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FINE STRUCTURE OSCILLATIONS OF A QUIESCENT PROMINENCE(QP)

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Content

Prominences: occurrence and evolution

Prominence basics

- In most cases occurrs together with formation of spots
- Occurs at the base of coronary streamers
- Traces the topology of the magnetic field
- End-stage: eruption or dissipation of mass
- Diameter of fine structures - up to about 4000 km

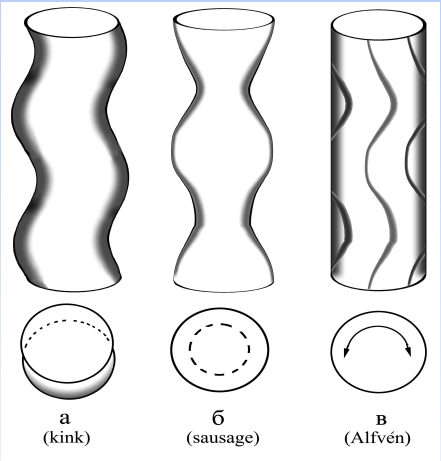
Physical characteristics

- Electron density 10^{10}-10^{11} cm^{-3} (Tandberg-Hanssen, 1974) [6]
- Temperature 5000-8000 K
- Magnetic field 4-8 Gs

Oscillation of QP

Theoretical models (Joarder et al. 1997)[4]

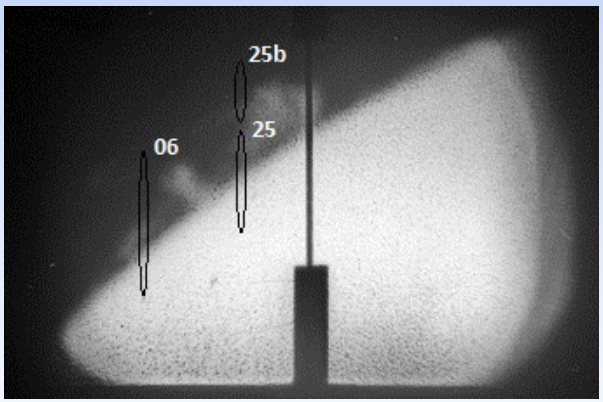
- Kink modes
- Sausage modes
- Alfven oscillations



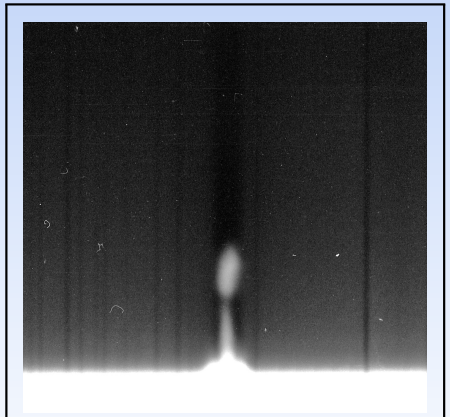
Shape changes of prominence threads: Kink (a), Sausage (b), Alfven (c)

Set of high resolution Hα spectra of QP

- Series of filtrograms and spectrograms were obtained on 16.10.1977.
- Instrument: horizontal solar spectrograph of Pik du Midi observatory.
- Exposure time of one frame - 5s.
- Full observig cycle: from 08:36:50 UT to 11:00:29 UT
- 37 series with 42 slit positions were obtained.
- All data series have been scanned - 2 slit positions are used in this study .

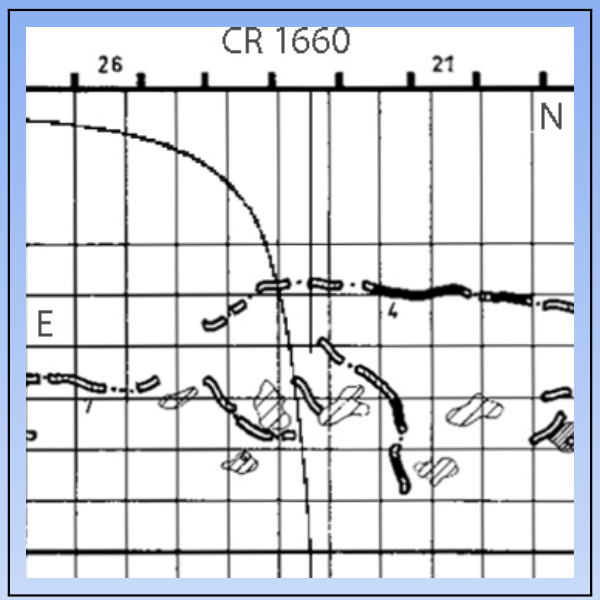


Hα filtrogram.

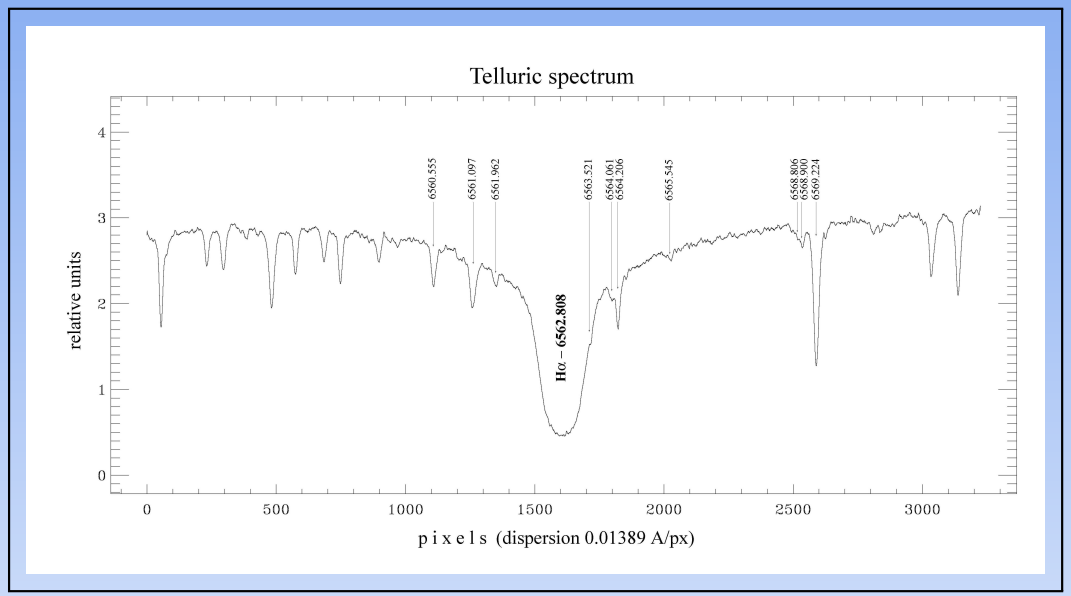


Hα spectrogram.

Position of the QP and telluric spectrum calibration



Part of synoptic map (MSP, 1977).

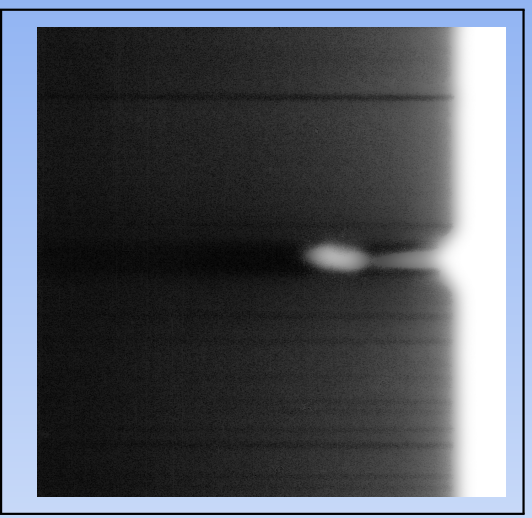


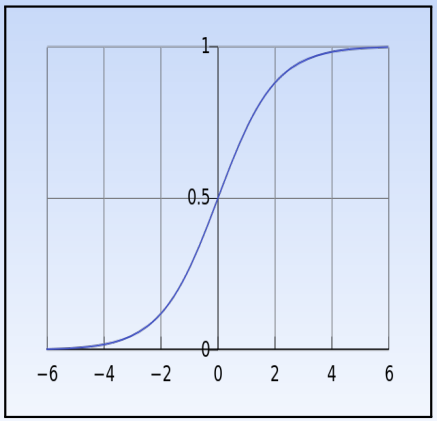
Spectrum for calibration from telluric lines.

- Position of QP at solar limb N45-E. Time of life two solar rotations.
- Laboratory wavelengths of Hα: 6562.808 Å , and of telluric lines used for calibration: λ=6560.555 Å, λ=6561.097 Å and λ=6564.206 Å

Orientation of the images

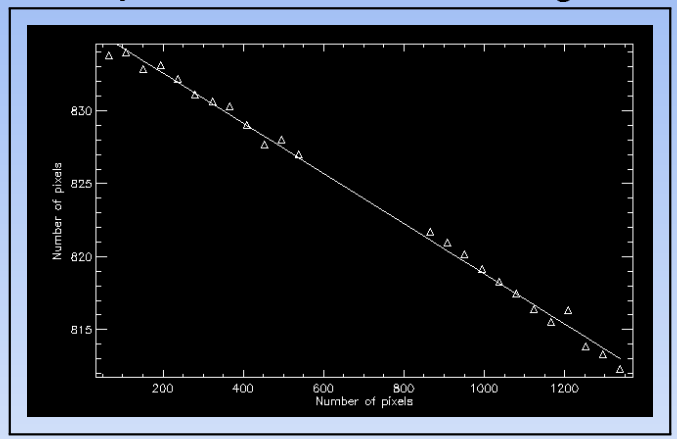
Oriented spectral image.





Linear fit of the inflection points.

The slope of the fit determins the angle of rotation.



$$y = \frac{c}{e^{-b(x-a)}+1} + d$$

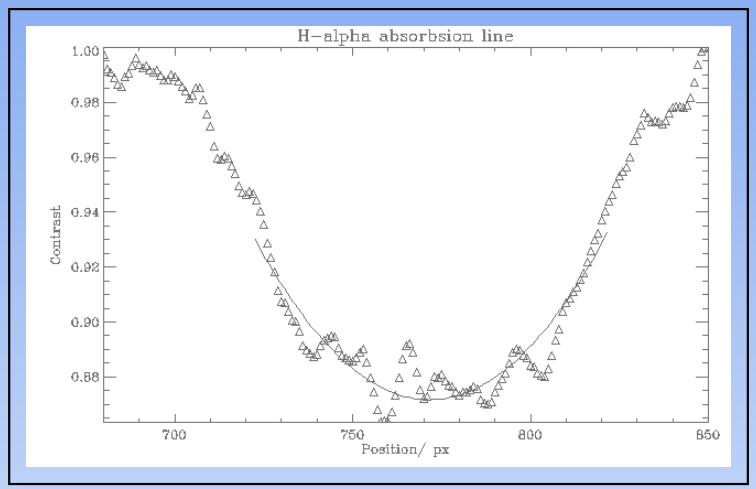
Why we need orientation (rotation)?

$\frac{\Delta r}{r} = sin(0.6), \quad \Delta r = r.sin(0.6) = 1.7px, \quad \Delta r.0.0139 = 0.02363A,$

$\frac{\Delta\lambda}{\lambda}.c \approx 1.1km/s$

Sigmoid function describes the transition background to

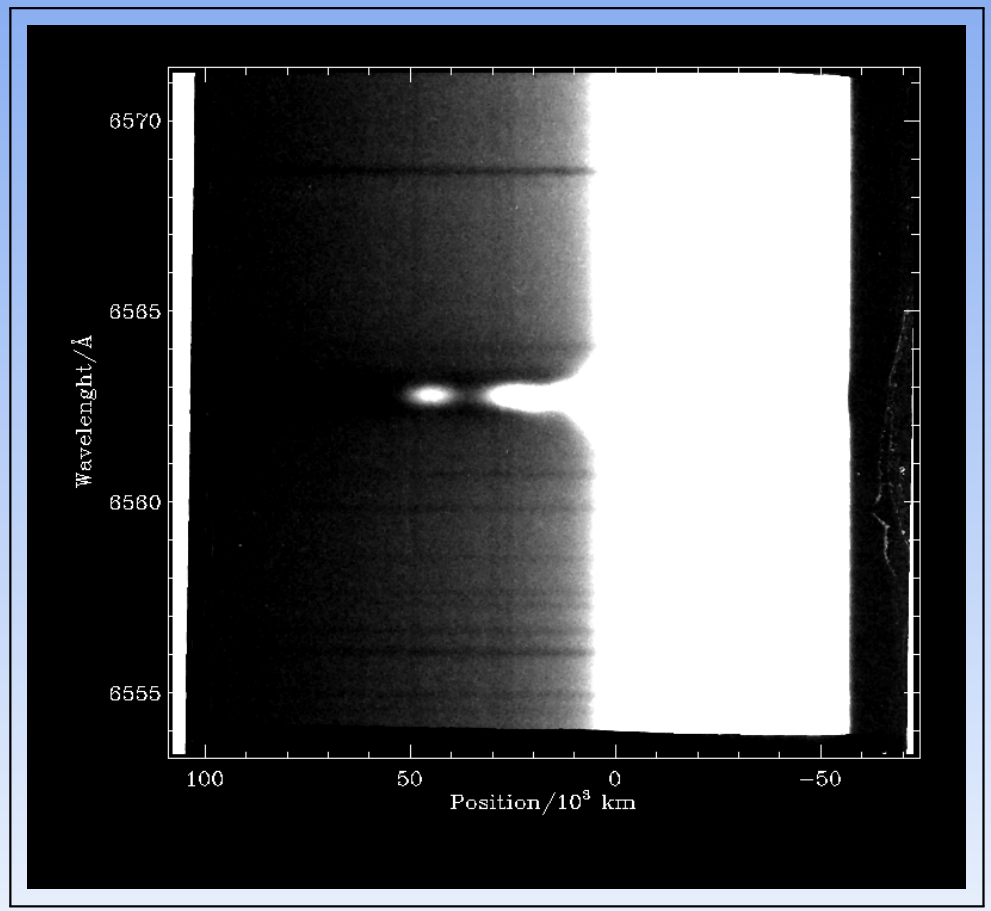
Dispersion



Typical Hα profile and fitting of line with parabolic function to determine the minimum/maximum.

$$\lambda = \lambda_o + \frac{d\lambda}{dp} dp,$$

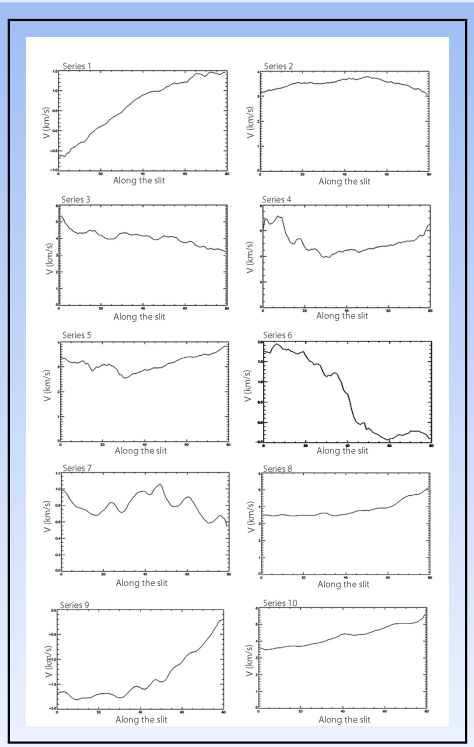
$$\frac{d\lambda}{dp} = 0.012514 \text{ Å/px}$$



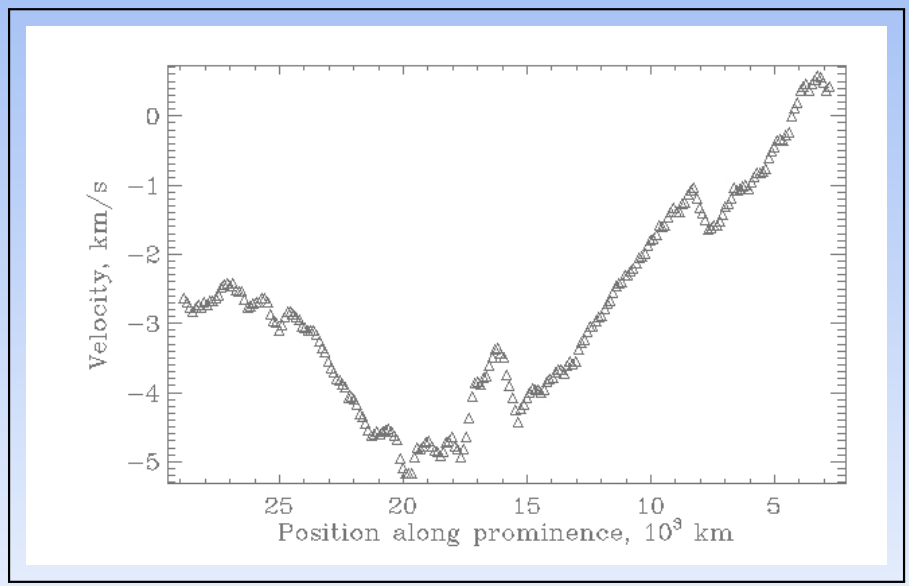
Wavelengths versus height (from the photosphere) of the QP for one of studied spectrograms.

Line of sight (l.o.s) velocities for slit positions 06 and 25a

- We calculated the l.o.s velocities for two slit positions of all series, and so we monitor their variation during the whole observation period.



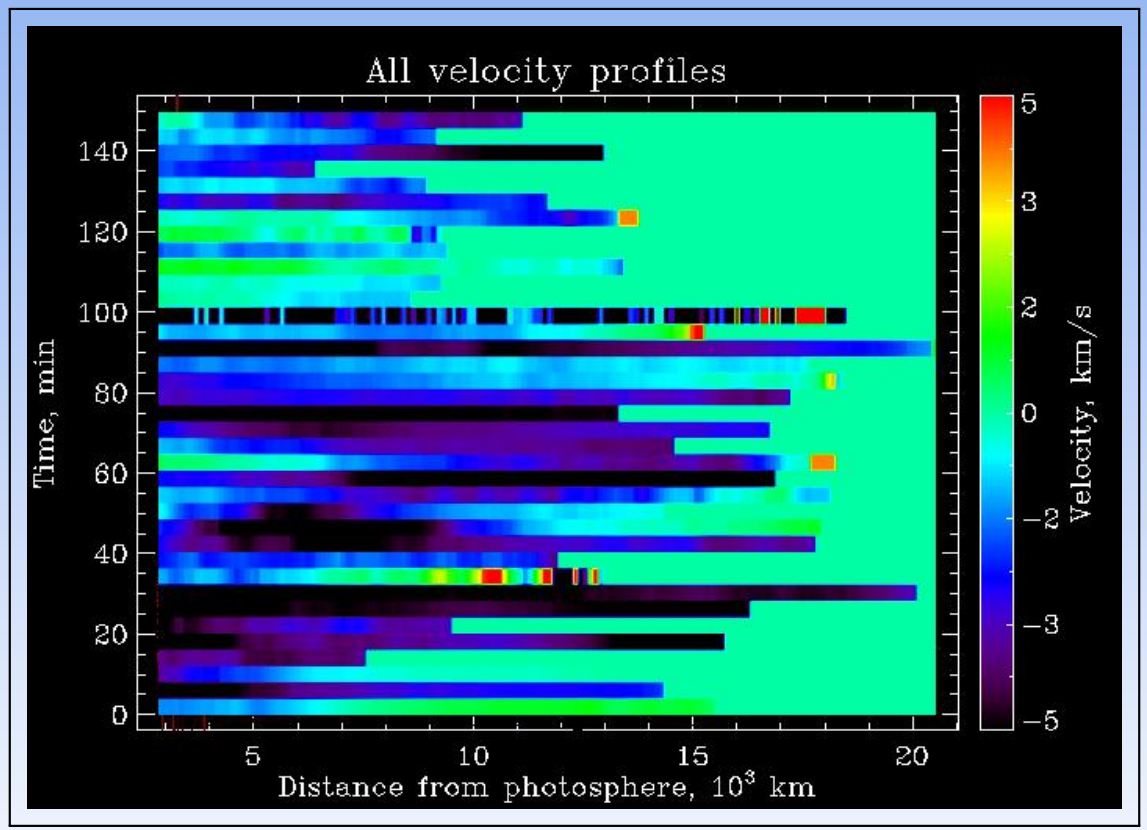
l.o.s velocities changes for slit position 06 in time.



Example for l.o.s velocities along the slit from position 25a.

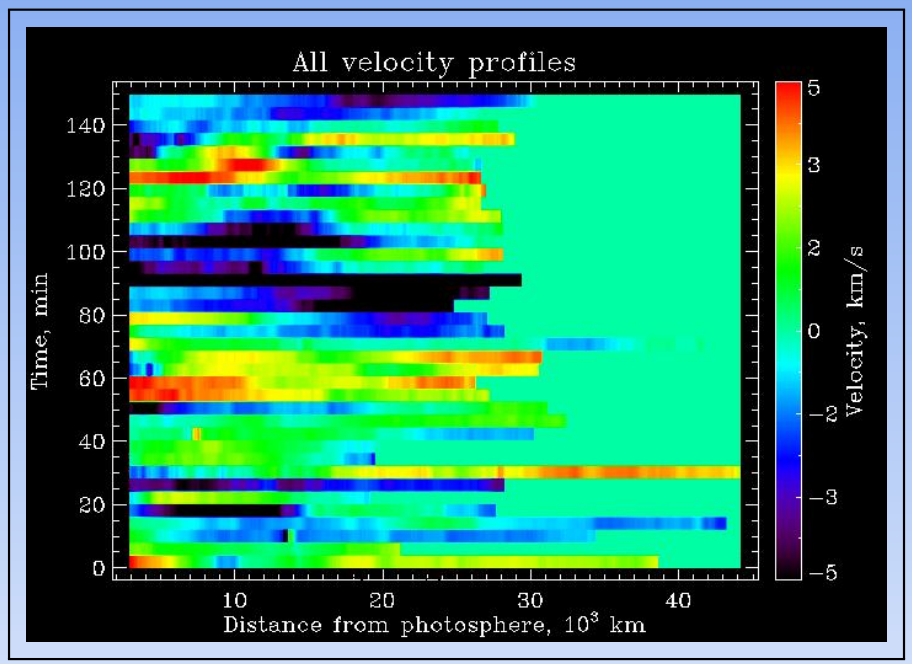
l.o.s velocities for slit position 06

- 3-D map of l.o.s velocities on the prominence body.

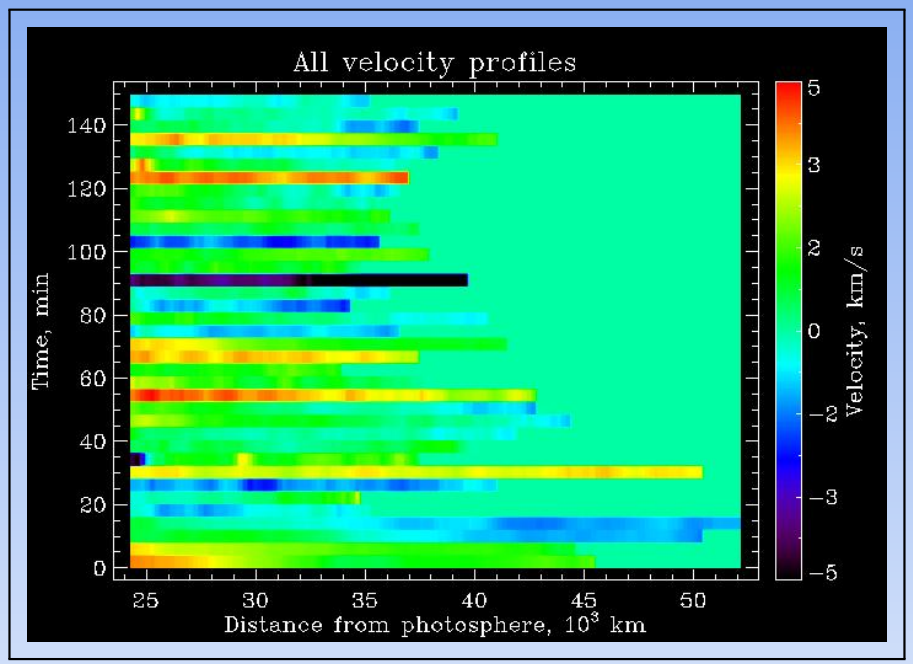


Distribution of l.o.s velocities in space and time.

l.o.s velocity plot for slit positions 25a and 25b



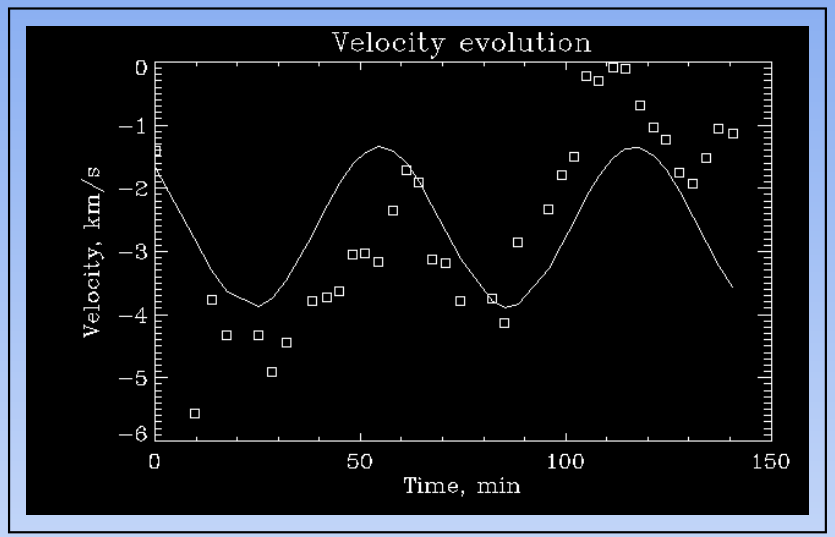
Distribution of l.o.s velocities in space and time - position 25a.



Distribution of l.o.s velocities in space and time - position 25b.

- 3-D map of all l.o.s velocity profiles for slit positions 25a and 25b.

Period of oscilation for slit position 06

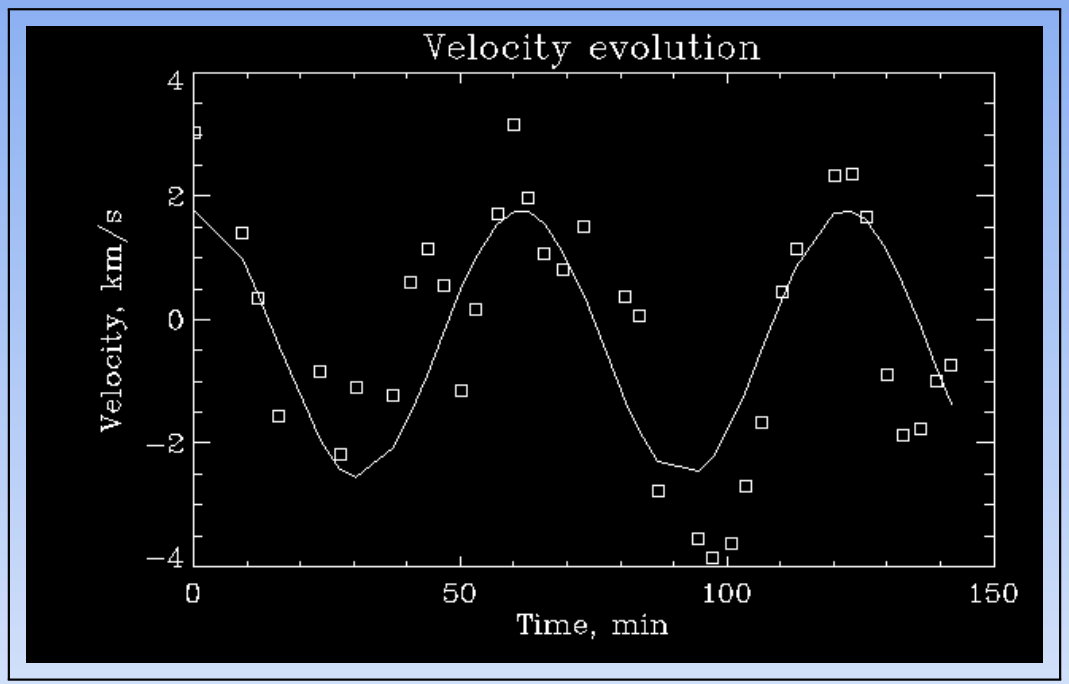


Time velocities evolution of the QP fibril (2-D data).

- We aproximate with function: $v = v_{mean} + v_o sin(\omega t + \varphi)$
- Period **T≈ 60 min** corresponds to frequency $\omega = \frac{2\pi}{T} = 1.74\text{x}10^{-3}$ s^{-1}
- Arch length of the prominence: (V_a= 55 km/s, B= 8Gs **(Tandberg-Hanssen, 1995)[5]**)

  L = TxV$_a$ = **195 000km**

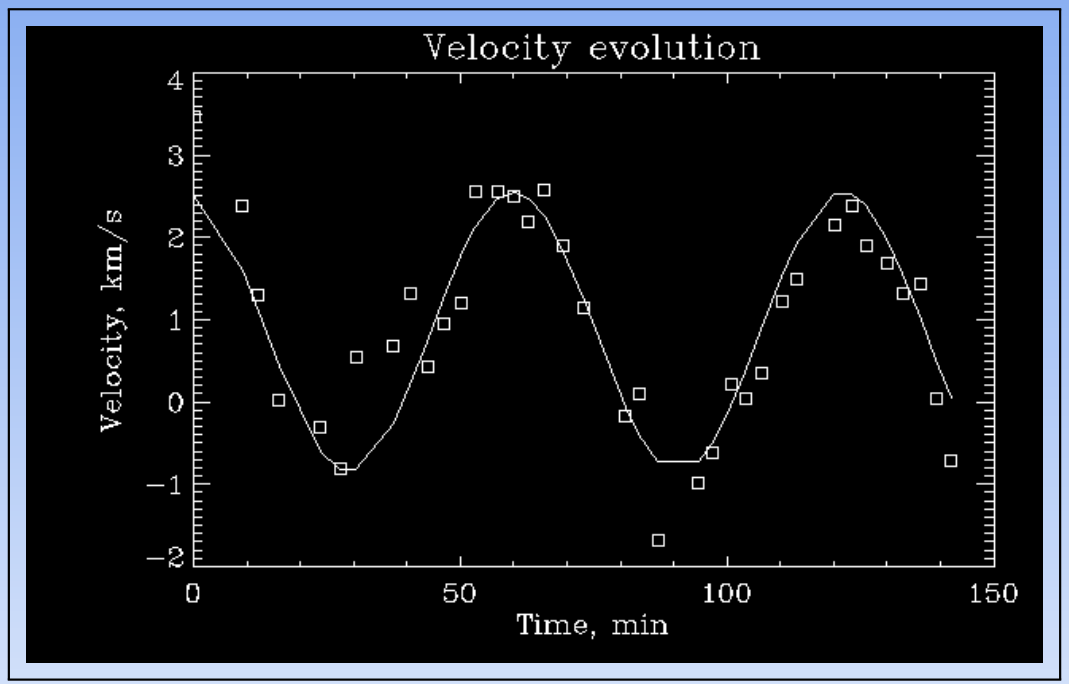
Period of oscilation for slit position 25a



Time velocities evolution of the QP fibril (2-D data).

- Period **T≈ 62 min** correspond of frequency ω= 1.69x10^{-3} s^{-1}
- Arch length of the prominence L = TxV$_a$ = **205 000km**

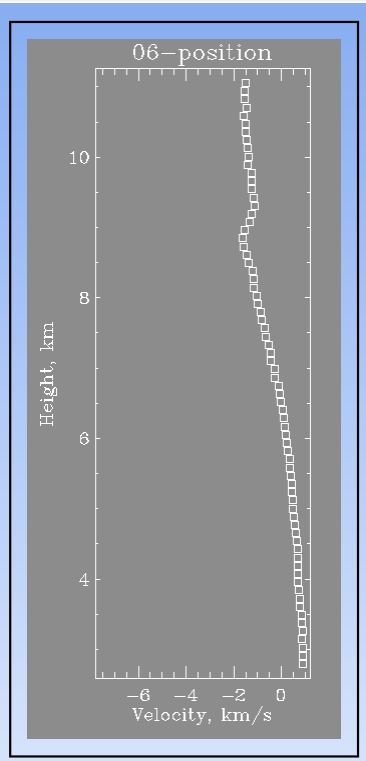
Period of oscilation for slit position 25b

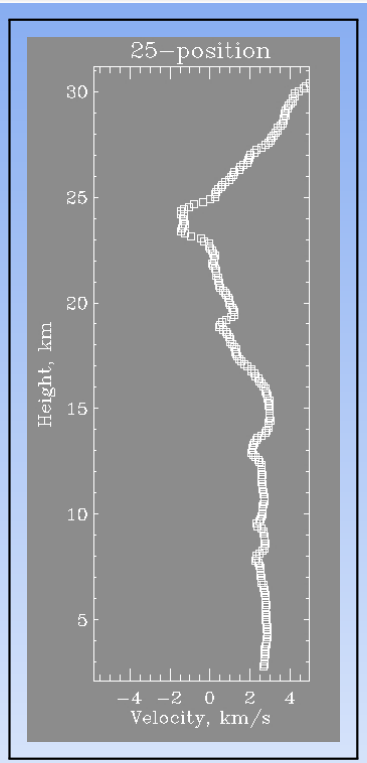


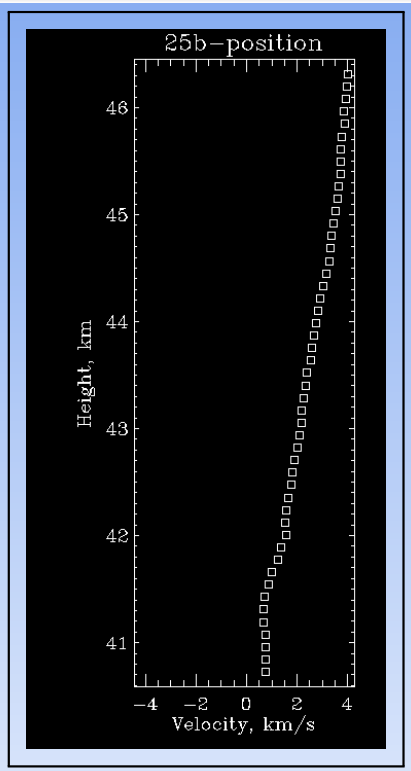
Time velocities evolution of the QP fibril (2-D data).

- Period **T≈ 62 min** correspond of frequency ω= 1.69x10^{-3} s^{-1}
- Arch length of the prominence L = TxV$_a$ = **205 000km**

Average Doppler velocity along the slit

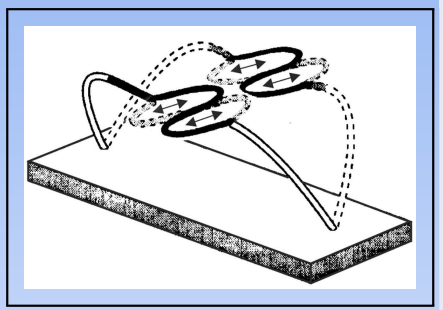






- *The Doppler velocities spatial distributions for the three slit positions is shown. Marked dots indicate the observed heights versus Doppler velocity (Indications of long period oscillations are seen).* **(v. Kukhianidze1, 2006)[8]**

Conclusions



2-D picture in the presence of Kink modes.

Results

- Three time series of l.o.s velocities of QP were analysed.
- Variations of l.o.s velocities were measured from the photosphere to distance of up to 50 000km over a time interval of about 2.5 hours.
- Oscillation velocities in the range [-5÷5] km/s were measured.
- Oscilation periods of about 60 and 62 min are derived.
- Calculation of the derived period with typical flow velocities yields an arch length of about 200 000km.
- The results obtained are typical for kink mode oscilations of QP.

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The end

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