Simultaneous SpectroPolarimetry of Active Region in both Photosphere and Chromosphere

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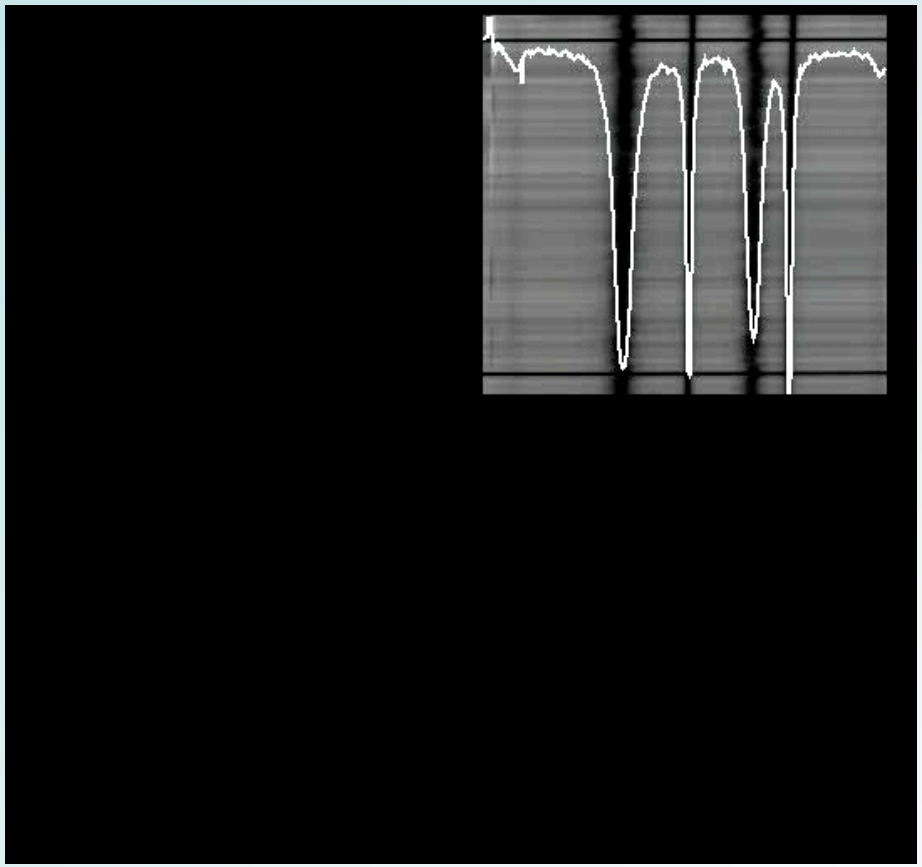
Motivation

- Chromosphere is an important layer.
- When extrapolating magnetic field into coronal heights using force-free methods, we'd better use chromospheric magnetic field as lower boundary condition.
- There are not many observations of magnetic field in the chromosphere.
- We show an example of multi-height spectropolarimetric observation obtained by multiple spectral lines covering both photosphere and chromosphere.

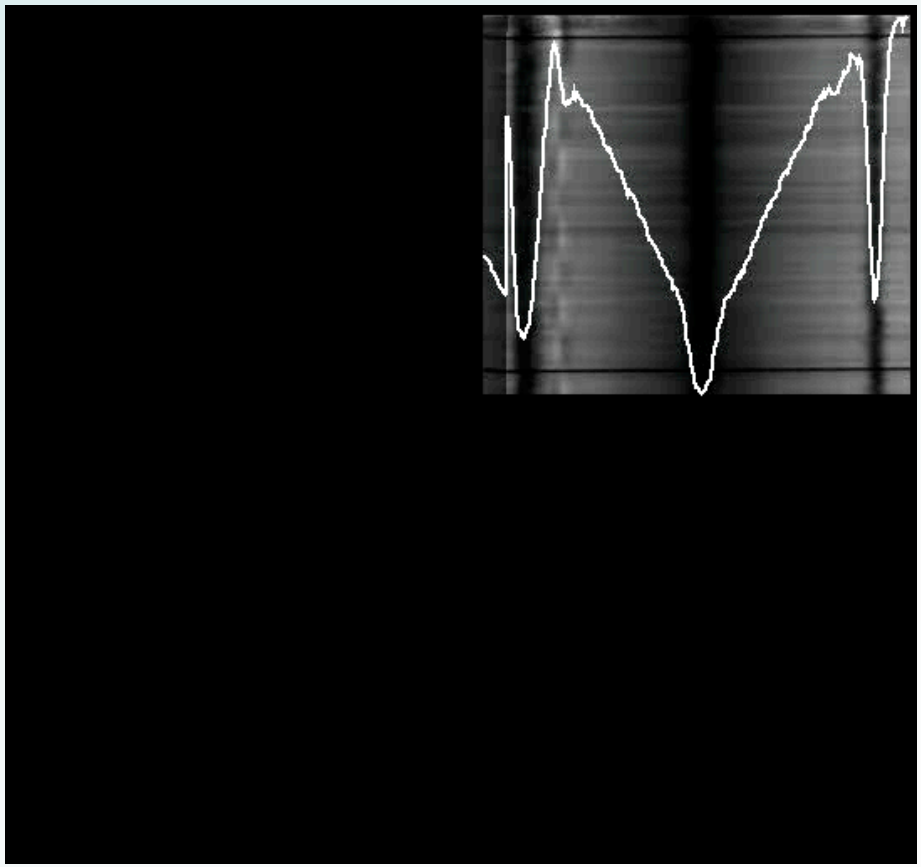
Observation

HAO/NSO Advanced Stokes Polarimeter (ASP)

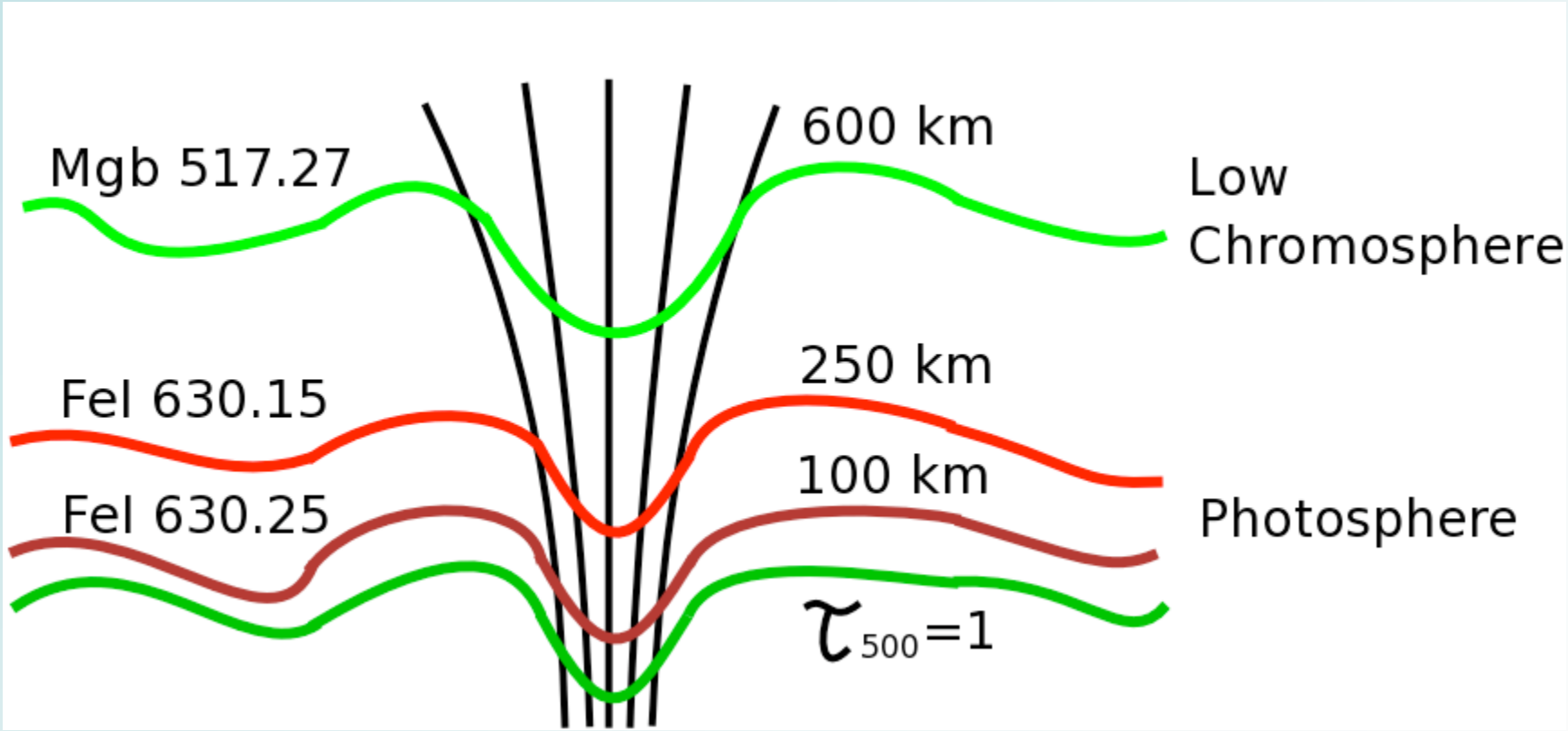
FeI 630.15 & 630.25 Line Pair
Photosphere



MgI b2 517.27 Line
Low Chromosphere



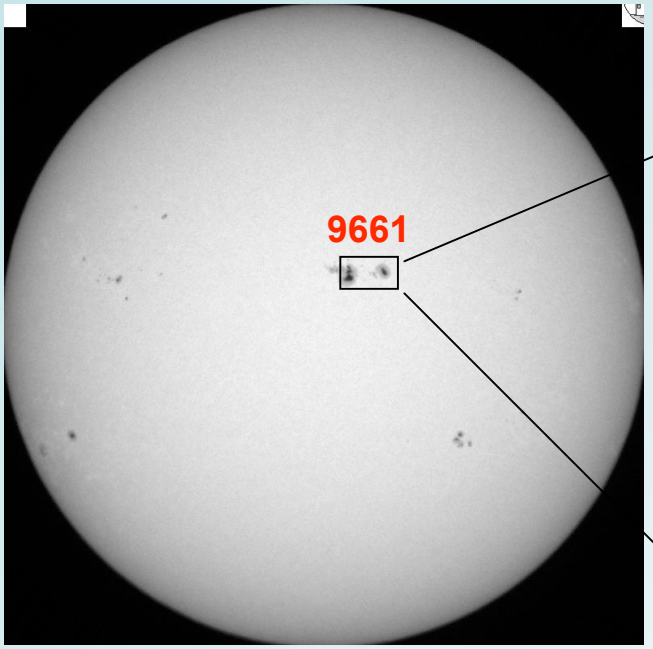
“Heights” of Formation of Spectral Lines



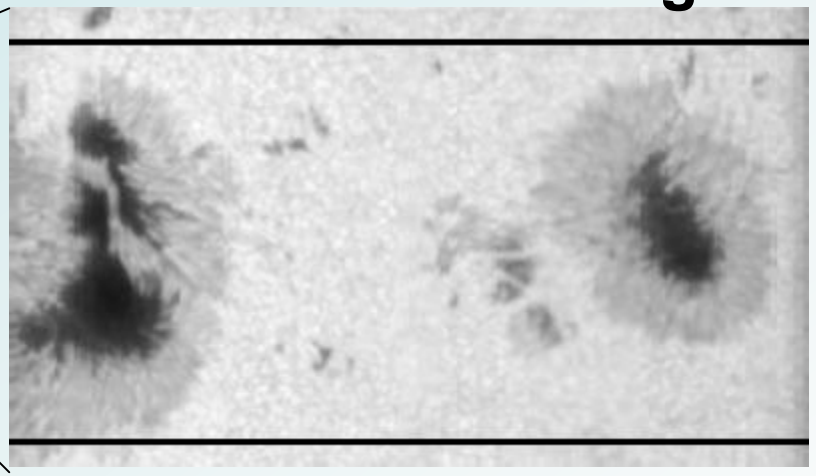
(Khomenko & Collados 2007; Lites et.al. 1988; Solanki & Bruls1994)

Active Region NOAA 9661

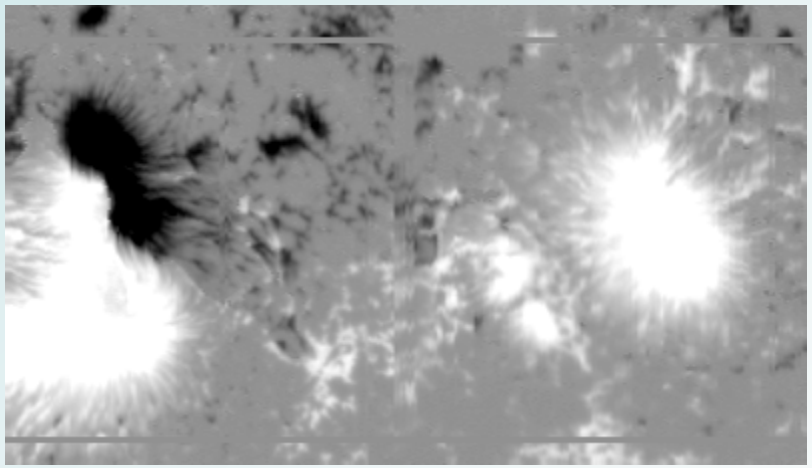
2001 Oct 17
NOAA 9661
Near Disc Ctr



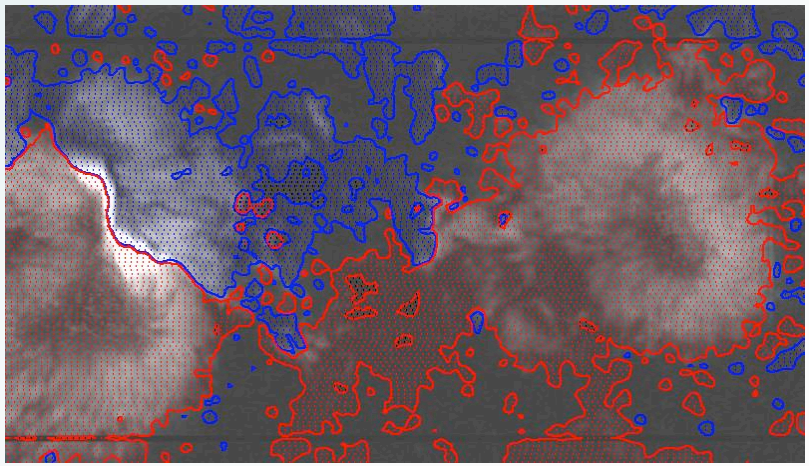
FeI Continuum Image



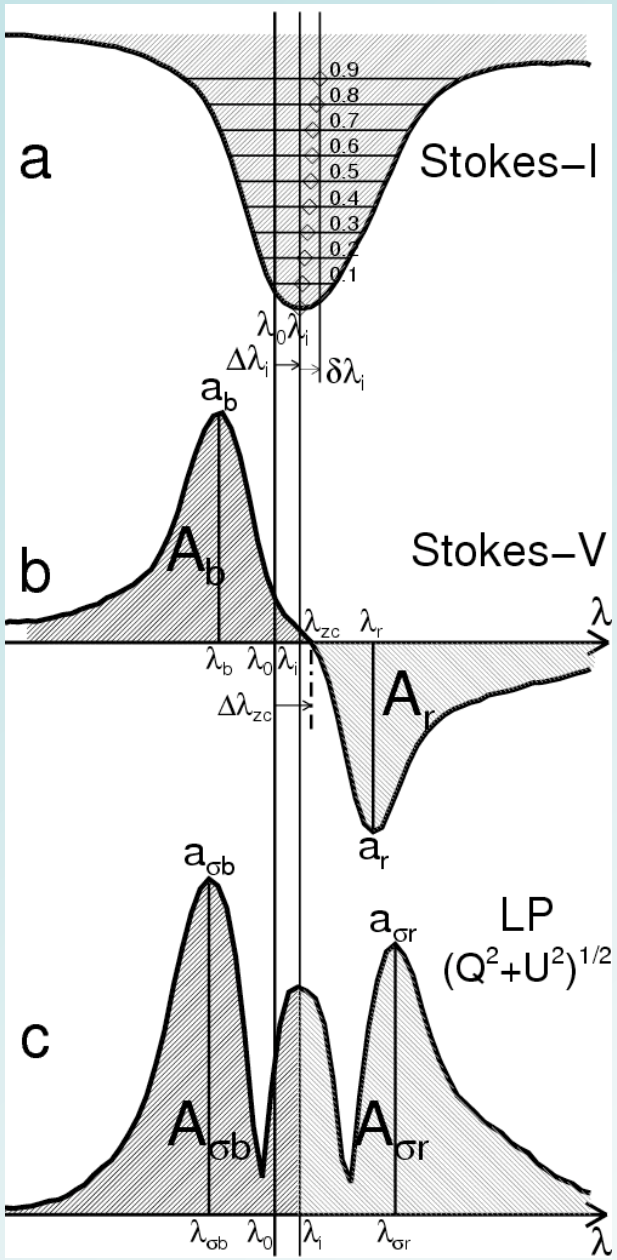
B_L



$|B_T|$ & B_L



Stokes Asymmetries



$$\text{Profile Shifts}: \Delta\lambda_i \quad \delta\lambda_i \quad \Delta\lambda_{zc}$$

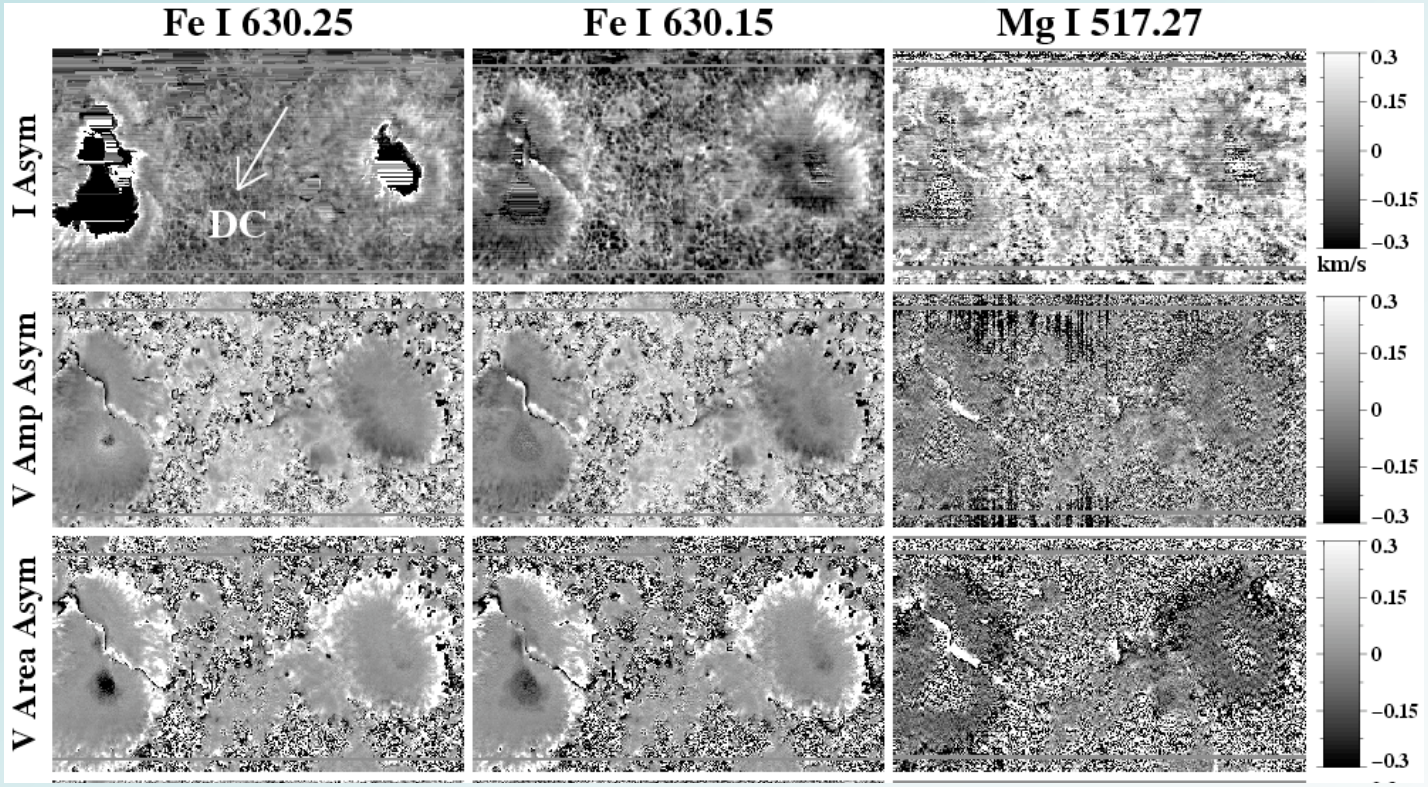
$$\text{Amplitude Asymmetry} = \frac{|a_b| - |a_r|}{|a_b| + |a_r|}$$

$$\text{Area Asymmetry} = \frac{|A_b| - |A_r|}{|A_b| + |A_r|}$$

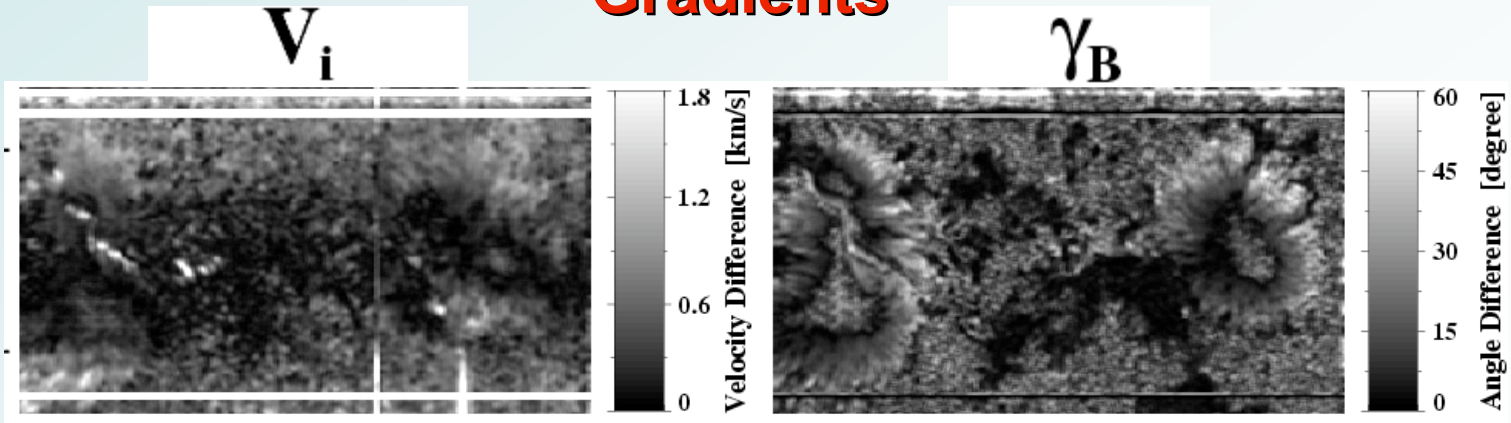
Origin of Stokes Asymmetries

- Large gradient of magnetic or velocity field along LOS
- Inhomogeneous atmosphere that contains two or more magnetic components.
- Spatially unresolved flows or mixed polarities

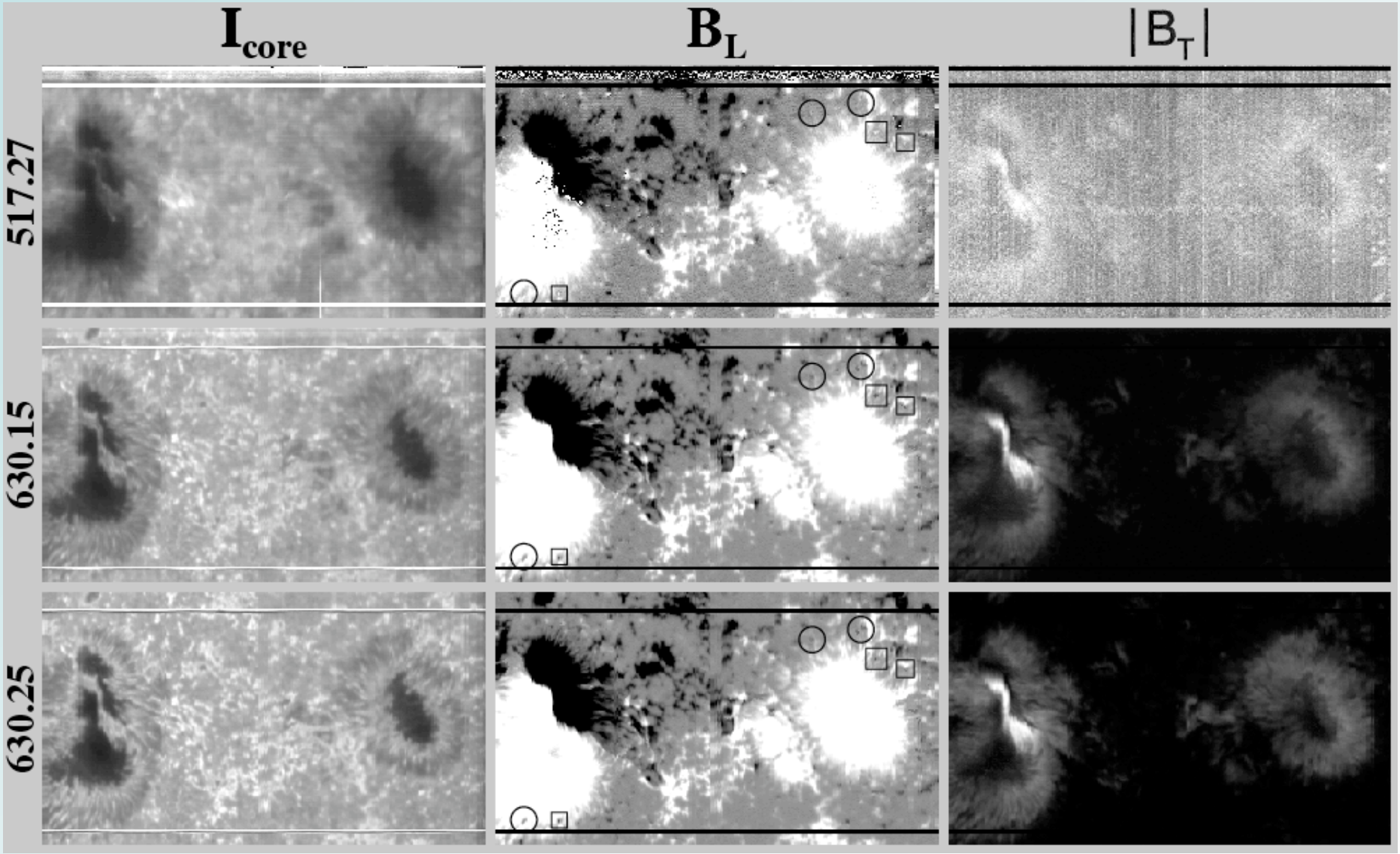
Stokes Asymmetry Images



Gradients



Multi-height



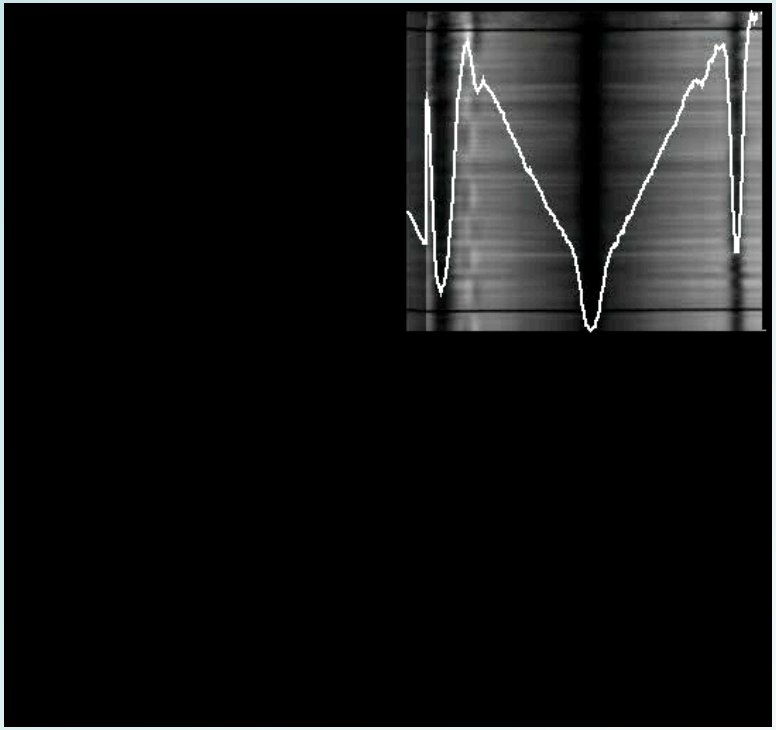
Unresolved Problems

- Chromosphere is elusive, complicated, non-LTE, difficult to model.
- No sufficient polarimetric observations in the chromosphere.
  (ASP, SOLIS, SPINOR, IBIS, BBSO/VIM, Mees , Hinode NFI).
- Stokes data of chromospheric lines are difficult to calibrate and invert.

Data

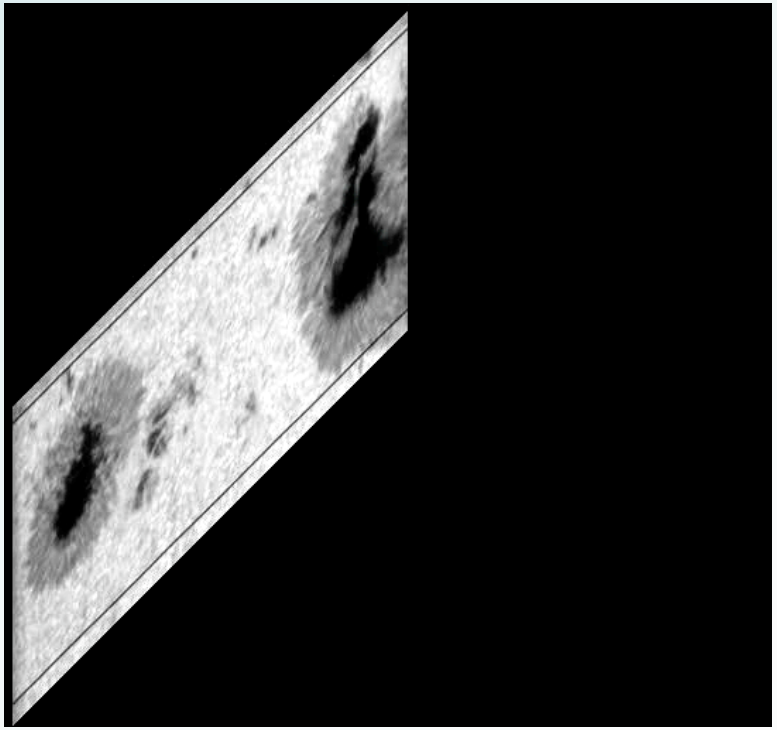
1D Slit-Grating-based Spectropolarimetry

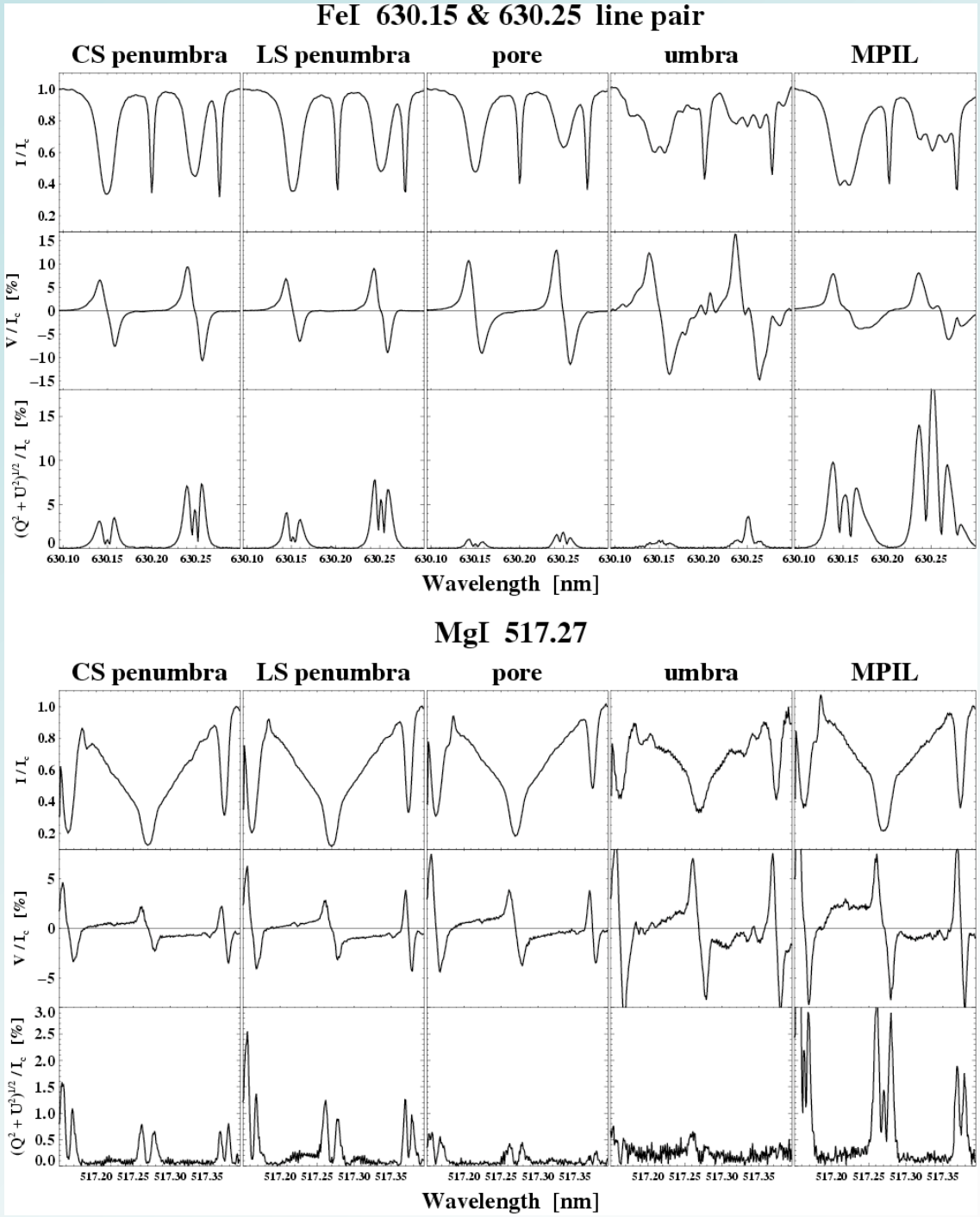
ASP, SPINOR, Hinode SP



2D tunable Filter-based Spectropolarimetry

NSO/IBIS, BBSO/VIM, Hinode NFI




FeI 630.15 & 630.25 line pair
CS penumbra
LS penumbra
pore
umbra
MPIL
I / I_c
V / I_c [%]
(Q² + U²)^1/2 / I_c [%]
Wavelength [nm]
MgI 517.27
CS penumbra
LS penumbra
pore
umbra
MPIL
I / I_c
V / I_c [%]
(Q² + U²)^1/2 / I_c [%]
Wavelength [nm]