observations, is not yet fully understood.*

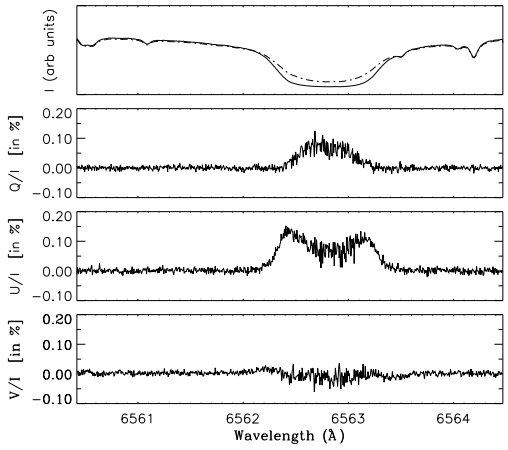


Figure 3. *Hα Stokes profiles averaged along the vertical white lines in Figure 2. Positive Q is defined as the linear polarization parallel to the local direction of the filament.*

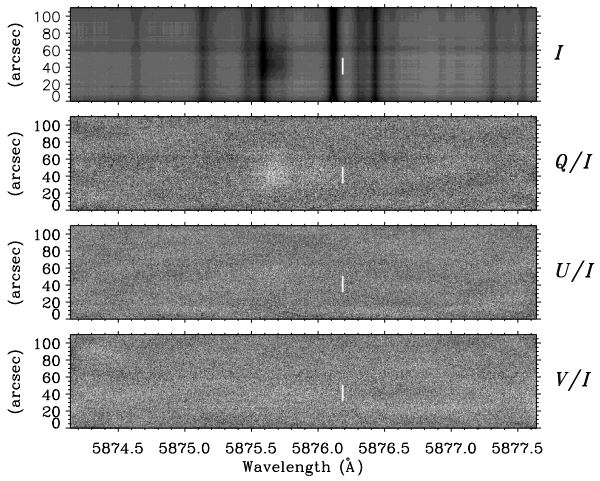


Figure 4. *Helium $D_3$ Stokes images. A faint filament signature can be detected in the intensity image and in the corresponding $Q/I$ region.*

The filament measurement reported here was observed on March 19, 2005 at longitude 13.5° and latitude 16.5° starting at 11 UT and lasting 130 min.

Figure 4 shows the four Stokes images indicating faint signatures. In the intensity image, around 5875.5 Å, one can recognize a faint darkening due to the filament. The corresponding $Q/I$ signature can be noticed. The vertical white line drawn at 5876.2 Å represents the interval along which the profiles in Figure 5 are integrated (from 40″ to 65″).

The two intensity profiles in Figure 5 are integrated along this interval (solid line) and along an interval (104″ to 120″) outside the filament. The vertical markings correspond to the wavelengths of the He $D_3$ multiplet.

The $Q/I$ plot shows signatures in the strong and faint He $D_3$ components. This profile shape is very similar to the ones already measured in prominences or in filaments (Ramelli et al. 2006). Note the very faint $Q/I$ amplitude: the peak is about $2 \times 10^{-4}$.

The interpretation of this signature can be understood in terms of the forward-scattering Hanle effect.

## 4. Conclusion

Observing filaments in H$\alpha$, certain shapes could be detected in the linear polarization profiles. Defining $Q$ as linear polarization parallel to the filament direction, $Q/I$ peaks in the line center and $U/I$ peaks in the line wings are measured with amplitudes reaching a few $10^{-3}$. The interpretation is not straightforward, and probably several physical effects are involved, like forward scattering in

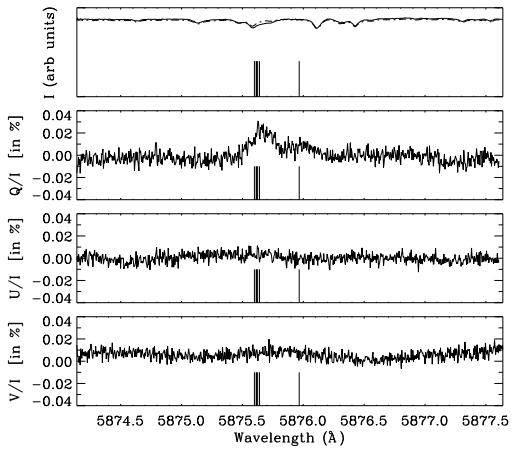


Figure 5. *Helium $D_3$ Stokes profiles averaged along the vertical white lines drawn in Figure 4. The amplitude of the Q/I peak is* $2 \times 10^{-4}$.

the presence of inclined fields in a medium whose optical thickness at the H$\alpha$ wavelength is significant.

Filaments observed in He $D_3$ show linear polarization signatures, whose profiles are similar in shape to those measured in prominences and spicules. Such signals can be interpreted in terms of forward Hanle scattering. The amplitudes measured in quiet filaments are in the range of a few $10^{-4}$.

The observations presented here represent an explorative work to prepare a more definite campaign using the ZIMPOL polarimeter either with the spectrograph or with the Fabry Perot filter (Feller et al. 2006).

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### References

Feller, A., Boller, A., Stenflo, J.O. 2006, these proceedings
Gandorfer, A., et al. 2004, A&A, 422, 703
Ramelli, R., Bianda, M., Merenda, L. & Trujillo Bueno, J. 2006, these proceedings
Küveler et al. 1998, Sol. Phys., 182, 247
Trujillo Bueno, J. 2001, ASP Conf. Ser. 236, 161
Trujillo Bueno, J., Landi Degl'Innocenti, E., Collados, M., Merenda, L. & Manso Sainz, R., 2002, Nat, 415, 403