

Analysis of Sunspot oscillations observed with the DST in Hida Obs.

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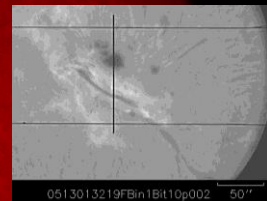
Abstract

Observation

Date : 13 May 2012
Target : NOAA AR 11476 (near N10, W30)
Total time : 01:02:27 (UT) - 03:46:42 (UT),
9855 sec
Time cadence : 14 sec
Instrument : The polarimeter (Anan et al.
2011) of the Vertical Spectrograph

Background image : H α center solar disk (SMART)

Fig.1. - H α center image shows NOAA AR 11476 observed the DST-HIS (H α Imaging System) on the same day. The slit (0.2 mm wide and 20 mm long) was placed over the target (and filament) and was kept fixed during the entire observing run with a spectral sampling of 0.03 \AA / pix and a spatial sampling of 0".6 / pix. Horizontal lines show hair line.



HAZEL (HANle and ZEeman Lights) that a inversion code in order to diagnostic of magnetic fields in the chromosphere and the prominence (Asensio Ramos, Trujillo Bueno & Landi Degl'innocenti, 2008) .

Maps

Inversions

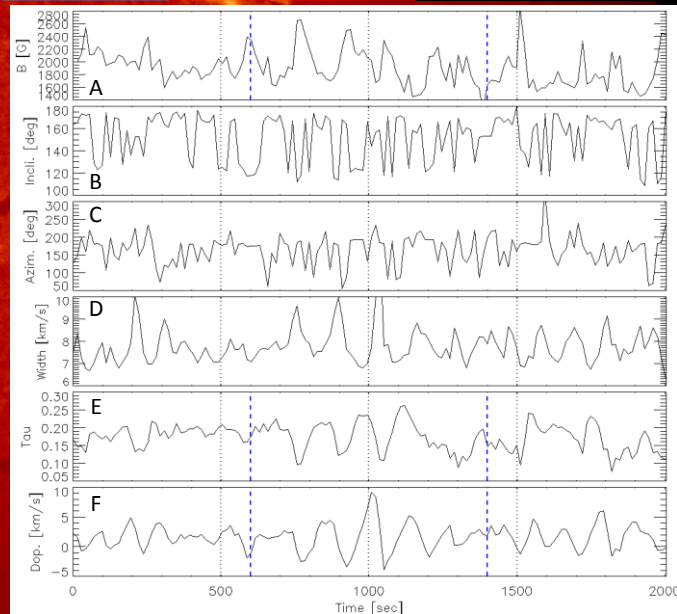
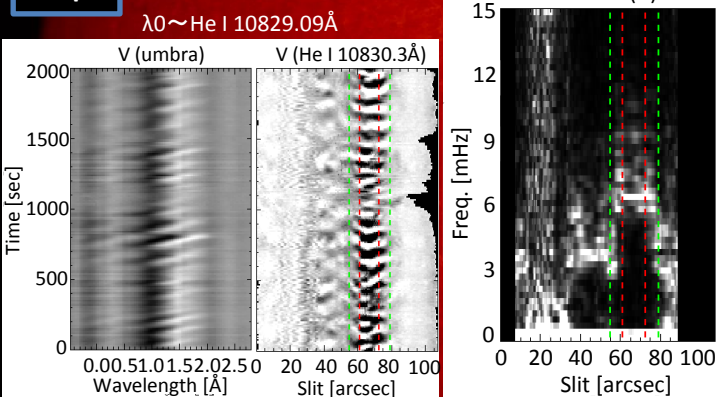


Fig.2. - **Left**: Wavelength - Time diagram of Stokes V in the umbral center (from the start time to 2000 sec). He I 10830 profile shows periodic variation with a clear sawtooth shape. **Center**: Space - Time diagram of Stokes V in He I 10830.3 \AA (contrast adjustment). Red & green dashed line are umbra & penumbra boundary, respectively. The umbral oscillation has spread outward. **Right**: Power map of Stokes V shows 3 minute oscillations (around 6mHz) in the umbra and 5 minute period (around 3.3mHz) with running penumbral waves.

Fig.3. - Inversion results in the upper chromospheric He I 10830 \AA in the umbral center (from the start time to 2000 sec); **A**: magnetic field strength (**B**), **B**: inclination angle of magnetic field line, **C**: azimuth of magnetic field line, **D**: doppler width, **E**: optical depth (**Tau**), **F**: doppler velocity. The angle of the inclination is a normal line direction toward the surface. The angle of the azimuth is the line-of-sight direction from disk center toward target, and the clockwise is positive. Note that the redshift of the doppler velocity is positive. The power spectra of each parameter variation shows a clear peak around 6.5 mHz (near equal to 3 minutes).

Phase

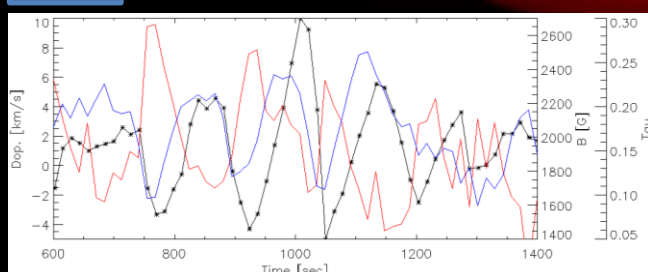


Fig.4. - Comparison of the magnetic field strength (Red line), the optical depth (blue line) and the doppler velocity (black line and points). Note that the redshift of the doppler velocity is positive, and this figure represents range of blue dashed line in Fig.3.

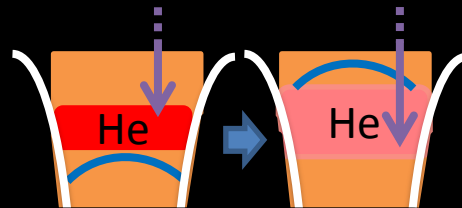


Fig.5. - The shock wave model. Blue curve is shock wave, white line is the magnetic field line, and purple line is like optical depth. Orange background is the chromosphere.