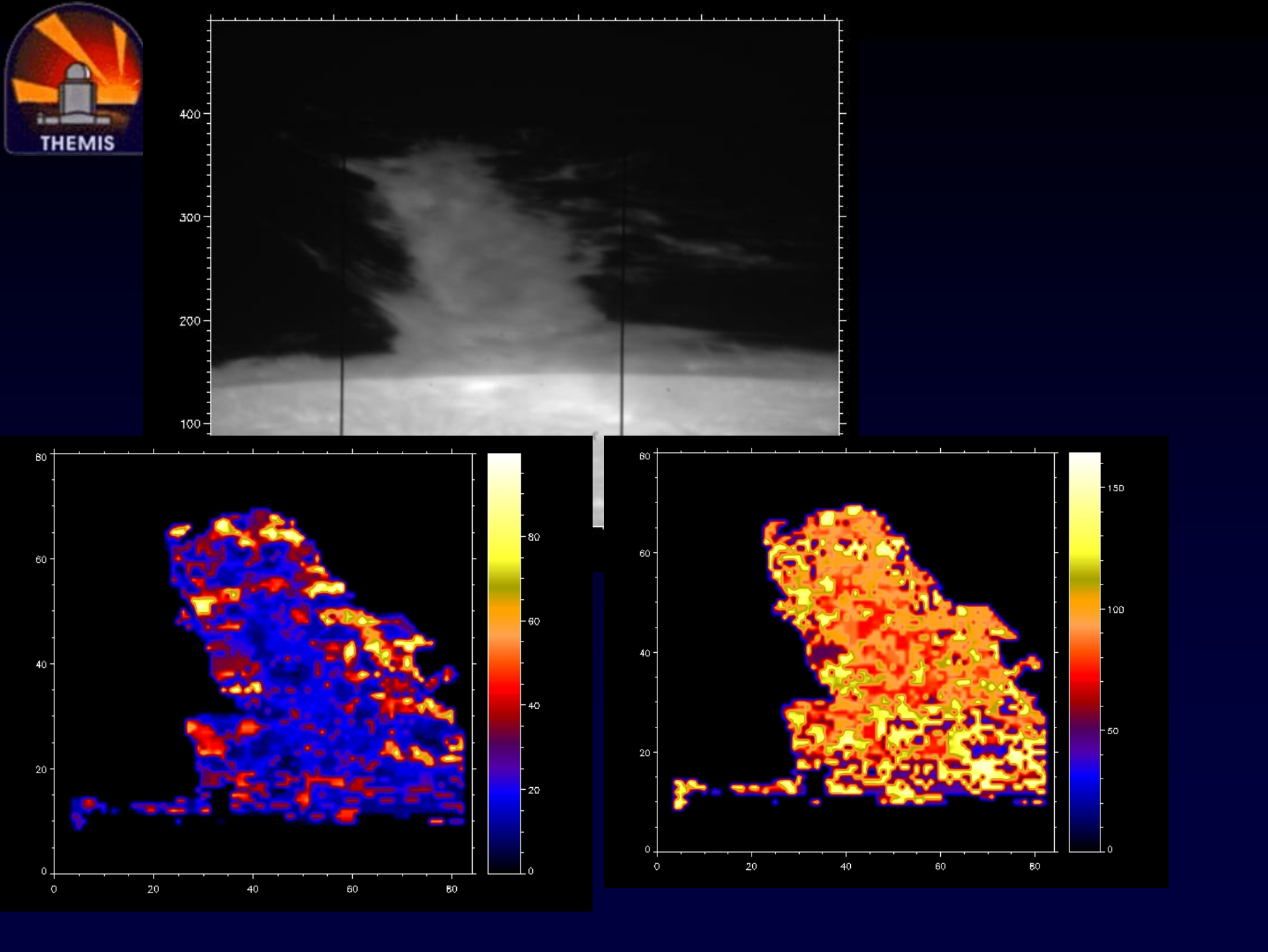
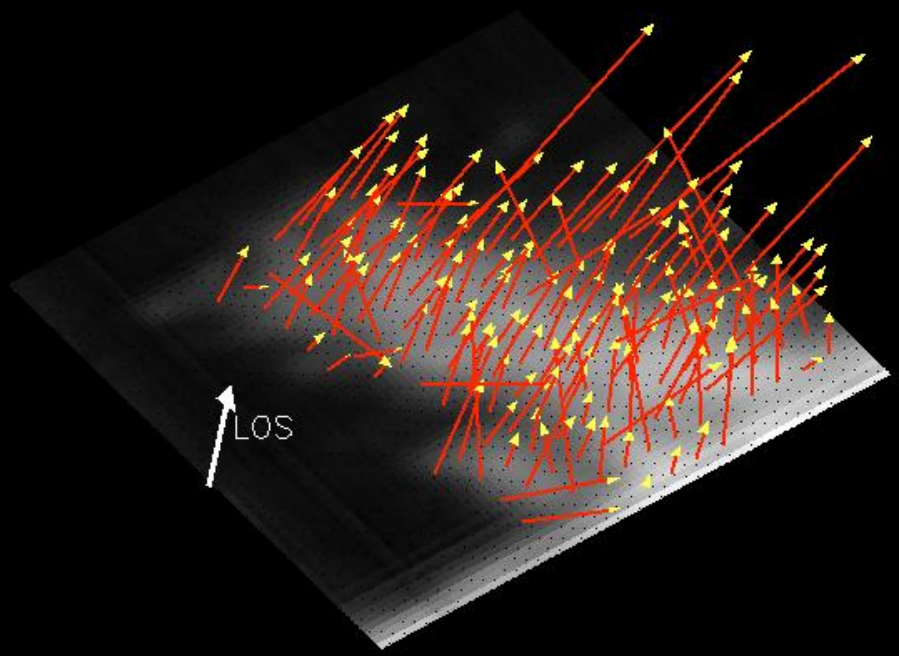
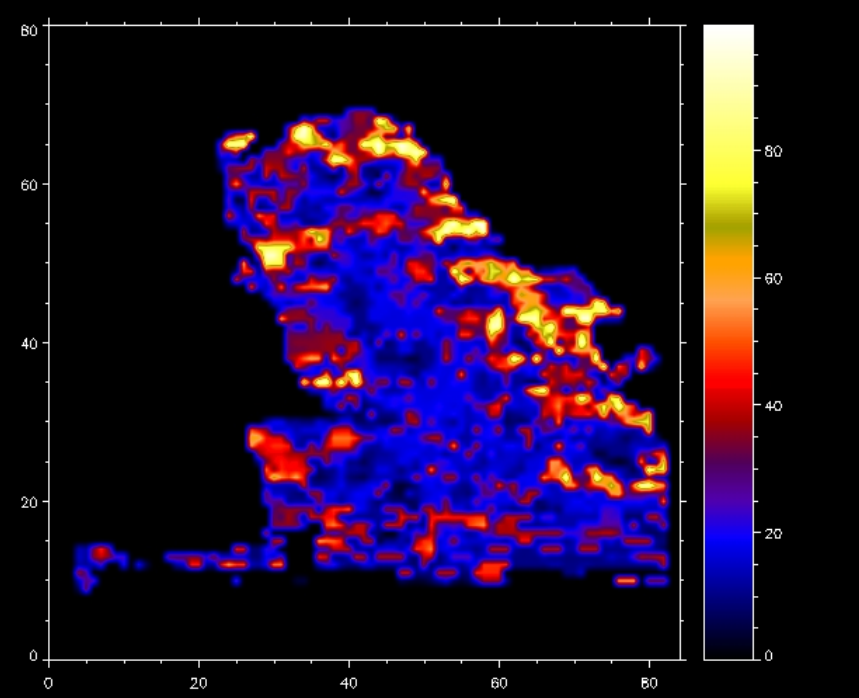
Magnetic fields in spicules

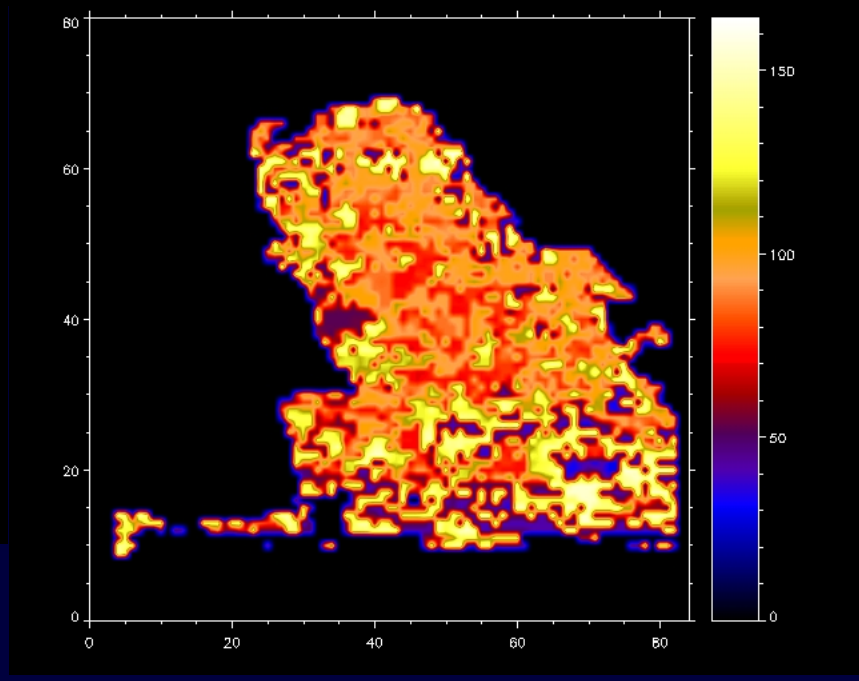
Arturo López Ariste
Roberto Casini (HAO)

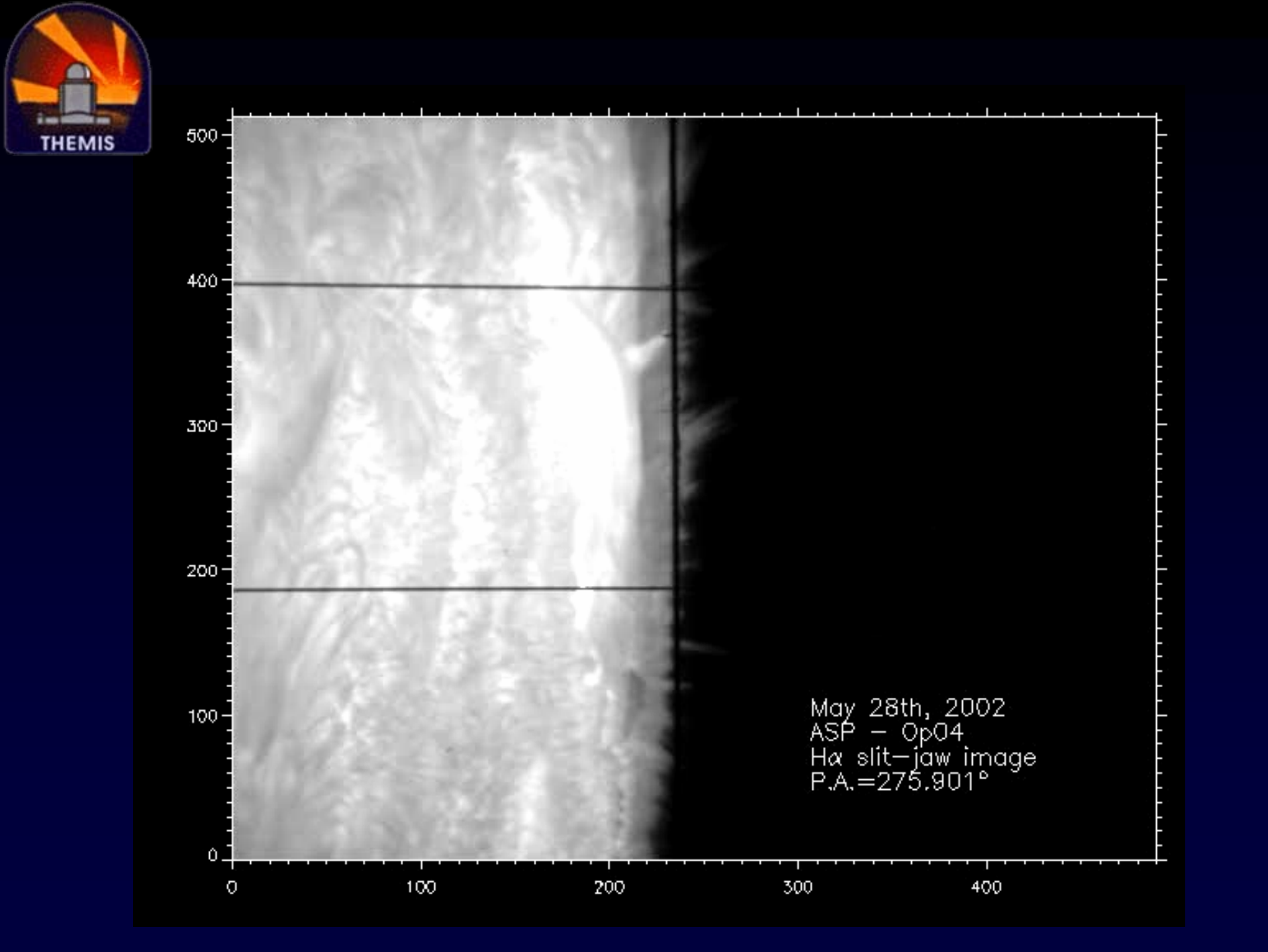

THEMIS
400
300
200
100
80
60
40
20
0
0
20
40
60
80
0
20
40
60
80
150
100
50
0


THEMIS

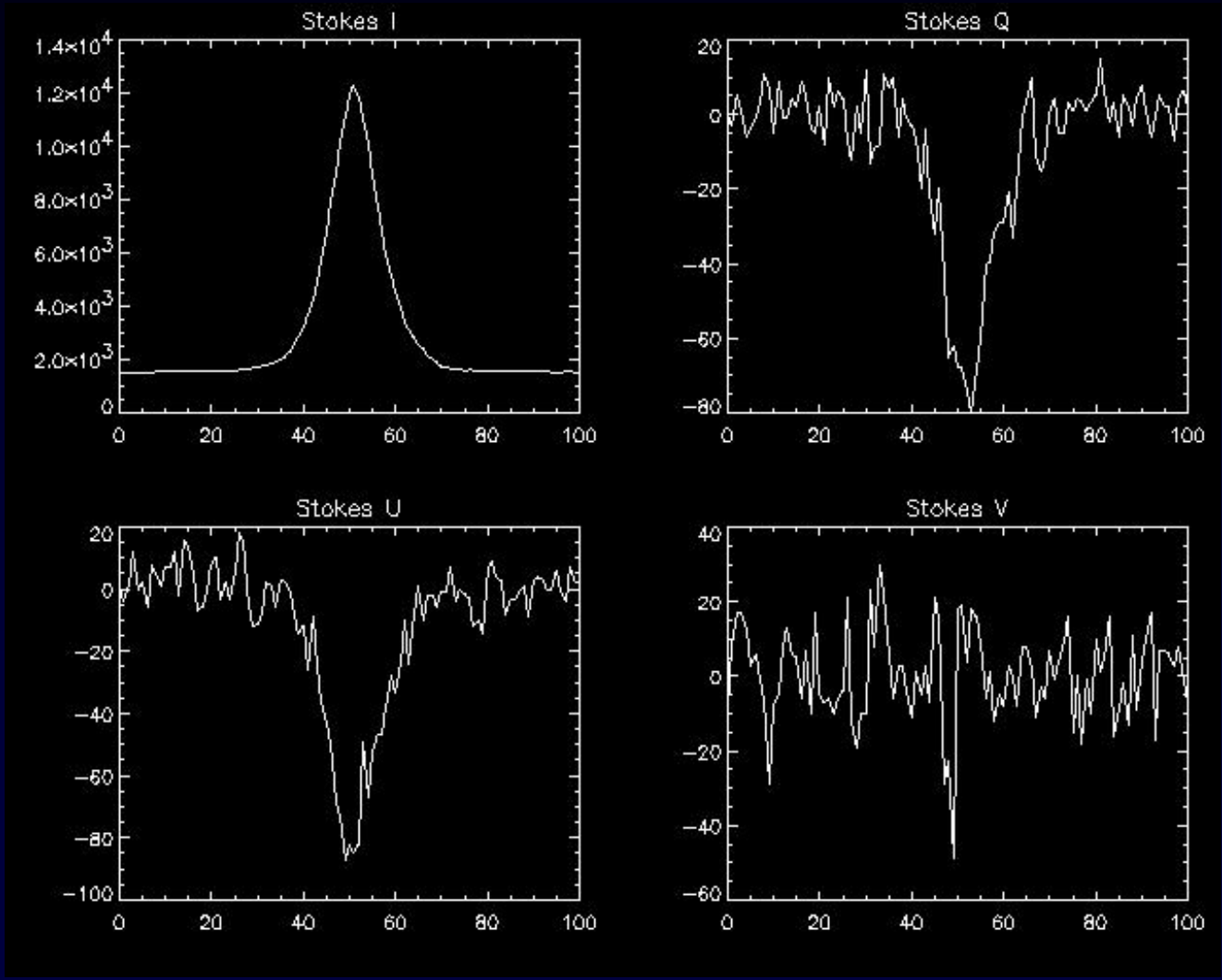

LOS


0
20
40
60
80
0
20
40
60
80

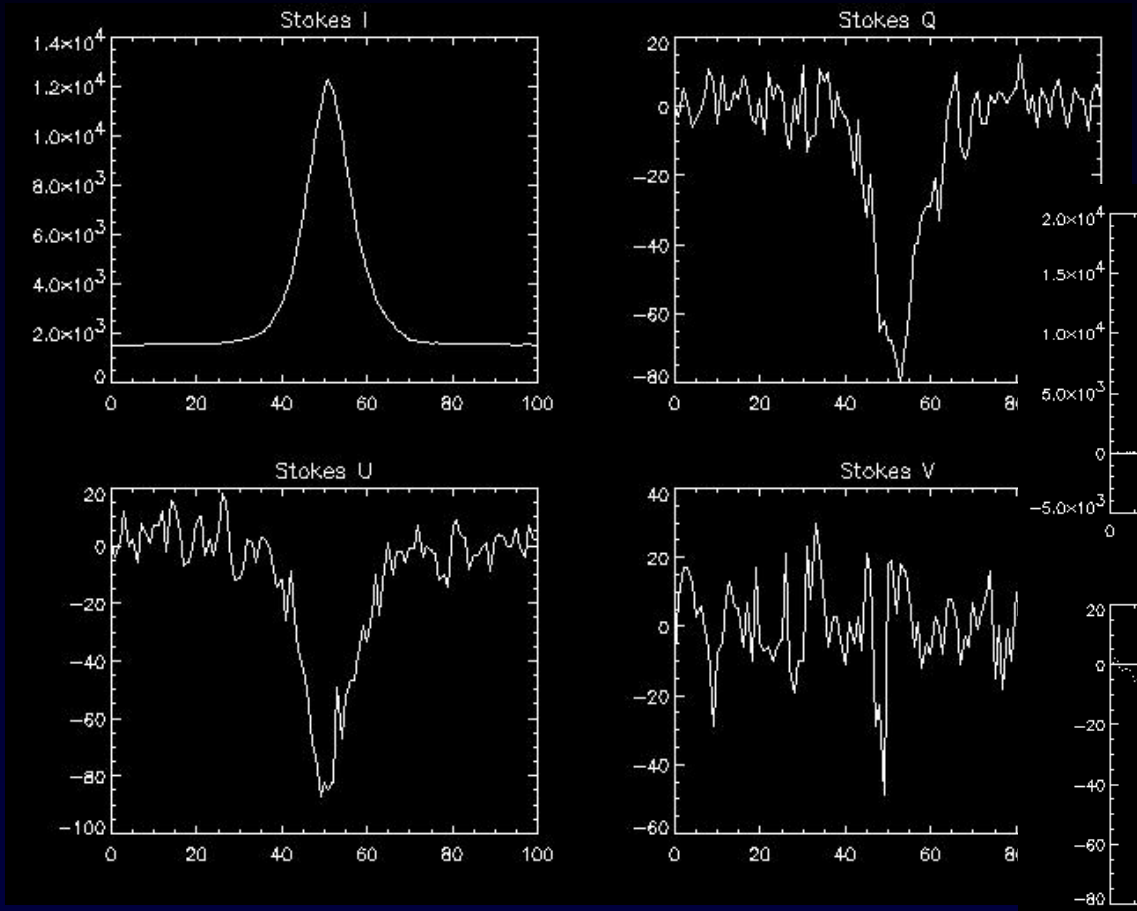

0
20
40
60
80
0
50
100
150

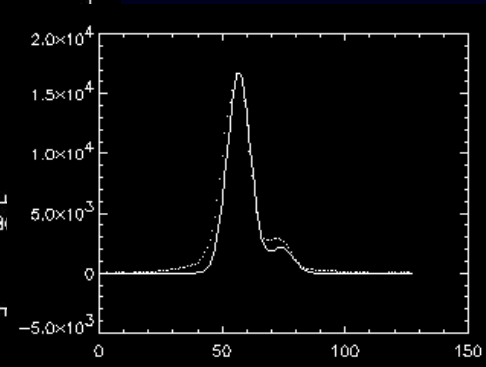

THEMIS
500
400
300
200
100
0
0
100
200
300
400
May 28th, 2002
ASP – Op04
Hα slit–jaw image
P.A.=275.901°

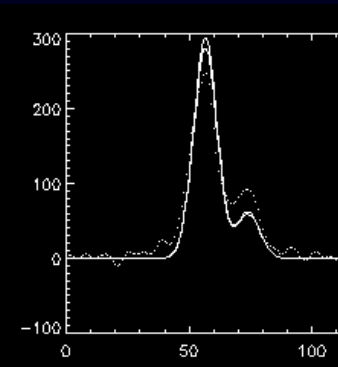
Broadened profiles

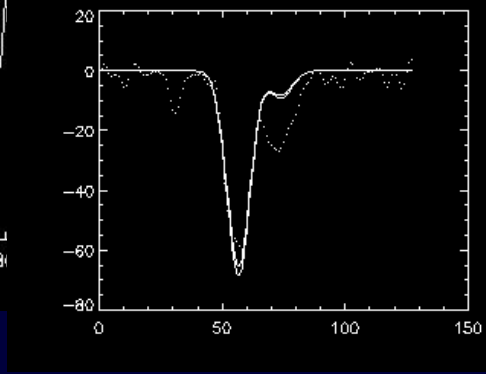


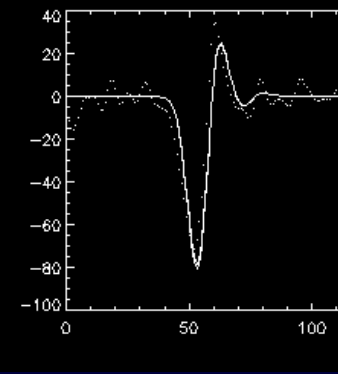
Broadened profiles











Aproach to inversion

1. Get an (empirical) description of the anomalous broadening:

   A convolution of Doppler-shifted profiles each one given a weight by a gaussian distribution

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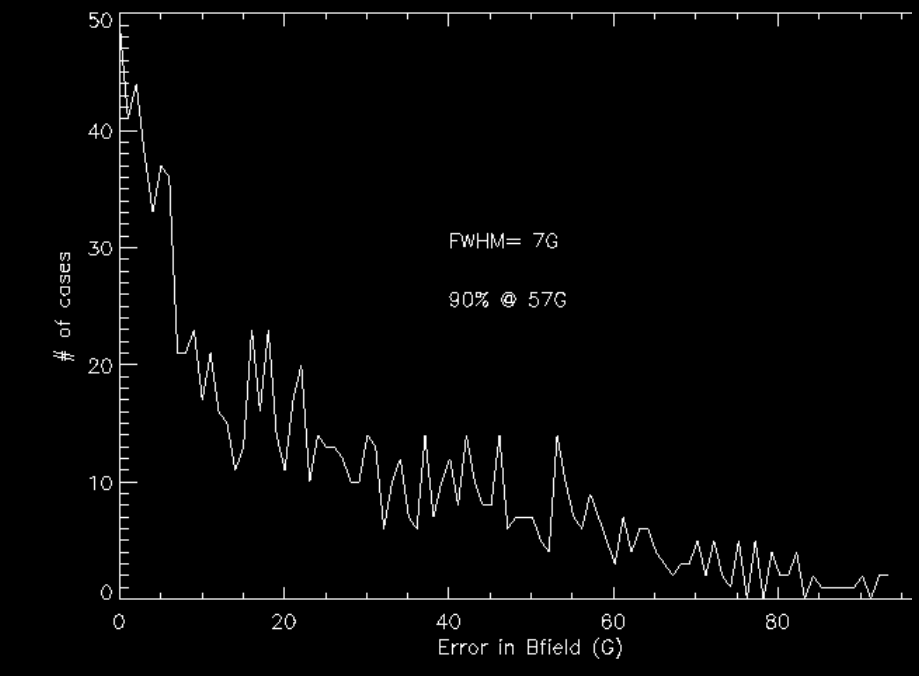
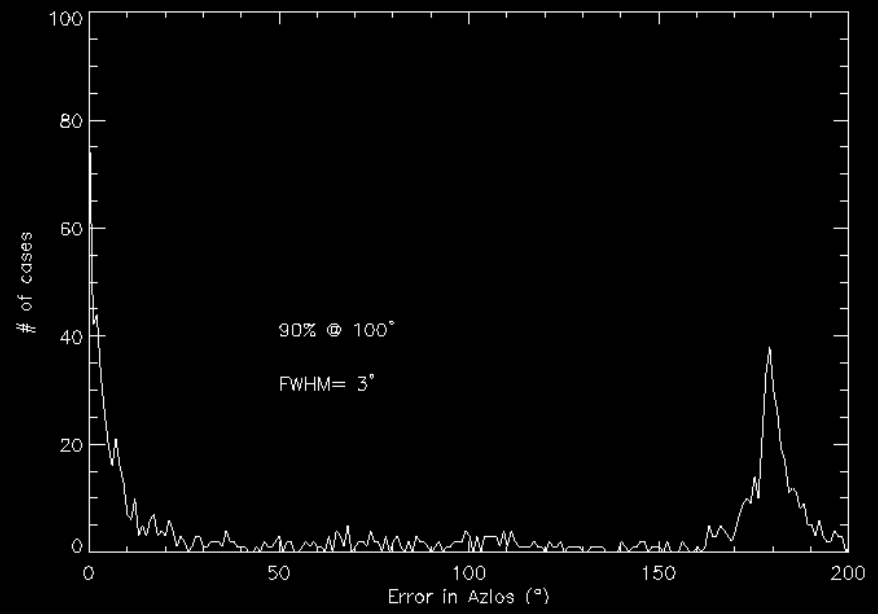
   Create synthetic profiles, broaden them and try to invert

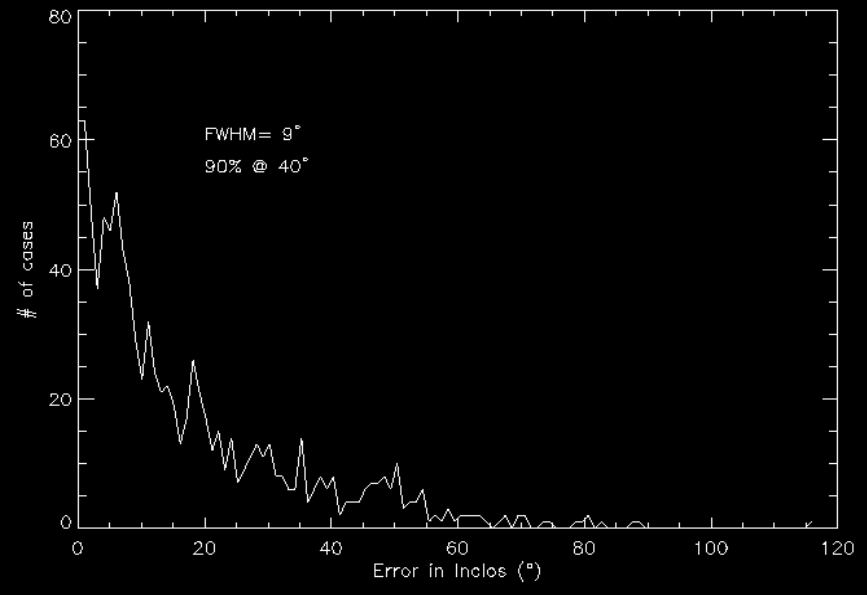
Model theory

- Quantum theory of polarized line formation (Landi Degl'Innocenti, 1983)
- Spectrally flat incident radiation (CRD)
- No collisions
- Includes level-crossing and coherence effects within each atomic term

Synthetic broad profiles inverted







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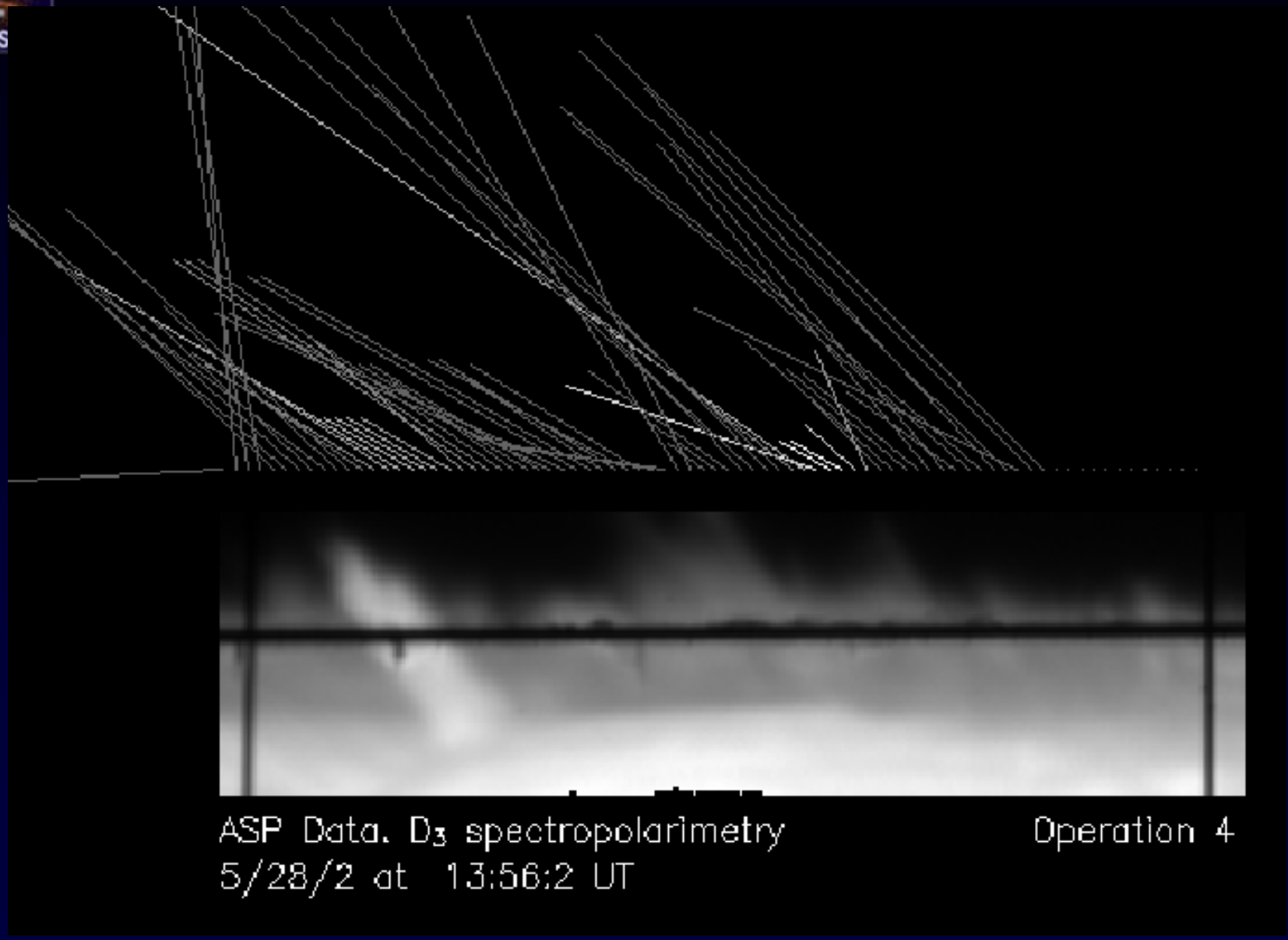
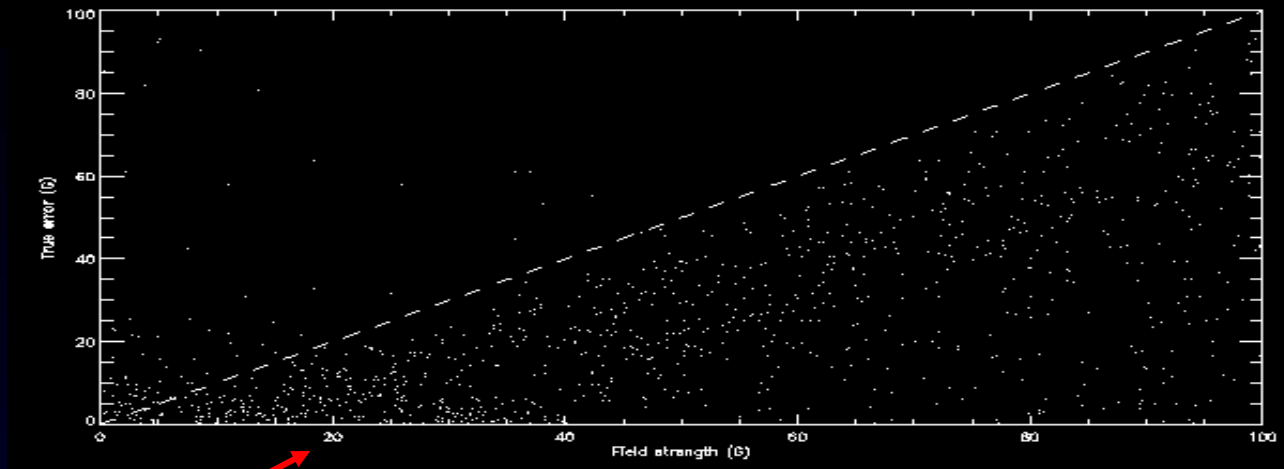
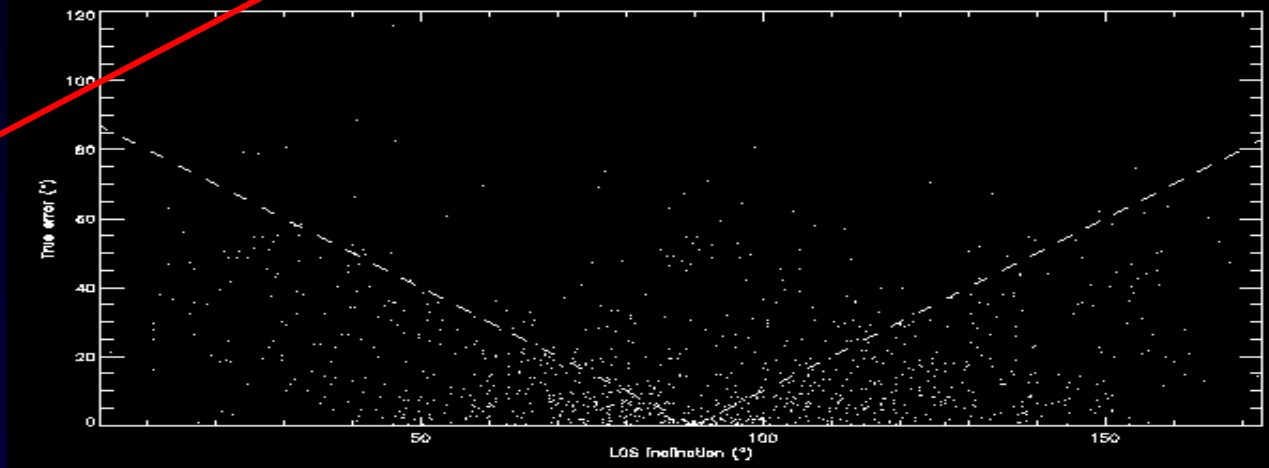
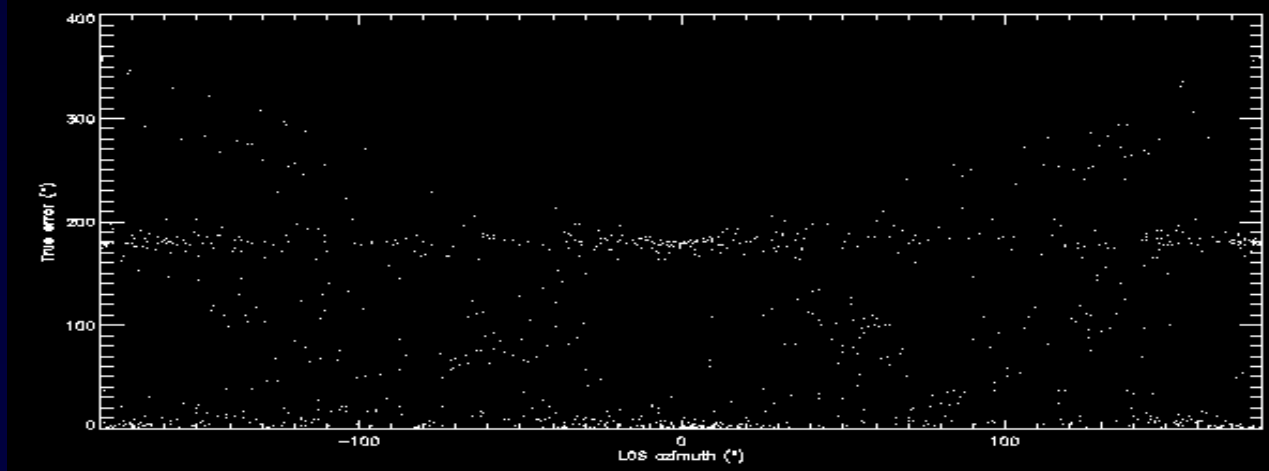
1. Get an (empirical) description of the anomalous broadening:
   A convolution of Doppler-shifted profiles each one given a weight by a gaussian distribution
2. Investigate how much magnetic information is still available in the so-broadened profiles:
   Create synthetic profiles, broaden them and try to invert
3. Try with the real data and see what happens!


ASP Data. D3 spectropolarimetry
Operation 4
5/28/2 at 13:56:2 UT

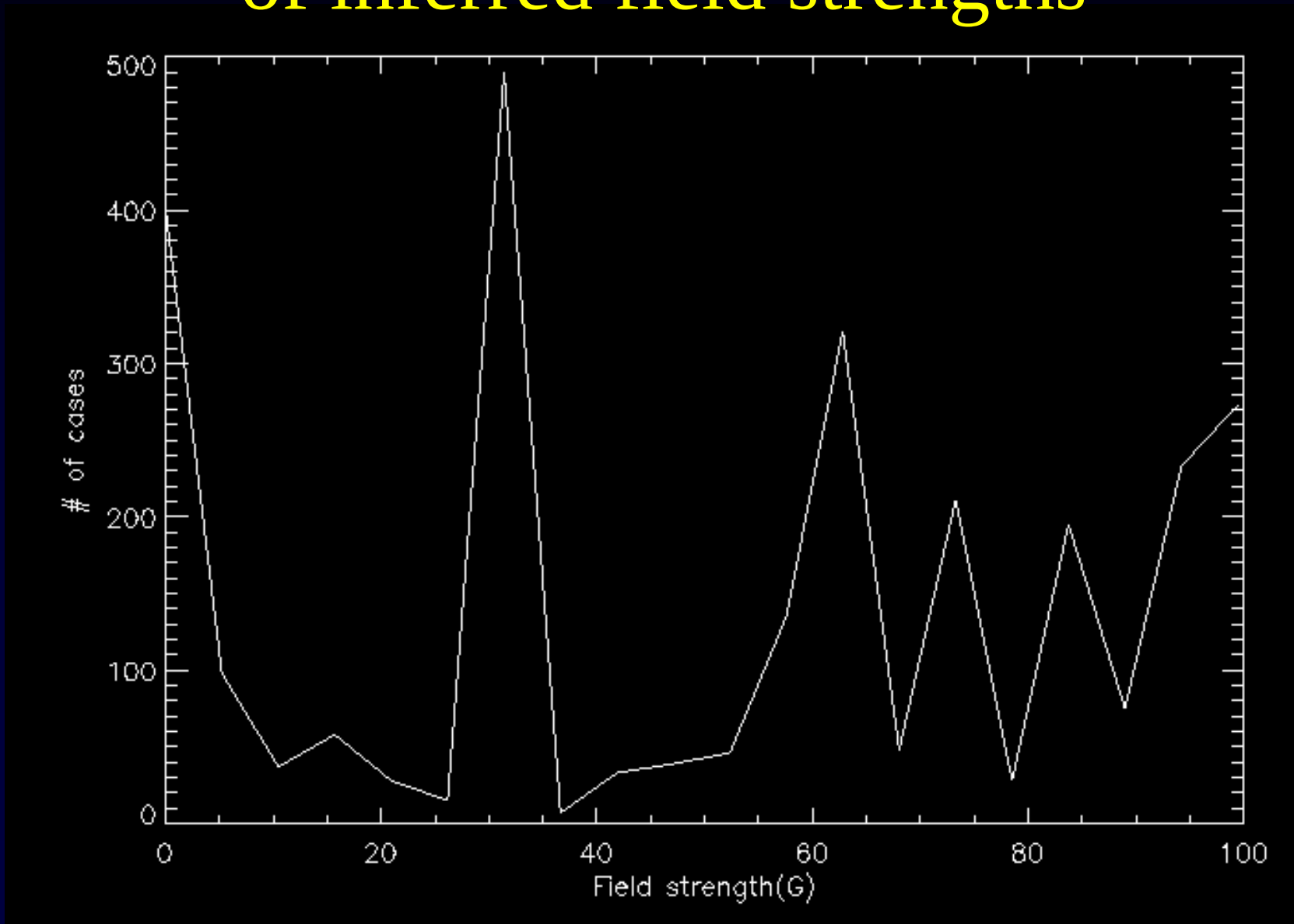
Error bars are not always just white noise







Inversion of real data: Distribution of inferred field strengths

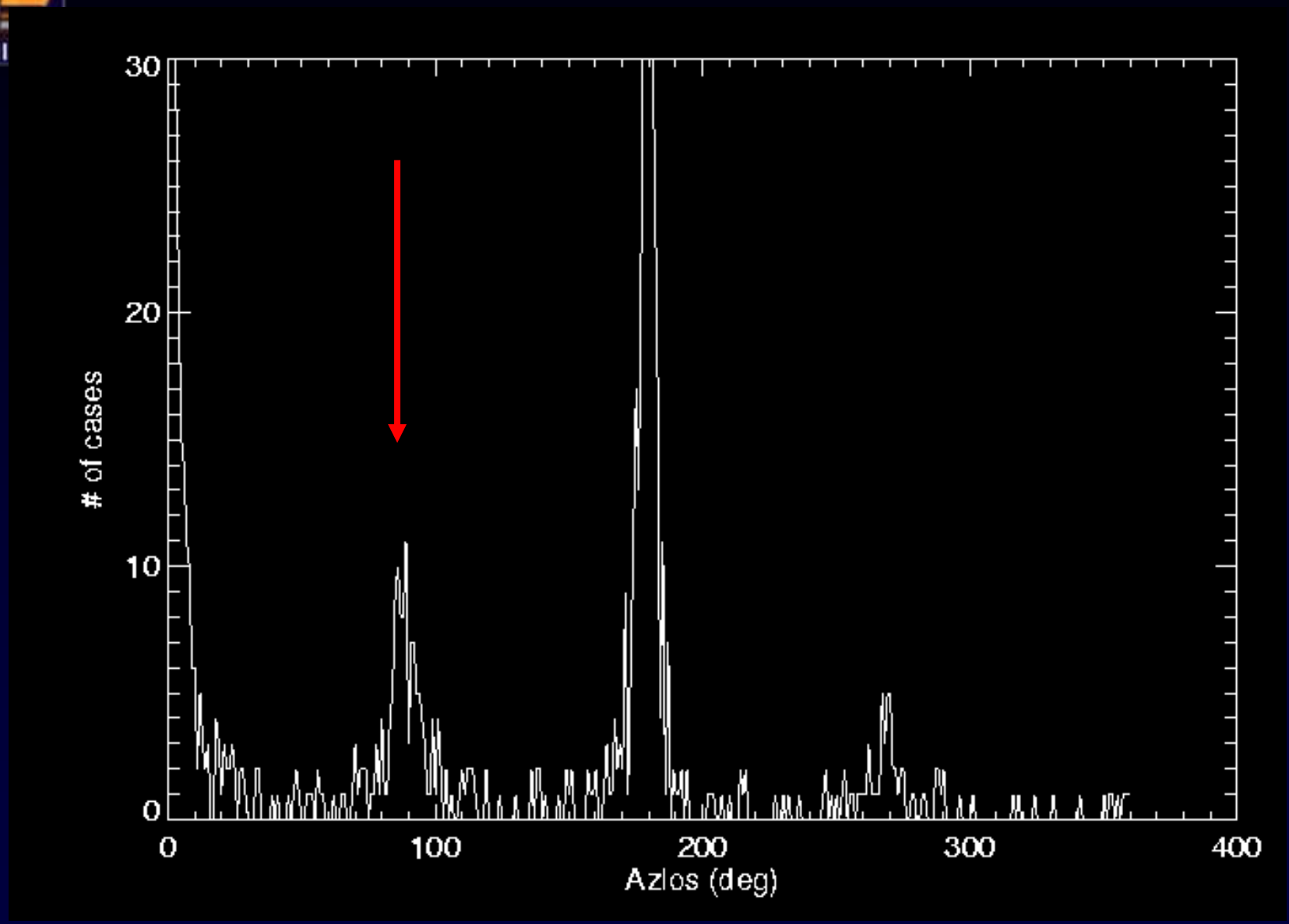


Not yet done!


ASP Data. D_3 spectropolarimetry
Operation 4
5/28/2 at 13:54:2 UT

The 90 degrees ambiguity

$$Q \approx \frac{3}{8}\omega(3\cos^2\vartheta_B - 1)\sin^2\Theta_B\cos 2\Phi_B$$

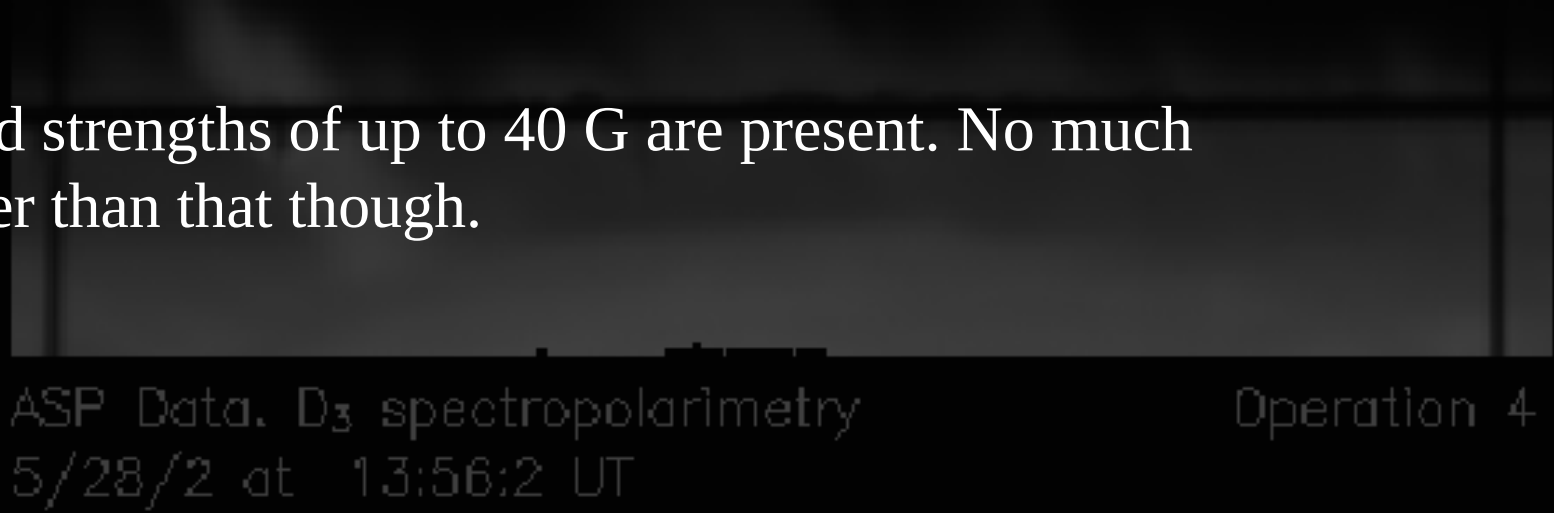

30
20
10
0
# of cases
0
100
200
300
400
Azlos (deg)

A few conclusions

•Broadened profiles are well reproduced by subpixel velocity distribution (either real or arisen from projection effects)

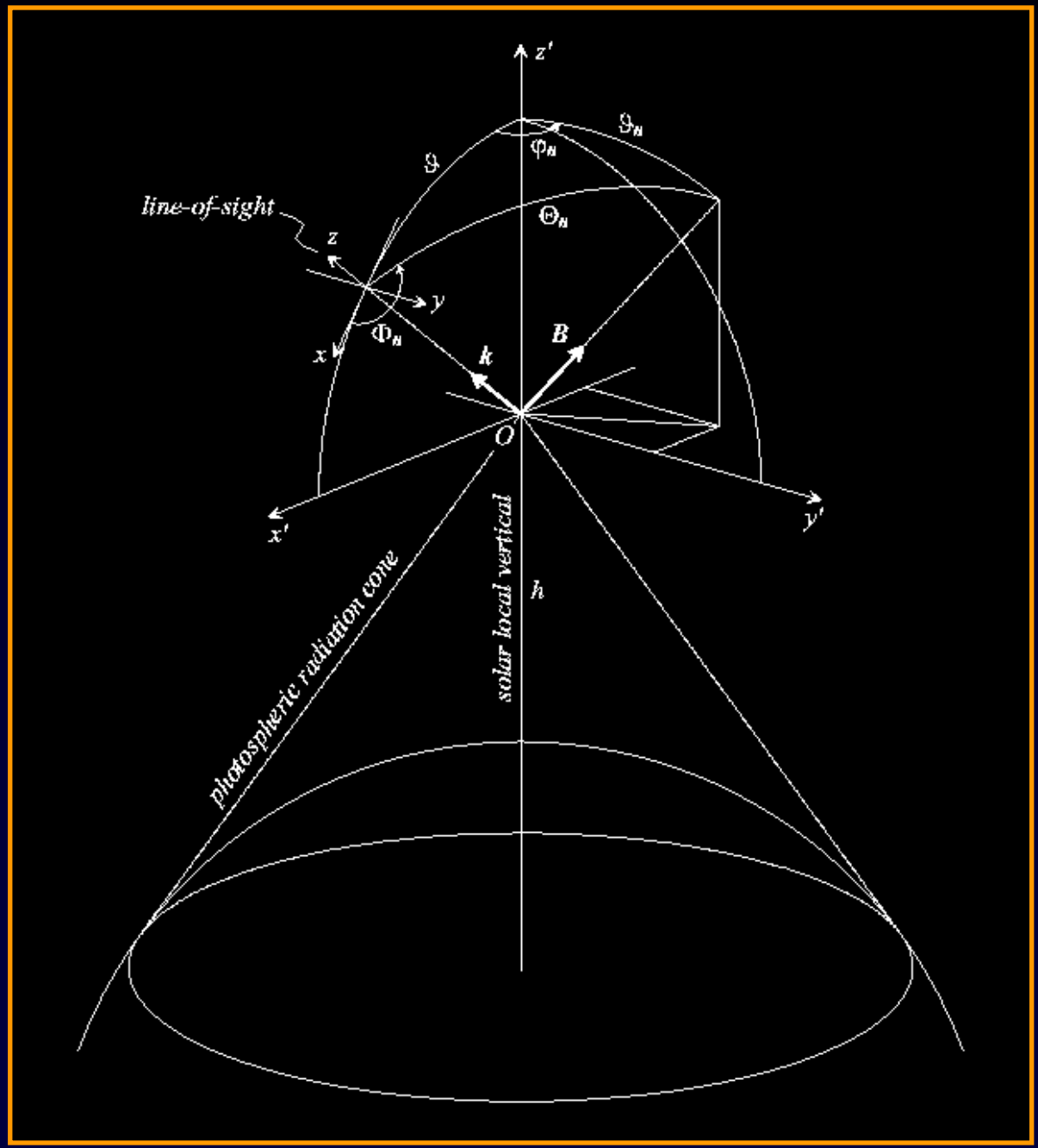
•Magnetic field in spicules appear to be either ALIGNED or TRANSVERSAL to the visible structure

•Field strengths of up to 40 G are present. No much higher than that though.

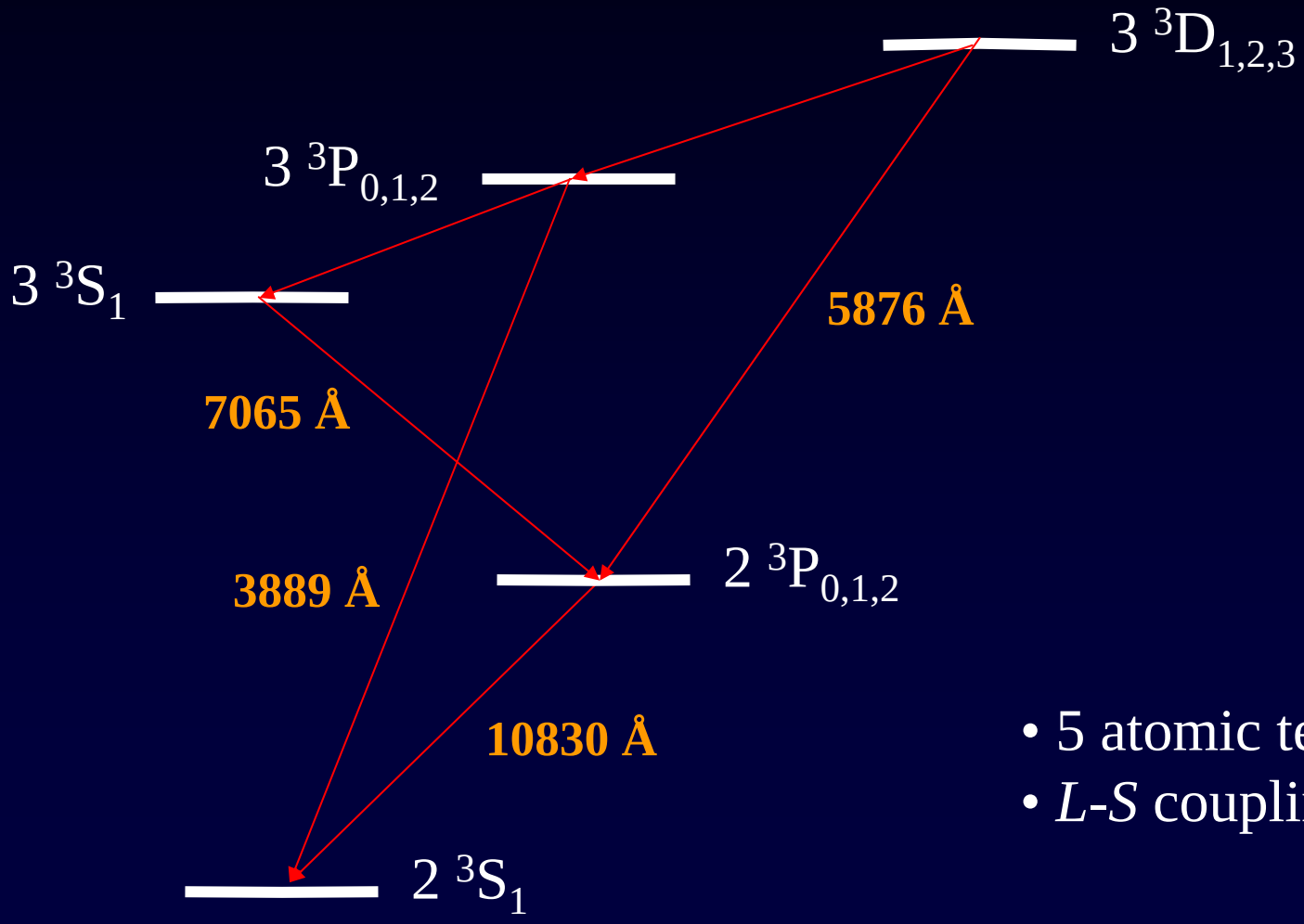



THEMIS

Scattering Geometry

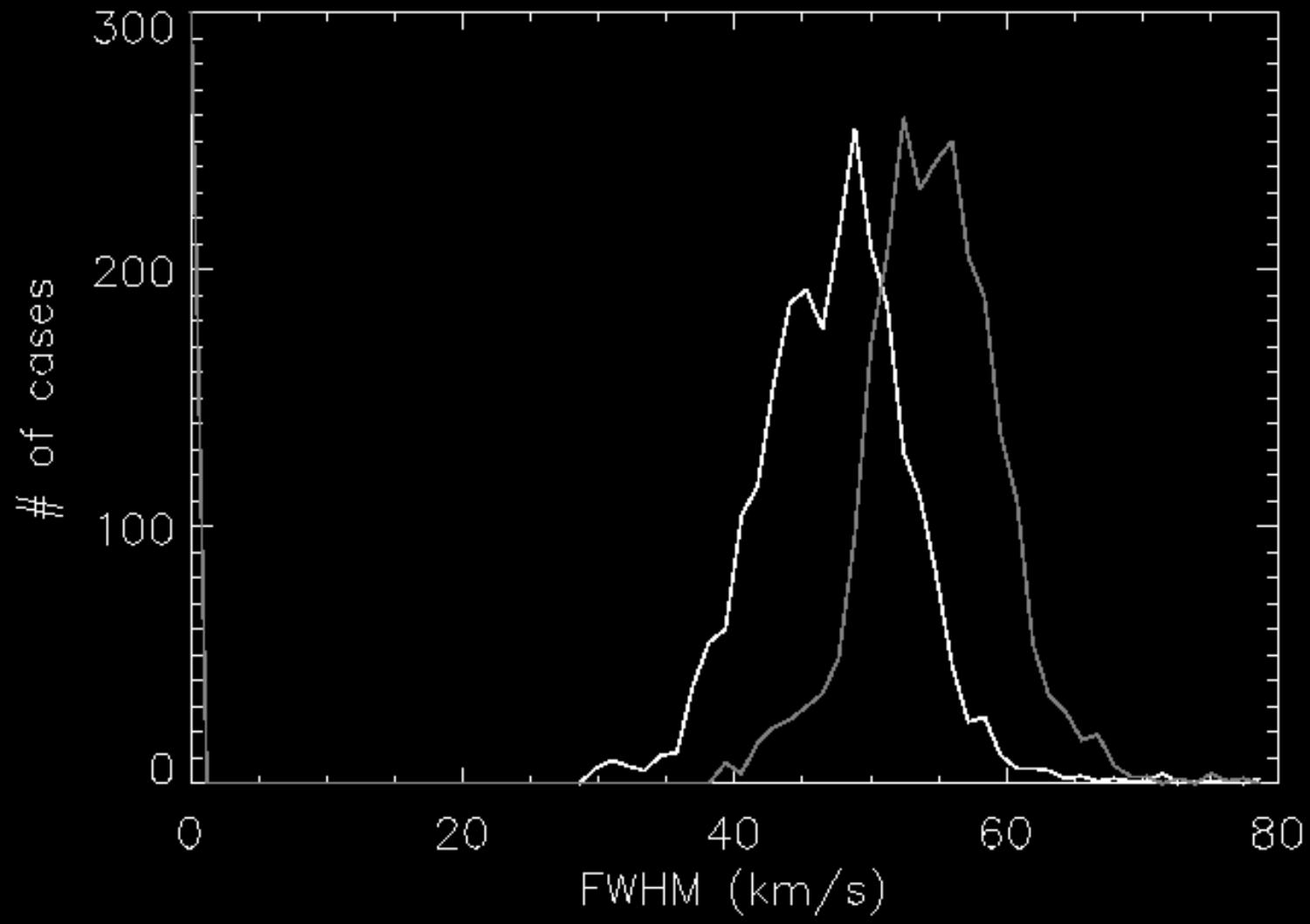


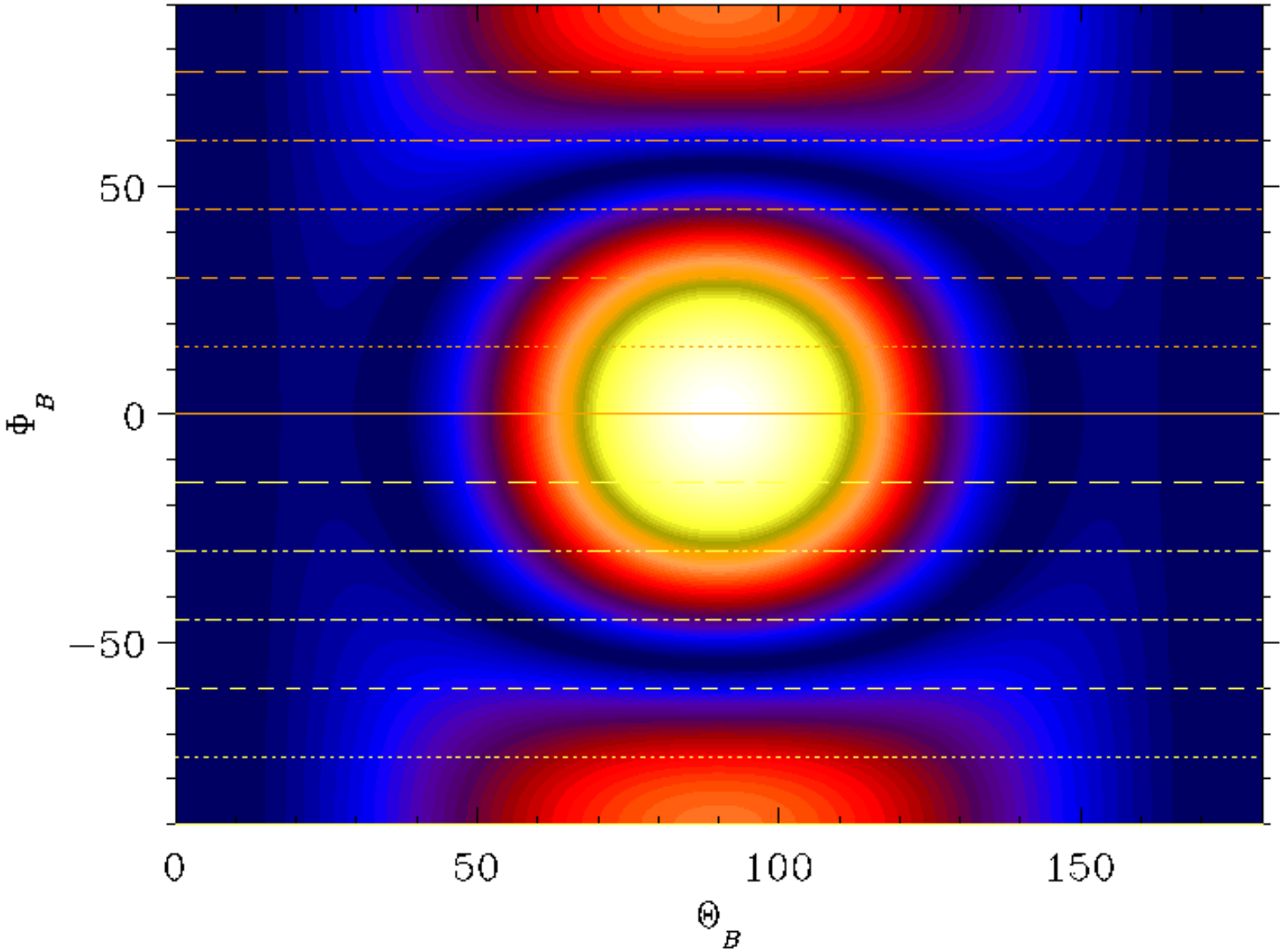
He I atomic model



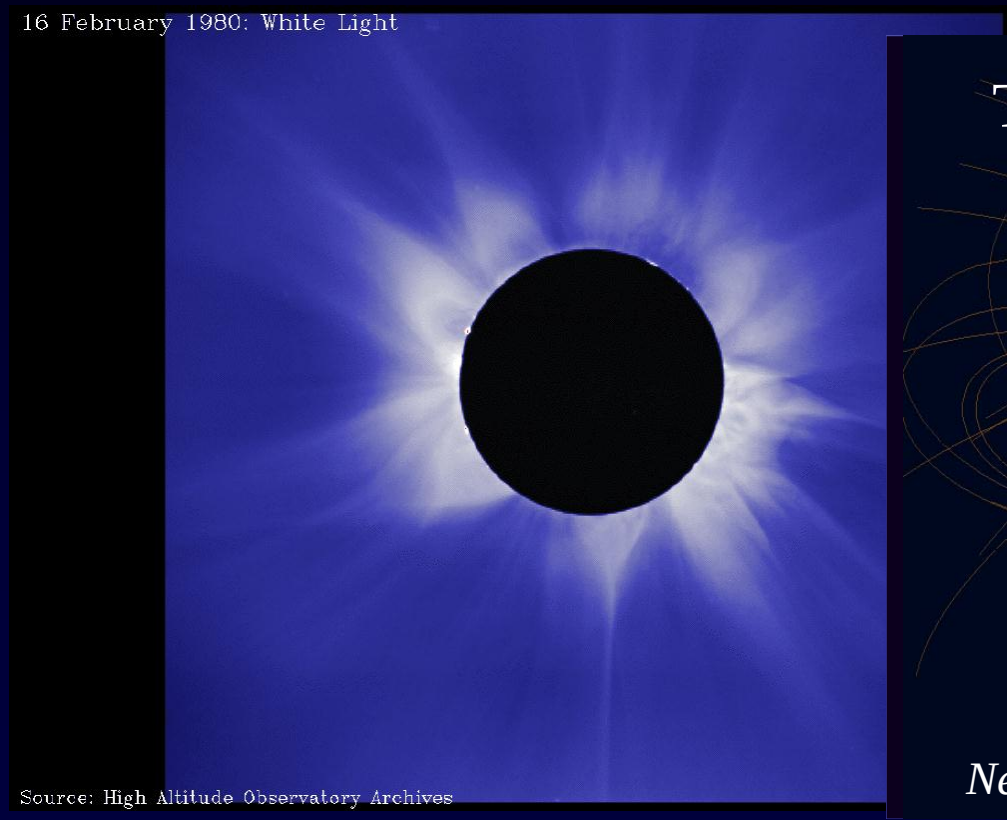
- 5 atomic terms
- *L*-*S* coupling

Subpixel velocity distributions

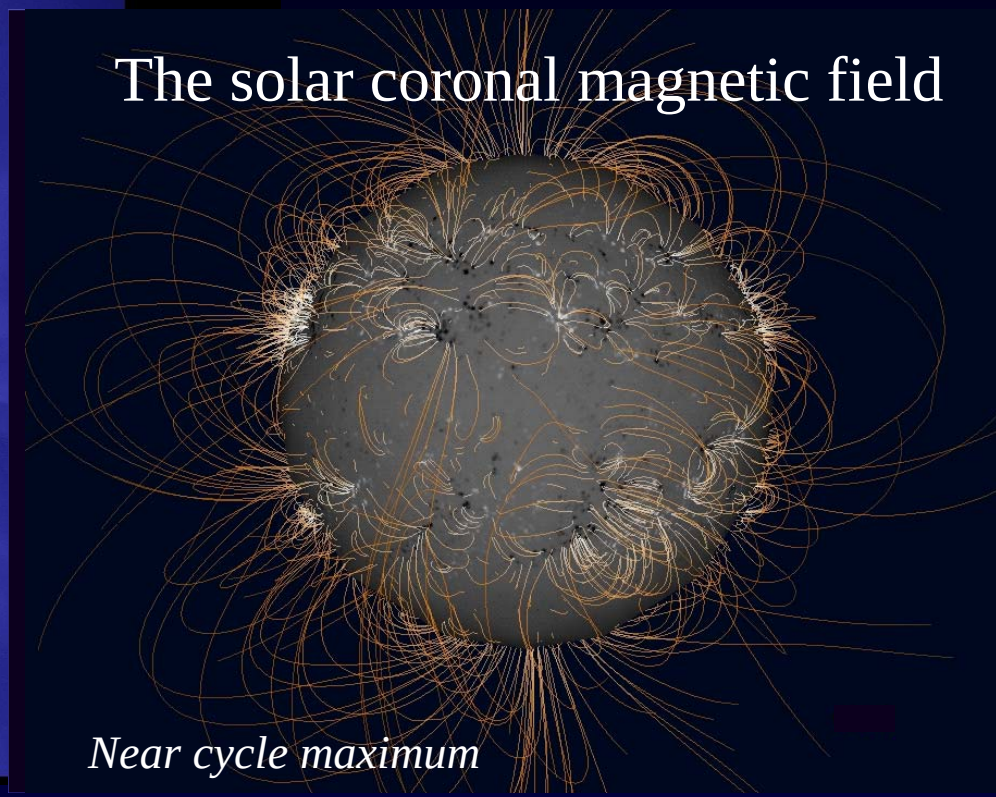



50
0
−50
Φ_B
0
50
100
150
Θ_B

Global magnetic structure



The solar coronal magnetic field



Near cycle maximum

Global magnetic structure