Spectropolarimetry of solar prominences

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Abstract: A large set of high precision full-Stokes spectropolarimetric observations of prominences in He-D3, Hα and Hβ lines have been performed with the ZIMPOL polarimeter at the Gregory-Coudé Telescope in Locarno. The observational technique allows us to obtain measurements free from seeing induced spurious effects. The instrumental polarization is well under control and taken into account in the data analysis. We present our observational results for each of the above-mentioned lines. Of particular interest is that most of our Hα measurements show the typical V profiles indicative of the action of the Zeeman effect in the prominence plasma. A Stokes inversion strategy technique based on the quantum theory of the Hanle and Zeeman effects is being applied on observed Stokes-profiles in the He-D3 line in order to obtain information on the magnetic field vector that confines the prominence plasma.

The observations

The observations were performed with the Gregory-Coudé Telescope (45 cm) at the *Istituto Ricerche Solari Locarno (IRSOL)*.

Instrumental setup:
- ZIMPOL (Gandorfer et al. 2004) allows precise measurements free form seeing induced spurious effects (modulation 42 kHz).
- Czerny-Turner spectrograph: 180 x 360 mm, 300 lines/mm, blaze 63°.
- Limb tracker: to keep the limb distance constant
- Derotator: to keep the slit parallel to the limb

Images of simultaneous measurements of Stokes I, V/I and one linear polarization component (alternatively Q/I and U/I) are stored ~every 2 minutes.

The prominence measurements were performed between May 2003 and June 2005.
He-D3:   49 measurements in different positions/prominences
Hα: 29 measurements in different positions/prominences
Hβ: 9 measurements in different positions/prominences
Total exposure time per measurement varying from ~10 to 60 minutes.

Calibrations measurements performed regularly:
- polarimetric efficiency
- flat fields
- dark current
- spectrum of the scattered light taken in a nearby region at about the same limb distance.
- measurements of the instrumental polarization (which is a function of declination and stays almost constant over one day).

Inference of the magnetic field from the He-D3 profiles

A database containing the theoretical He-D3 Stokes profiles for different limb distances, magnetic field orientations and strengths has been created according to the quantum theory of the Hanle and Zeeman effects (see, e.g., Landi Degl'Innocenti & Landolfi 2004). The prominences were assumed to be optically thin.
The theoretical profiles that better fit the measured profiles are carefully searched in the database, in order to infer the magnetic field vector.
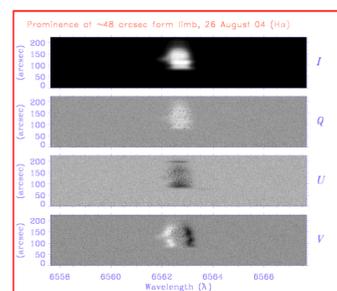
Examples of Hα measurements

Fig.5
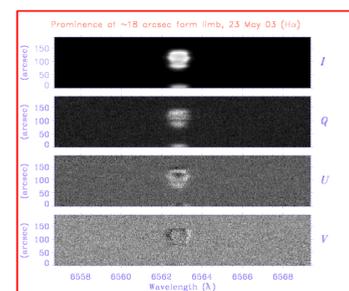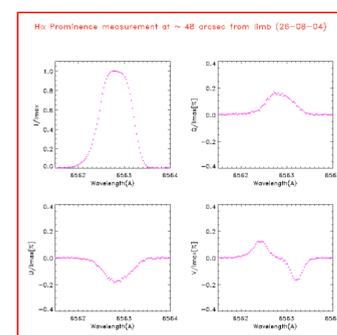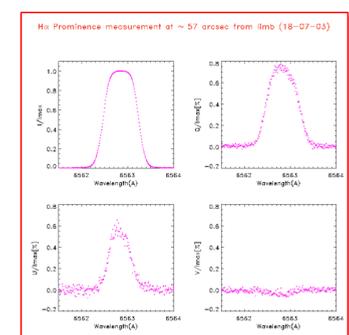

Fig.6

Fig.7

Fig.8

Comments:

- The Hα Stokes V profiles found in our measurements show usually a typical antisymmetric Zeeman like structure (e.g Figs 5-7). In the only example we have found with a symmetric shaped Stokes V profile (Fig.8), the amplitude was very small (few 10^{-4}). Therefore our observational results are not in agreement with those presented by Lopez Ariste et al. (2005).

- Often self-absorption is noted in the center of the line (e.g. Fig 6).

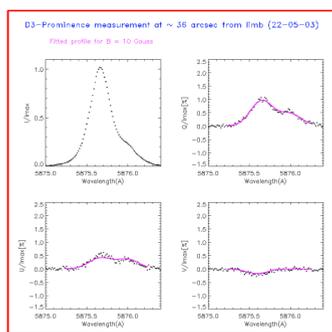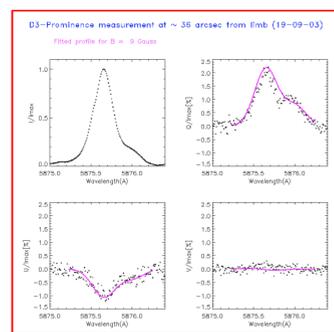## Examples of He-D3 Stokes Profiles with Inversion

Fig.1

Fig.2

Examples of Hβ Stokes Profiles
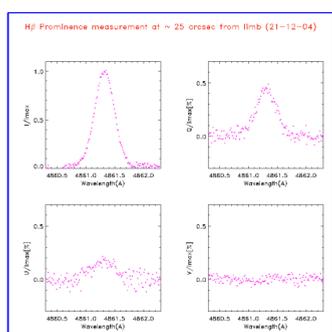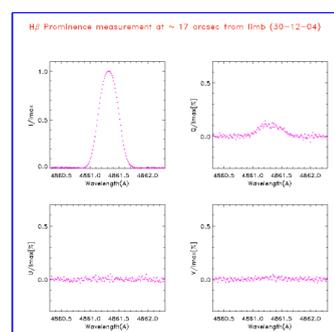

Fig.3

Fig.4

Prominence before erupting (Hα)
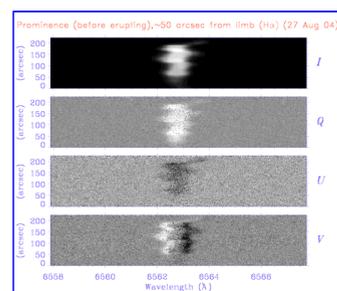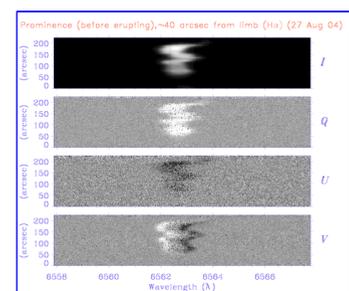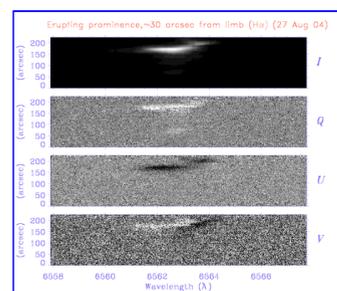

Fig.9

Fig.10

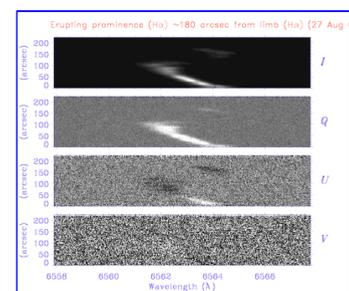## Erupting Prominence (Hα)

Fig.11

Fig.12

References:
Gandorfer A. et al., 2004, A&A **422,** 703.
Landi Degl'Innocenti E. & Landolfi M., 2004, *Polarization in Spectral Lines* (Dordrecht: Kluwer)
Lopez Ariste A. et al., 2005, ApJ **621,** L145.