

# High precision spectropolarimetry in the solar atmosphere, results of ZIMPOL3



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## About solar polarimetry 1)

High resolution solar polarimetry is difficult!

We deal with a blurring, changing in the time (down to  $\sim 300$  Hz) surface. Intensity fluctuations compete with polarization signatures.

Solutions:

- Two beams technique
- Two beams exchange technique
- Fast modulation

## About solar polarimetry 2)

Problems: (give me a solution, I will find a problem)

- Two beams technique

  - Precise calibration of the two beams required
  - Murphy law: all constants are variables

- Two beams exchange technique

  - Couples of images are exposed at different times

- Fast modulation

  - Fast sensor required, ~1 kHz

## ZIMPOL, based on fast modulation

ZurichIMagingPOLarimeter technique (H. Povel 1991)

Properties:

Fast modulation (PEM 42 kHz, FLC 1 kHz)

High speed reached shifting electrical charges on the CCD, synchronized with the modulator

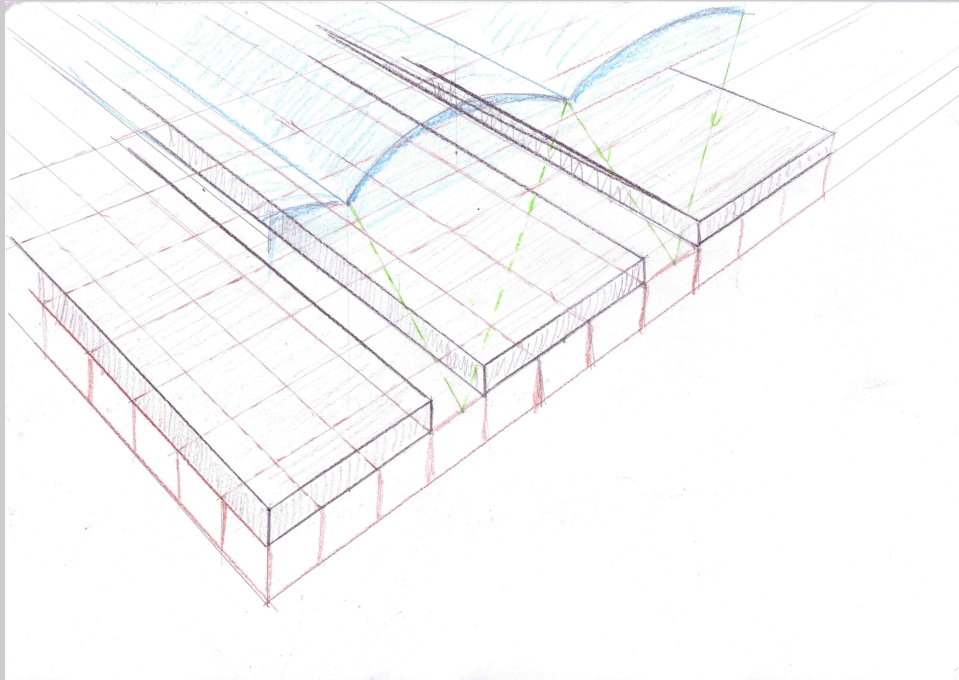
Mask in front of the sensor: one pixel is exposed to the light, three are used as charge buffers

Same pixel is used to measure all four Stokes parameters

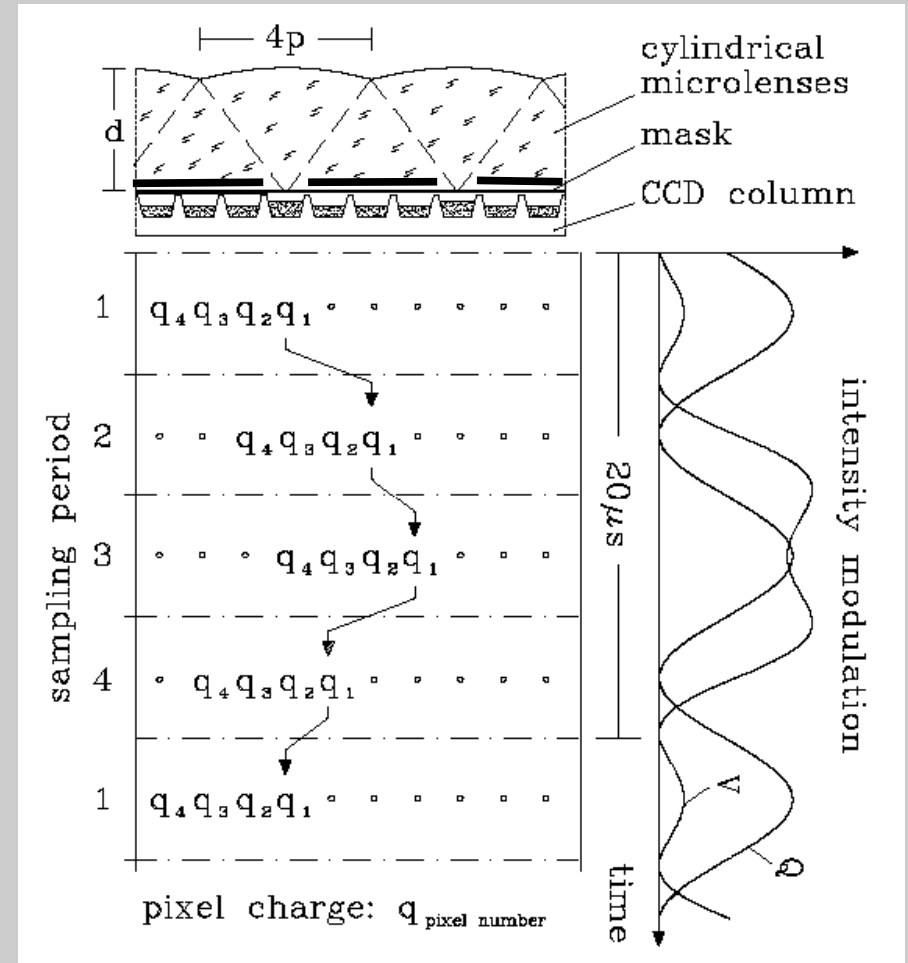
Typical exposure times are few 0.1 sec to few seconds

More: Ramelli et al., 2010, SPIE con.pro., 7735-238

# ZIMPOL, masked CCD with microlenses



One image is composed by 4 interlaced images measured in precise time intervals within the modulation period. Ratios of linear combinations of the 4 images give us the polarization images (I, Q/I, U/I, V/I)



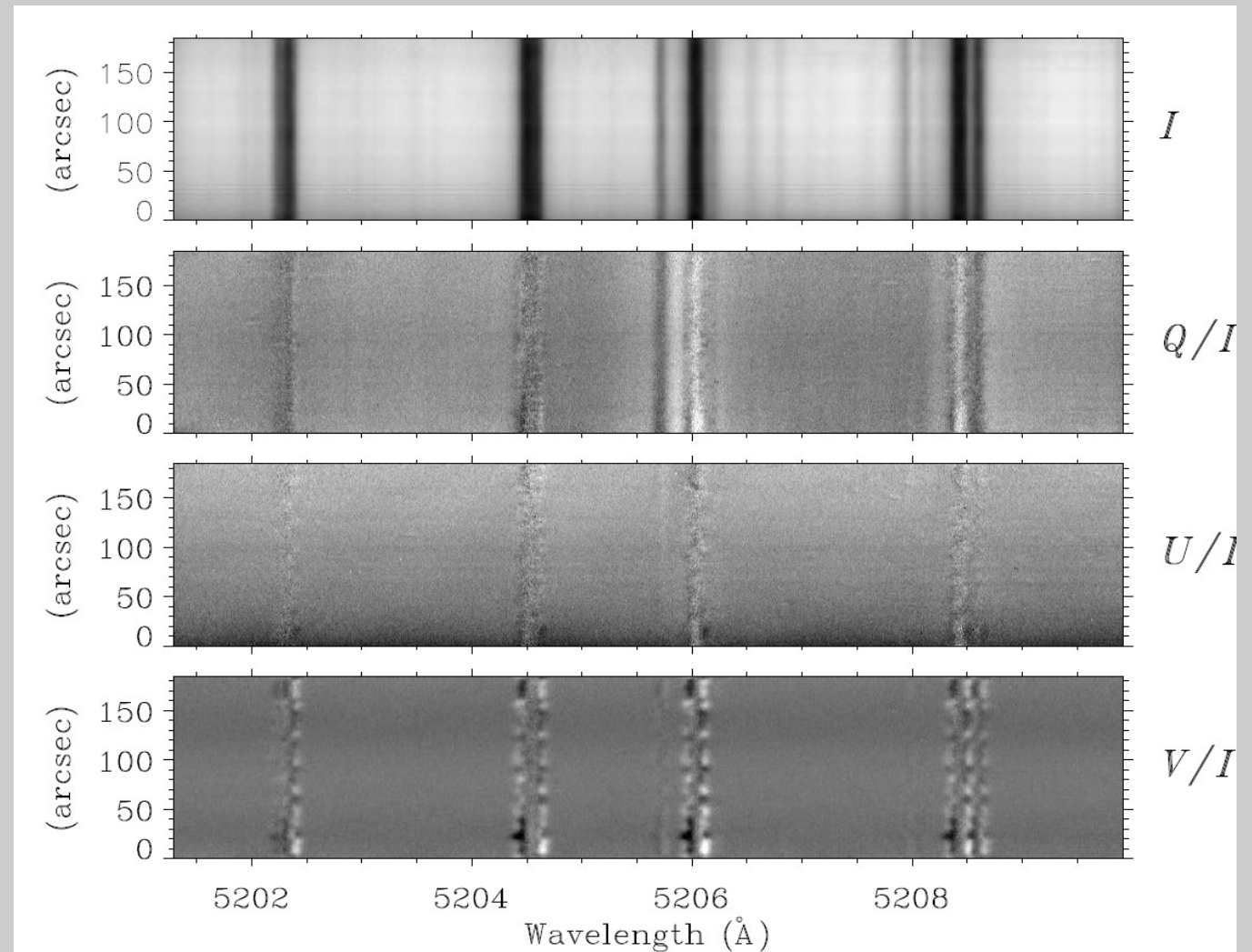
## Example of an observation

Scattering polarization  
of the Chromium triplet  
lines around 5206 Å

The spectrograph slit  
is placed parallel to  
the solar limb (North  
pole), about 10" inside  
the solar disk.

Exposure time:  
20 minutes

Date (observation):  
24<sup>th</sup> March 2012

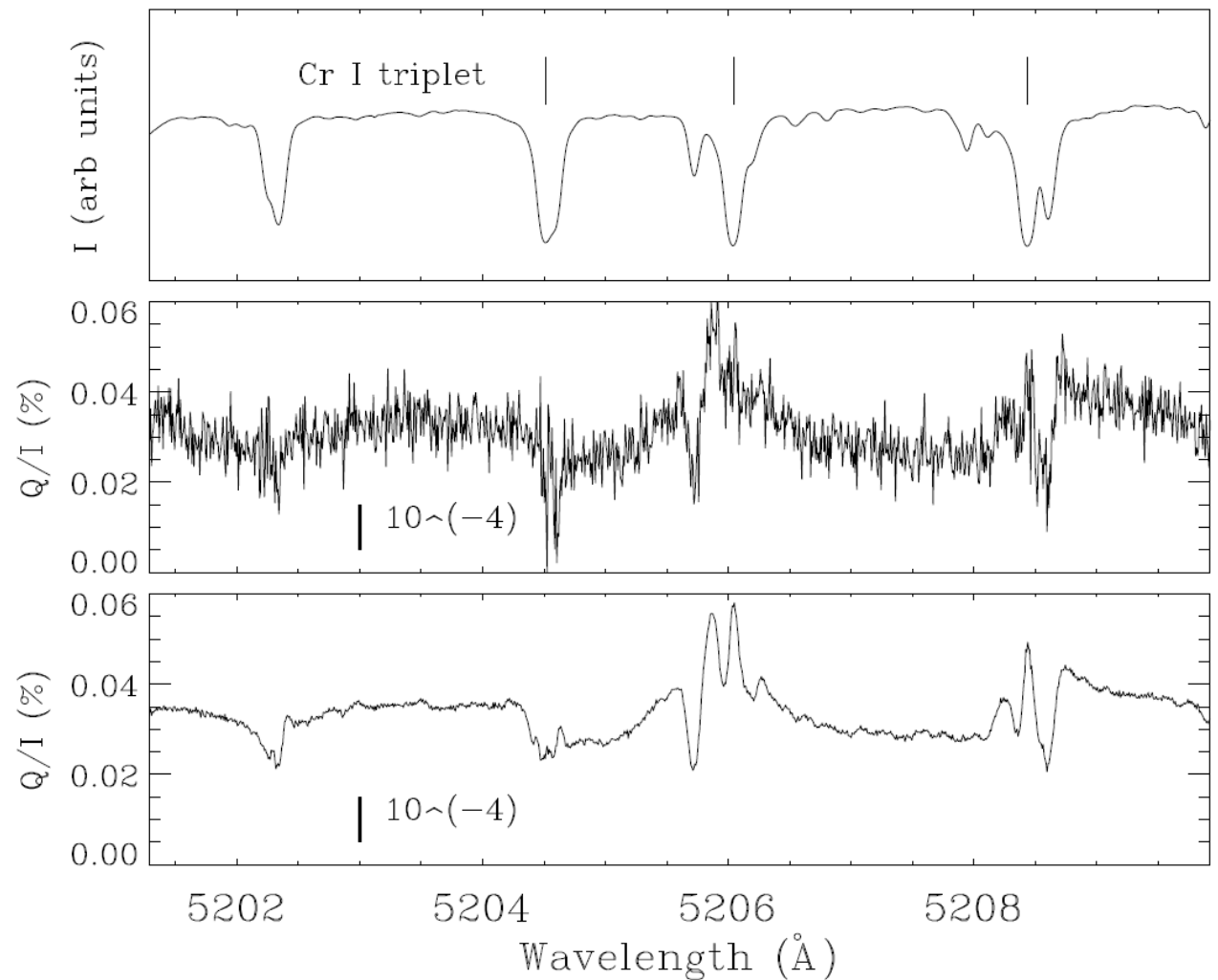


# I and Q/I profiles of the previous observation

Q/I profile of a single pixels line

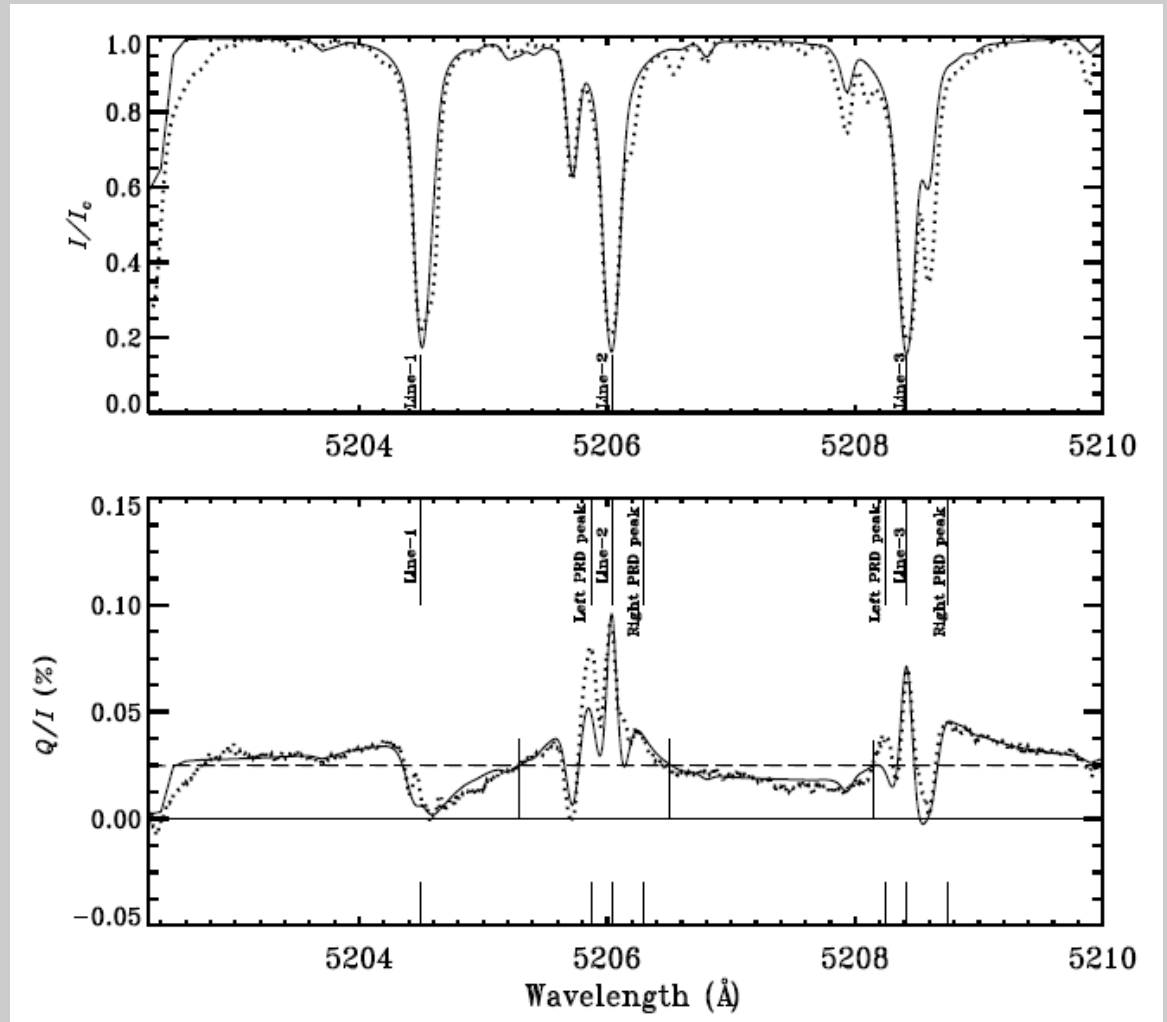
Q/I profile averaged over the 140 pixel lines along the spatial resolution,

Rms  $\sim 7 * 10^{-6}$



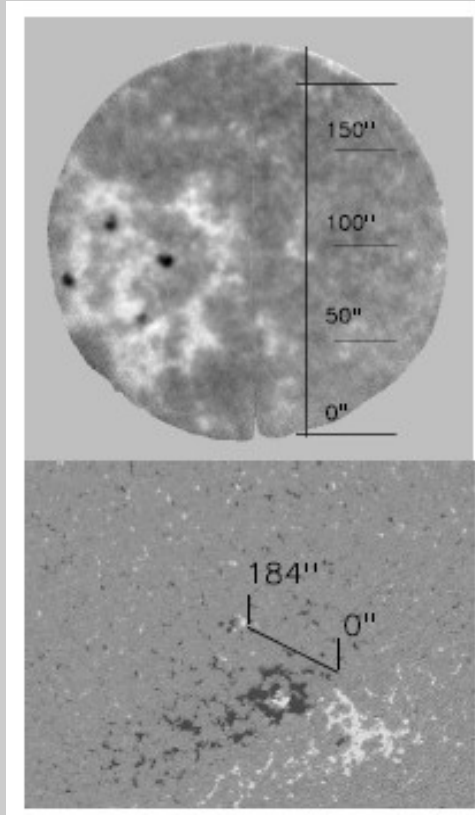
# Theoretical profile

Smitha et al., 2012,  
Astron. & Astrophys.,  
541, 24

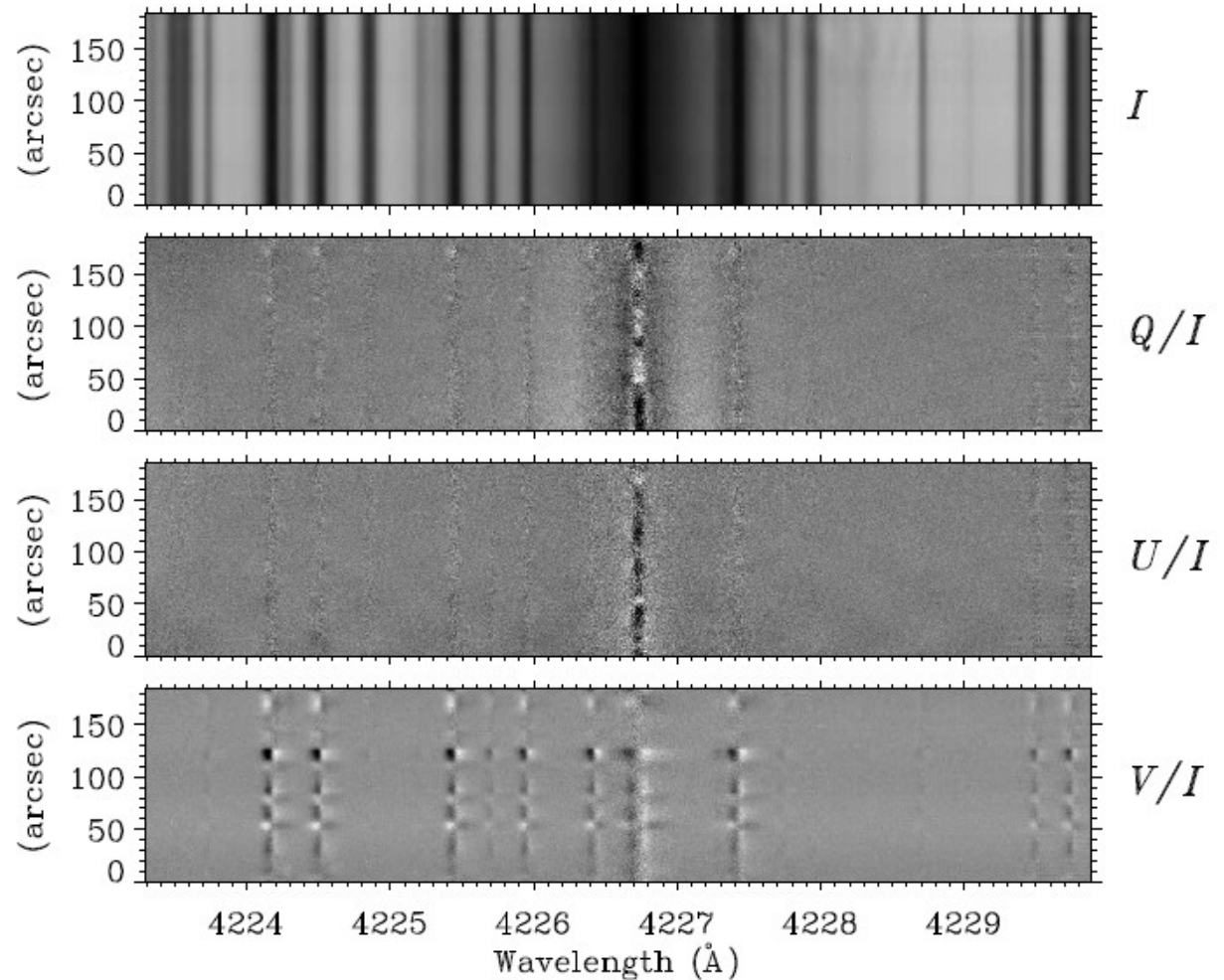




# Forward scattering Hanle effect in the Ca I 4227 Å line



Bianda et al., 2011,  
A&A, 530, 13



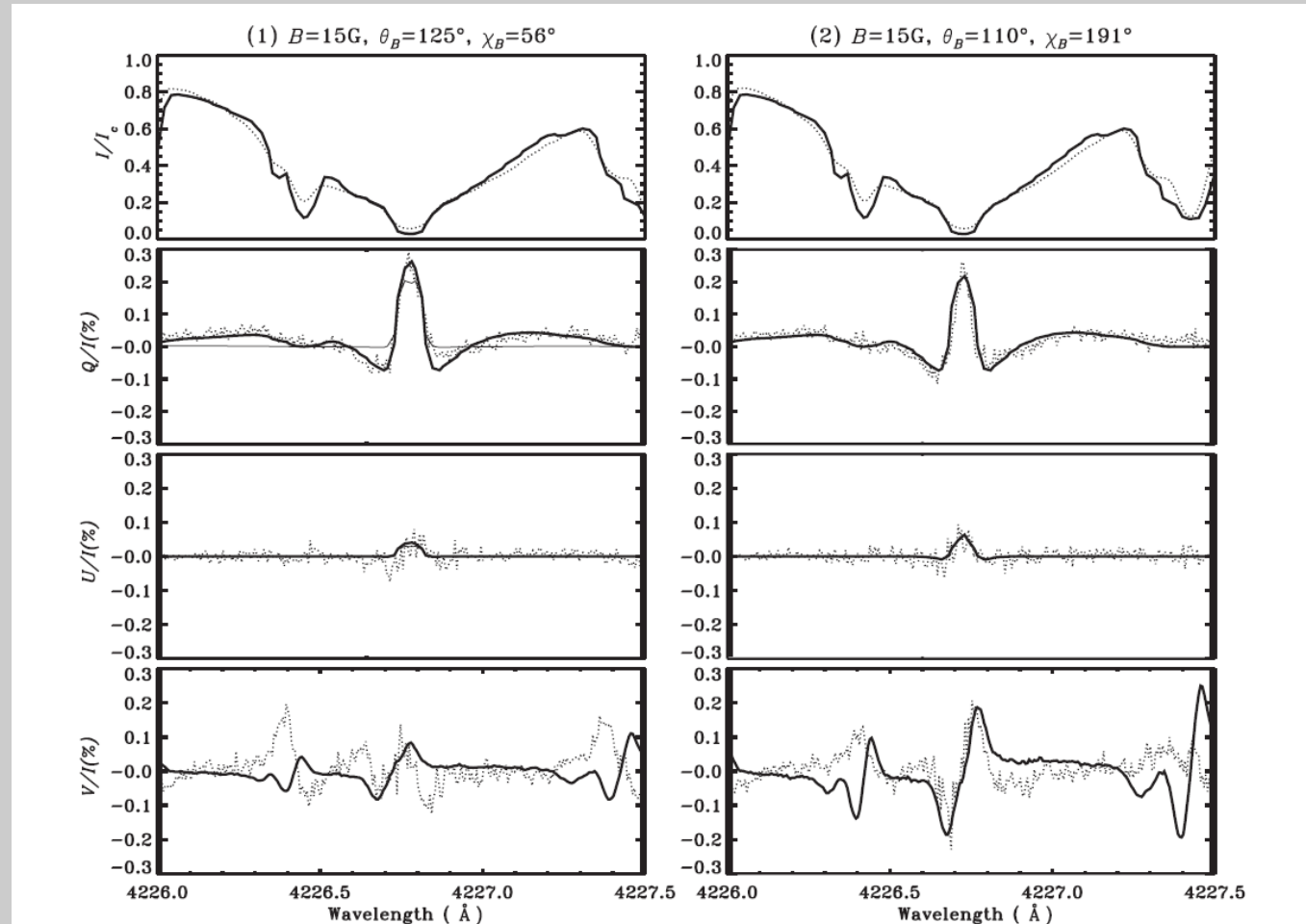
# Theoretical model profiles fit to the observed profiles

The V/I Zeeman effect signatures and the forward scattering Hanle effect signatures in Q/I and U/I are used

The magnetic field vector can be calculated without ambiguities

This method allows measuring chromospheric magnetic maps

Anusha et al.,  
2011, APJ, 737, 95



## Current and future collaborations

- IRSOL, in collaboration with SUPSI (University of Applied Science in Southern Switzerland), takes care now of the further development of the solar version of ZIMPOL
- Observational projects at IRSOL are welcome
- We are installing a ZIMPOL system at GREGOR in Tenerife
- Depending on the financing of the Swiss State Secretariat for Education and Research, IRSOL should expand; opportunity to deepen existing collaborations and open new ones