Jupiter observations with PlanetCam at a 2.2m telescope at Calar Alto Observatory (Spain)

Scientific project: A. Sánchez-Lavega (PI), S. Perez-Hoyos, I. Mendikoa, R. Hueso, J. F. Rojas.

Image processing software (PLAYLIST): R. Hueso

Technical project: J. Aceituno and iTec (Calar Alto Obs.)

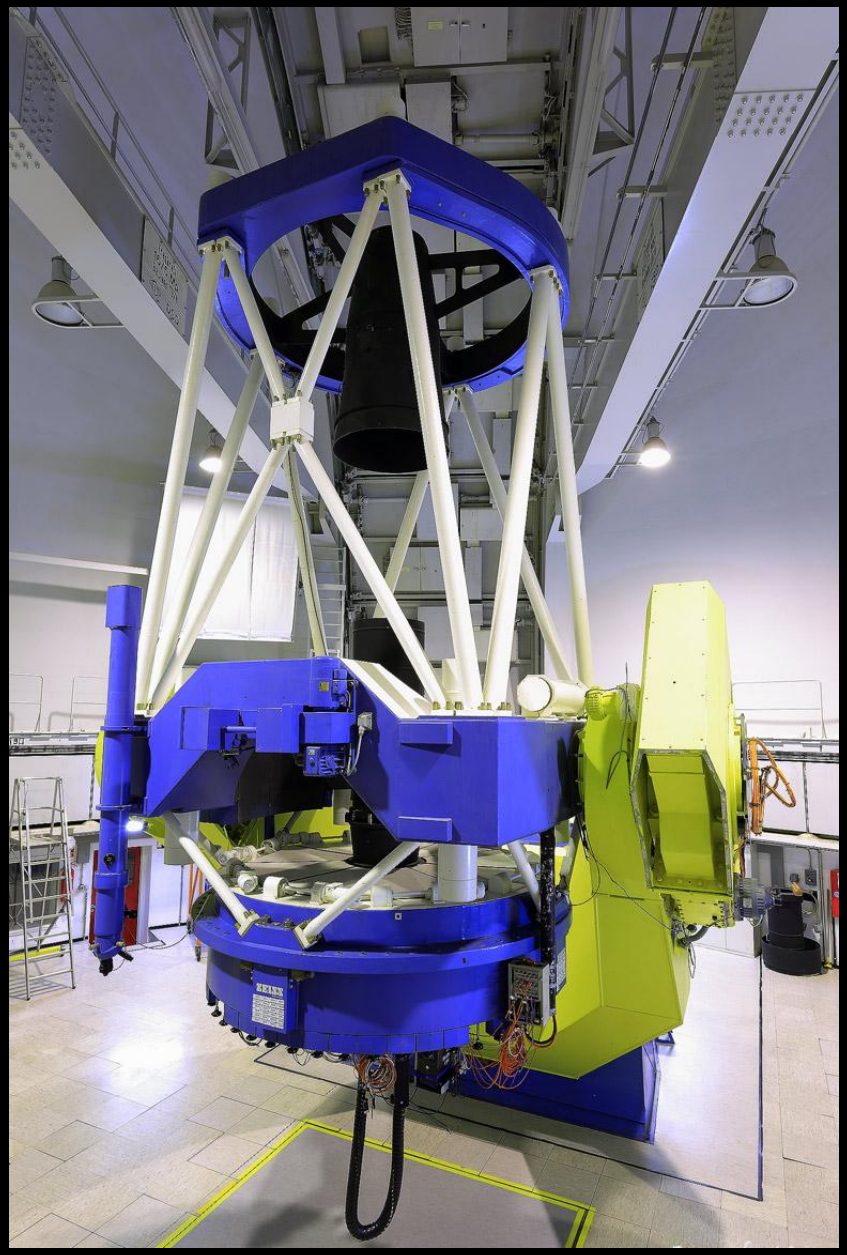
Workshop on Juno Ground-Based Support from Amateurs
12 – 13 May 2016 - Nice (France)

Calar Alto Observatory

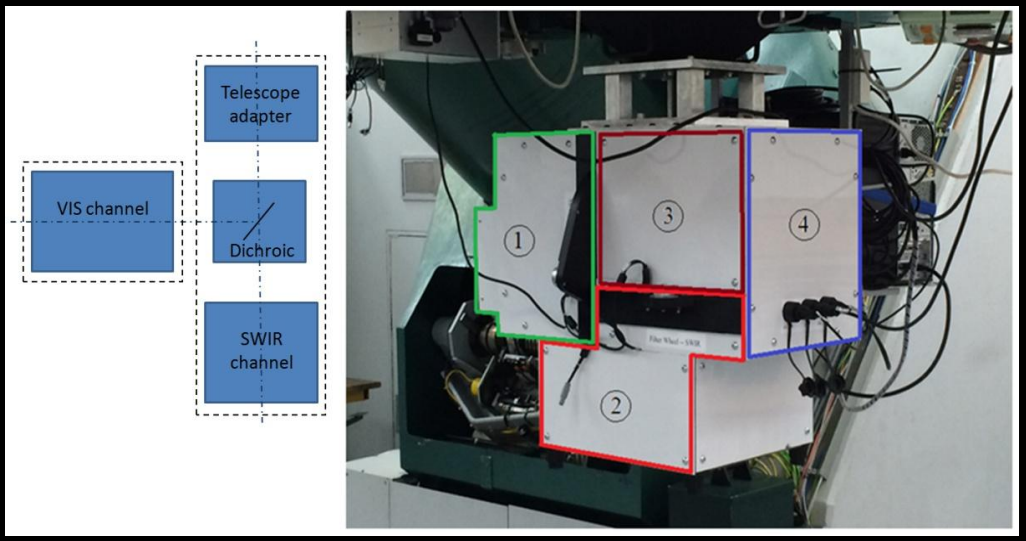
Centro Astronómico Hispano Aleman (CAHA):
* Max Plank Institute for Astronomy (Germany)
* Instituto Astrofísica de Andalucía (Spain)

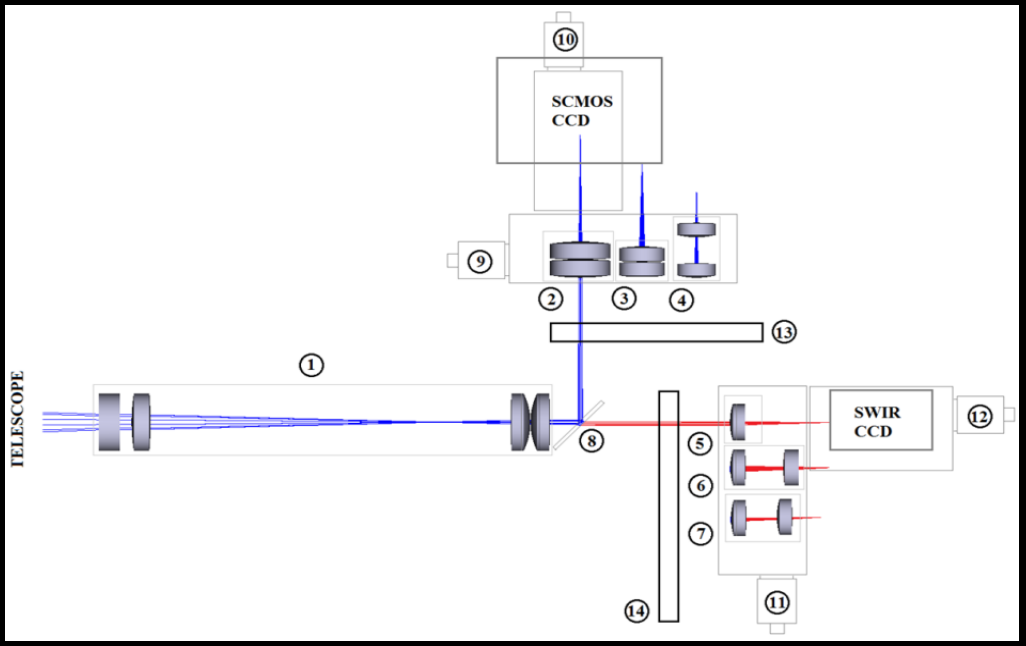
Sierra Filabres (2158 m)
Almeria (Spain)
Latitude = +37° 13.5'
Longitude = 2° 32.5'

Telescopes: 2.2m (left) and 1.23m (right)



PlanetCam UPV/EHU





Two channel VISIBLE - SWIR "Lucky imaging" camera

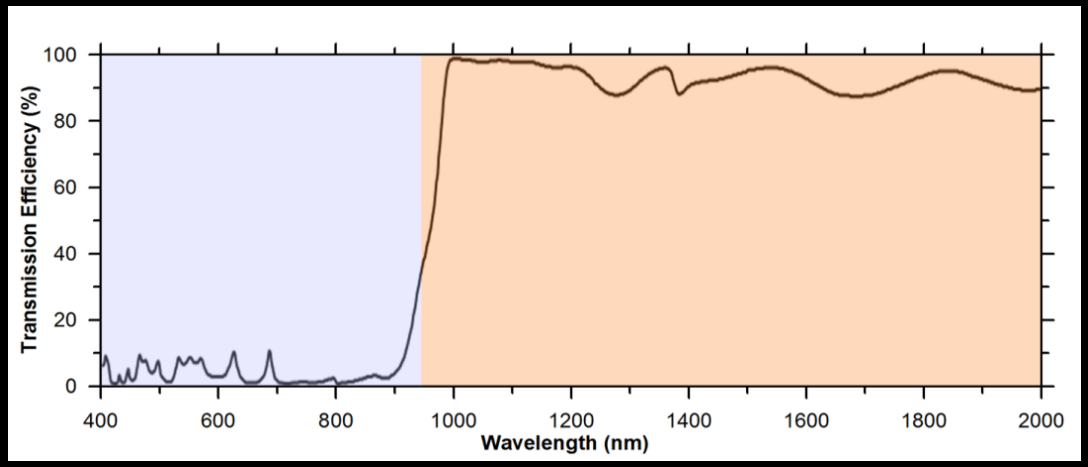
- Simultaneous observations in two channels (Visible – SWIR)
- Spectral coverage: 0.38 -1.7 μm
- Imaging in narrow band filters.
- Absolute photometry (standard stars)

Diffraction limit @500 nm
T2.2 m ~ 0.05" (FOV = 72")
→ Pixel scale 0.025"/pix

Diffraction limit @1500 nm
T2.2 m ~ 0.15" (FOV = 56")
→ Pixel scale 0.09"/pix

A. Sanchez-Lavega et al, Proc. SPIE 8446 (2012)
I. Mendikoa et al., PASP, 128:035002, 22p, (2016)

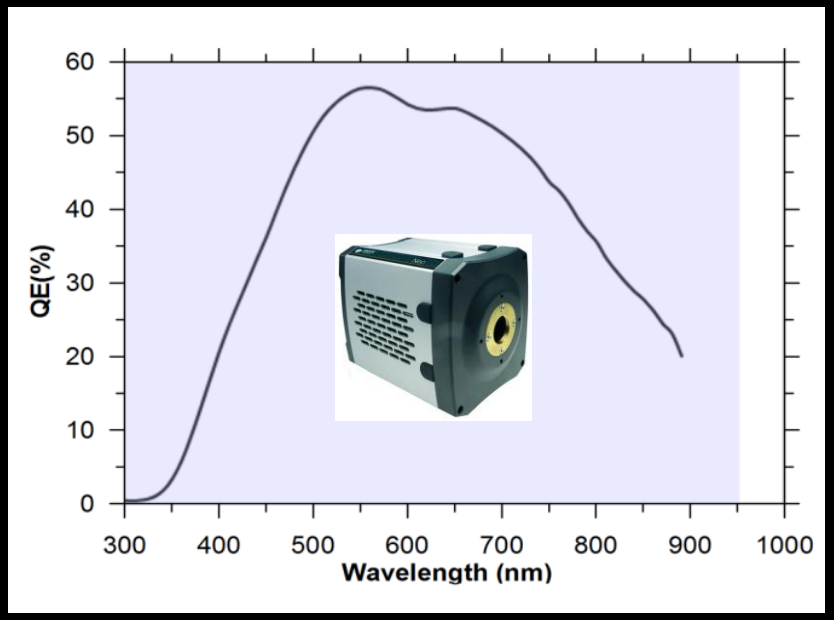
PlanetCam UPV/EHU: Detectors



Dichroic (Omega Optics)

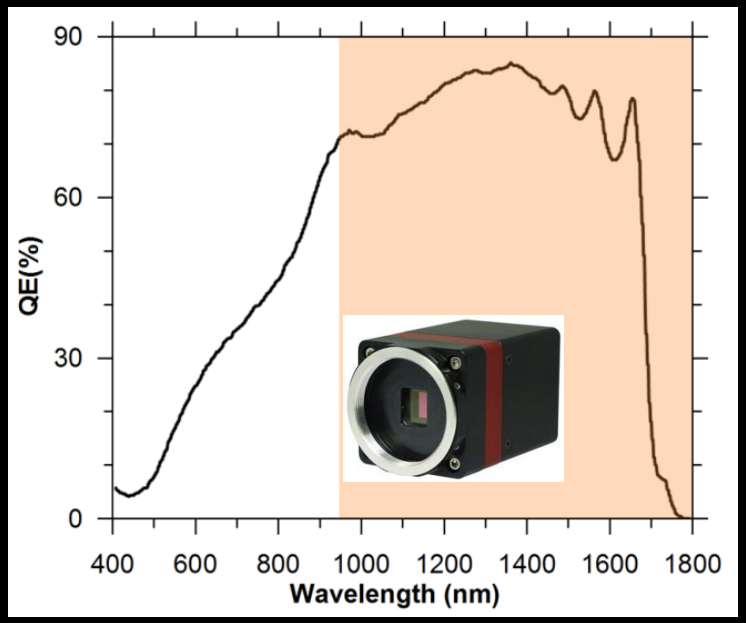
Neo SCMOS (Andor)

Size 2560x2180
Pixel size: 6.5 x 6.5 μm
100 fps (T = -40°C)

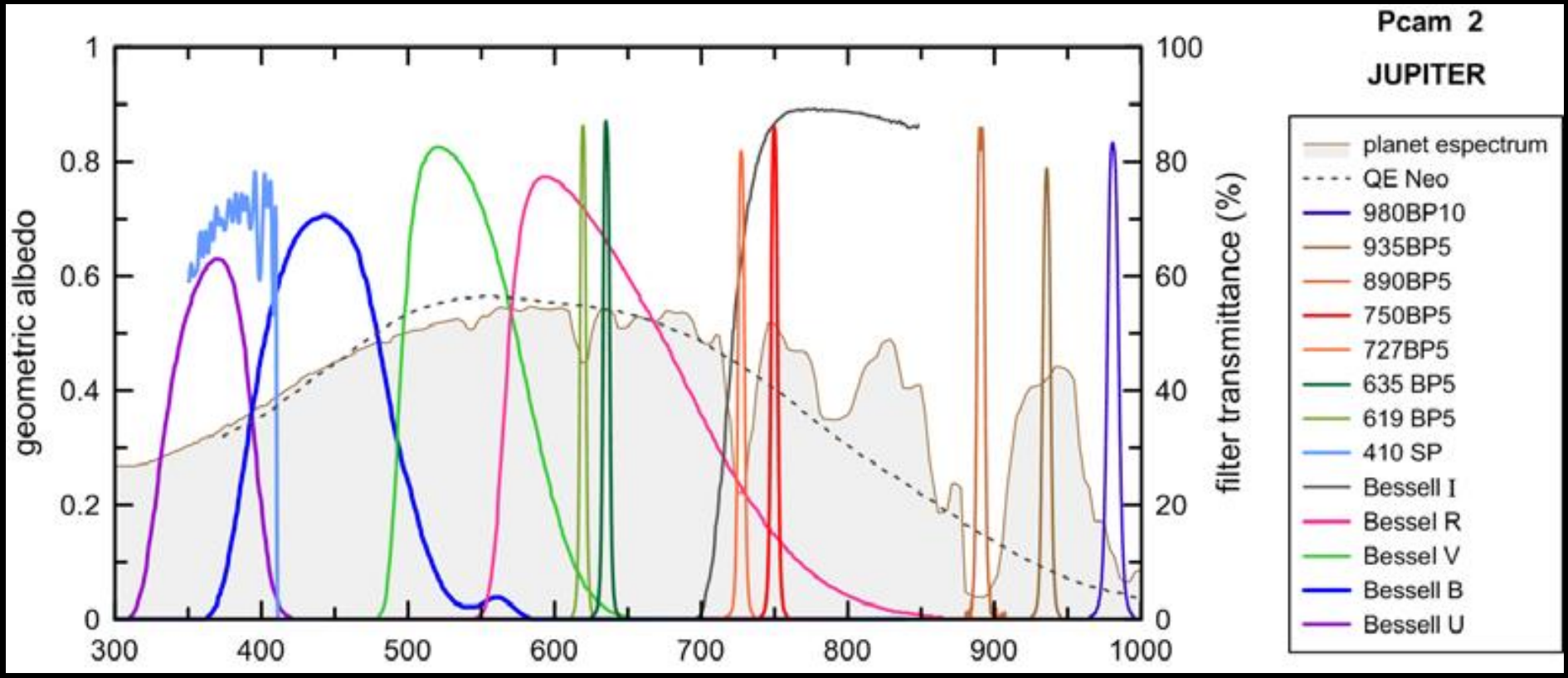


OWL 640 (Raptor)

Size: InGaAs 640x512
Pixel size: 15 x 15 μm
120 fps (T = -15°C)

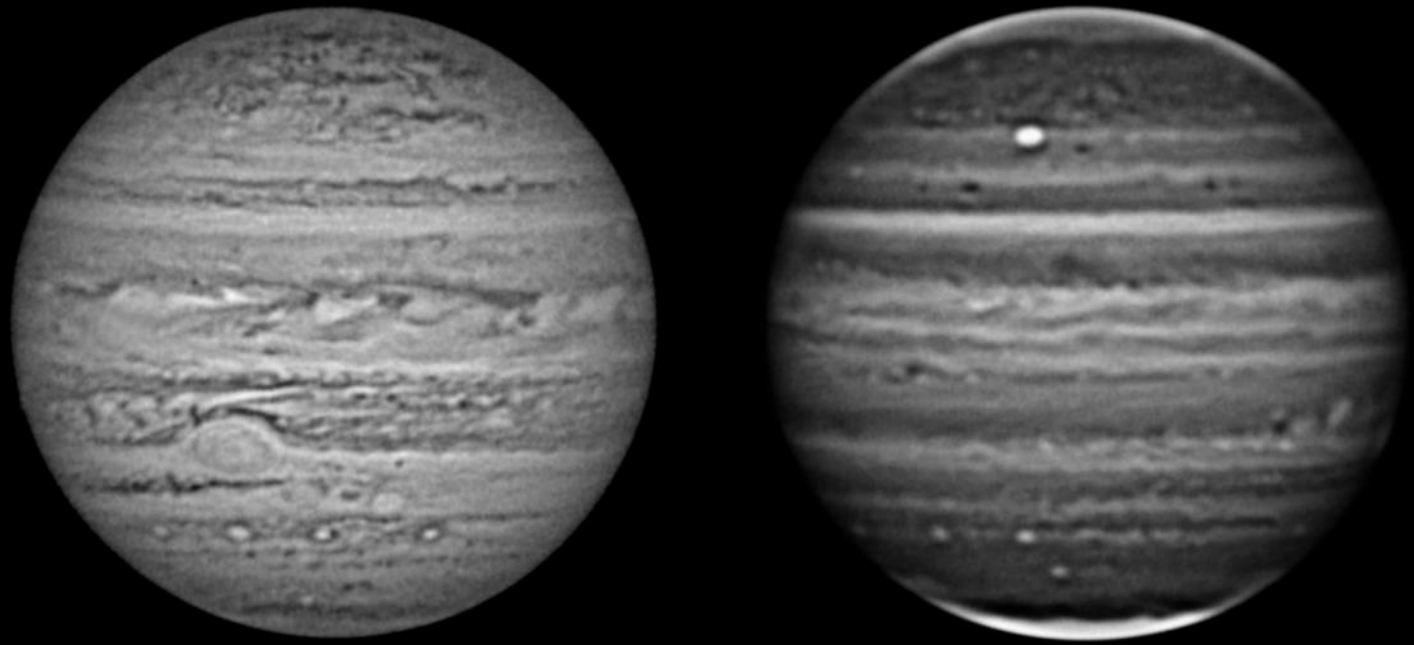


PlanetCam UPV/EHU: Visible channel filters

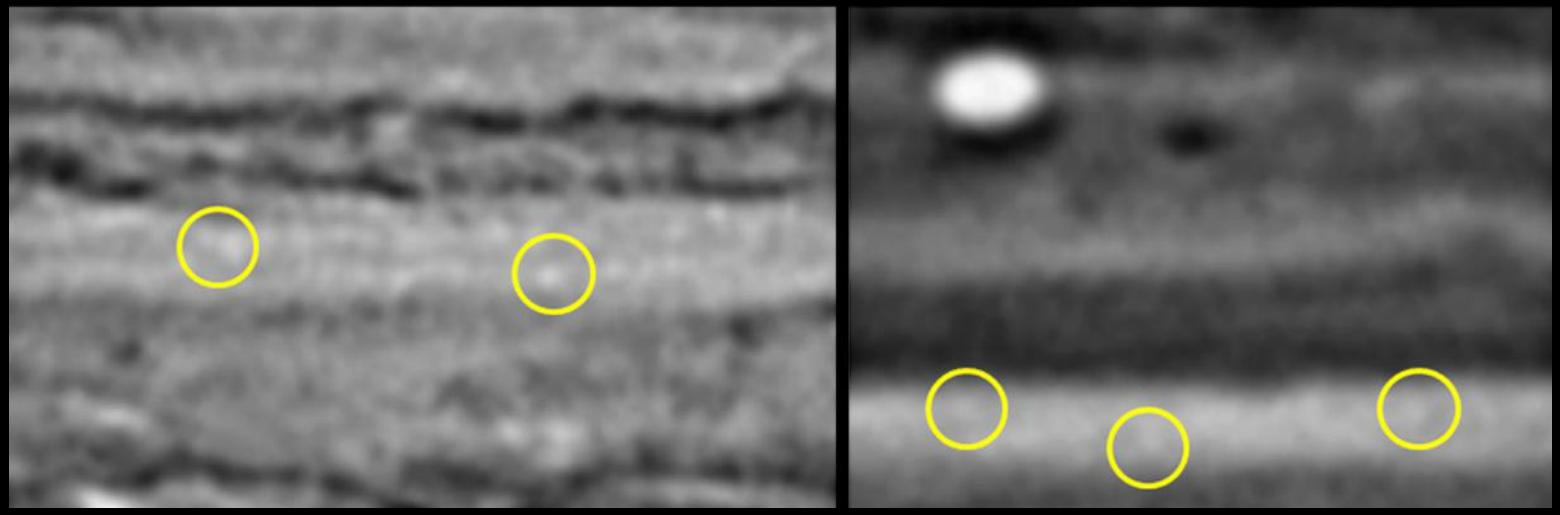


Narrow band filters M1, M2, M3, C1, C2, C3 → FWHM = 5 nm

PlanetCam at 2.2 m (Visible)



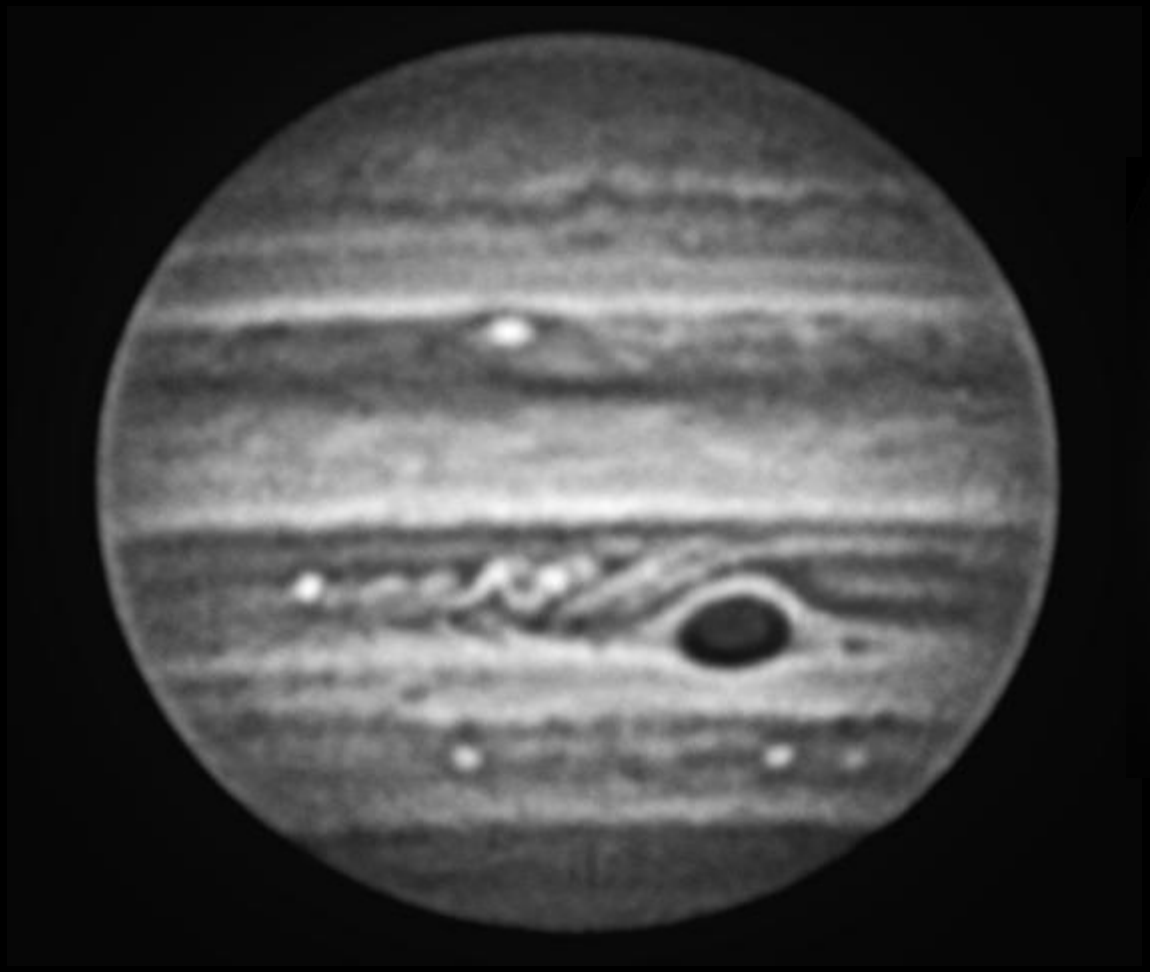
3 December 2012: I and M3 (890 nm)

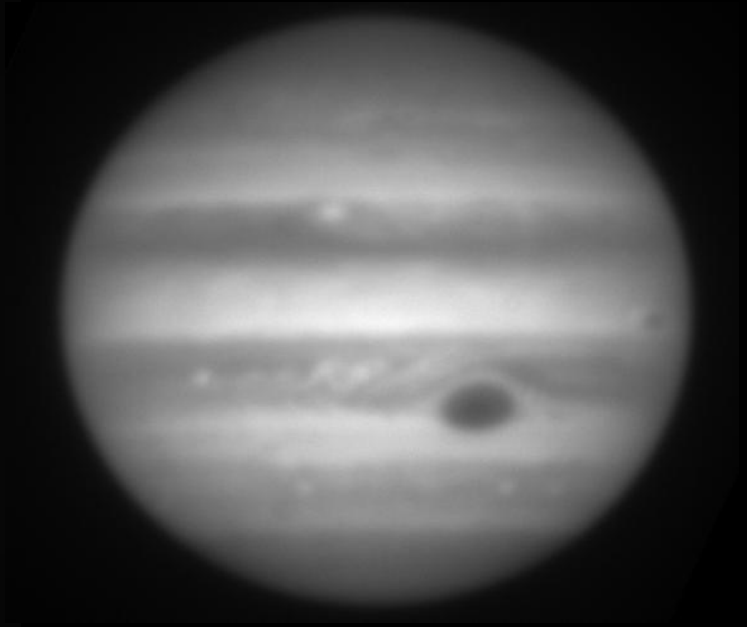


Circled: features with a size of 0.30-0.35 arcsec

High-resolution observations: PlanetCam at Calar Alto 2.2m telescope

Date: 2016-03-04 Time: 01:40 UT | Filter: U (370-400 nm)





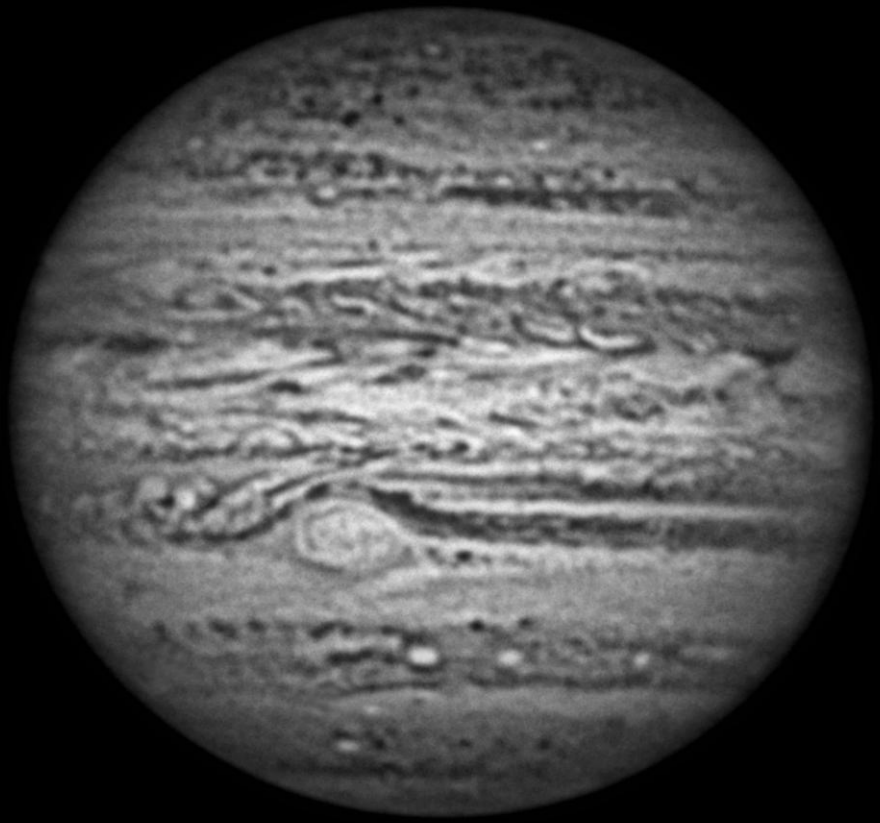
Resolution: 0.026 arcsec/pixel

Smallest features: 0.30 arcsec ~ 900 km

High-resolution observations: PlanetCam at Calar Alto 2.2m telescope

Date: 2016-03-04 Time: 00:43 UT (derotated)

Filter I Johnson



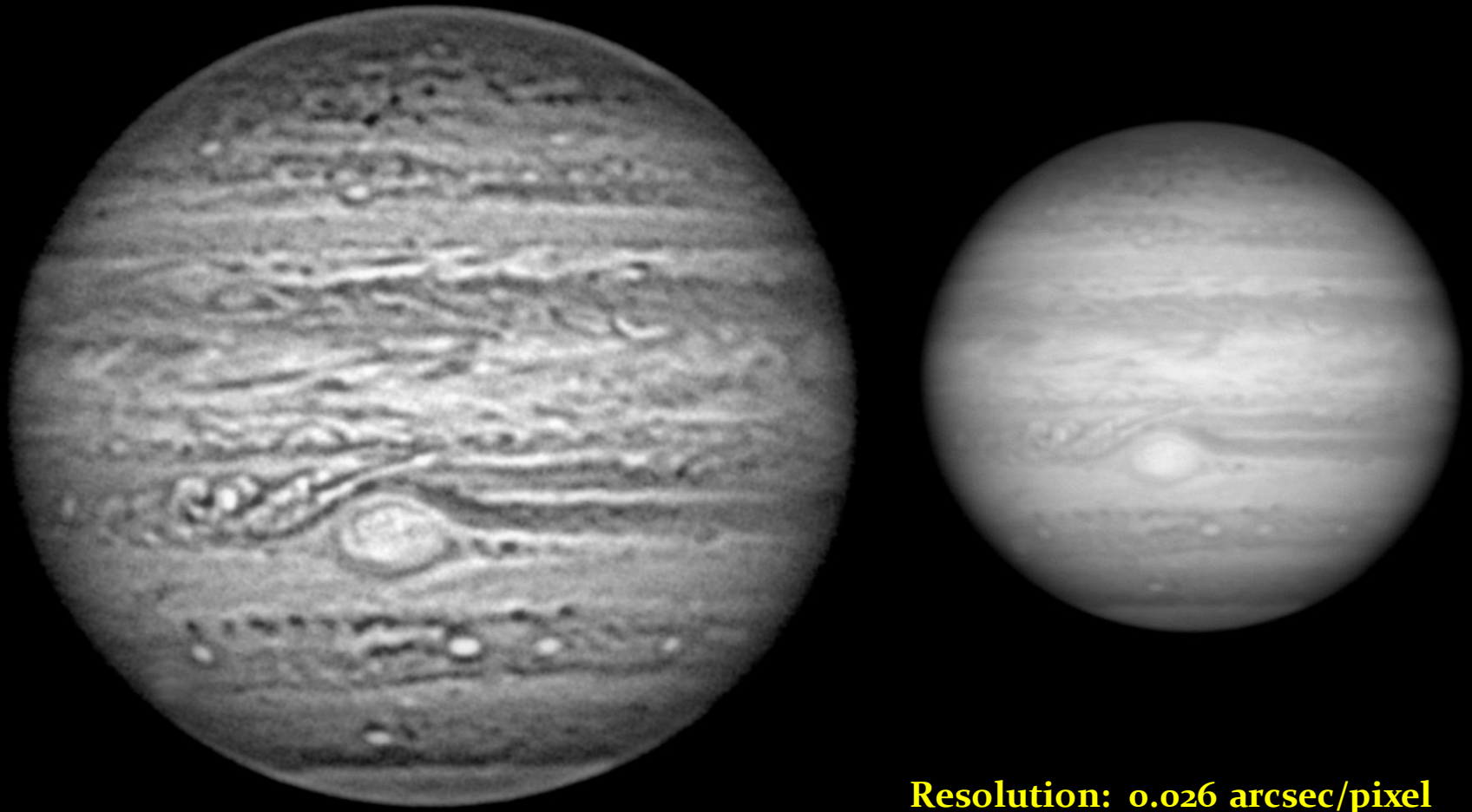
Color composite: Johnson IRVB

Resolution: 0.026 arcsec/pixel

Smallest features: 0.14 arcsec ~ 500 km

High-resolution observations: PlanetCam at Calar Alto 2.2m telescope

Date: 2016-03-04 Time: 00:57 UT | Filter: Johnson M2 (Methane 727 nm) - derotated

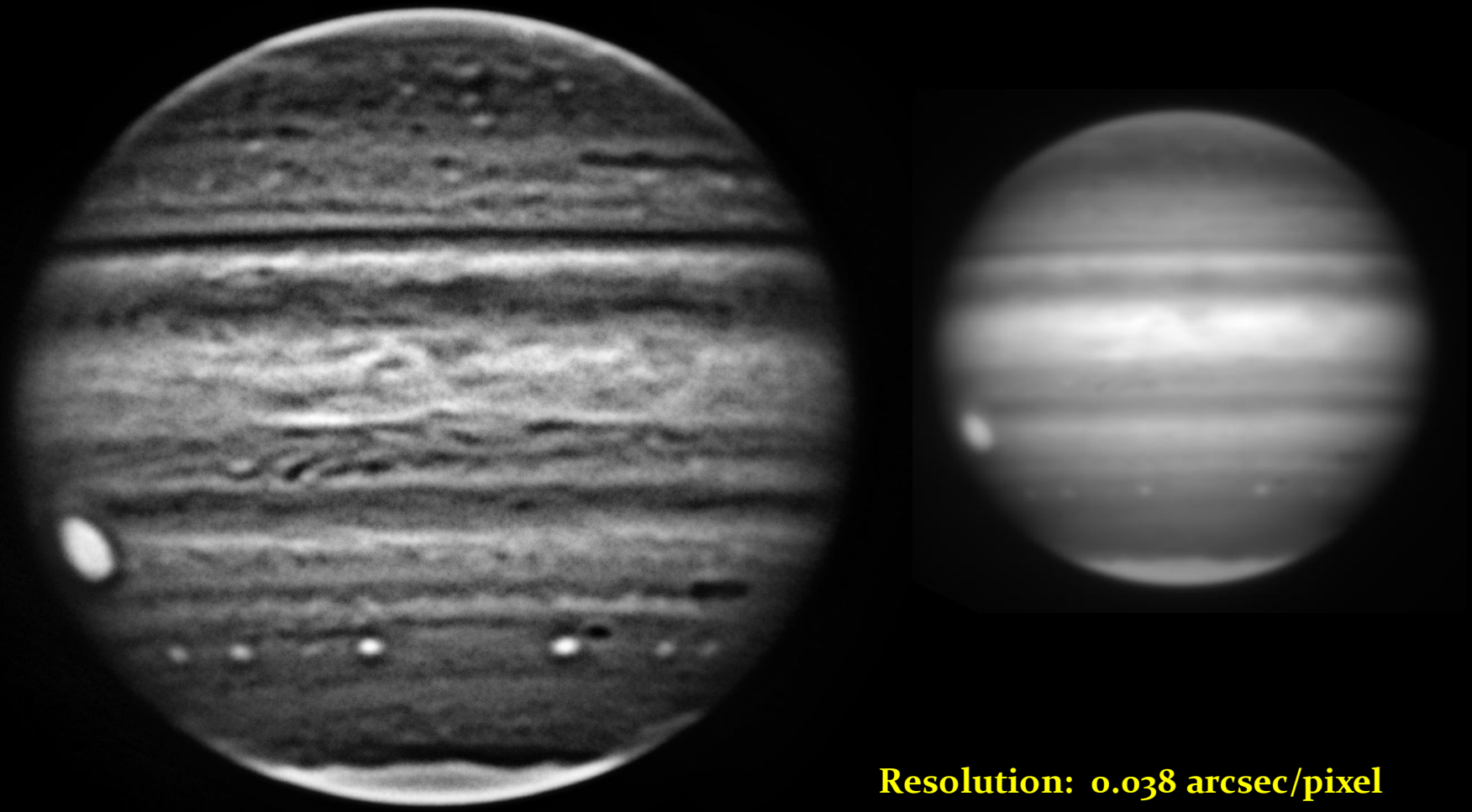


Resolution: 0.026 arcsec/pixel

Smallest features: 0.14 arcsec ~ 500 km

High-resolution observations: PlanetCam at Calar Alto 2.2m telescope

Date: 2016-03-03 Time: 23:27 UT | Filter: M3 (Methane 890 nm)

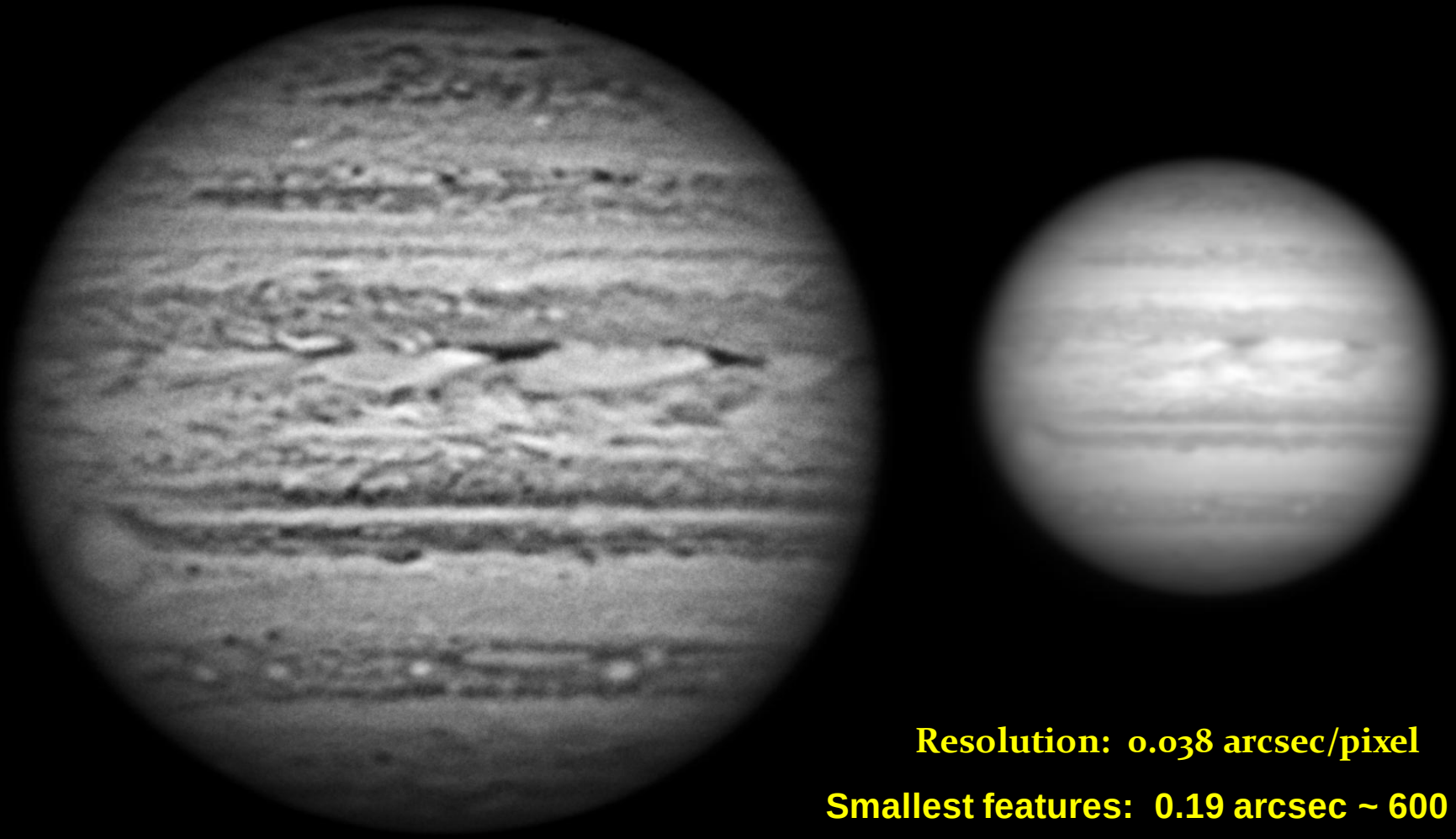


Resolution: 0.038 arcsec/pixel

Smallest features: 0.19 arcsec ~ 600 km

High-resolution observations: PlanetCam at Calar Alto 2.2m telescope

Date: 2016-03-03 Time: 23:39 UT | Filter: C3 (935 ± 5nm)

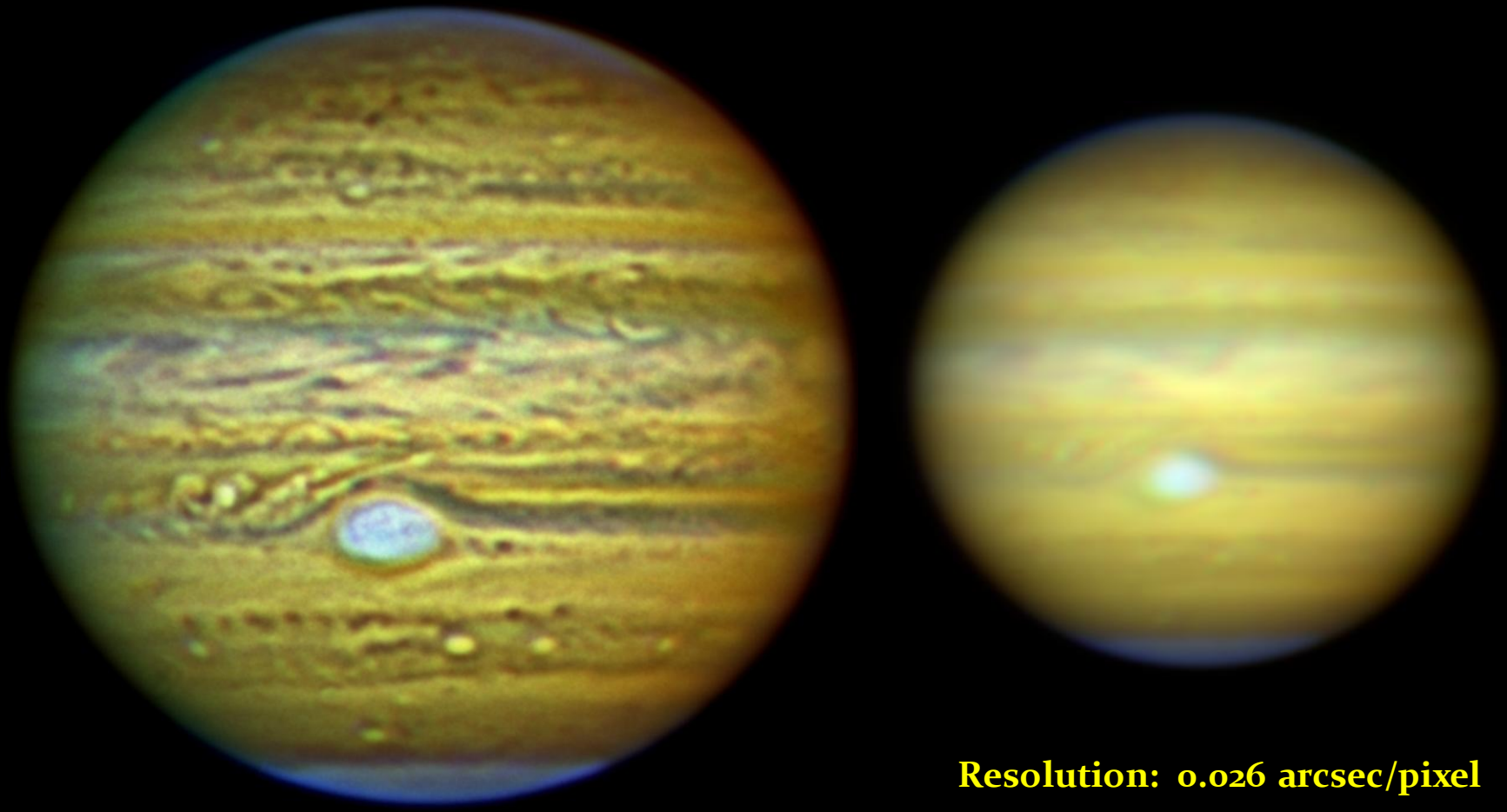


Resolution: 0.038 arcsec/pixel

Smallest features: 0.19 arcsec ~ 600 km

High-resolution observations: PlanetCam at Calar Alto 2.2m telescope

Date: 2016-03-04 Time: 00:57 UT | Filter: M1, M2, M3

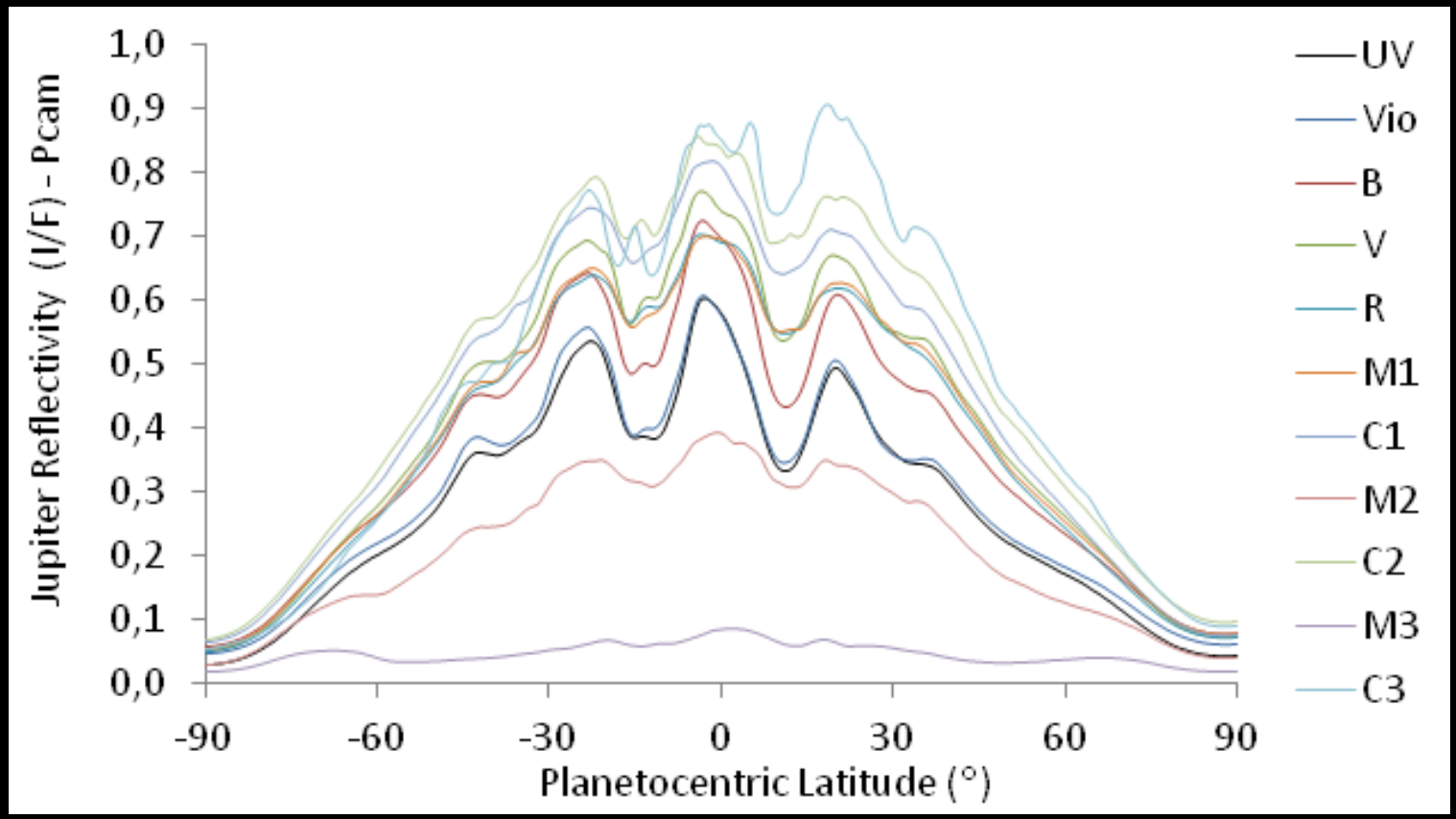


Resolution: 0.026 arcsec/pixel

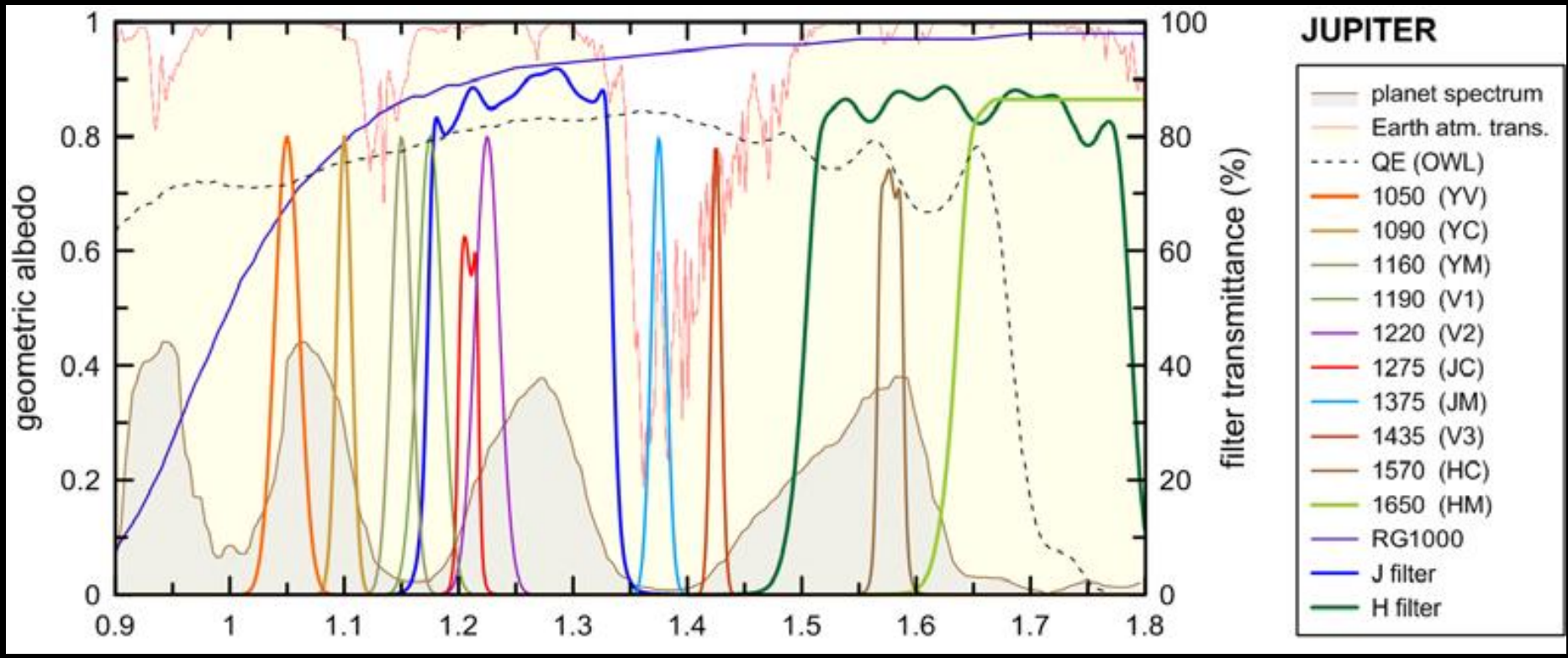
Smallest features: 0.14 arcsec ~ 500 km

Photometry: Visible channel (standard stars)

Absolute reflectivity (North-South scans)



PlanetCam UPV/EHU: SWIR channel filters



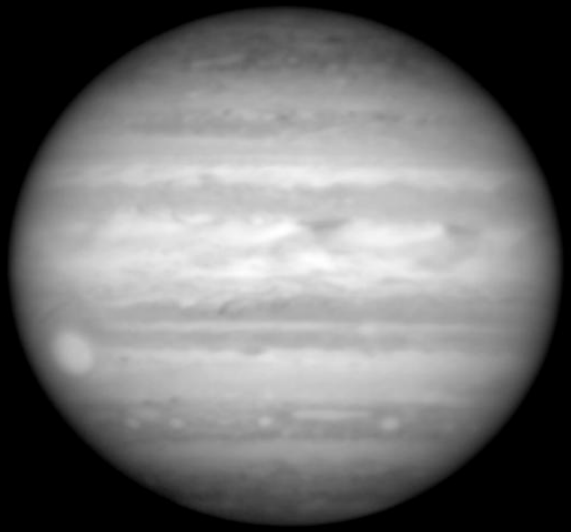
Narrow band filters M4 (YM), C4 (YC), M5 (JM), C5 (JC), M6 (HM)→ FWHM = 20-50 nm

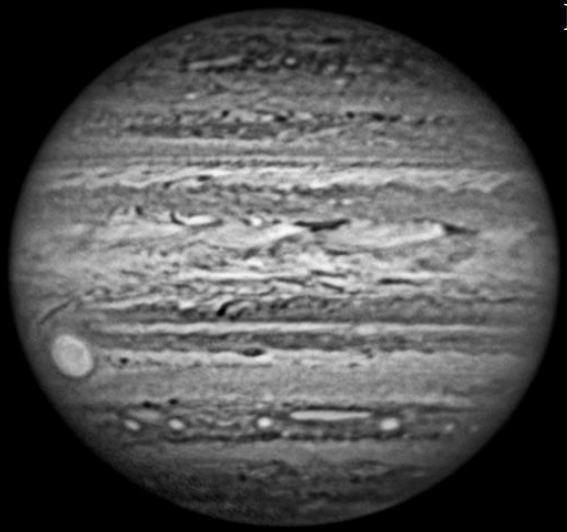
Take into account water vapour absorption from Earth's atmosphere

High-resolution observations: PlanetCam at Calar Alto 2.2m telescope

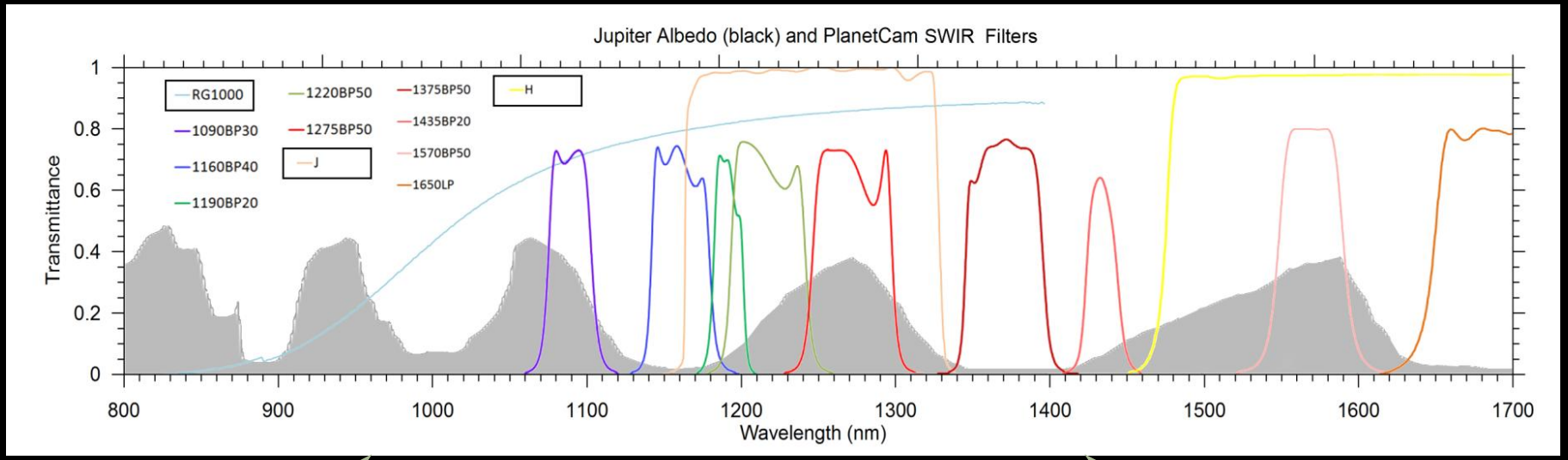
Date: 2016-03-03 Time: 23:32 UT | Filter: RG1000

Resolution: 0.088 arcsec/pixel





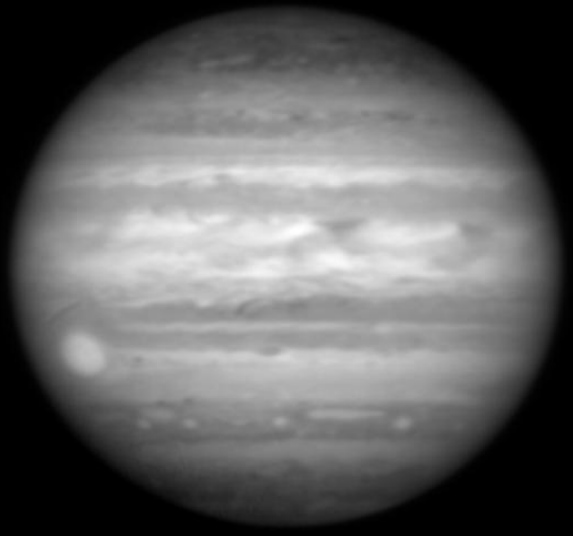
Photometric image (radiative transfer, cloud properties) Enhanced image for dynamics (morphology & winds)

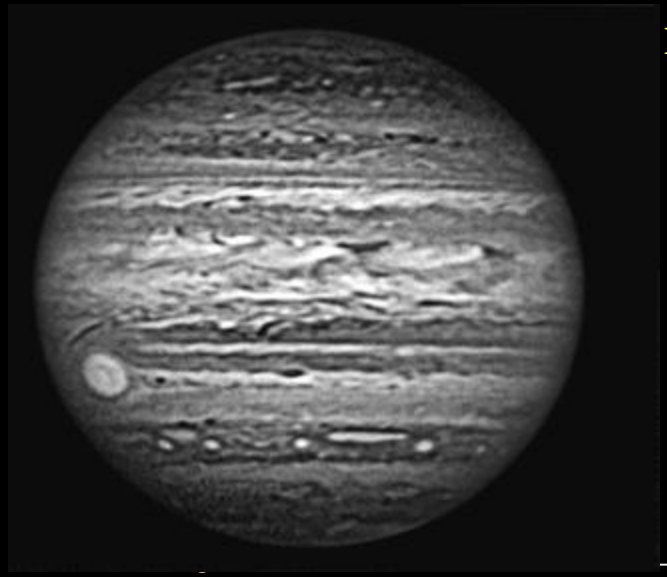


High-resolution observations: PlanetCam at Calar Alto 2.2m telescope

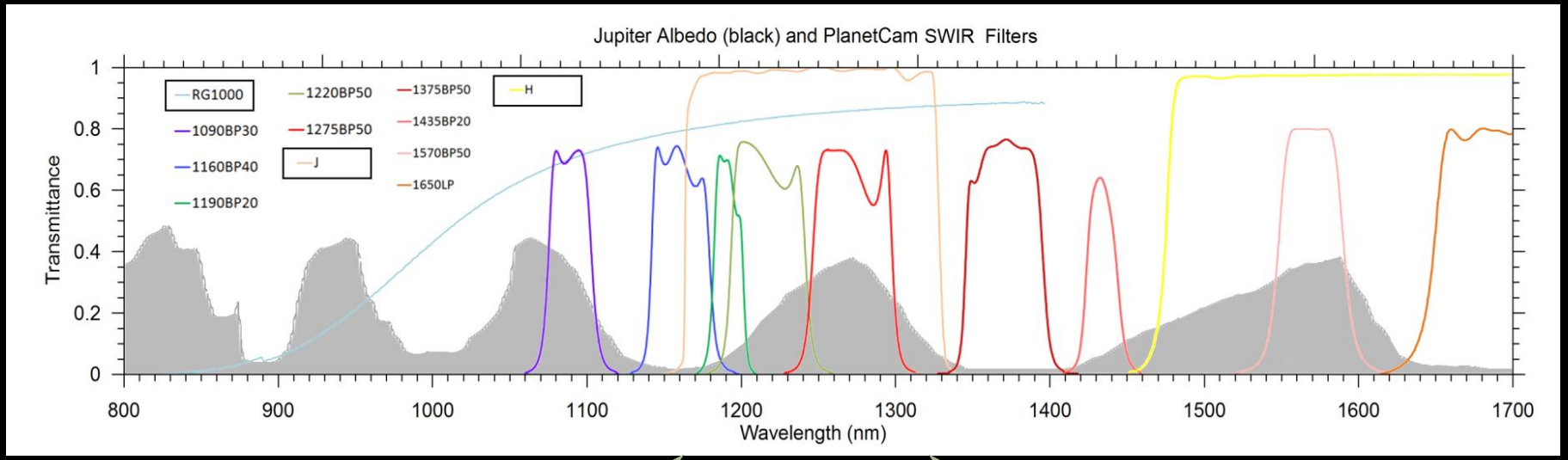
Date: 2016-03-03 Time: 23:37 UT | Filter: J

Resolution: 0.088 arcsec/pix





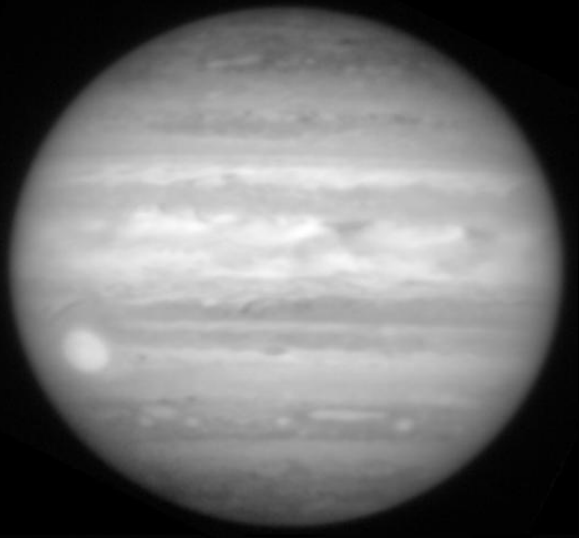
Photometric image (radiative transfer, cloud properties) Enhanced image for dynamics (morphology & winds)

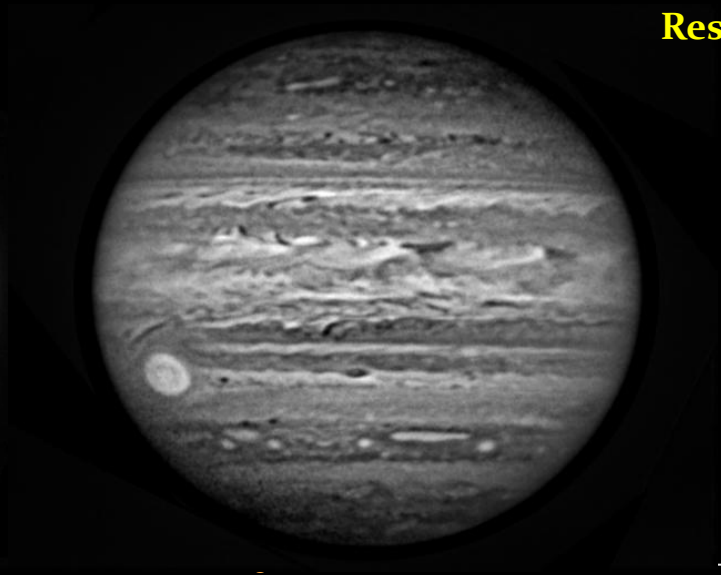


High-resolution observations: PlanetCam at Calar Alto 2.2m telescope

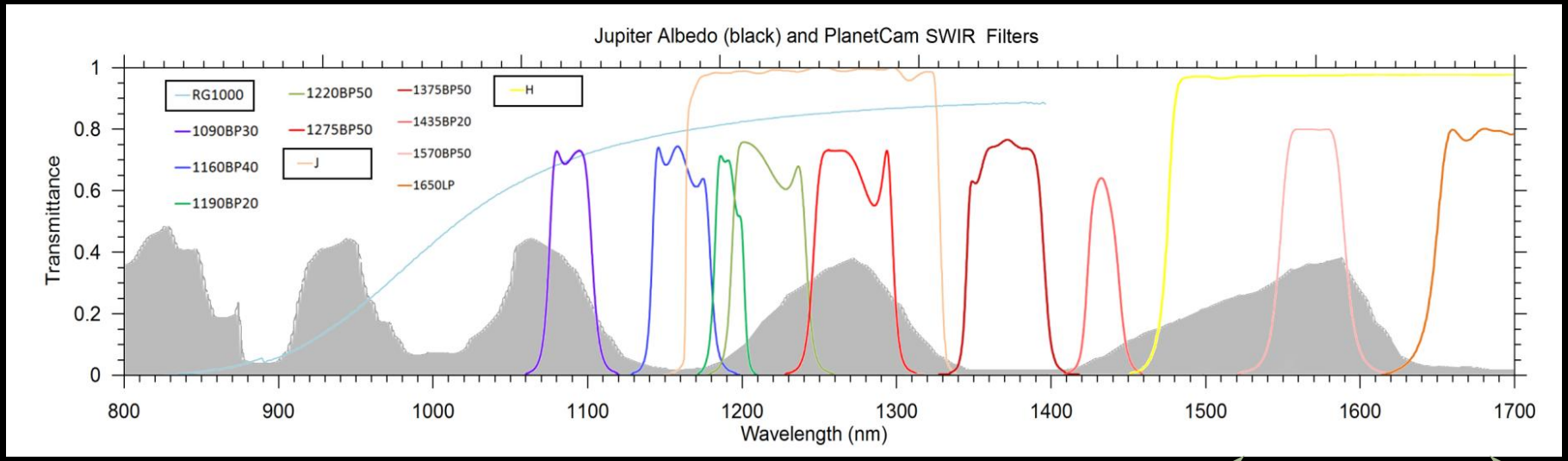
Date: 2016-03-03 Time: 23:41 UT | Filter: H

Resolution: 0.088 arcsec/pixel





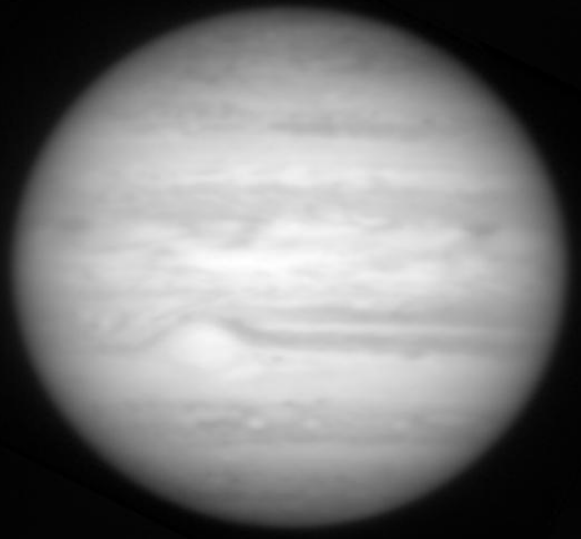
Photometric image (radiative transfer, cloud properties) Enhanced image for dynamics (morphology & winds)

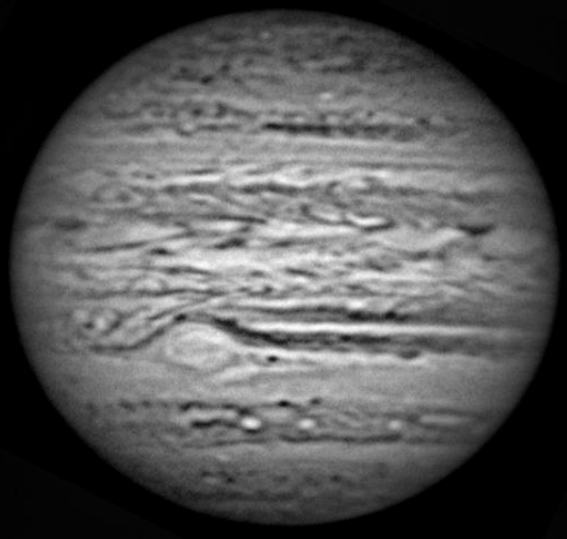


High-resolution observations: PlanetCam at Calar Alto 2.2m telescope

Date: 2016-03-04 Time: 00:33 UT | Filter: 1090BP30

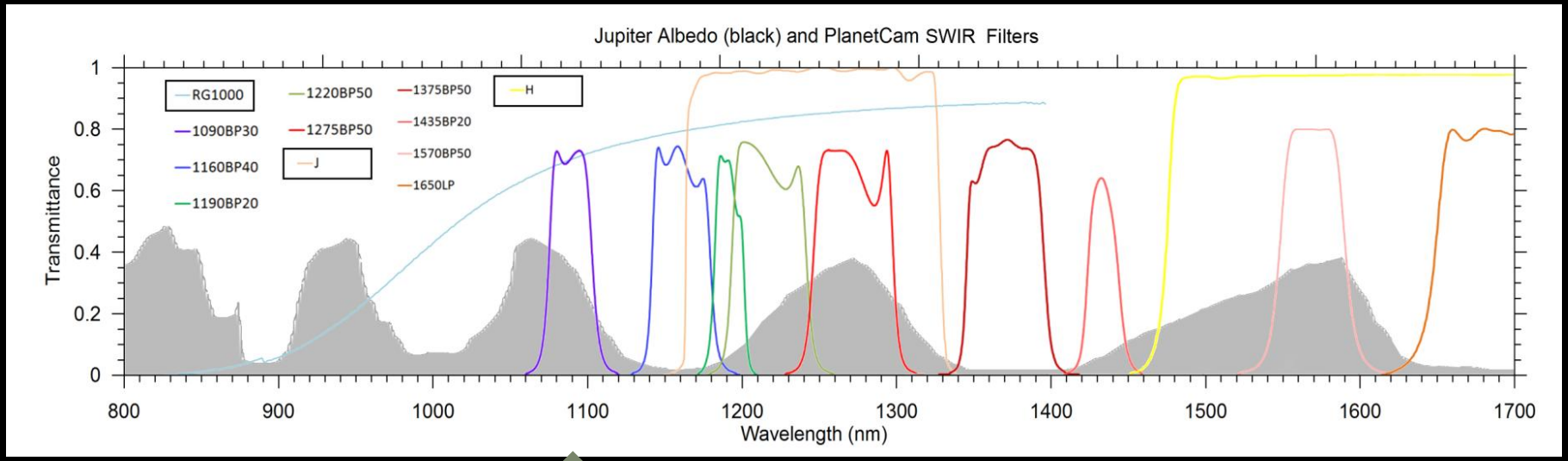
Resolution: 0.088 arcsec/pixel





Photometric image (radiative transfer, cloud properties)

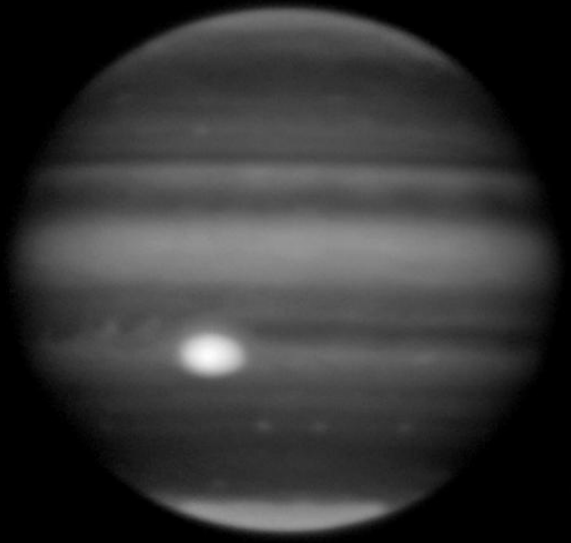
Enhanced image for dynamics (morphology & winds)



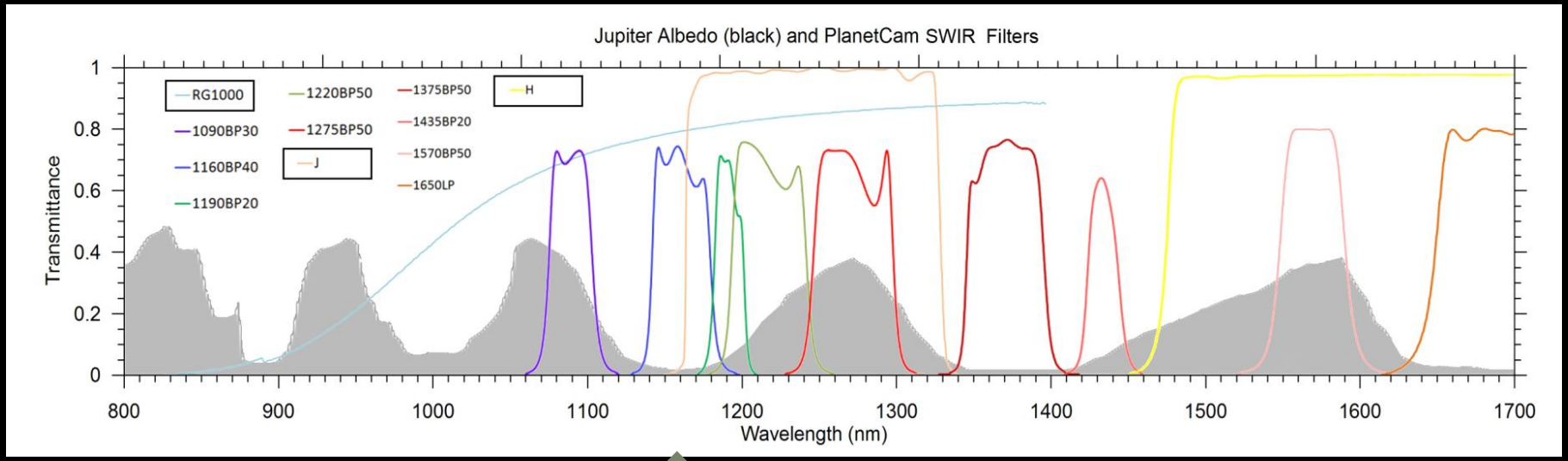
High-resolution observations: PlanetCam at Calar Alto 2.2m telescope

Date: 2016-03-04 Time: 00:41 UT | Filter: 1160BP40

Resolution: 0.088 arcsec/pixel



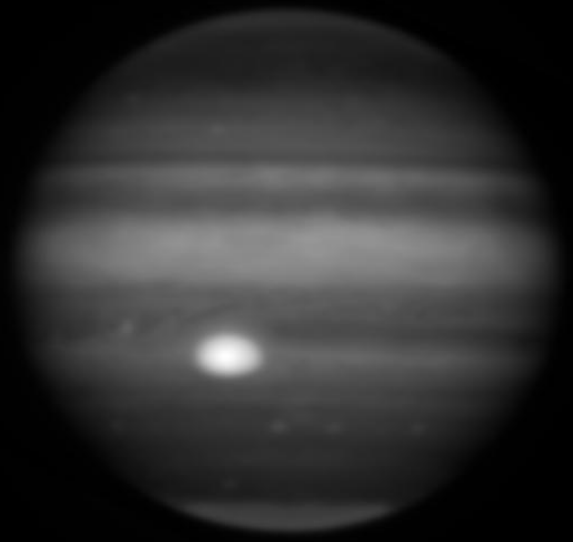
Photometric image (radiative transfer, cloud properties) Enhanced image for dynamics (morphology & winds)

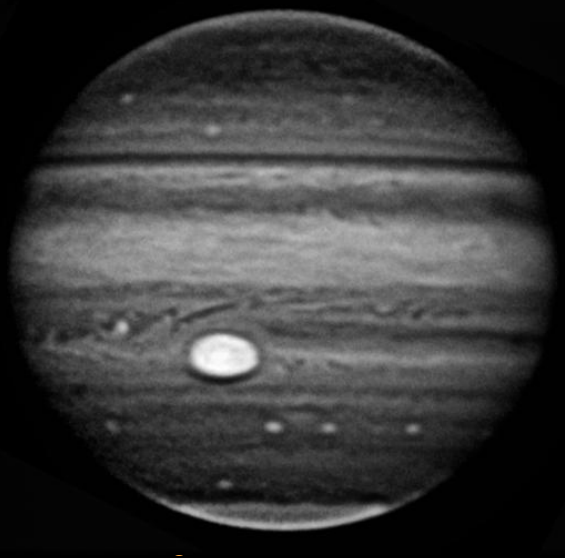


High-resolution observations: PlanetCam at Calar Alto 2.2m telescope

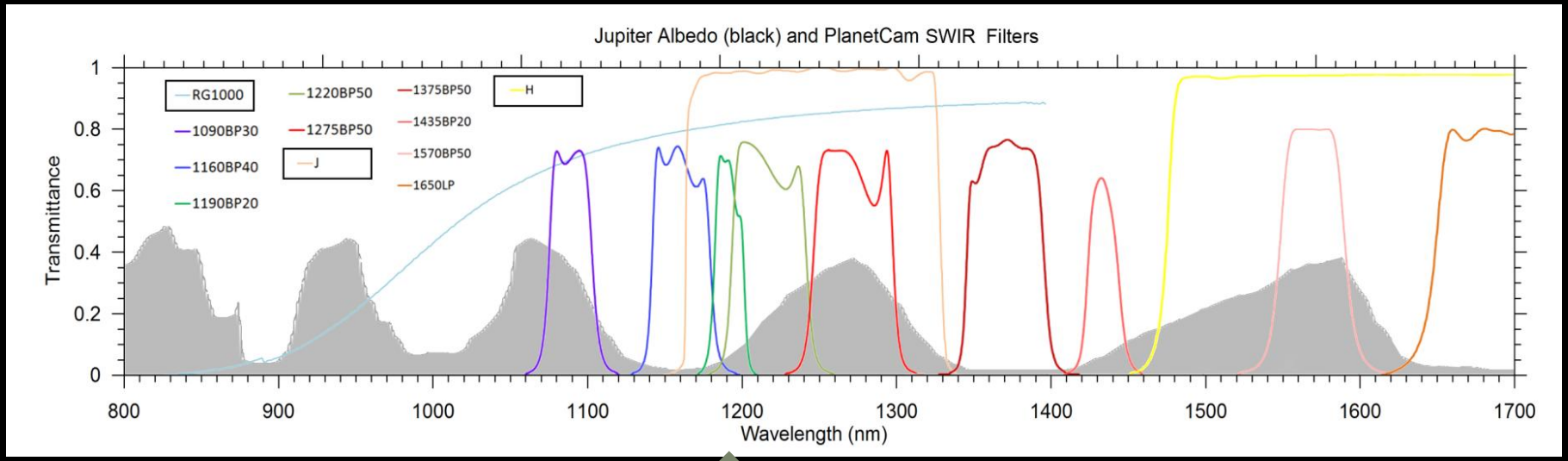
Date: 2016-03-04 Time: 00:46 UT | Filter: 1190BP20

Resolution: 0.088 arcsec/pixel





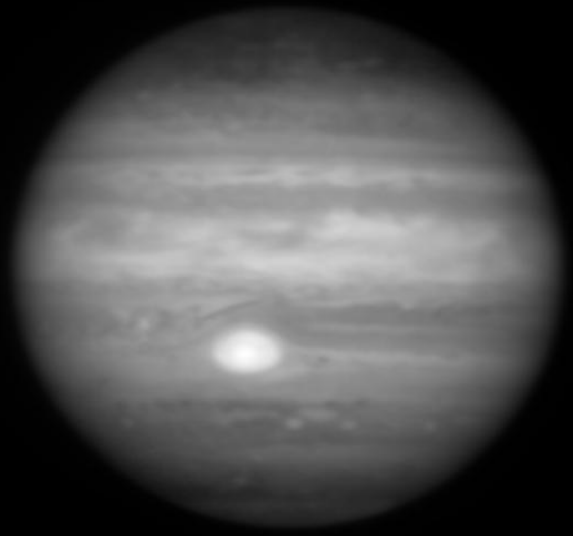
Photometric image (radiative transfer, cloud properties) Enhanced image for dynamics (morphology & winds)

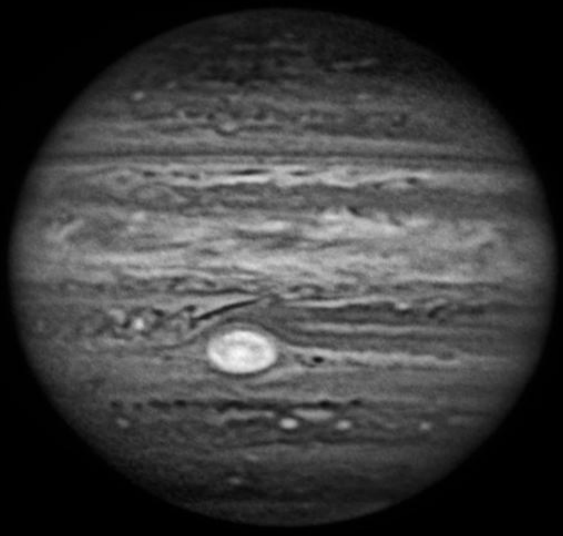


High-resolution observations: PlanetCam at Calar Alto 2.2m telescope

Date: 2016-03-04 Time: 00:48 UT | Filter: 1220BP50

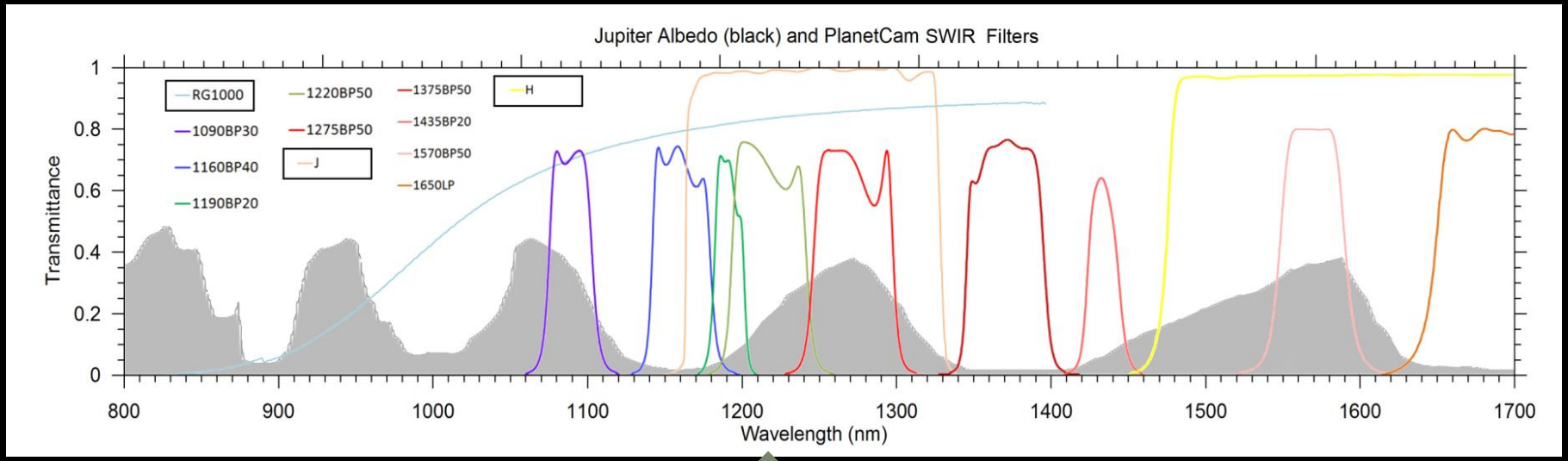
Resolution: 0.088 arcsec/pixel





Photometric image (radiative transfer, cloud properties)

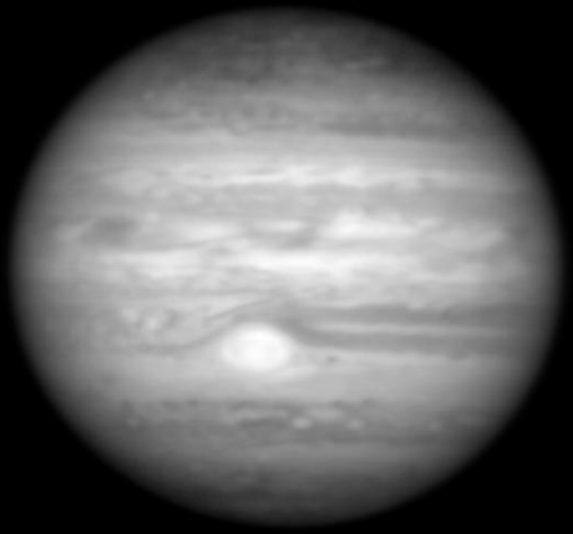
Enhanced image for dynamics (morphology & winds)



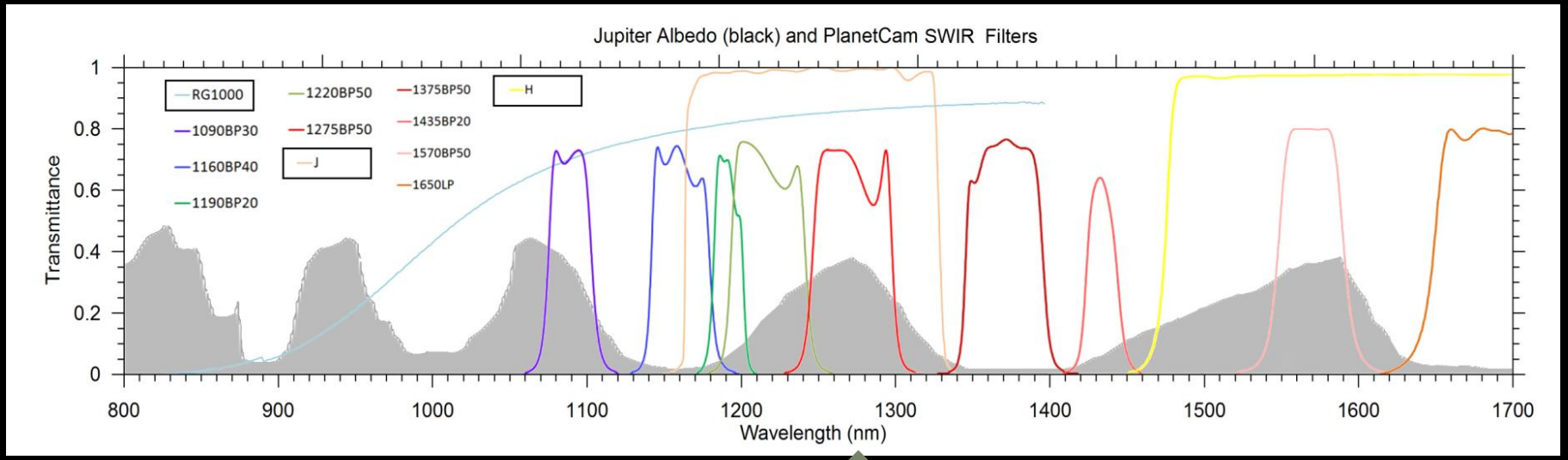
High-resolution observations: PlanetCam at Calar Alto 2.2m telescope

Date: 2016-03-04 Time: 00:54 UT | Filter: 1275BP50

Resolution: 0.088 arcsec/pixel



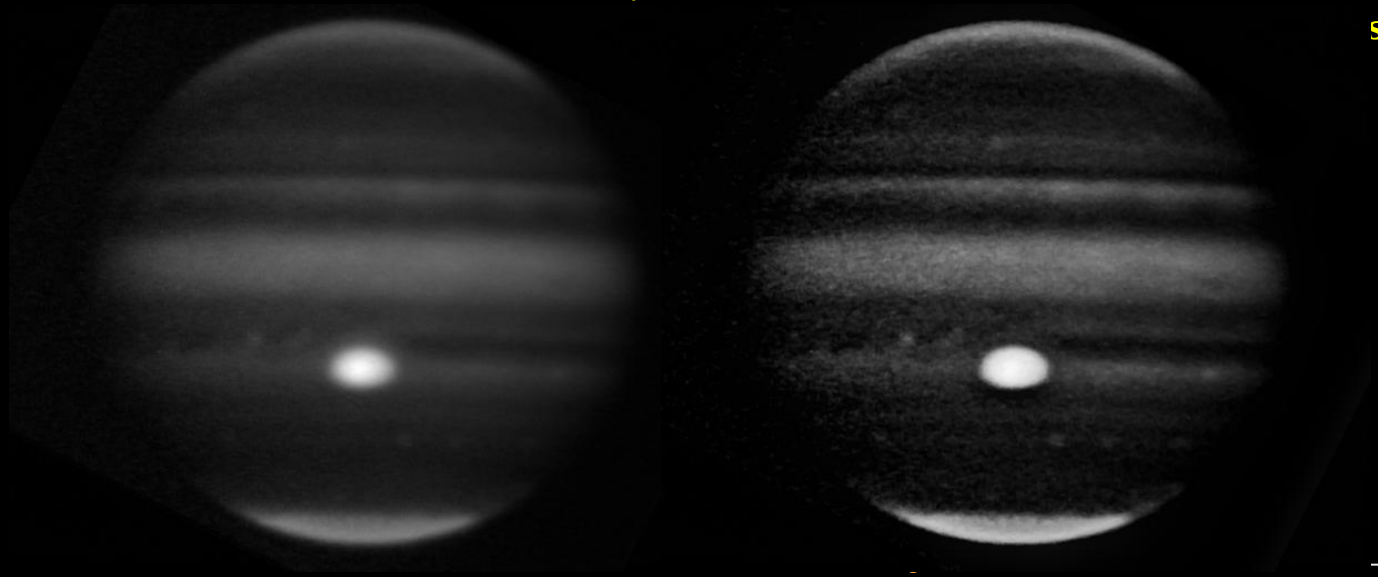
Photometric image (radiative transfer, cloud properties) **Enhanced image for dynamics (morphology & winds)**



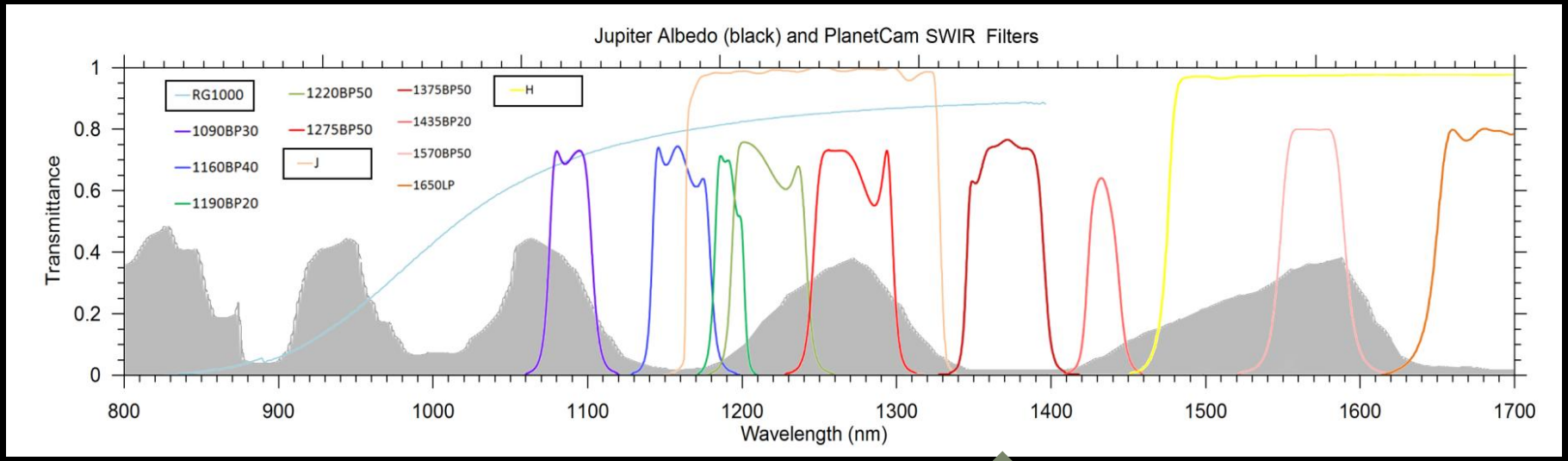
High-resolution observations: PlanetCam at Calar Alto 2.2m telescope

Date: 2016-03-04 Time: 01:06 UT | Filter: 1375BP50

solution: 0.088 arcsec/pixel



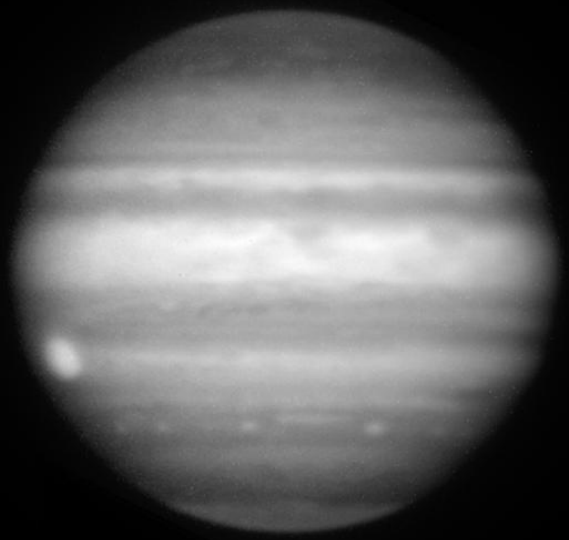
Photometric image (radiative transfer, cloud properties) Enhanced image for dynamics (morphology & winds)

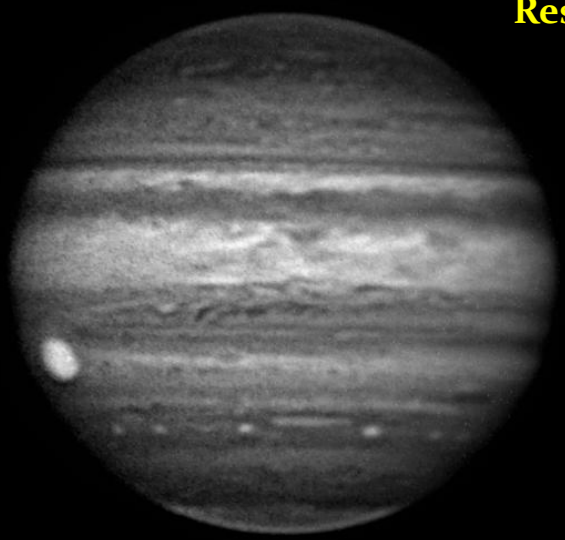


High-resolution observations: PlanetCam at Calar Alto 2.2m telescope

Date: 2016-03-03 Time: 23:28 UT | Filter: 1435BP20

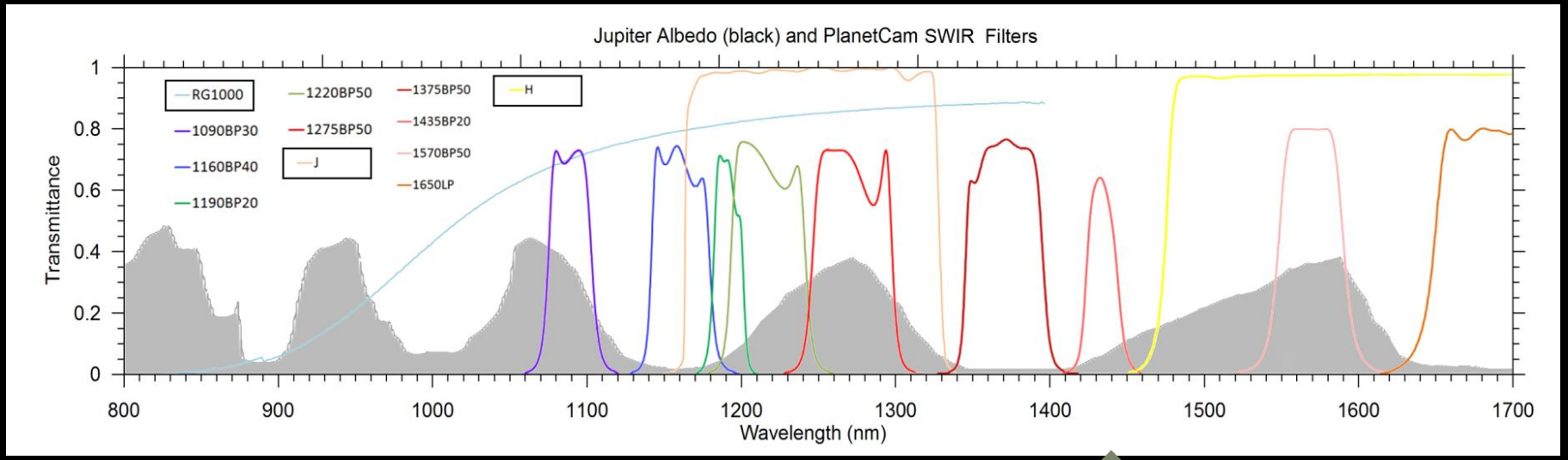
Resolution: 0.088 arcsec/pixel





Photometric image (radiative transfer, cloud properties)

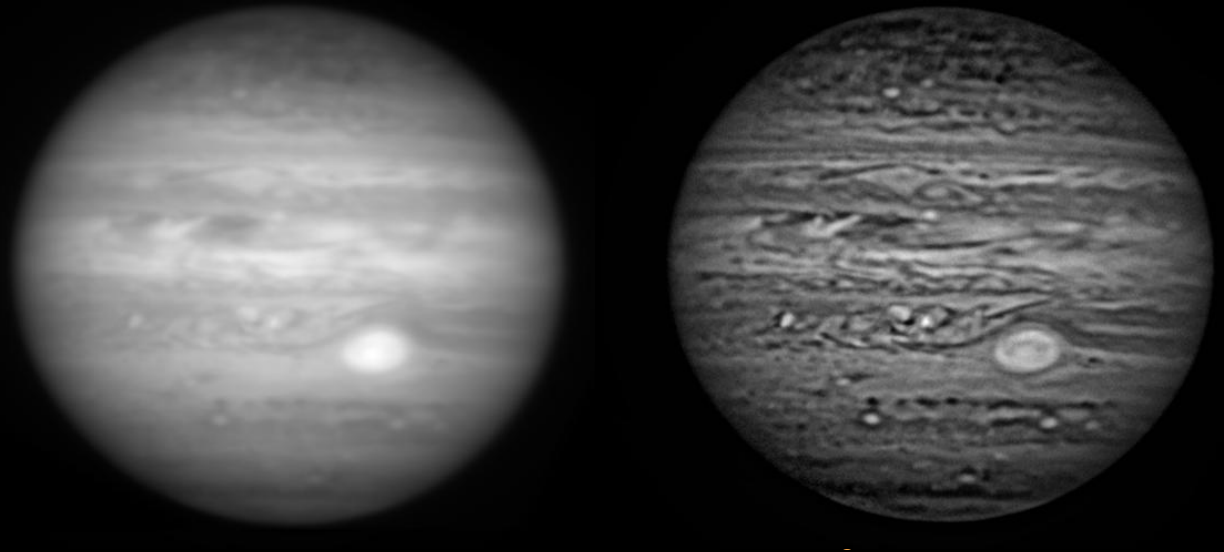
Enhanced image for dynamics (morphology & winds)



High-resolution observations: PlanetCam at Calar Alto 2.2m telescope

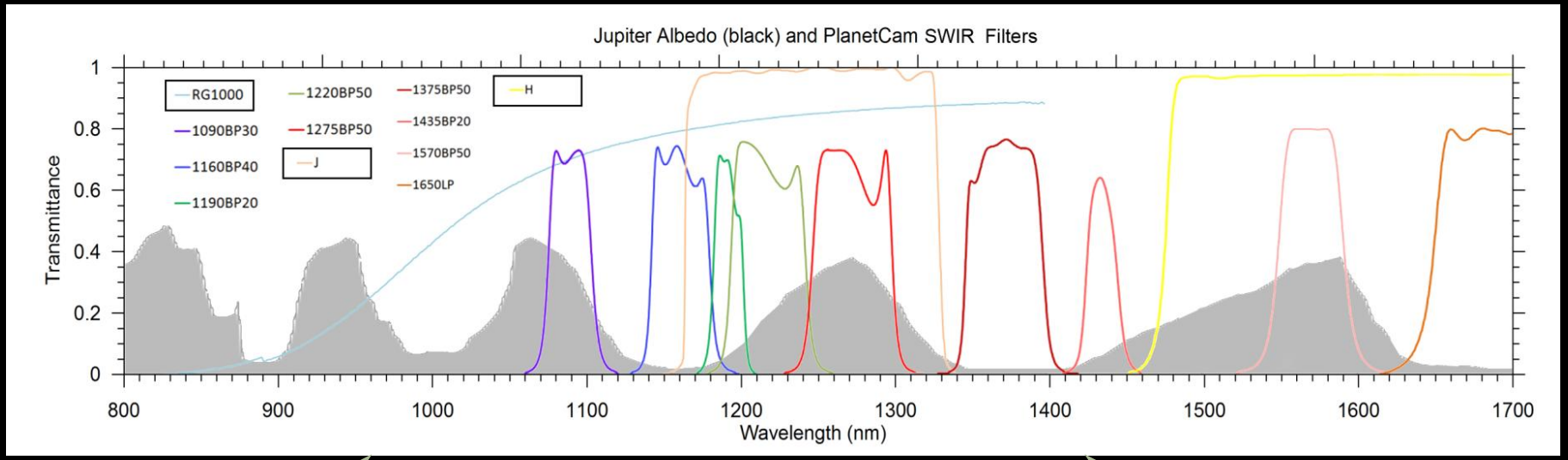
Date: 2016-03-04 Time: 01:39 UT | Filter: RG1000

Resolution: 0.088 arcsec/pixel



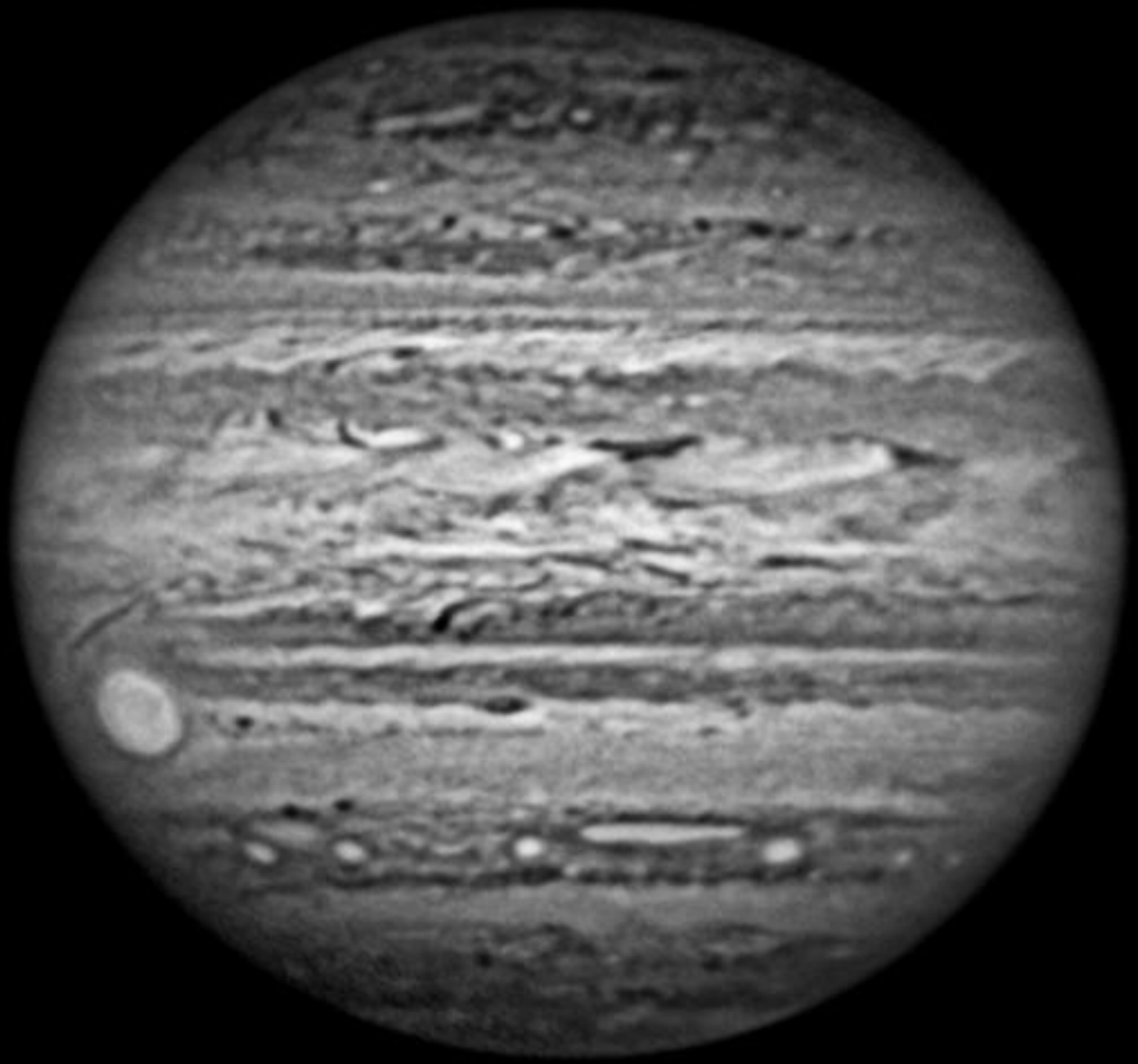
Photometric image (radiative transfer, cloud properties)

Enhanced image for dynamics (morphology & winds)



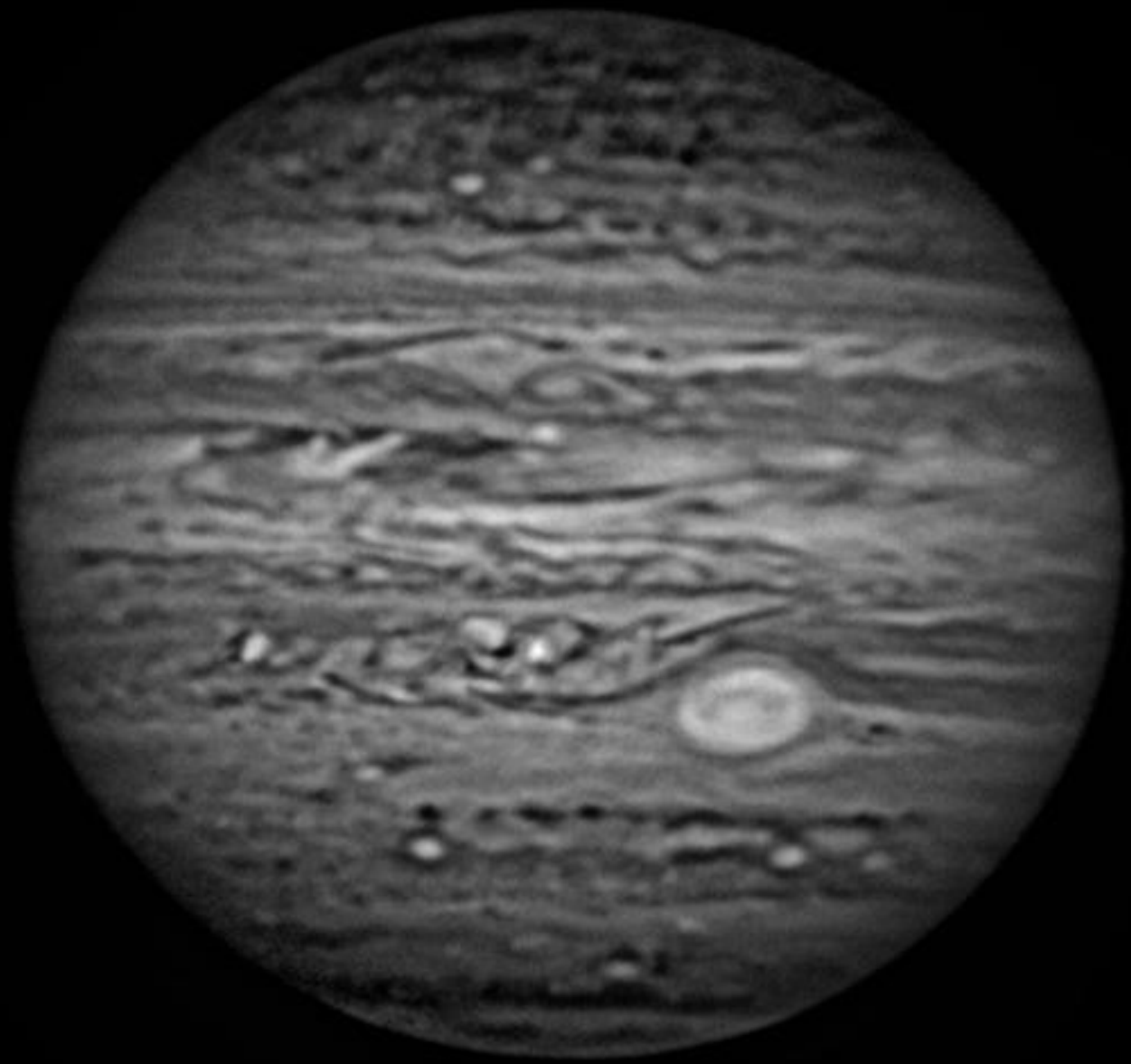
High-resolution observations: PlanetCam at Calar Alto 2.2m telescope

Date: 2016-03-03 Time: 23:32 UT | Filter: RG1000 Resolution: 0.088 arcsec/pixel



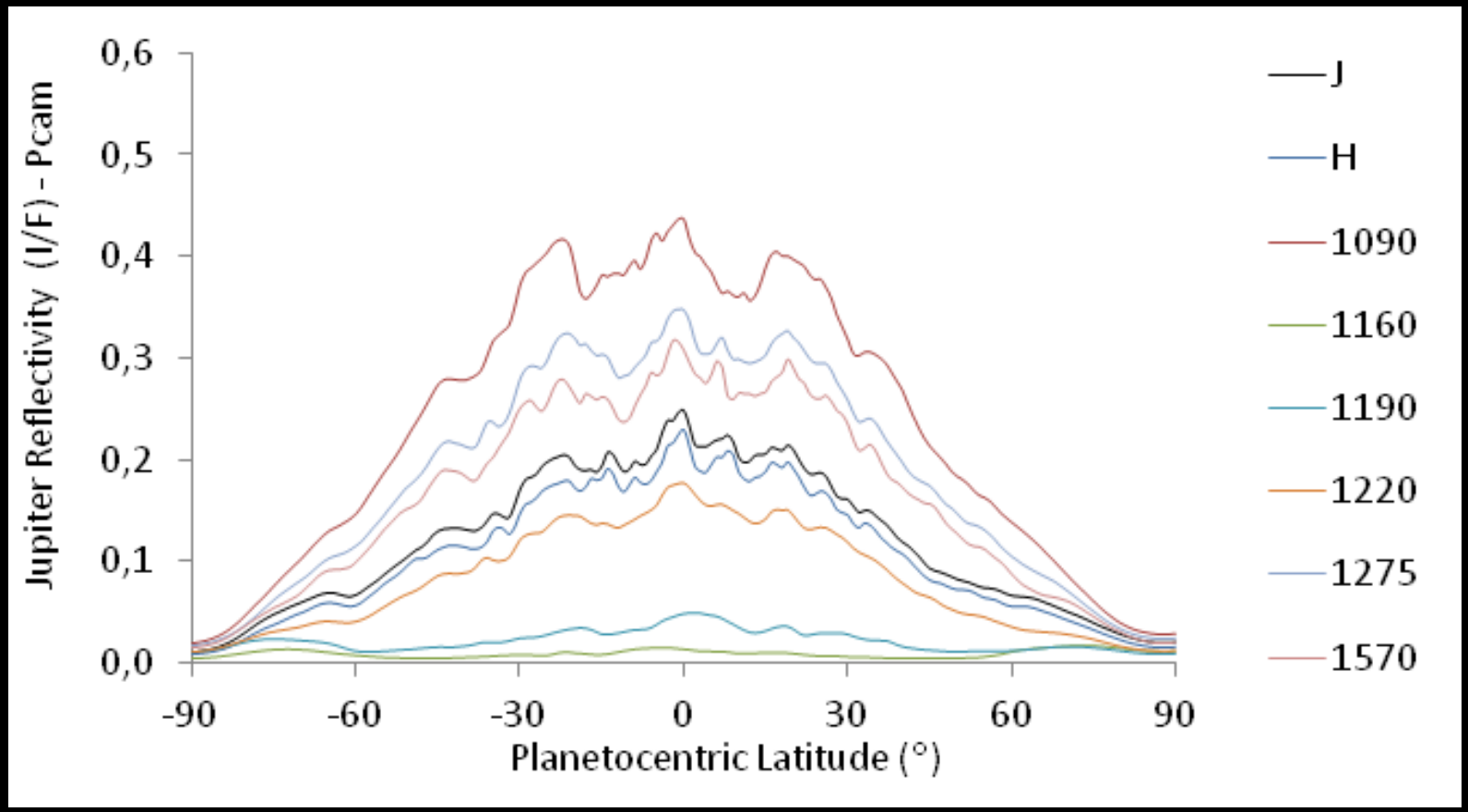
High-resolution observations: PlanetCam at Calar Alto 2.2m telescope

Date: 2016-03-04 Time: 01:39 UT | Filter: RG1000 Resolution: 0.088 arcsec/pixel



Photometry: SWIR channel (standard stars)

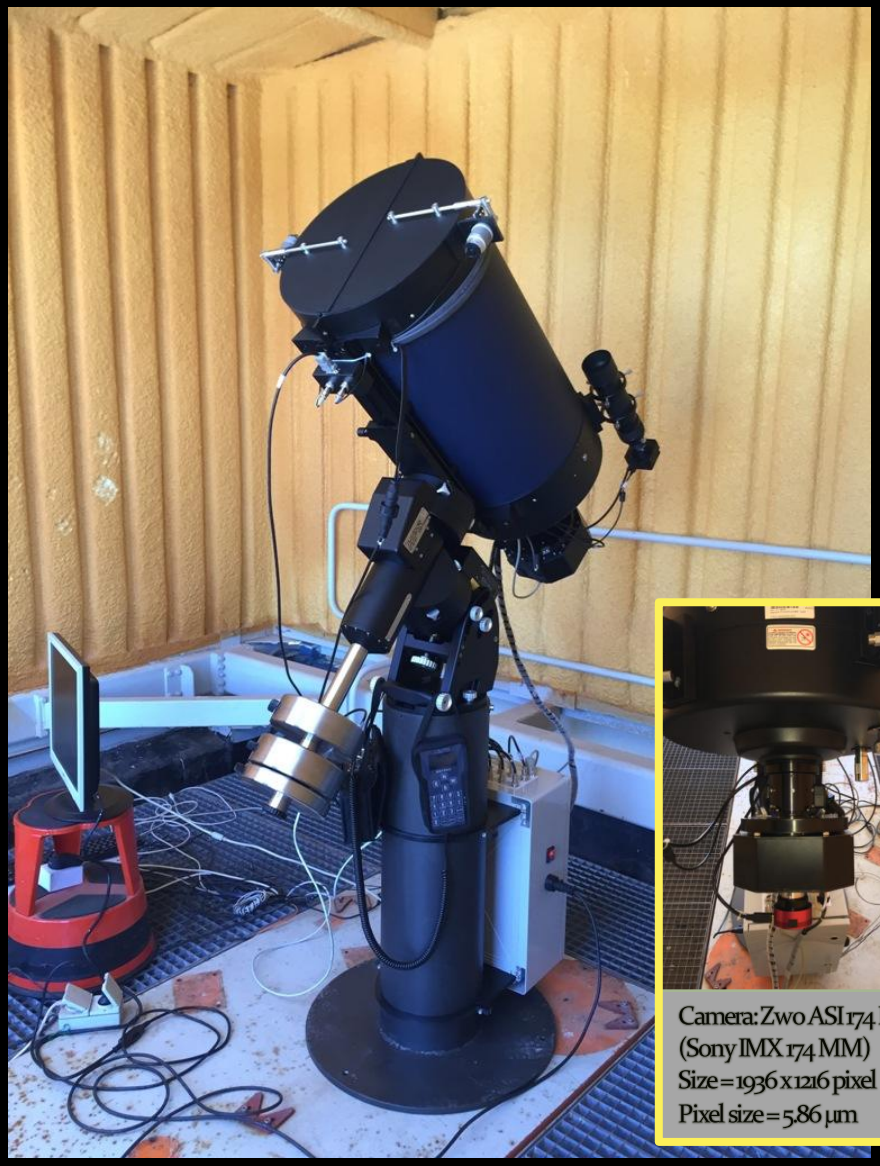
Absolute reflectivity (North-South scans)

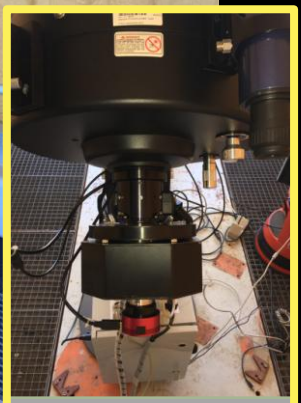


Support from small telescopes
Aula EspaZio

Meade 14" at Calar Alto Obs.: operated by remote control

LX200 - D = 35.6 cm @ f/10



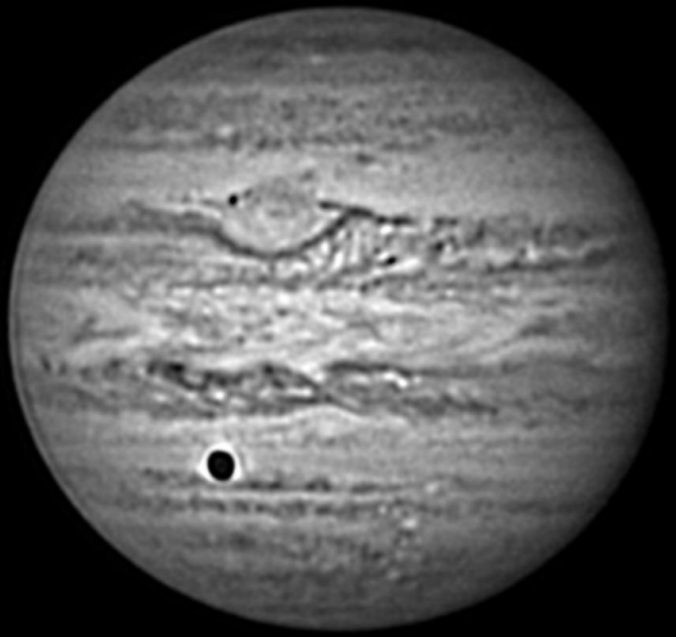


Camera: Zwo ASI 174 MM
(Sony IMX 174 MM)
Size = 1936 x 1216 pixel
Pixel size = 5.86 µm

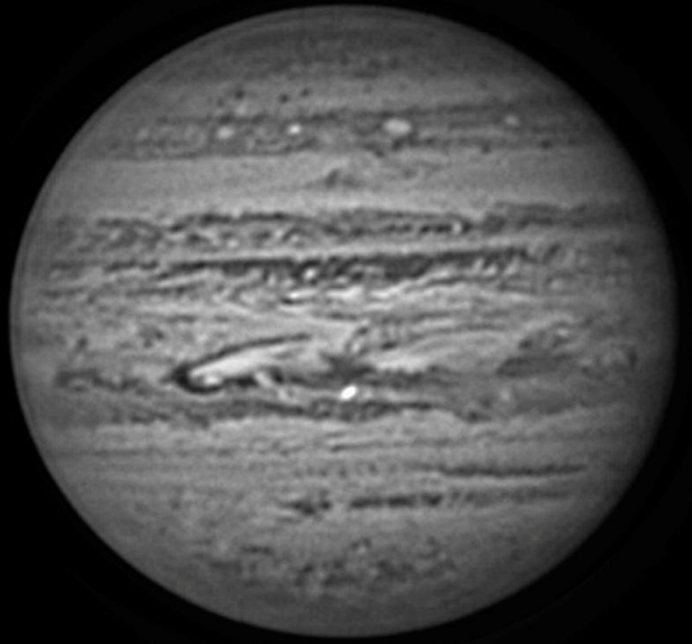
Celestron 11”
D = 28 cm @ f/10
(Getxo)

March 9, 2015
Barlow x3 - Filter R (> 610 nm)

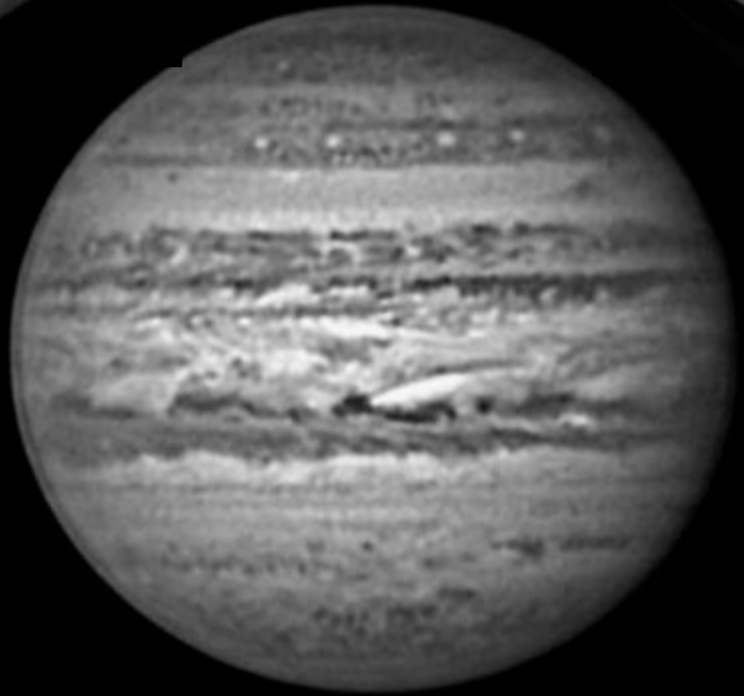
Additional support from Aula EspaZio Gela Observatory: Celestron 11”



April 28, 2016
Barlow x3 - Filter W21



May 2, 2016
Barlow x3 - Filter W21



May 4, 2016
Barlow x3 - Filter W21

Conclusions

- **Instruments :**

- PlanetCam (VIS-SWIR) is fully operative in both channels at the 1.23 m and 2.2 m Calar Alto Telescopes.

- A Meade 14" planetary dedicated telescope at Calar Alto Obs. is expected to have first light in May-June 2016, operated by remote control (Aula EspaZio)

- Complementary support provided by a Celestron 11" (Aula EspaZio)

- Occasional observations with Astralux camera (Visible range) at the 2.2 m telescope

- **Jupiter science:**

→ Cloud morphology evolution & winds → dynamics

→ Cloud-aerosol properties, chromophore agents and vertical structure (radiative transfer analysis)

→ Impact survey

Thank you for your attention