Spectropolarimetry of the two faces of Saturn's moon Iapetus

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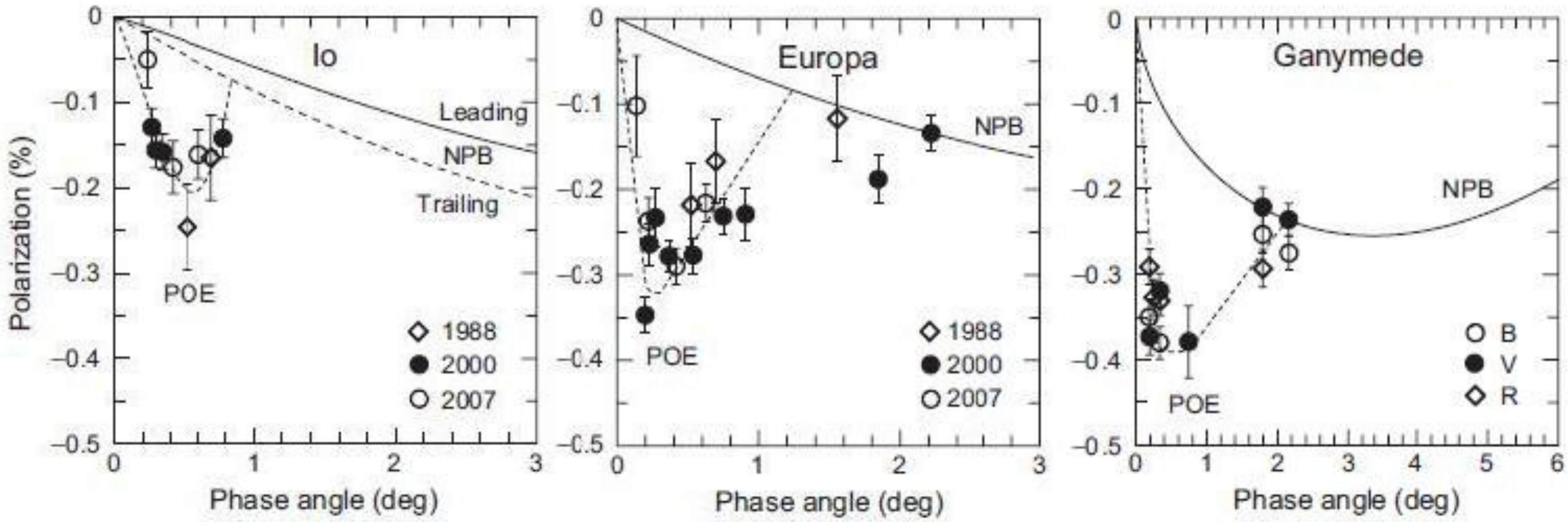
Outlines

- Polarimetry of Galilean satellites of Jupiter
- Iapetus Observing Program
- Method of performing linear spectropolarimetry
- Conclusions and Outlook

Polarimetry of Galilean Satellites



Mishchenko et al, 2010, in Polarimetric remote sensing of SSOs (book)

Io:

==> has a surface of partly absorbing crystals believed to be resulted from evaporates released from mantle.

==> Pure water frost is not likely to be present.

Europa:

==> has a water frost dominated surface.

Ganymede:

==> has an alternating frosted areas, mostly composed of water, with interstitial dark terrain most probably of a rocky nature.

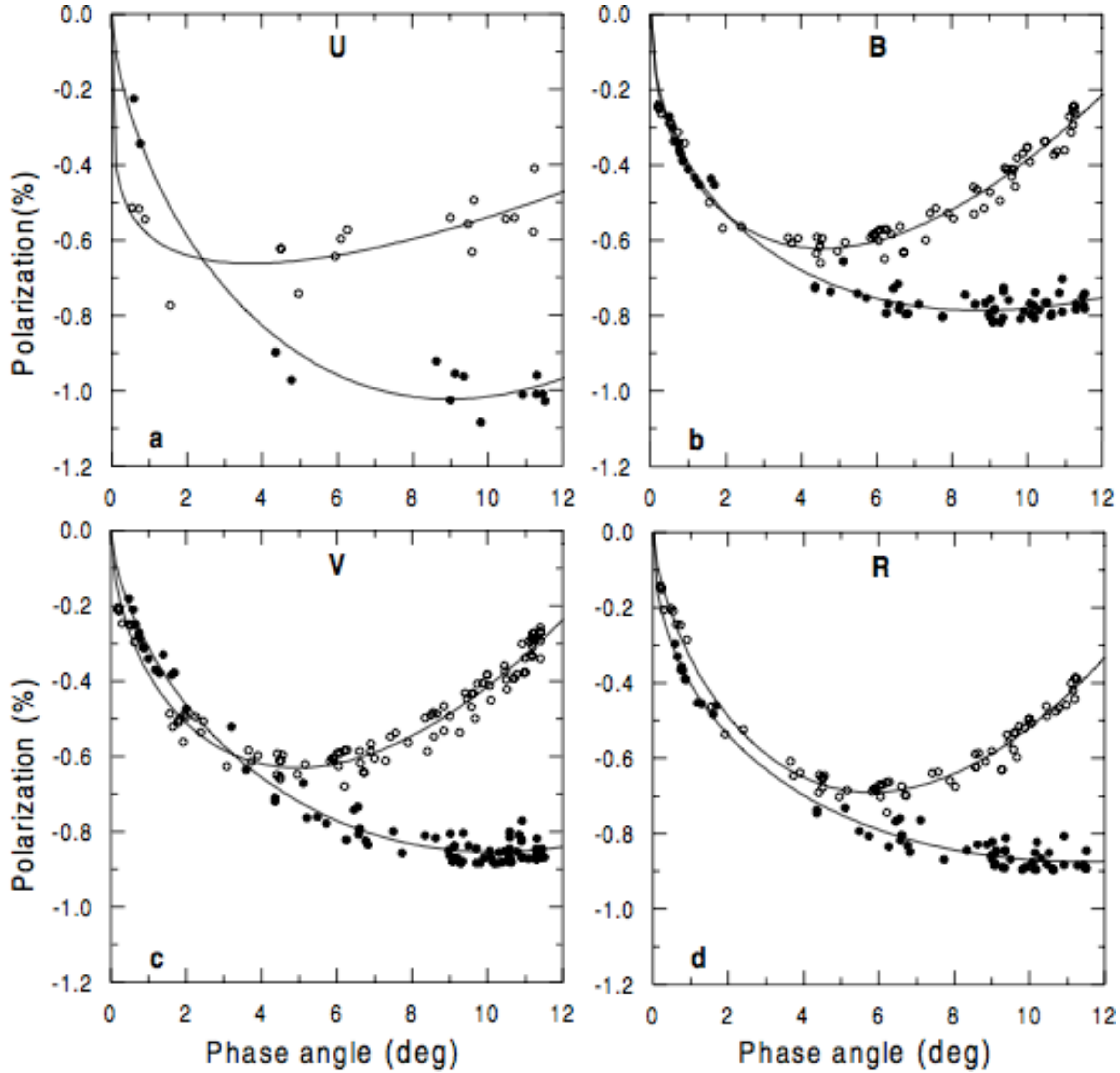
Galilean Satellites --- Callisto

Leading hemisphere:

==> covered mostly by a layer of pulverized rocks, of the "regolith" type .

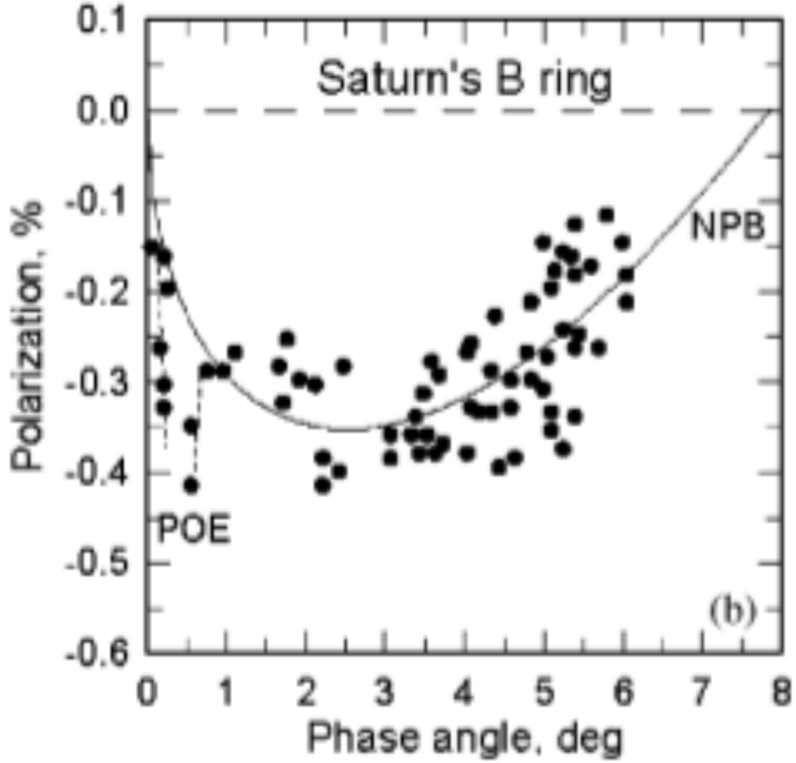
Trailing hemisphere:

==> covered mostly by rock or gravel free of fine regolithic powder .

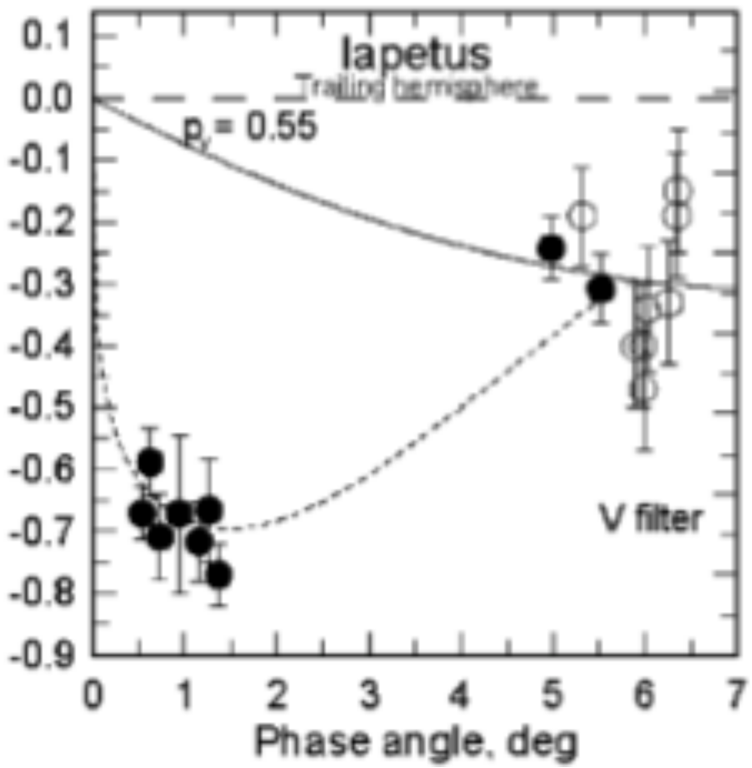


Rosenbush, Icarus, 2002

Polarimetry of Saturn's B ring & Iapetus



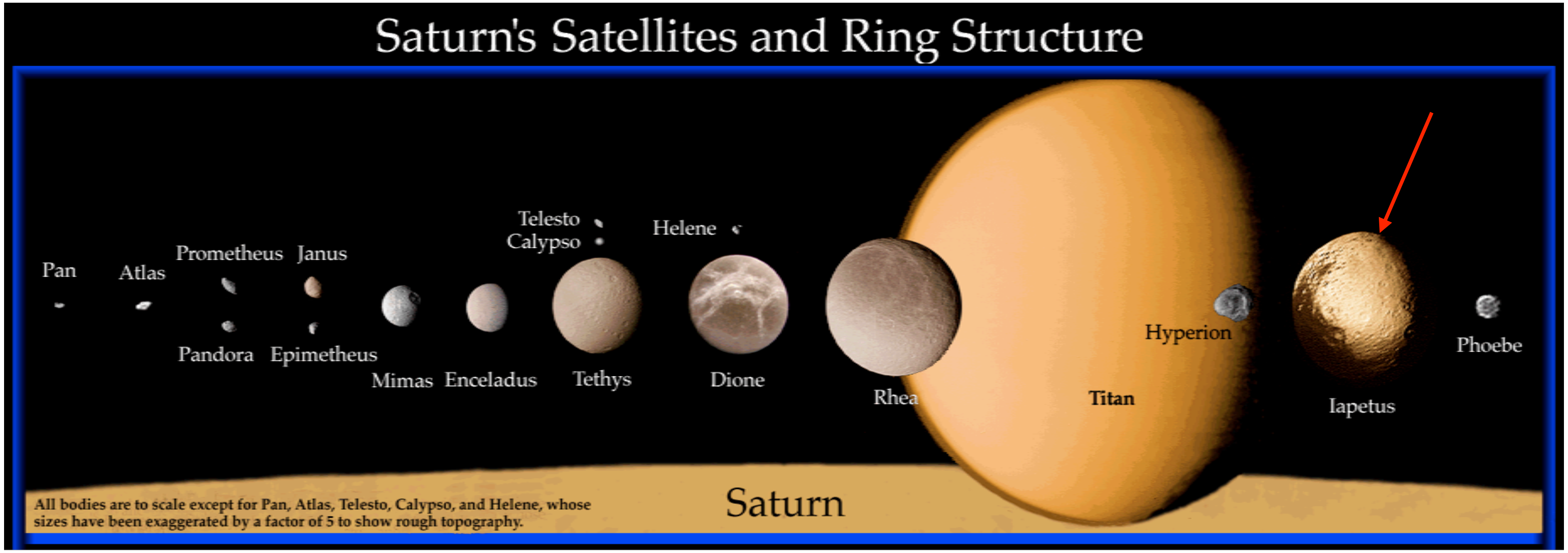
Rosenbush et al. JQSRT, 2006

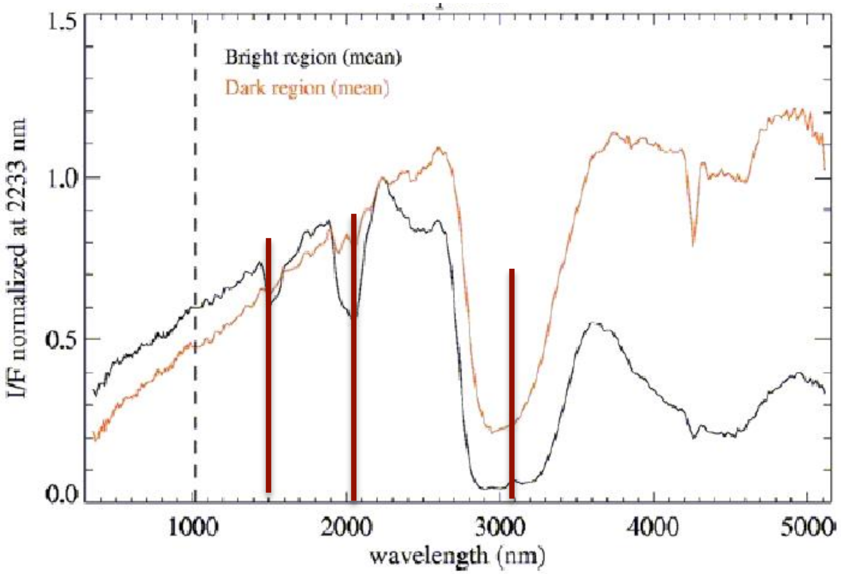


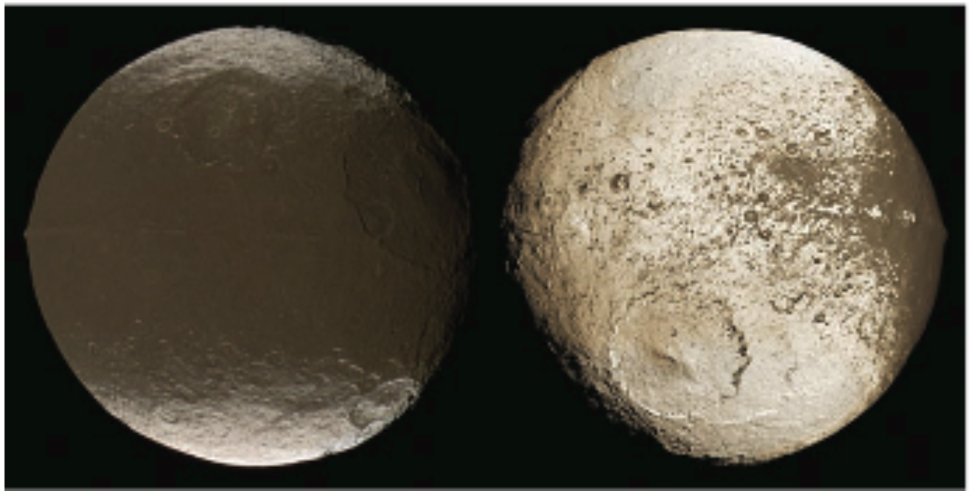
Rosenbush et al., 2002, in Optics of cosmic dust (book)

==> deposits of aggregates and sub-micrometer-sized icy particles on its surface.

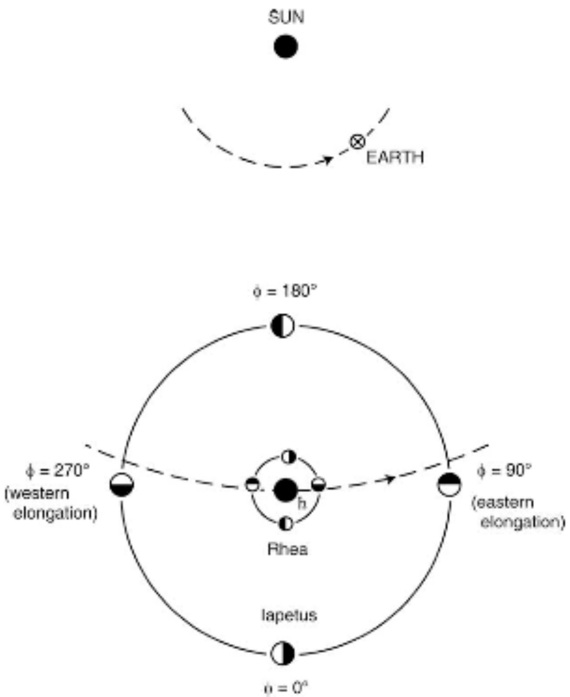
Iapetus


Saturn's Satellites and Ring Structure
Pan
Atlas
Prometheus
Janus
Pandora
Epimetheus
Mimas
Enceladus
Telesto
Calypso
Tethys
Helene
Dione
Rhea
Titan
Hyperion
Iapetus
Phoebe
Saturn
All bodies are to scale except for Pan, Atlas, Telesto, Calypso, and Helene, whose sizes have been exaggerated by a factor of 5 to show rough topography.


Bright region (mean)
Dark region (mean)
I/F normalized at 2233 nm
1.5
1.0
0.5
0.0
1000
2000
3000
4000
5000
wavelength (nm)

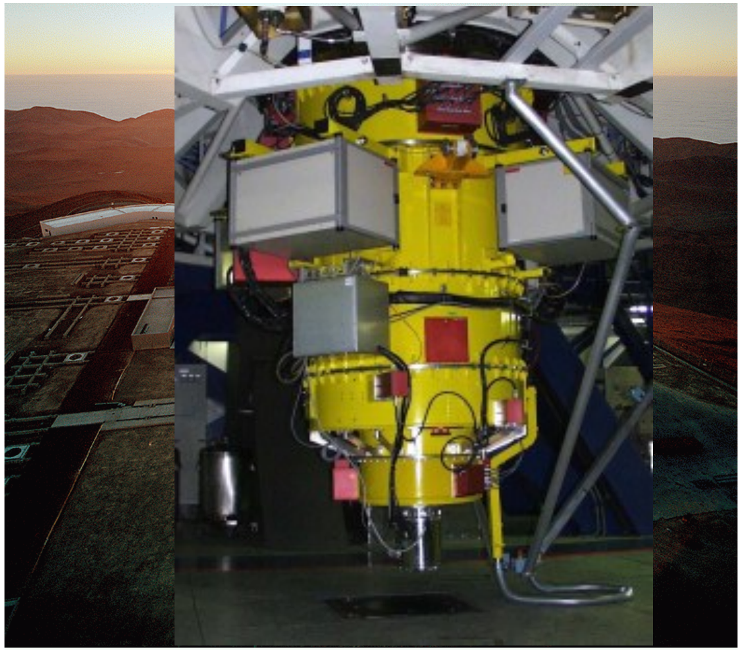


Iapetus Observing Program

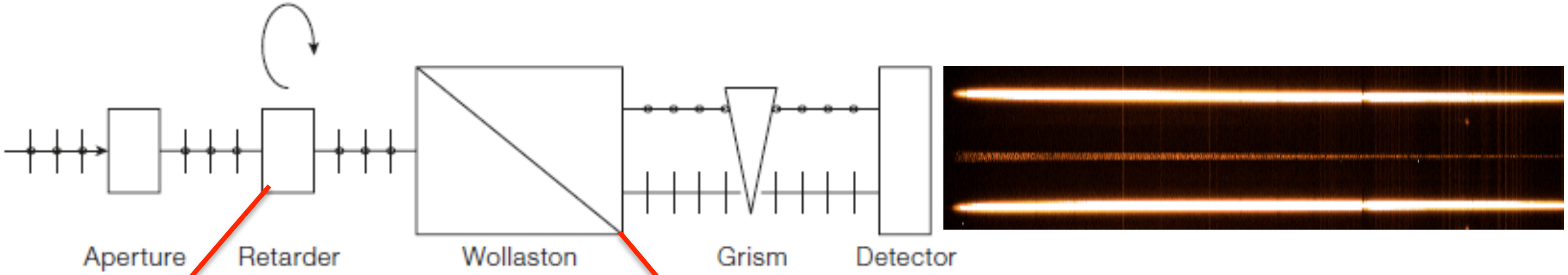


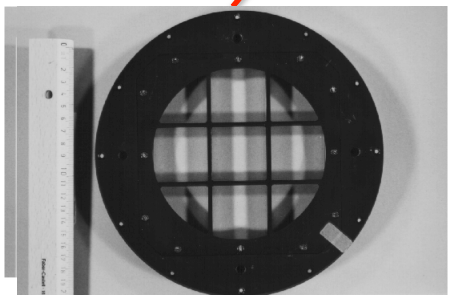
Western Bright		Eastern Dark	
Date	α (in deg.)	Date	α(in deg.)
2009/04/03	2.7	2009/05/13	5.7
2009/06/22	6.0	2010/01/11	5.7
2010/02/18	3.3	2010/03/30	0.9
2010/05/07	4.5	2010/06/16	6.1
2010/07/27	5.1	2011/02/14	4.6
2011/01/05	5.9	2011/05/03	3.0
2011/03/25	1.1	2011/07/21	5.8
2011/06/10	5.6	2011/12/31	5.5
2011/12/01	5.5	2012/03/19	2.9
2012/02/08	5.5	2012/06/05	4.7
2012/04/26	1.2	2012/08/24	4.8
2012/07/14	6.0	2013/02/02	5.7
2013/03/13	4.3	2013/04/22	0.7
2013/05/30	3.2	2013/07/09	5.6
2013/08/18	5.6		

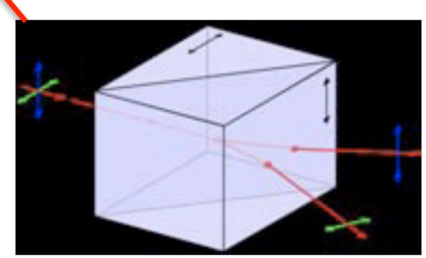
Method



FORS2 at the ESO VLT







Schematic concept of spectro-polarimetry

Method….

- The reduced Stokes parameters (normalized by intensity):

$$P_Q^{ij} = \frac{1}{2}\left\{\left(\frac{f^o - f^e}{f^o + f^e}\right)_{\alpha=2(i-1)\times 45^0} - \left(\frac{f^o - f^e}{f^o + f^e}\right)_{\alpha=(2j-1)\times 45^0}\right\}$$

$$P_U^{ij} = \frac{1}{2}\left\{\left(\frac{f^o - f^e}{f^o + f^e}\right)_{\alpha=2(i-1)\times 45^0+22.5^0} - \left(\frac{f^o - f^e}{f^o + f^e}\right)_{\alpha=(2j-1)\times 45^0+22.5^0}\right\}, \text{ where}$$

i and j are integer numbers.

- After transforming P_Q and P_U to the scattering plane:

==> fraction of linearly polarized radiation, $P_L = \sqrt{P_Q'^2 + P_U'^2}$

==> Position angle of polarization, $\Theta' = \frac{1}{2} arctan\left(\frac{P_U'}{P_Q'}\right) + \Theta_0'$, where

$$\Theta_0' = \begin{cases} 0 \ \ if\ P_Q' > 0\ and\ P_U' \geq 0 \\ \pi \ \ if\ P_Q' > 0\ and\ P_U' < 0 \\ \pi/2\ if\ P_Q' < 0 \end{cases}$$

Or $\Theta' = \begin{cases} \pi/4 \ \ if\ P_Q' = 0\ and\ P_U' > 0 \\ 3\pi/4 \ \ if\ P_Q' = 0\ and\ P_U' < 0 \end{cases}$

Conclusions & Outlook

- The first few FORS2 measurements indicate that dark hemisphere of Iapetus has high degree of polarization than the bright one (in agreement with the fact that darker surfaces exhibit higher negative polarization than brighter surfaces) with different overall spectral slopes.
- We'll observe each hemisphere at two more phase angles to obtain a good phase angle sampling.
- We'll model the observed polarization to constrain the surface properties of the object.