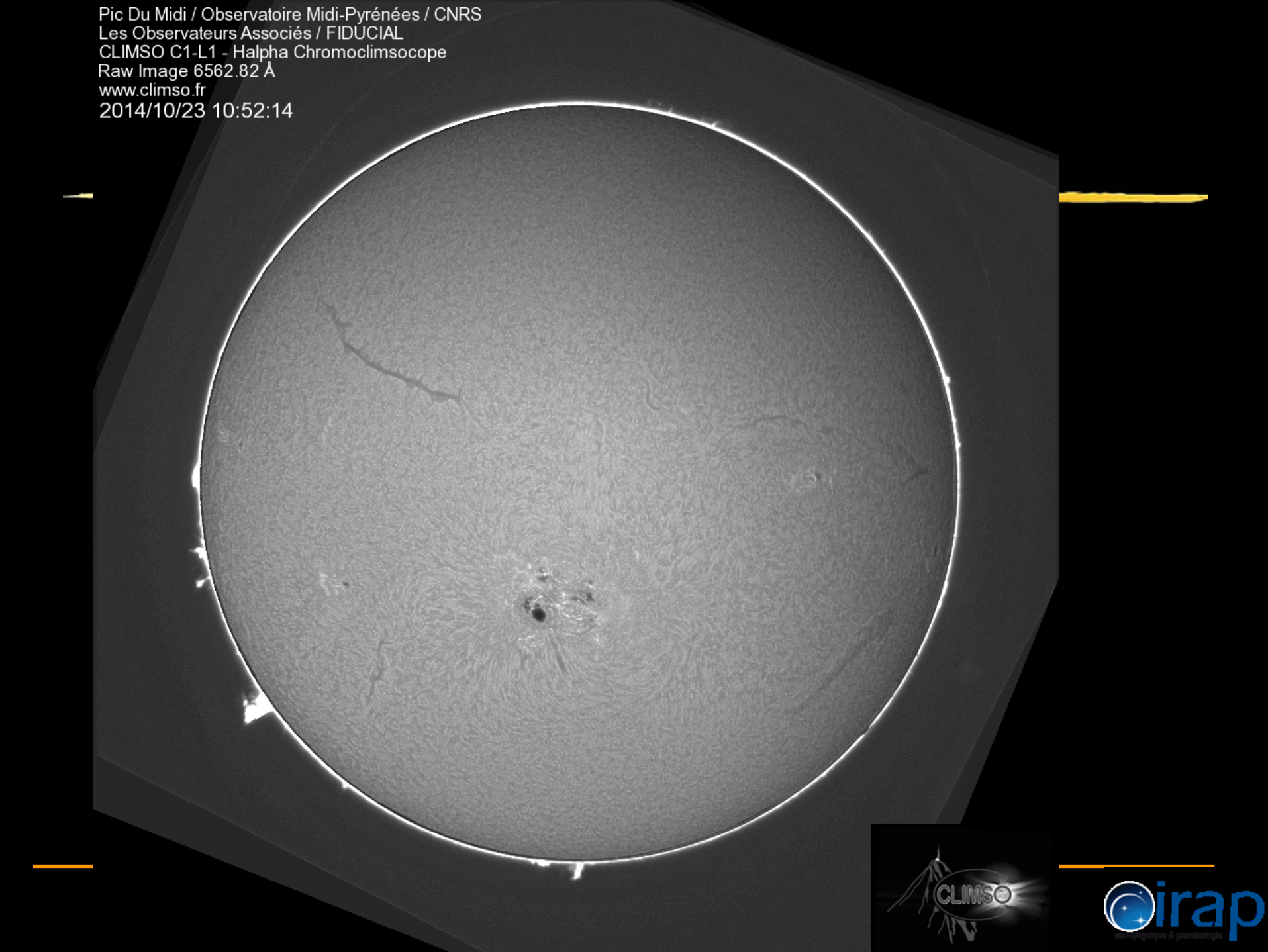
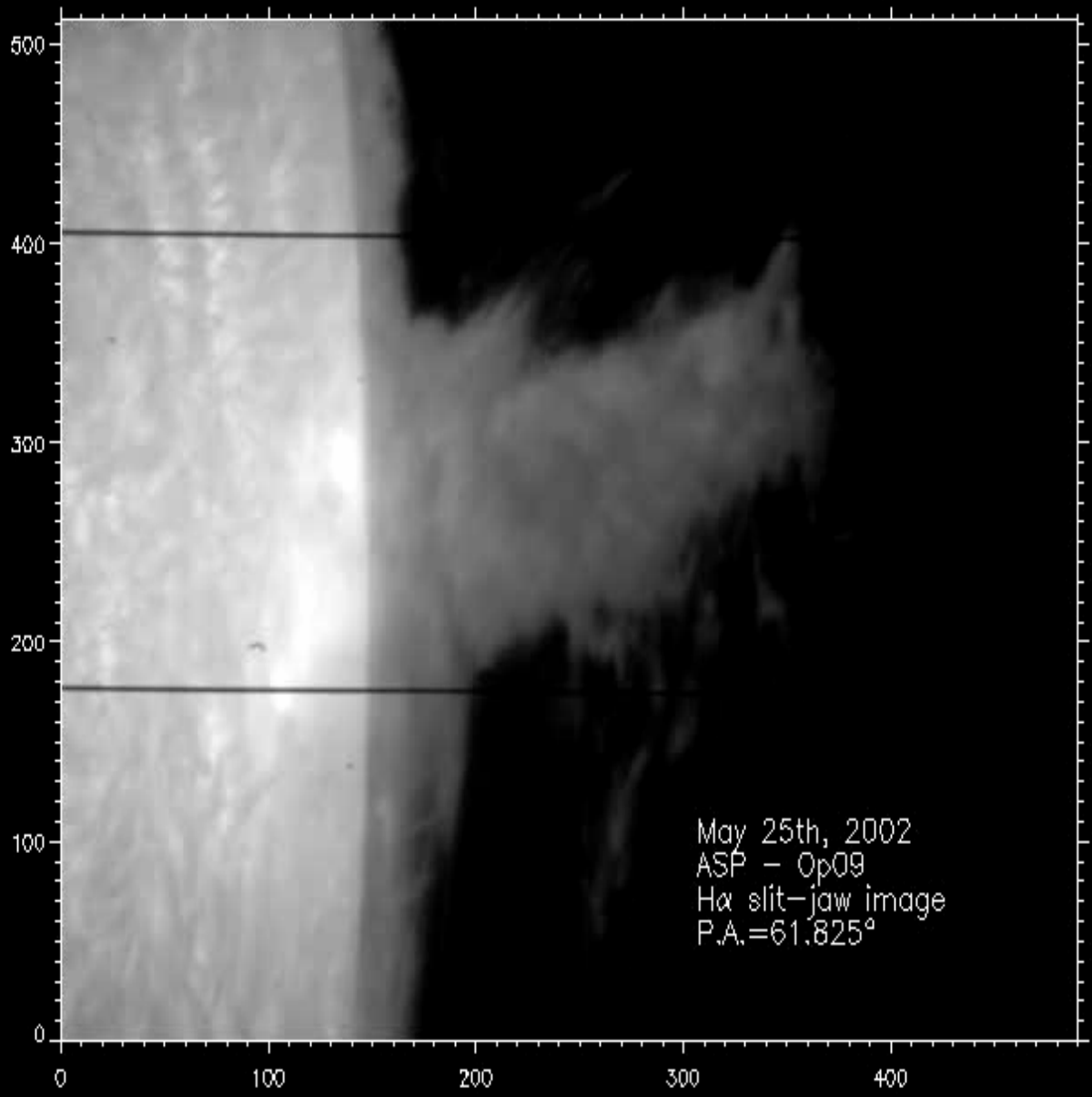
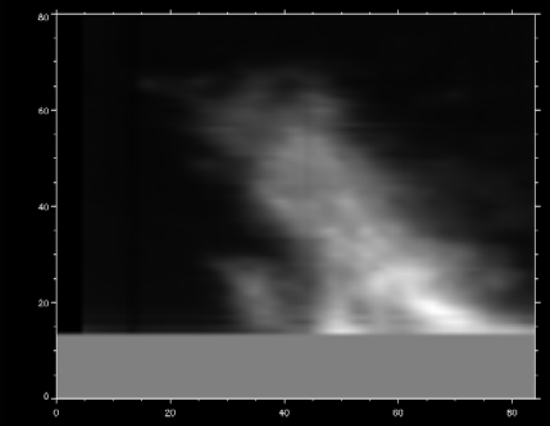
Towards measuring the magnetic field of Mercury through spectropolarimetry

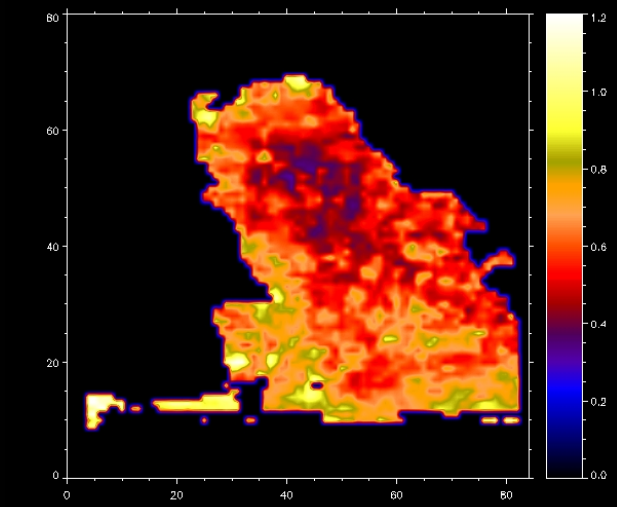
A. López Ariste

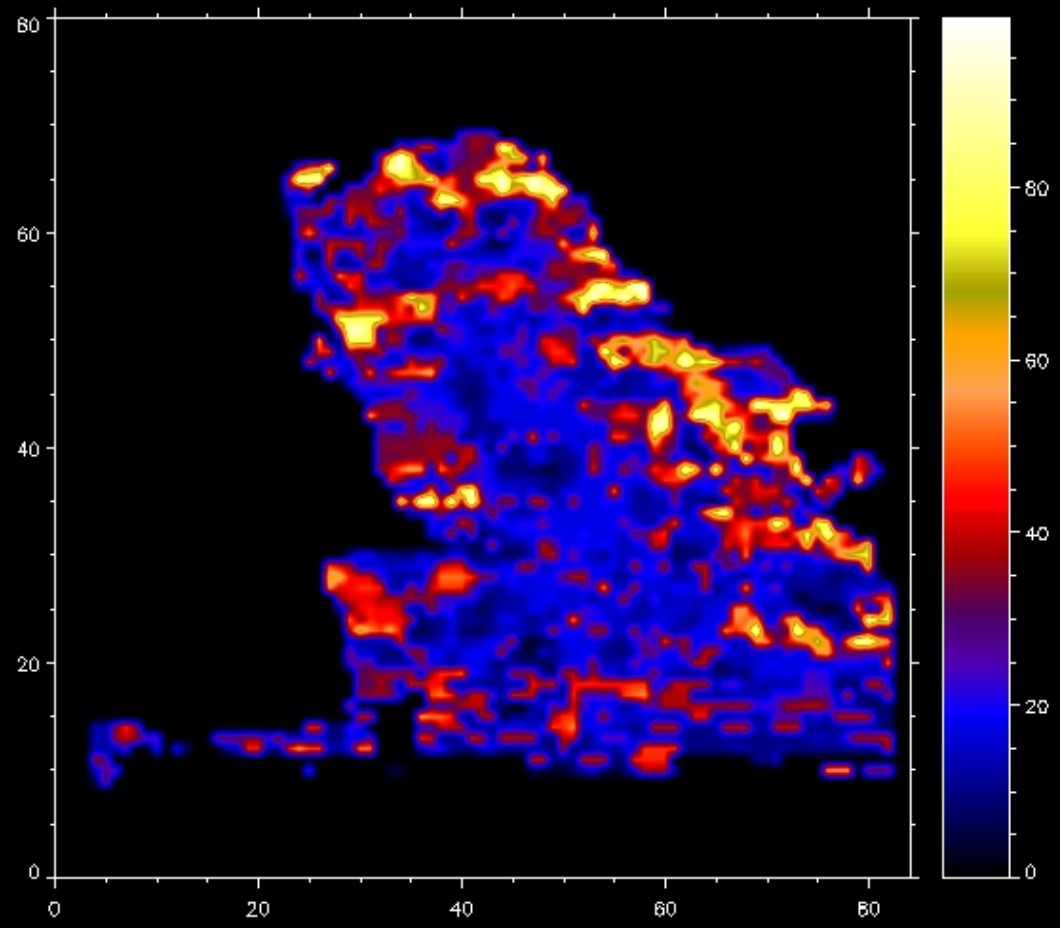

Pic Du Midi / Observatoire Midi-Pyrénées / CNRS
Les Observateurs Associés / FIDUCIAL
CLIMSO C1-L1 - Halpha Chromoclimsocope
Raw Image 6562.82 Å
www.climso.fr
2014/10/23 10:52:14
CLIMSO
irap


500
400
300
200
100
0
0
100
200
300
400
May 25th, 2002
ASP – Op09
Hα slit-jaw image
P.A.=61.825°

An example







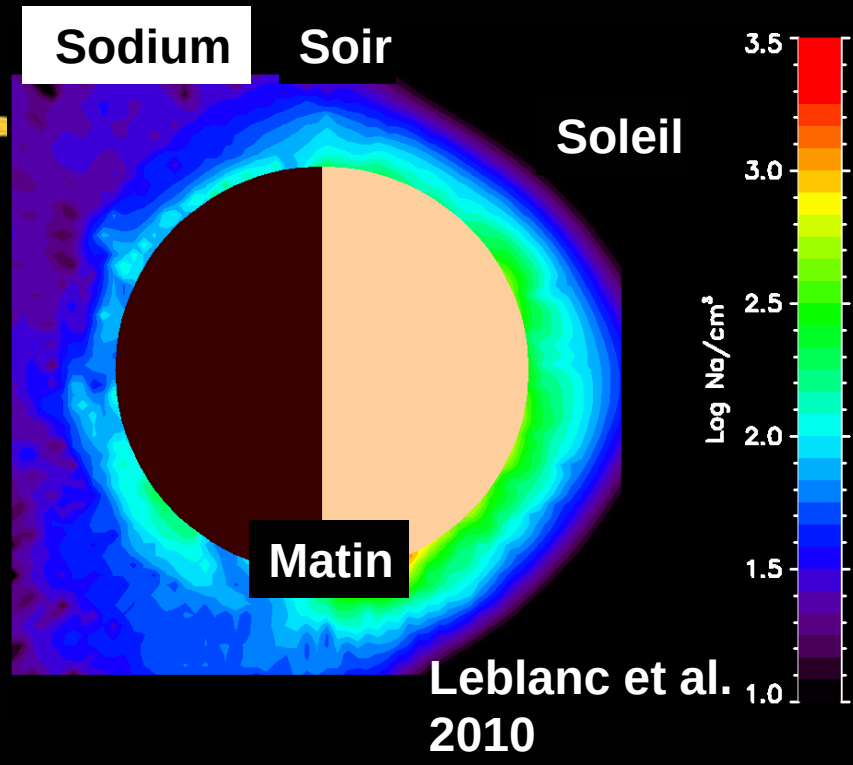
NSO/SPO DST with HAO/ASP, *by Casini, López Ariste, Tomczyk, & Lites 2002*


Prominence Eruption
1945 June 28
High Altitude Observatory

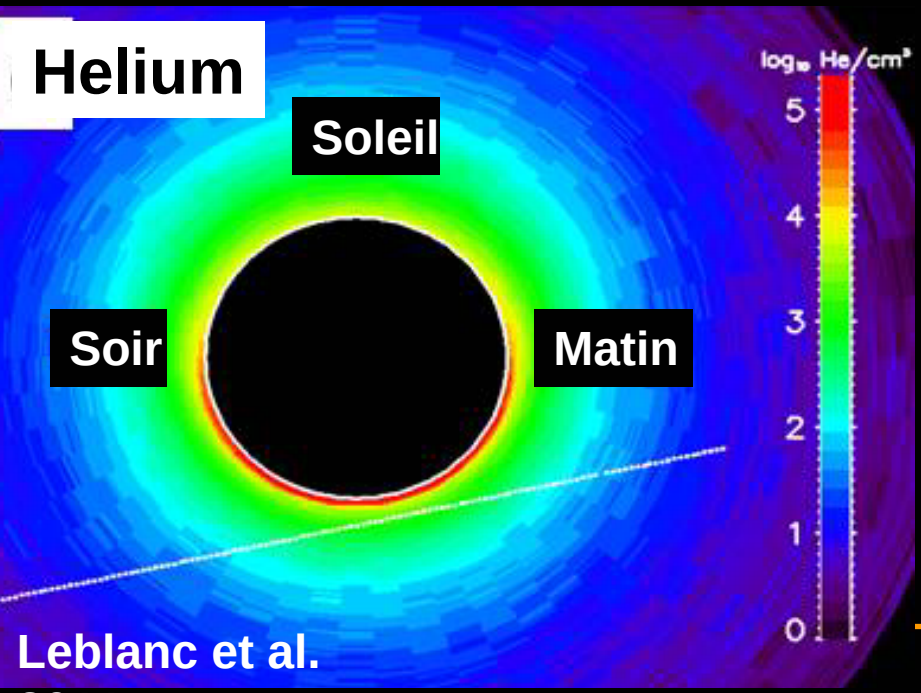

2013-09-23 16:57:41

Mercury's exosphere

Complex spatial structure different from one species to another



Leblanc et al. 2010



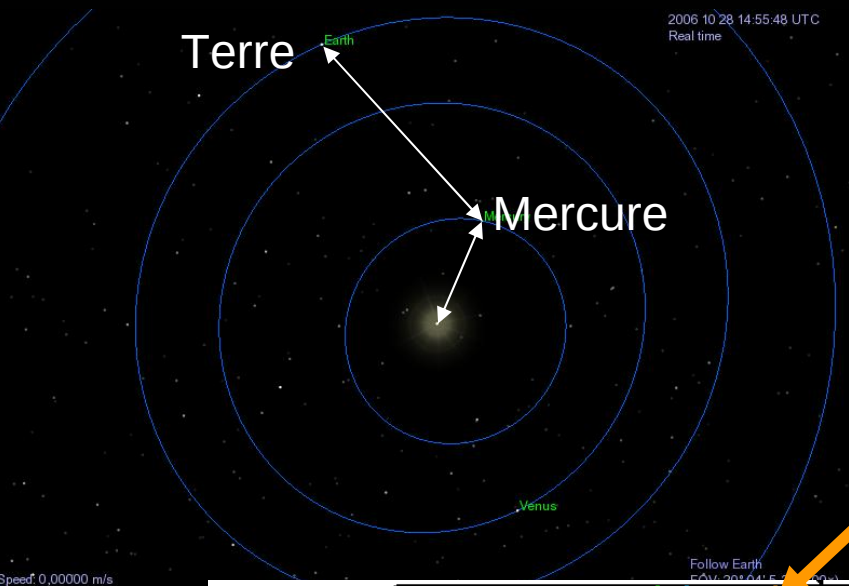
Leblanc et al. 2011

With strong temporal variations

Sodium in the exosphere

Two bright lines: D_1 and D_2

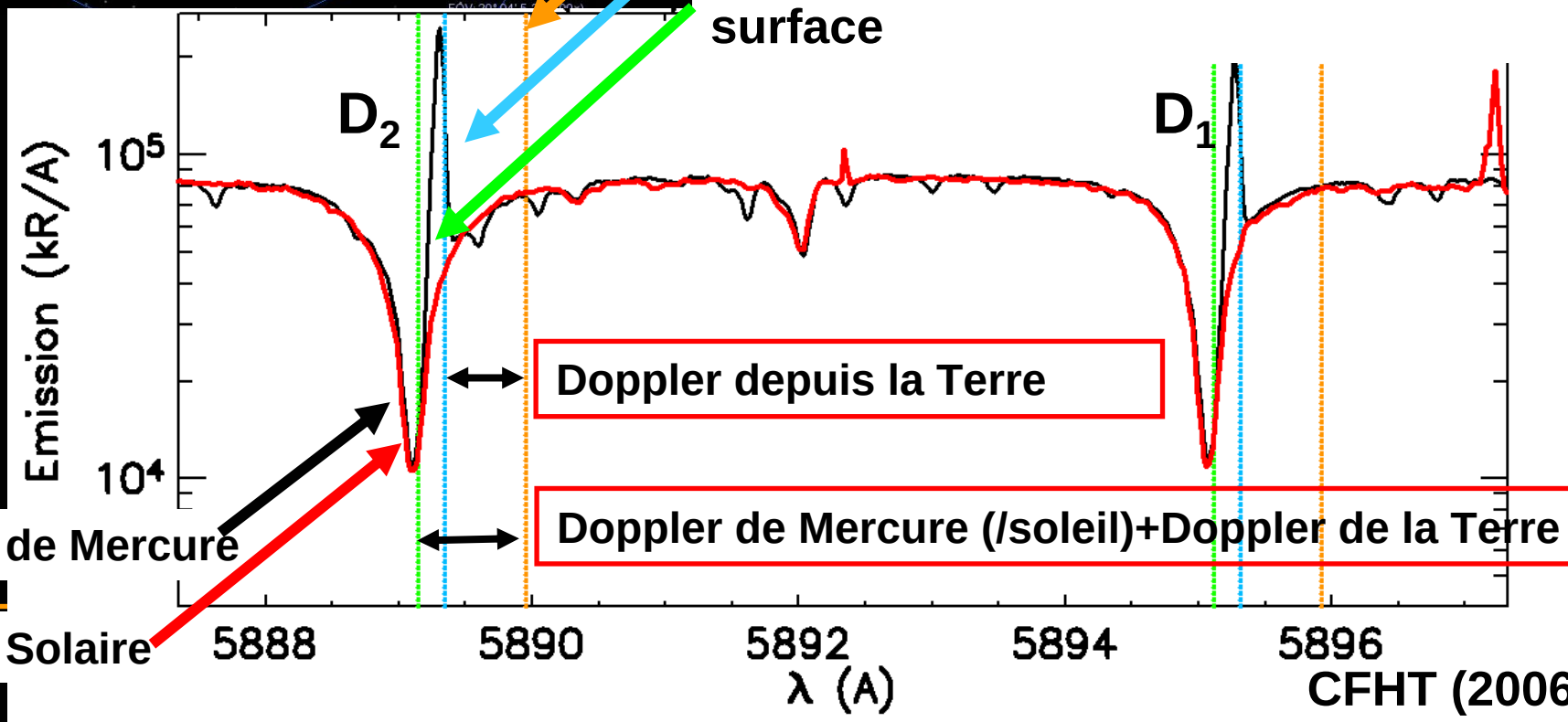
Discovered in 1985 (Potter et al.)



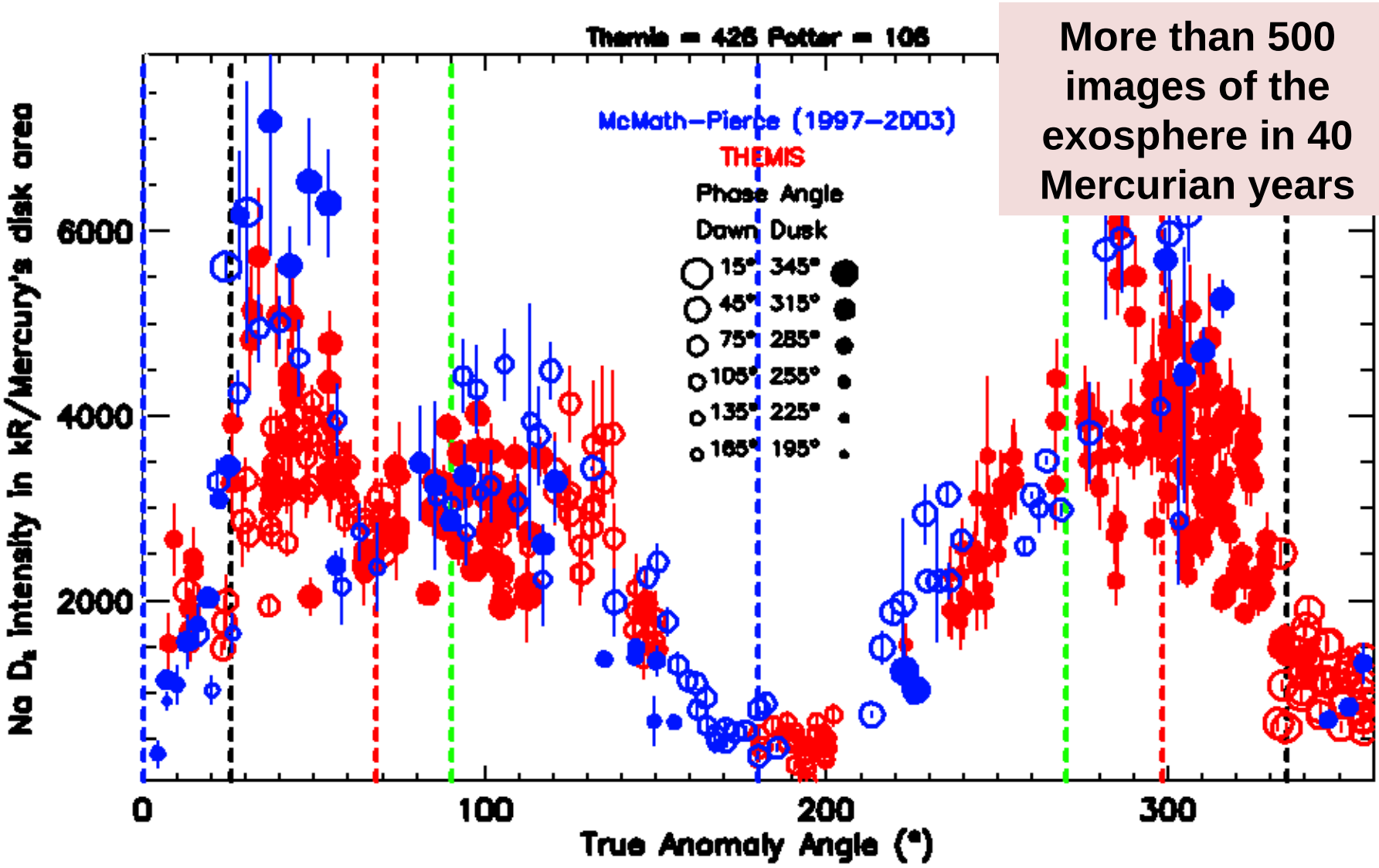
Wavelength at earth

Exospheric emission

Solar Spectra reflected at the surface



The year cycle of Mercury's exosphere

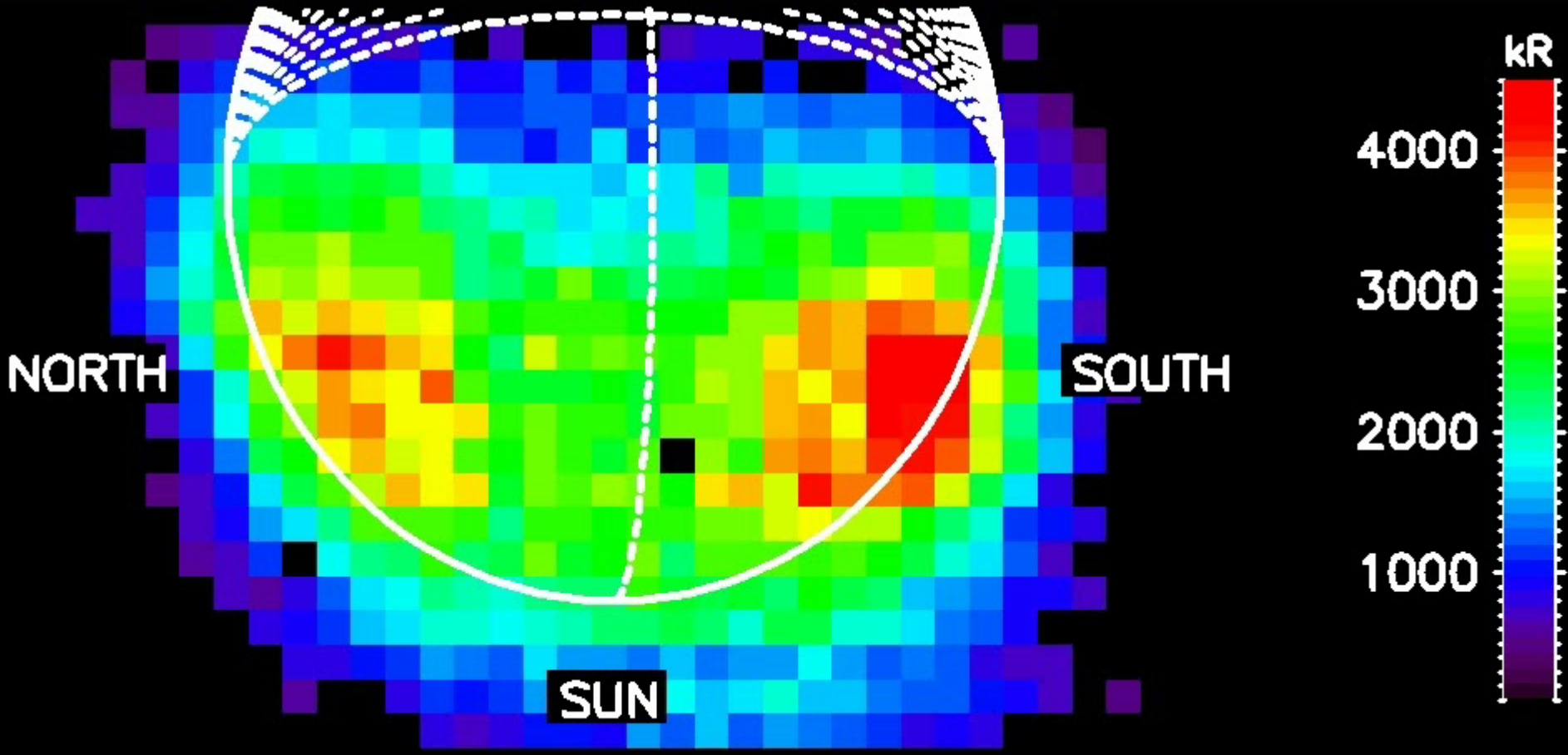


More than 500 images of the exosphere in 40 Mercurian years

Mercury's exosphere is relatively stable (factor 2)

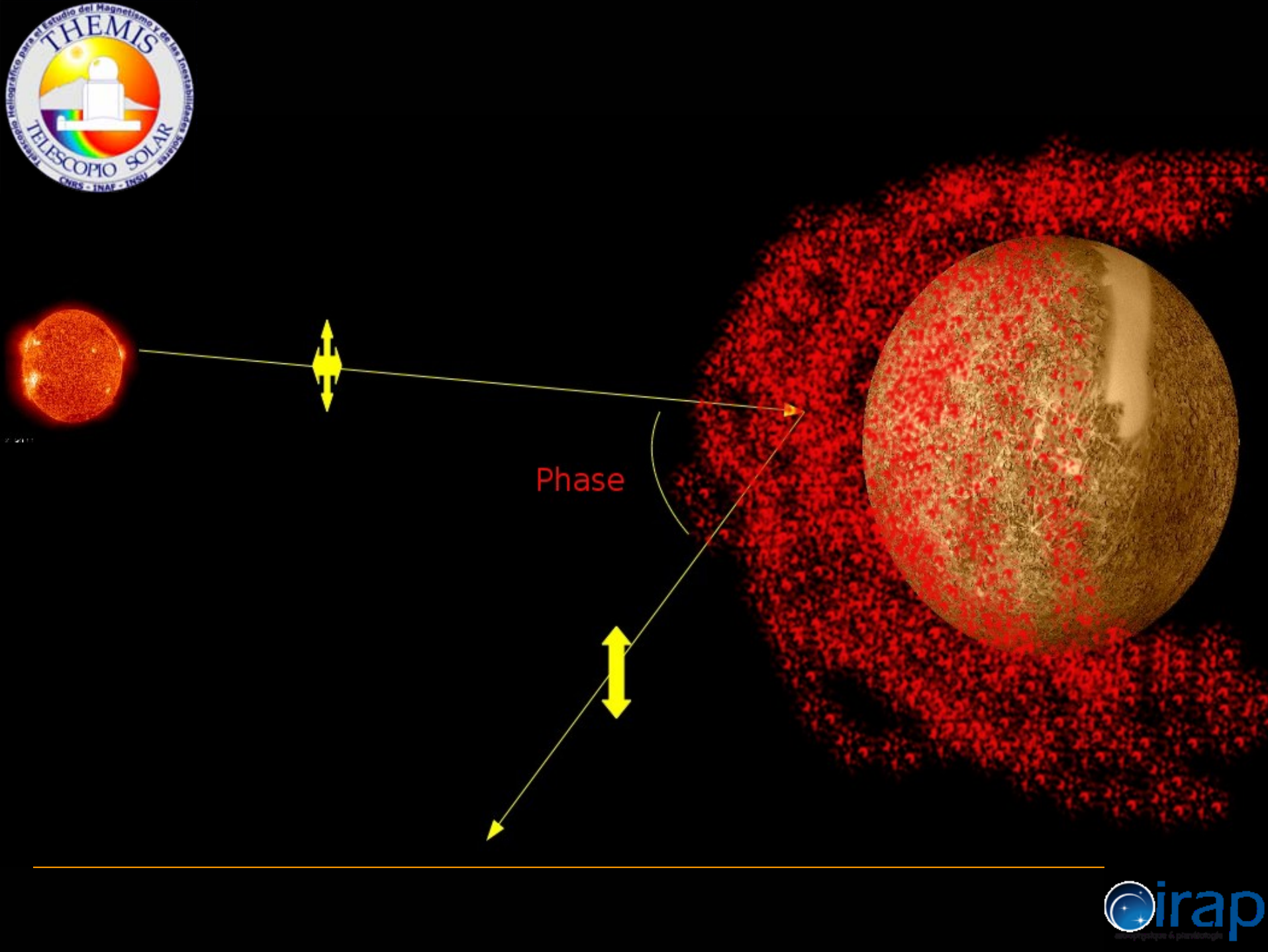
But a very dynamic one too

THEMIS
13 Juillet 2008

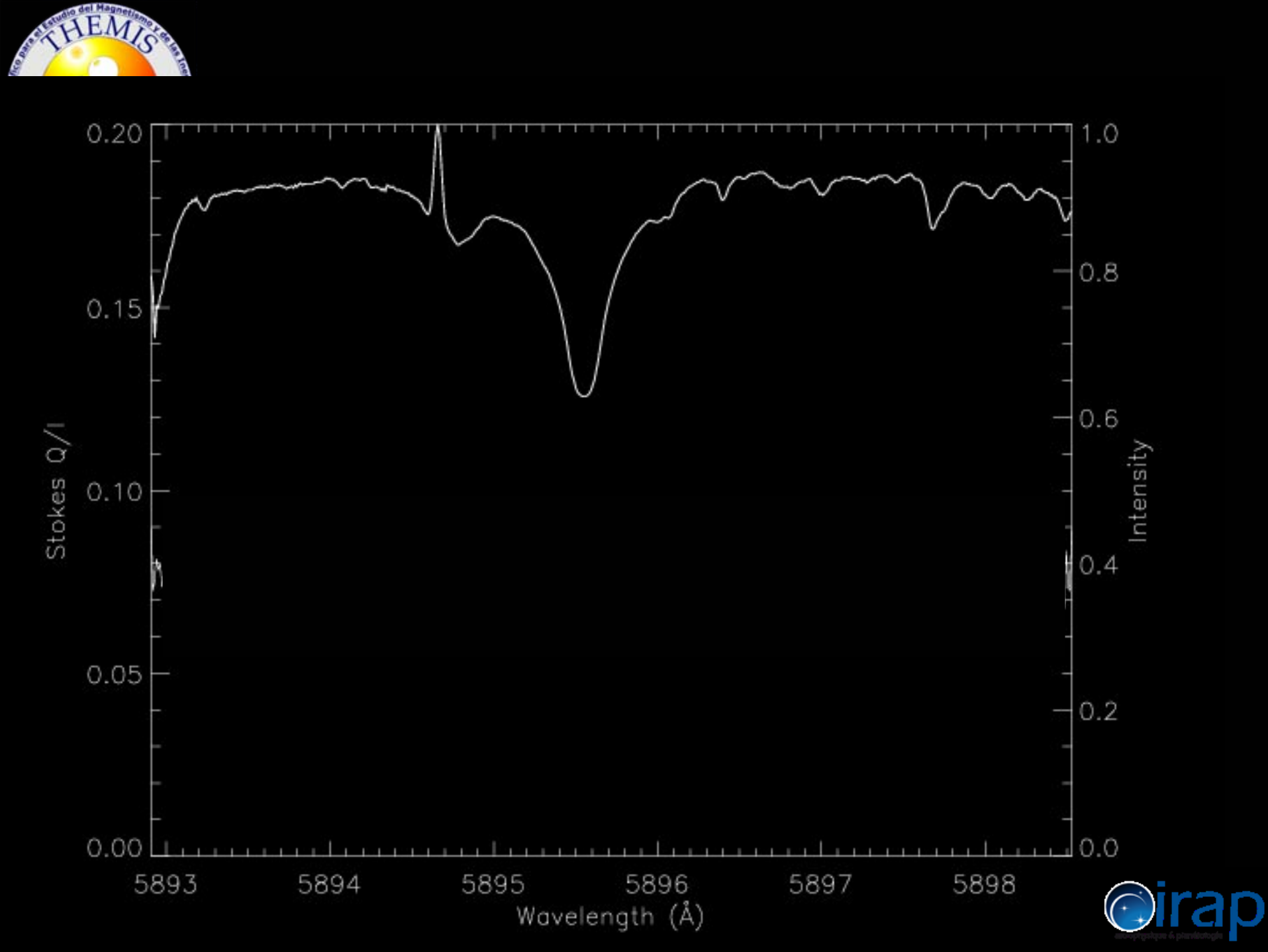


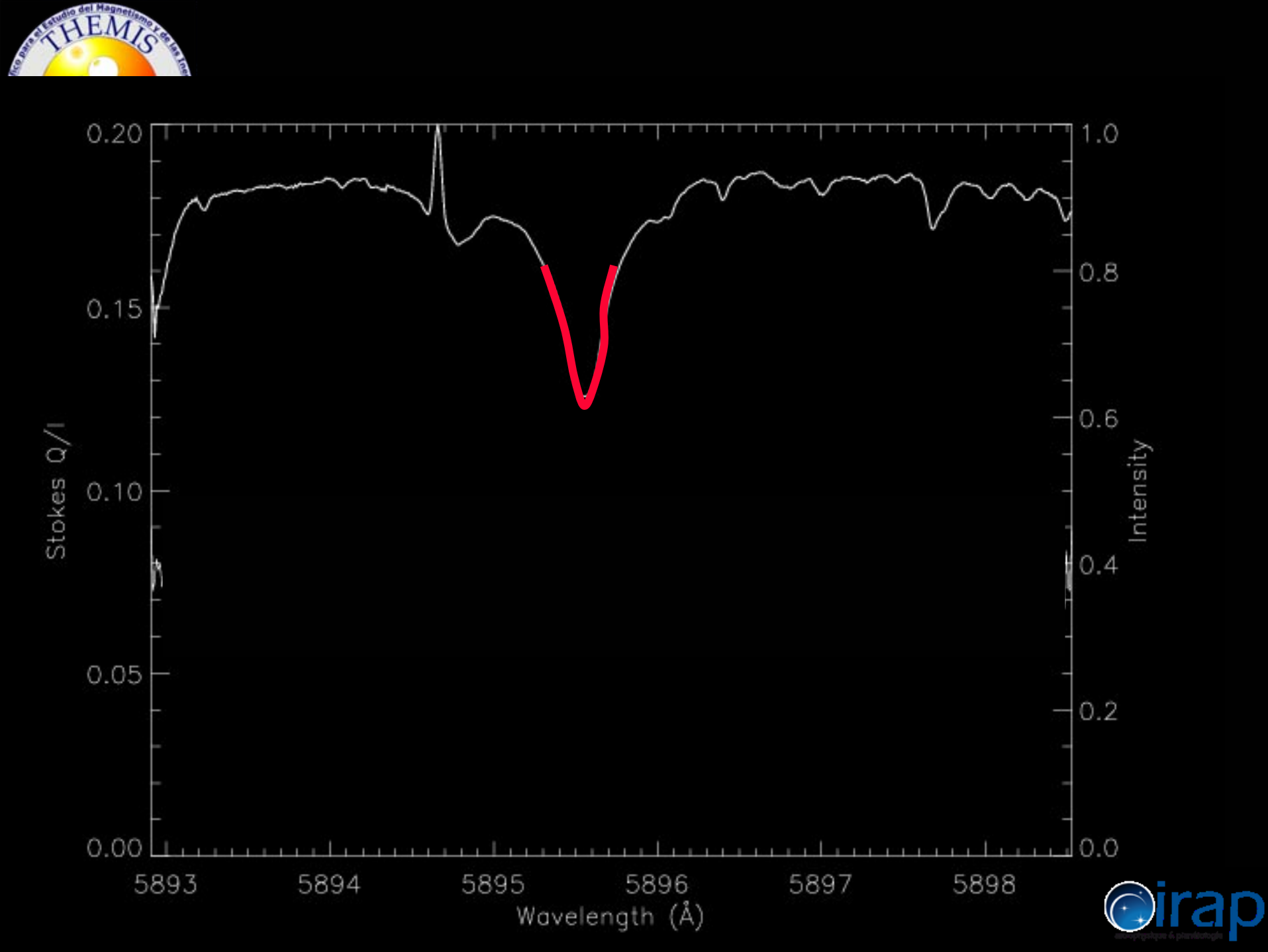
7 hours of continuous mapping.
Only solar telescopes can do this

Intensity of the Na $D_{2\,I}$ line


Phase


2013-09-23 16:57:41


0.20
0.15
0.10
0.05
0.00
Stokes Q/I
1.0
0.8
0.6
0.4
0.2
0.0
Intensity
5893
5894
5895
5896
5897
5898
Wavelength (Å)


0.20
0.15
0.10
0.05
0.00
Stokes Q/I
1.0
0.8
0.6
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Intensity
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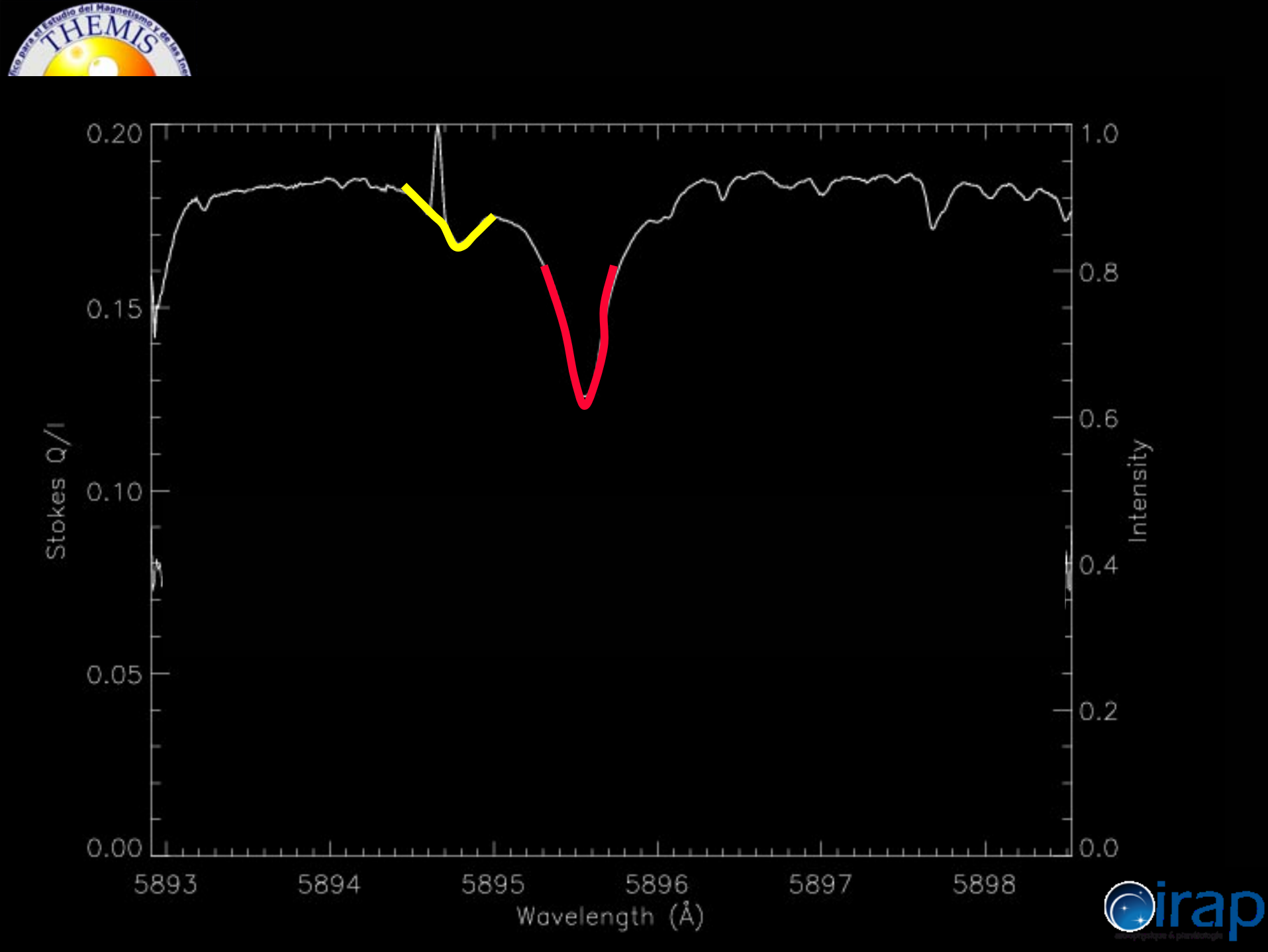
Wavelength (Å)


0.20
0.15
0.10
0.05
0.00
Stokes Q/I
1.0
0.8
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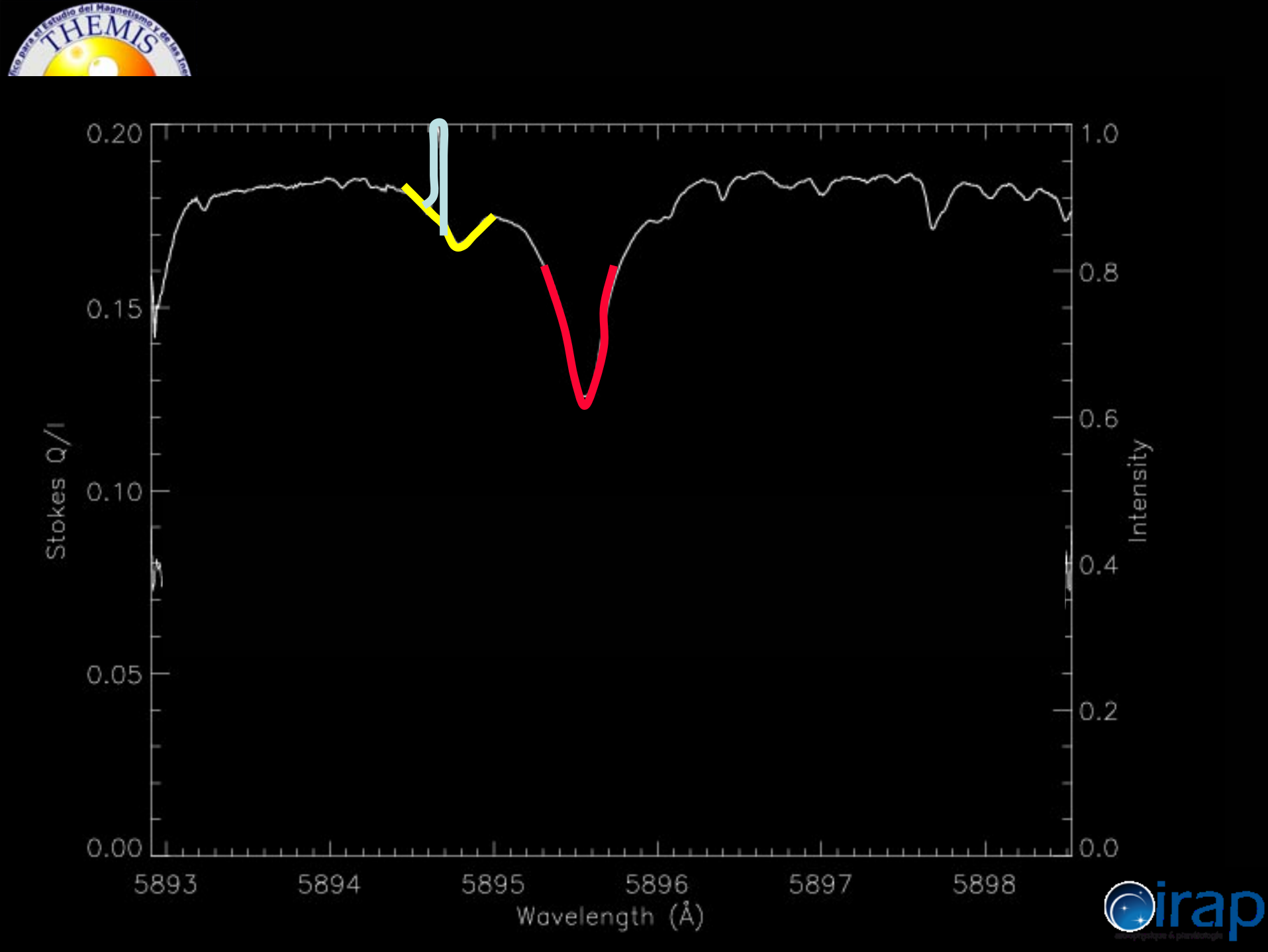
Wavelength (Å)


0.20
0.15
0.10
0.05
0.00
Stokes Q/I
1.0
0.8
0.6
0.4
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Intensity
5893
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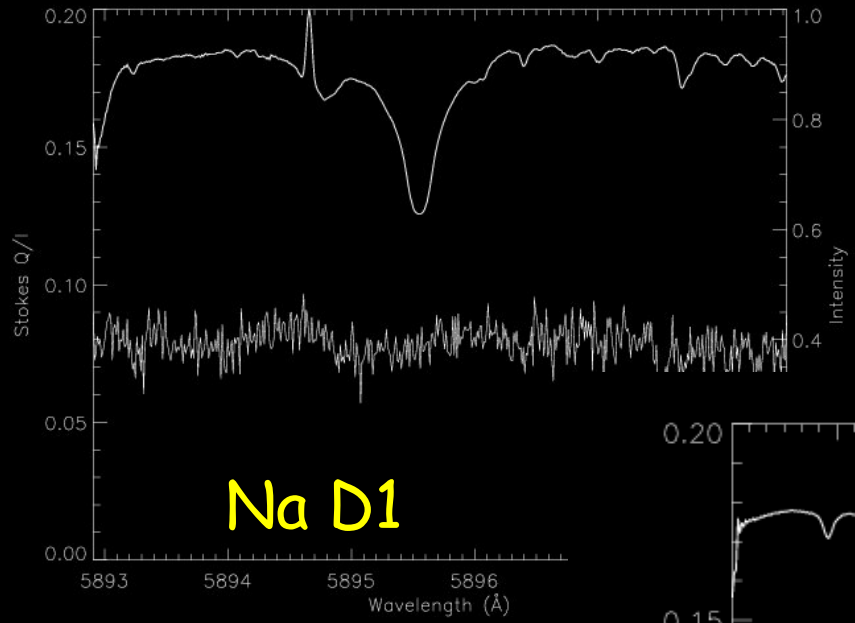
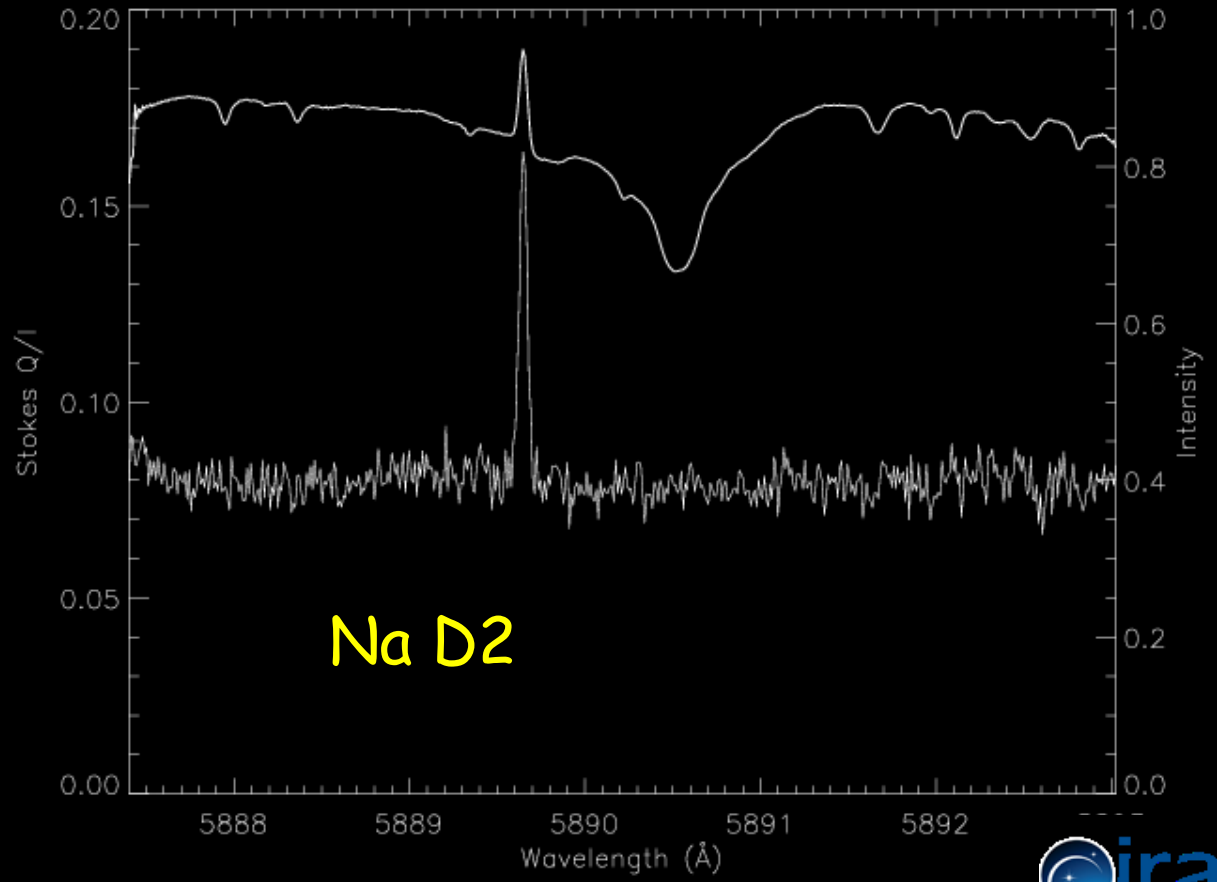
Wavelength (Å)

THEMIS POL^3 instrument
October 2010 & April 2011

López Ariste et al. (2011)

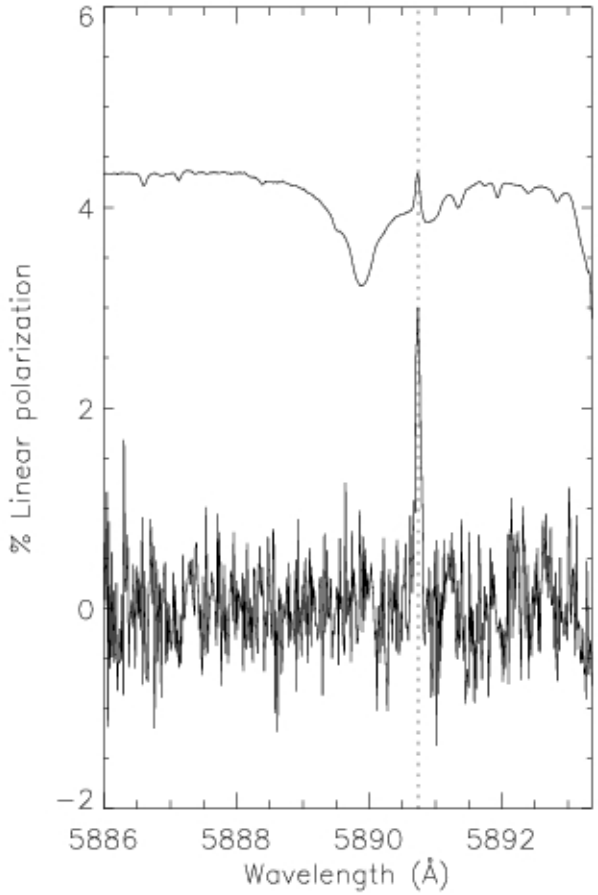


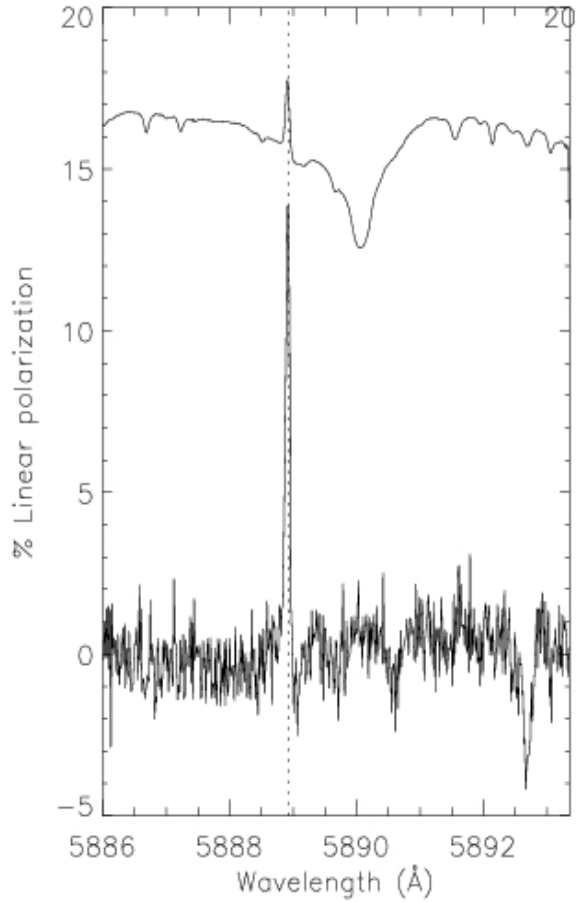
Na D1



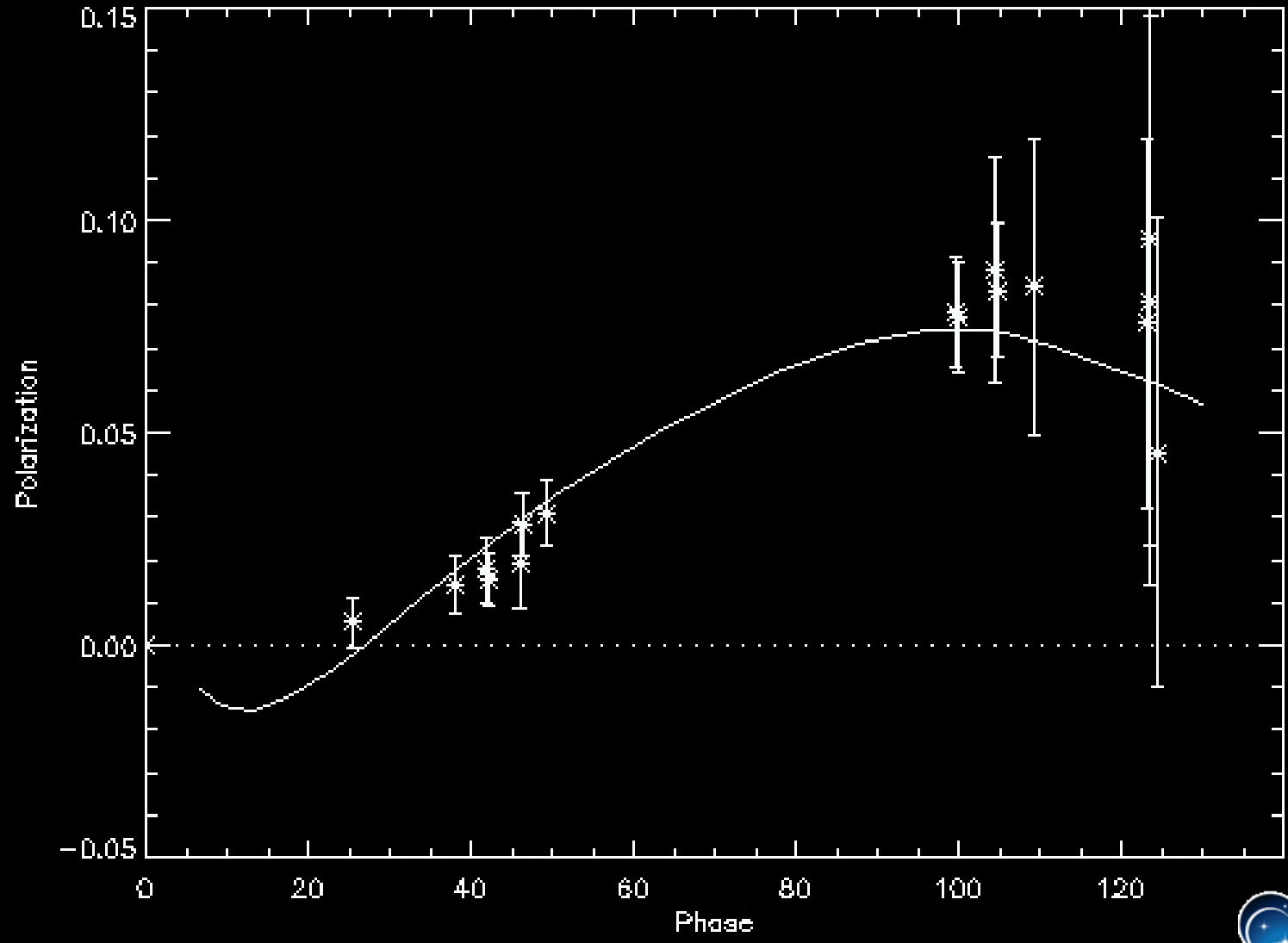
Na D2

Orbital shifts





Polarisation of the continuum



THEMIS POL^3 instrument
October 2010 & April 2011

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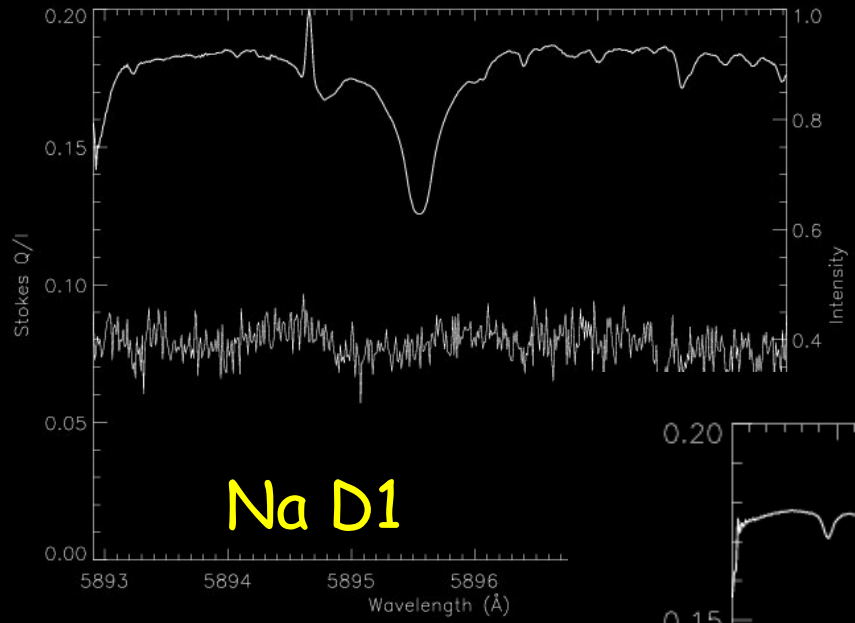
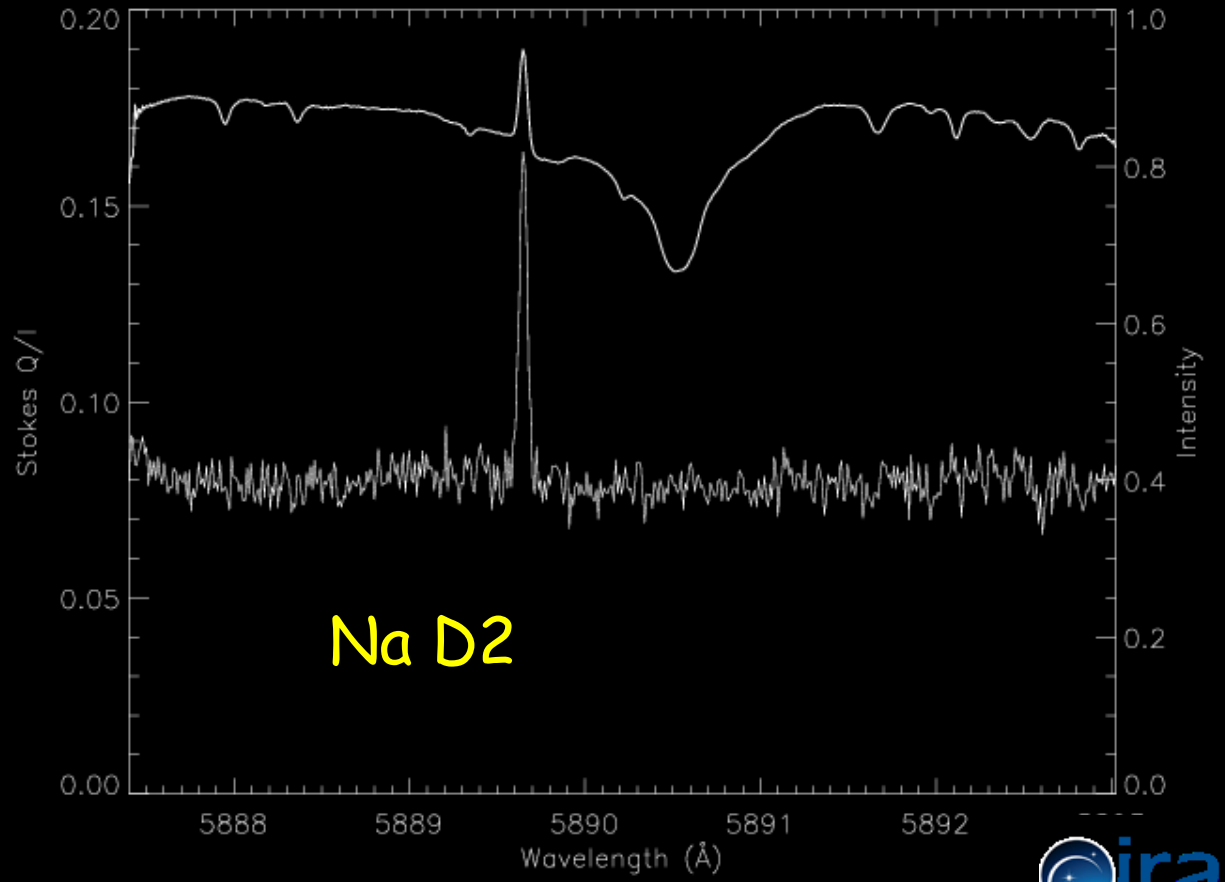
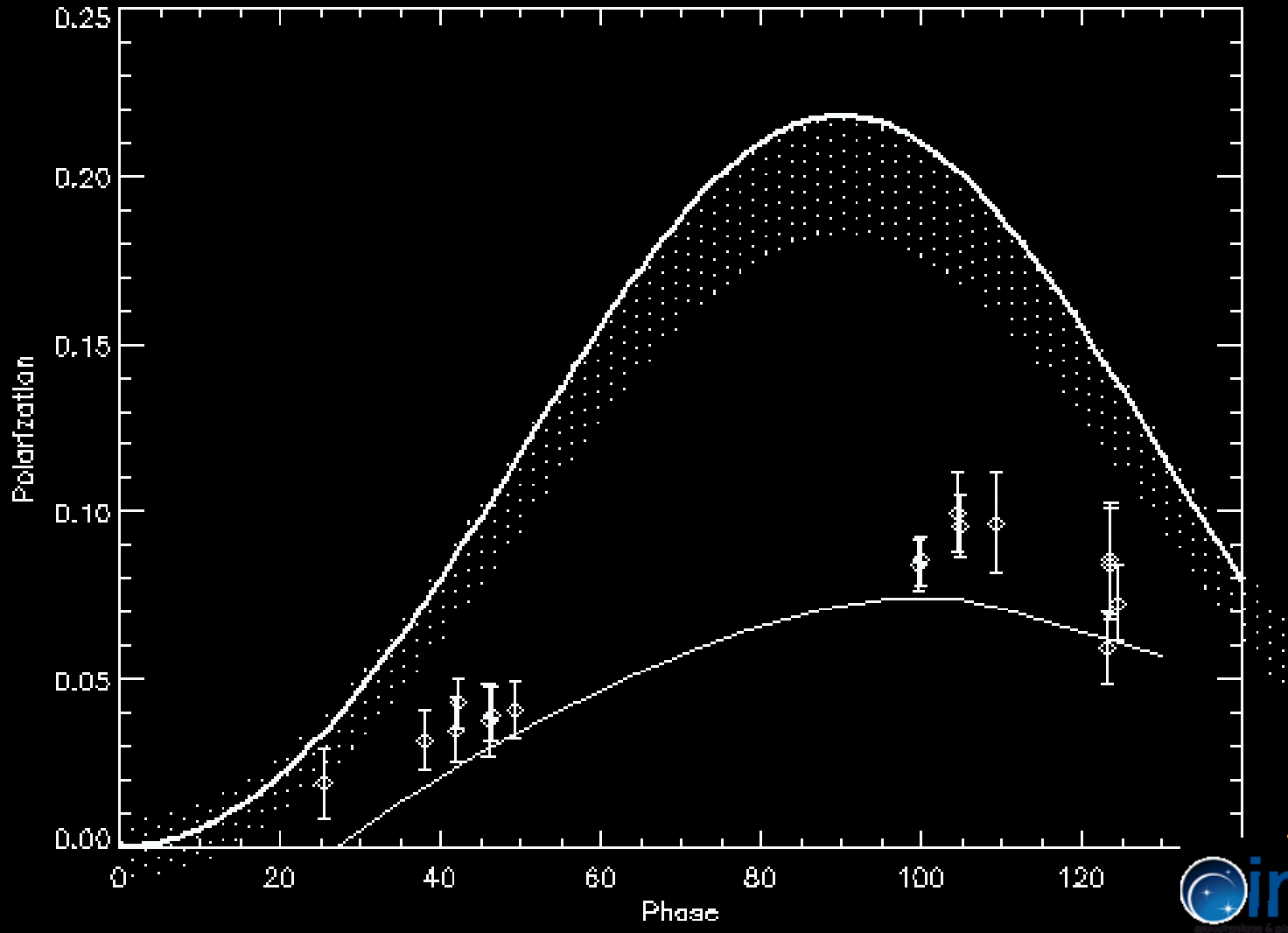
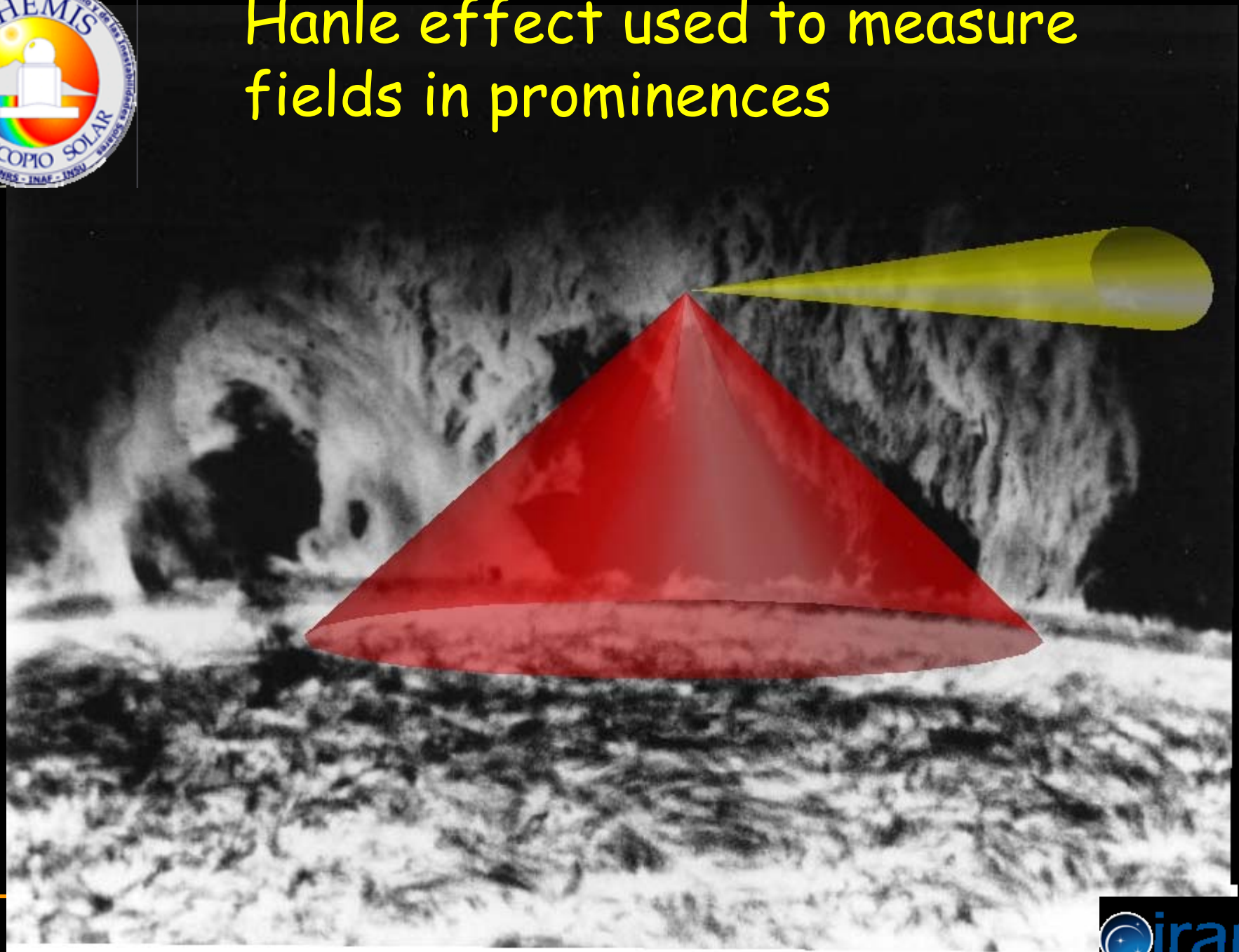


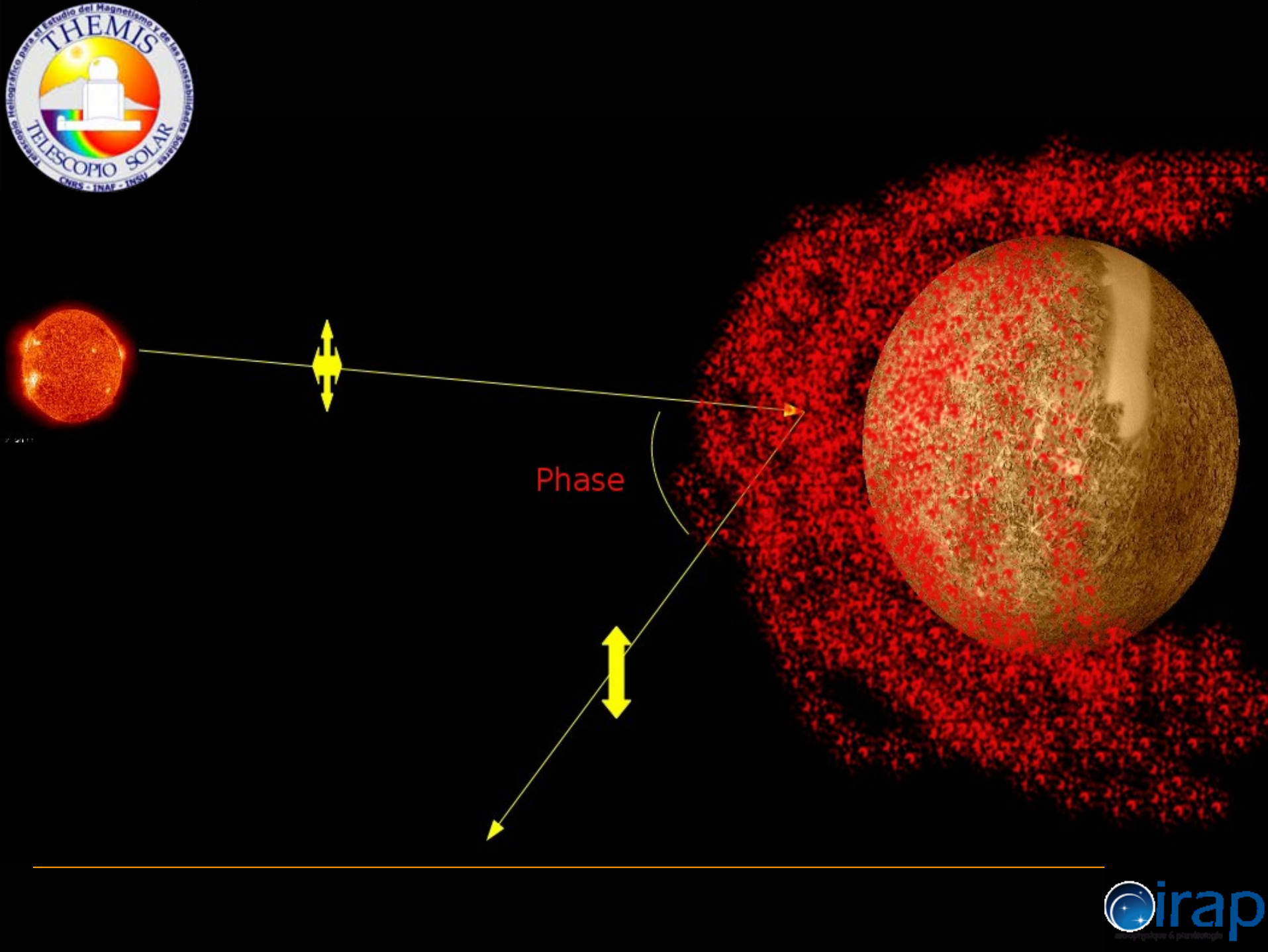


Polarisation of Na D_2



Hanle effect used to measure fields in prominences




Phase

Hearing atomic polarization

Two levels- Incoherent

ZEEMAN EFFECT

Two levels – Coherent

HANLE EFFECT

Hearing atomic polarization

Two levels- Incoherent

ZEEMAN EFFECT

Two levels – Coherent

HANLE EFFECT

Hearing atomic polarization

Two levels- Incoherent

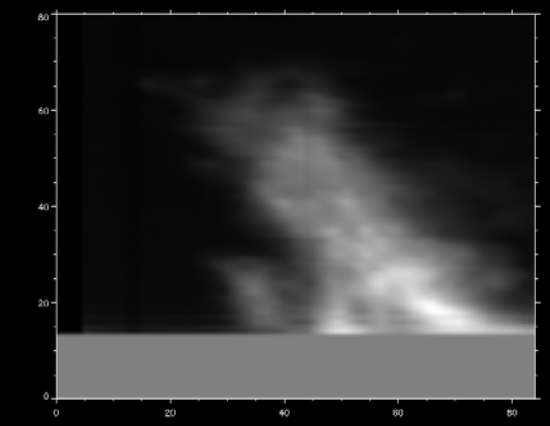
ZEEMAN EFFECT

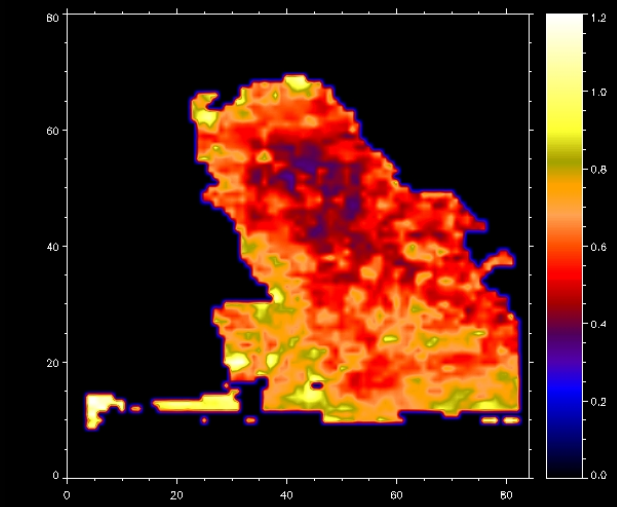
Two levels – Coherent

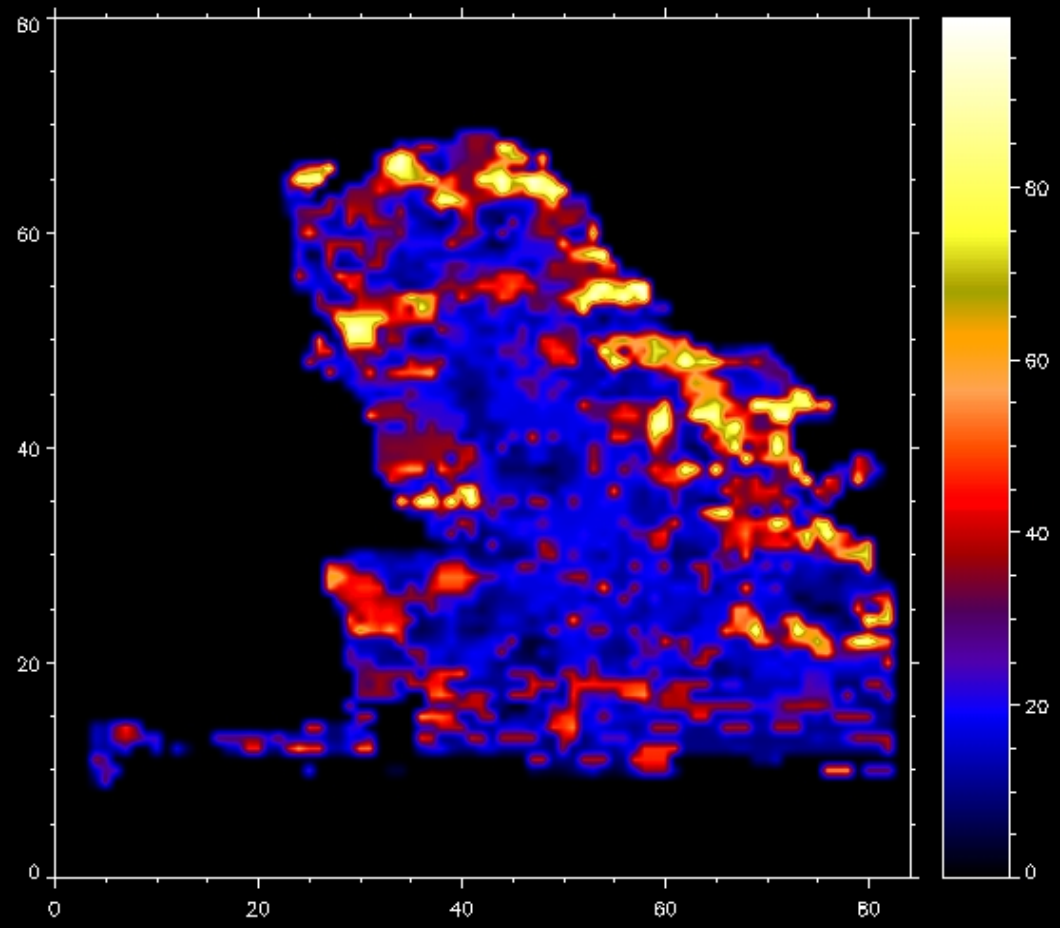
HANLE EFFECT

Hanle effect in a heavy metal atom

An example

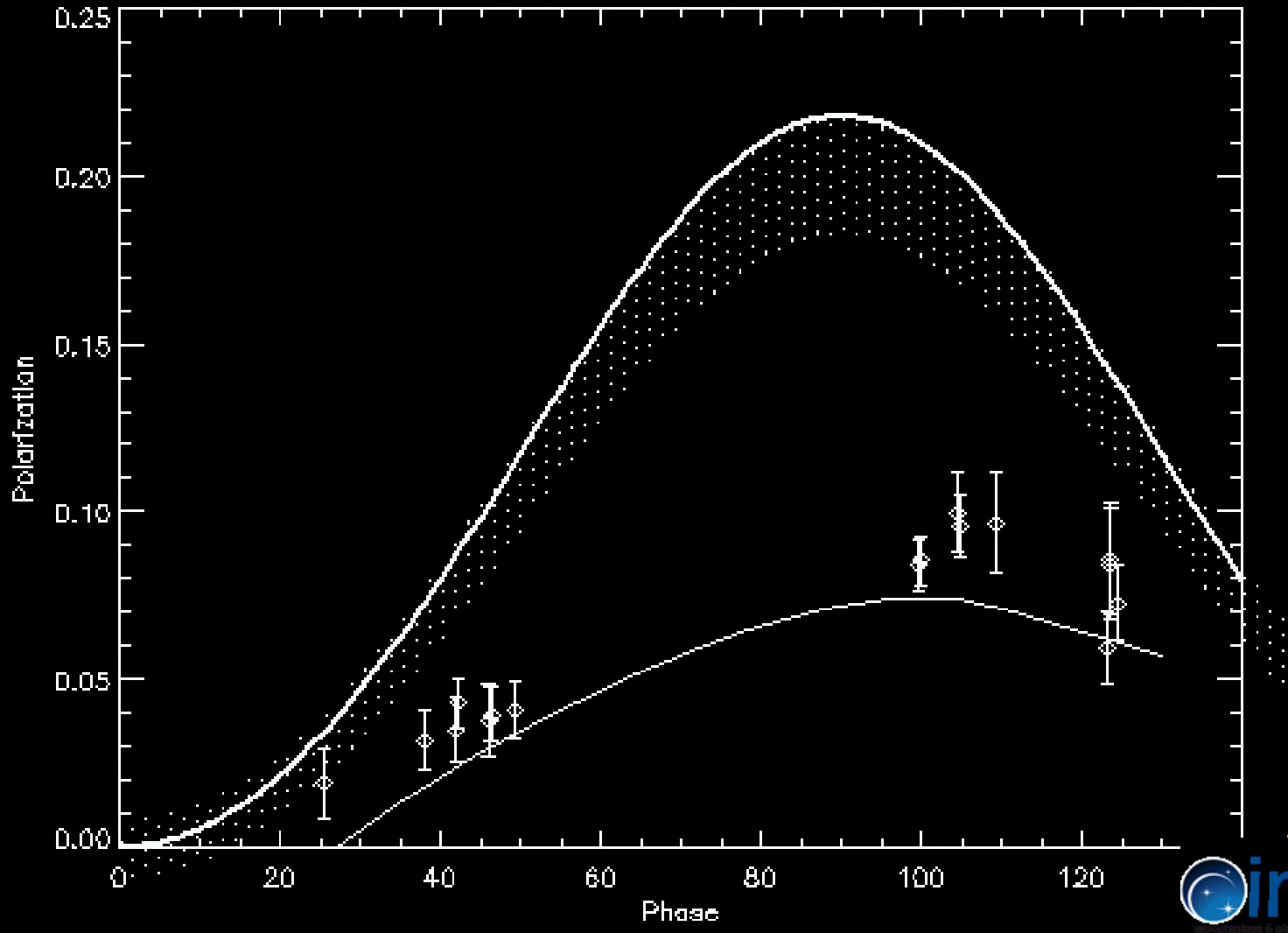


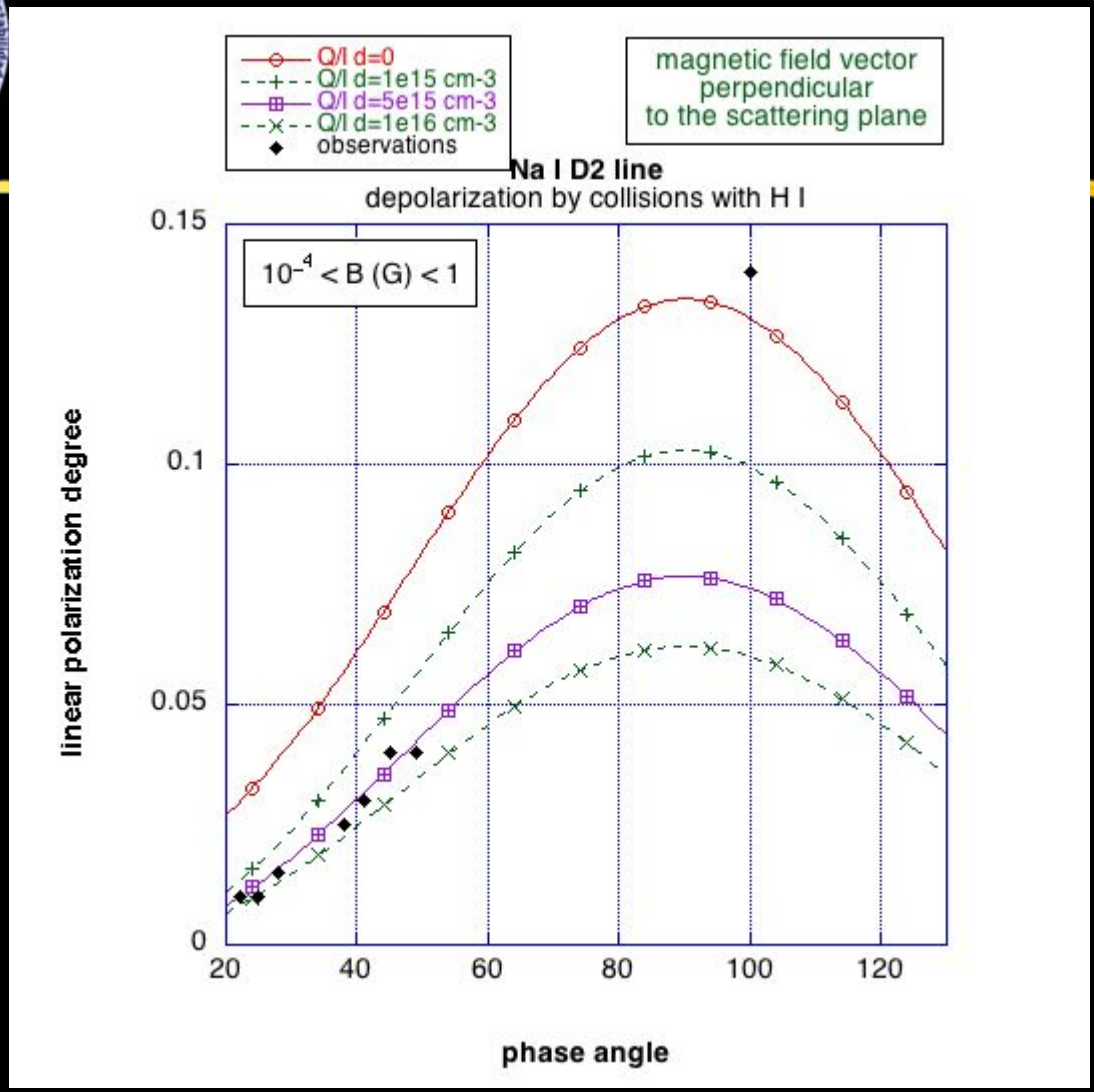




NSO/SPO DST with HAO/ASP, *by Casini, López Ariste, Tomczyk, & Lites 2002*

Polarisation of Na D_2





Density:

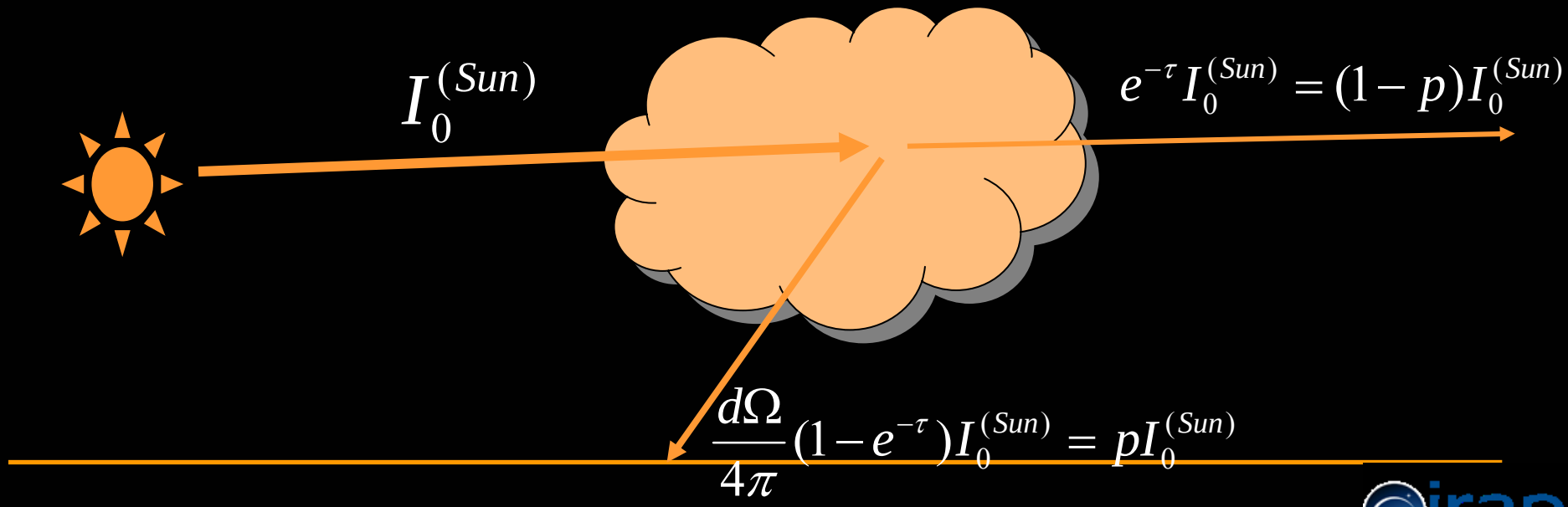
10^6 neutrals/cm^3

########!!!!!

Computations by V. Bommier (LESIA. Obs de Meudon)

Radiative transfer effects

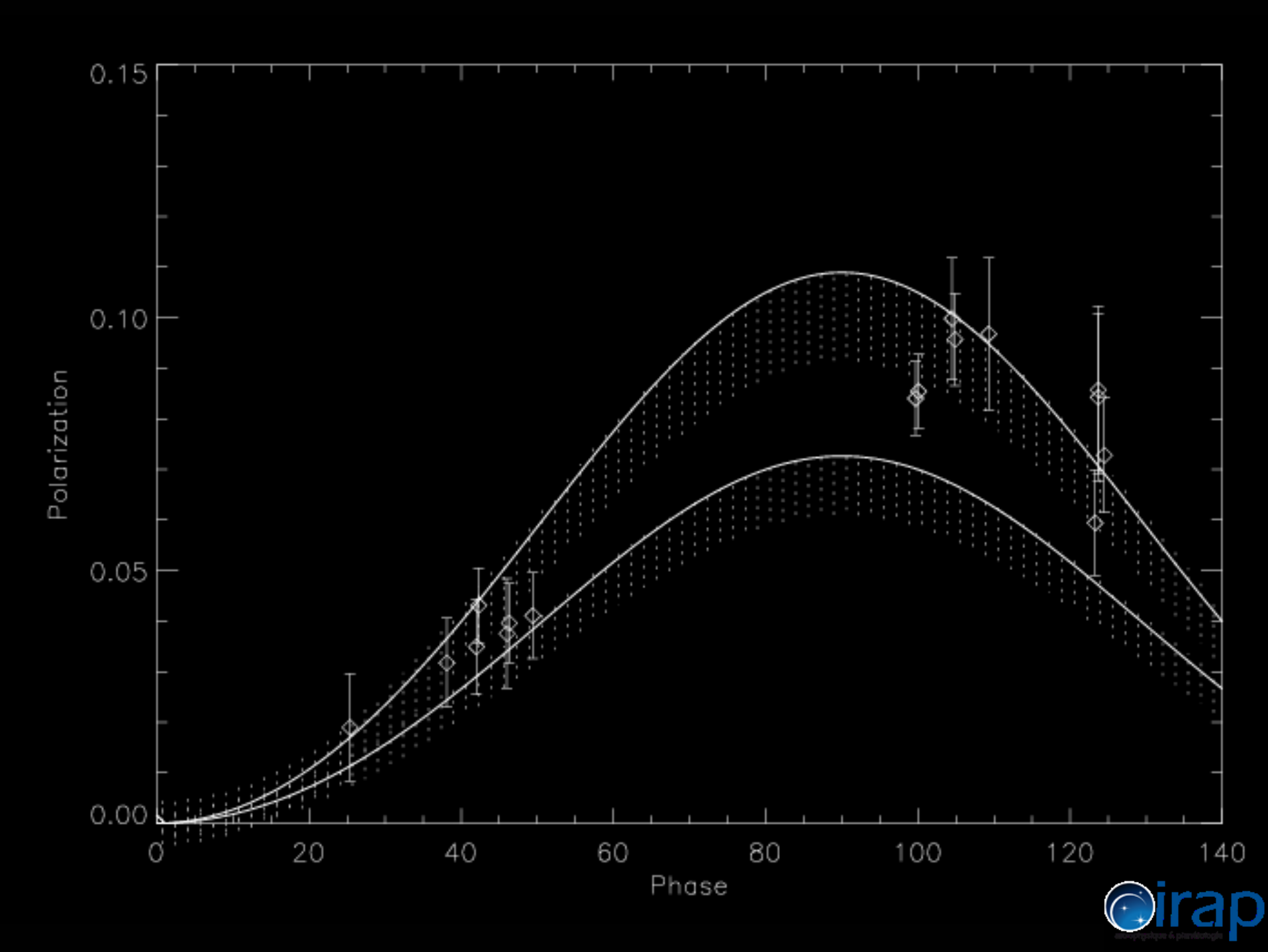
$$M\left(\frac{Q}{I}\right) = \frac{pQ}{pI + p^2 I + p^3 I + \cdots}$$



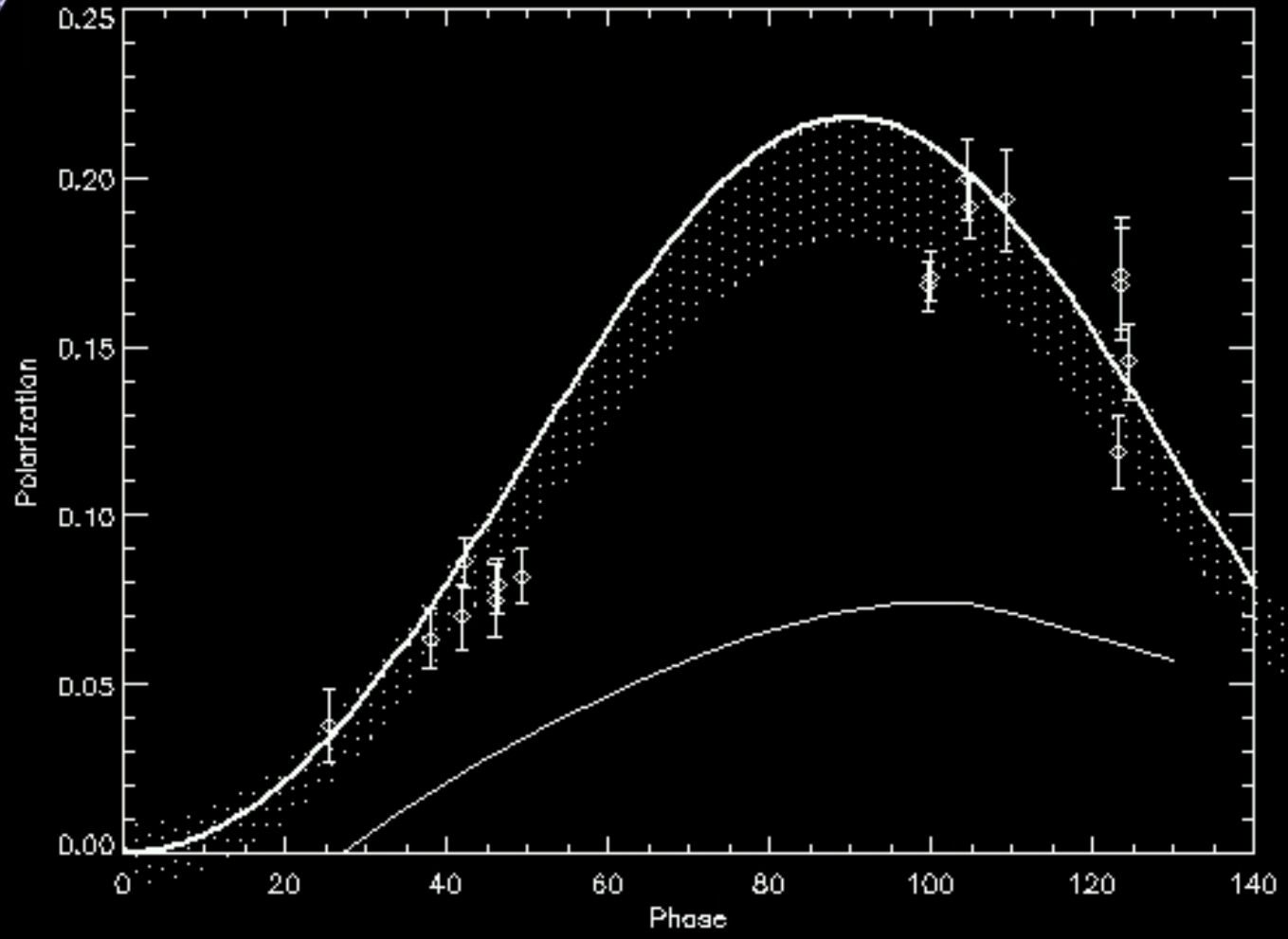
From D_2/D_1 intensity ratios and models of the exosphere of Mercury

$$\tau = 1 \rightarrow 1.5$$

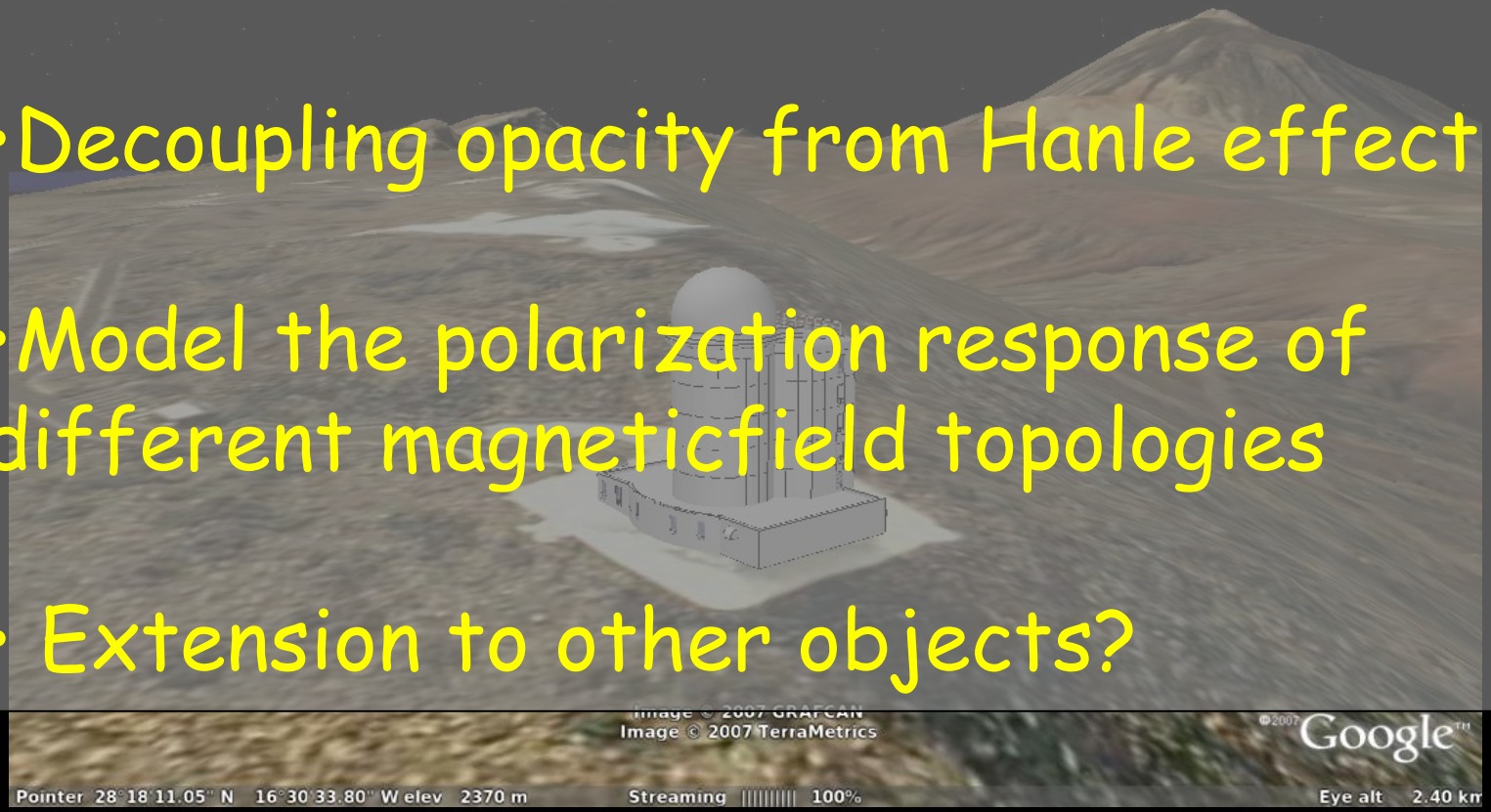
$$p = 0.6 \rightarrow 0.8$$


0.15
0.10
0.05
0.00
Polarization
0
20
40
60
80
100
120
140
Phase

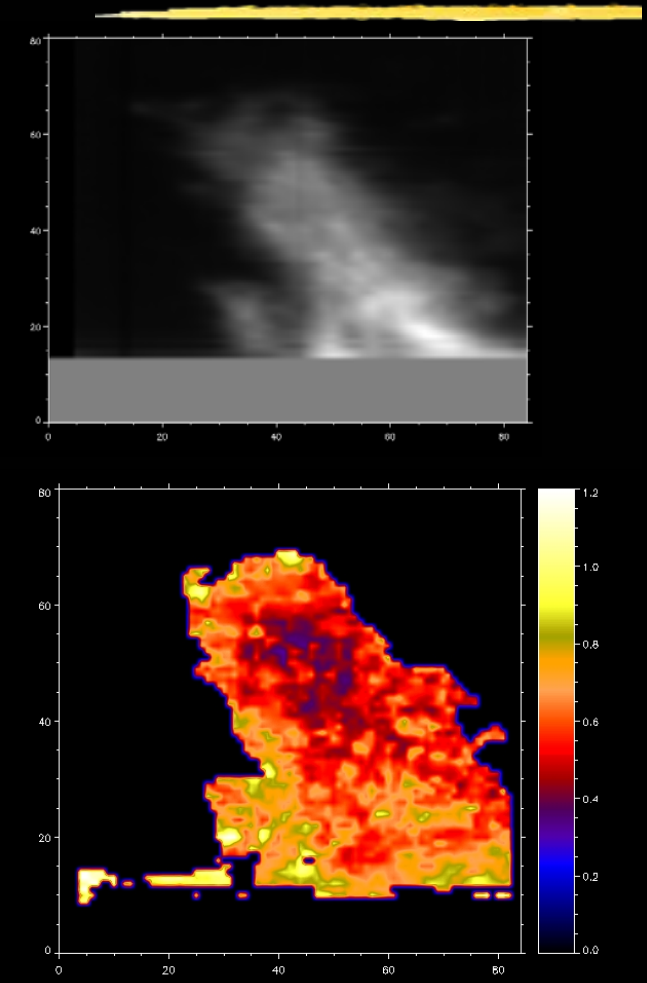
If $\tau = 1.3$


0.25
0.20
0.15
0.10
0.05
0.00
Polarization
0
20
40
60
80
100
120
140
Phase

- Bigger telescope to increase S/N
- Decoupling opacity from Hanle effect
- Model the polarization response of different magneticfield topologies
- Extension to other objects?




THEMIS


0
20
40
60
80
0.0
0.2
0.4
0.6
0.8
1.0
1.2
0
50
100
150