EXPLORATION OF JUPITER

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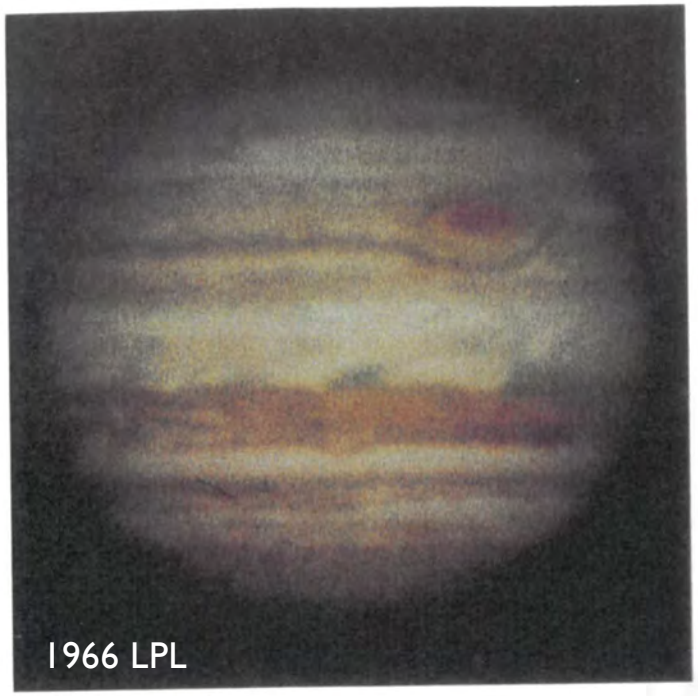
50 Years of Discovery Since Apollo

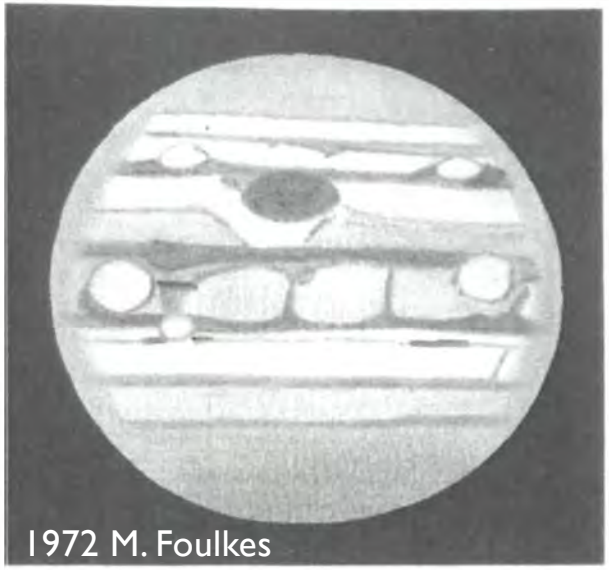
NASA/JPL-Caltech/SSI/SwRI/MSSS/ASI/INAF/JIRAM/Björn Jónsson

JUPITER BEFORE APOLLO

Ground-based monitoring of weather



(2) 1966 Dec 23. LPL.

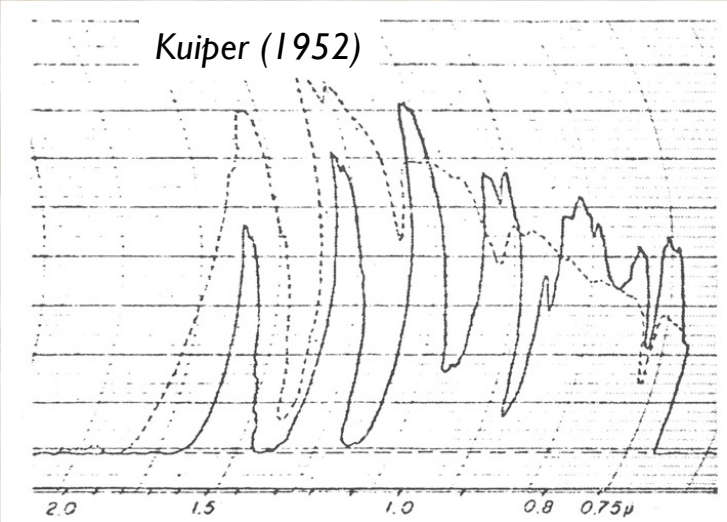


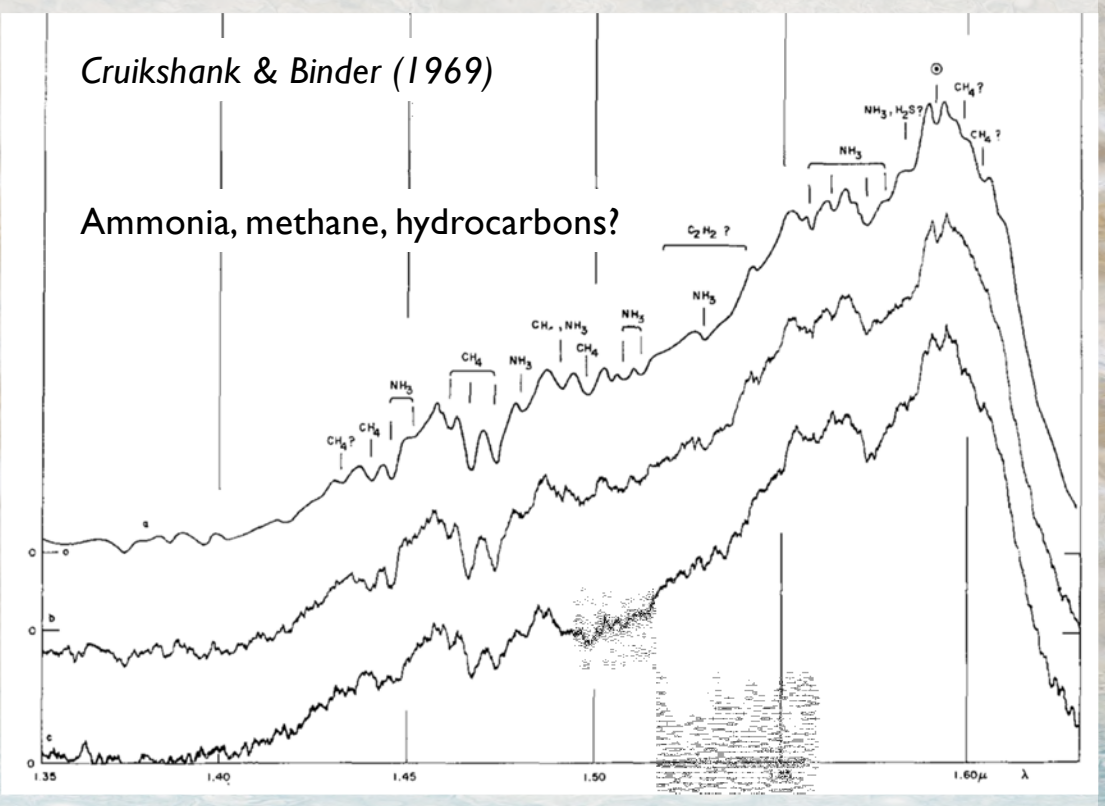
(3) 1972 Jul 13, ω_2 7. M. Foulkes (England). SEB(S) fading again, with orange shading across EZ and SEB, and GRS still dark red. Large light spots spanning SEB(N) and NEB(S).

Giant Planet Jupiter by John Rogers

JUPITER BEFORE APOLLO

Spectra showed atmospheric constituents

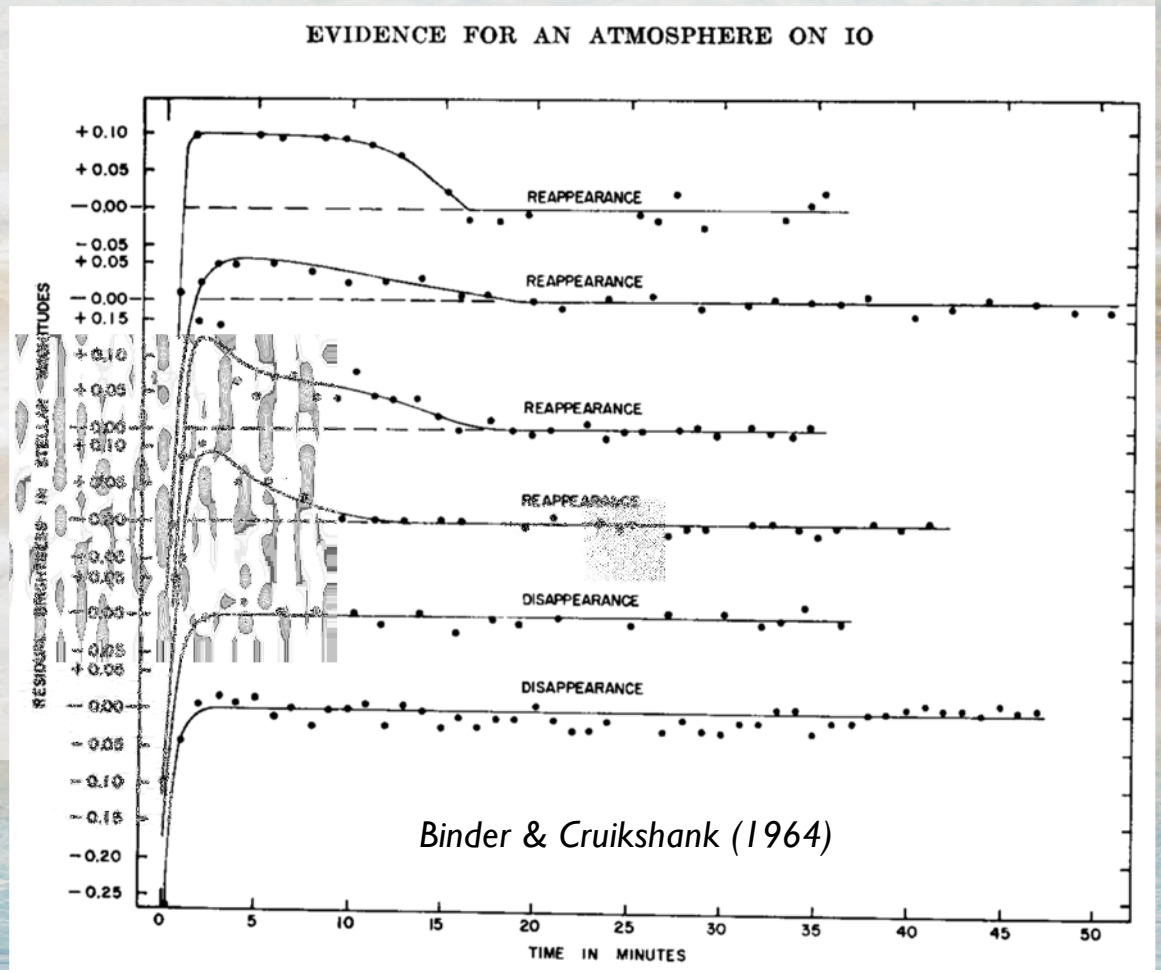




JUPITER BEFORE APOLLO

1969 only 11 moons!

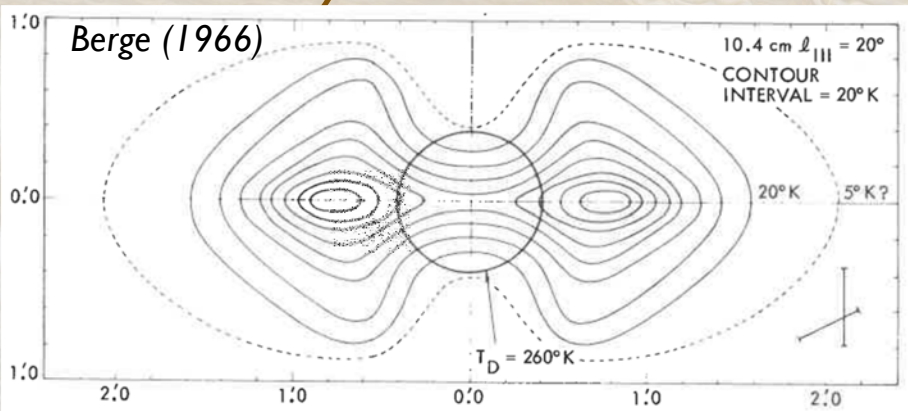
Post-eclipse brightening of Io – evidence of frost?



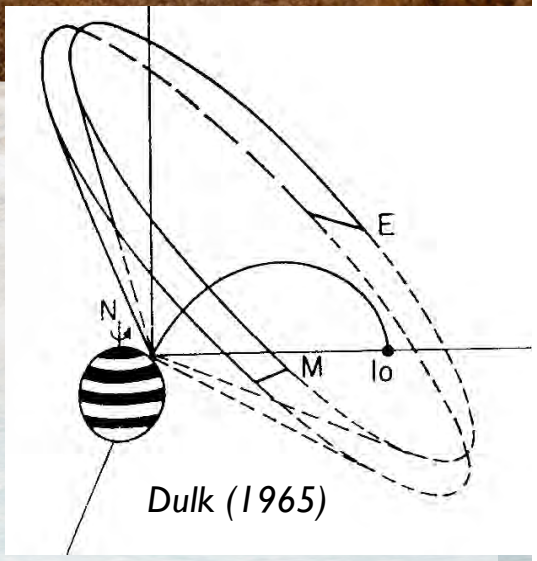
JUPITER BEFORE APOLLO

Hints of Jupiter's Magnetosphere

- Decametric Radio Bursts1955
- Decimetric Synchrotron Emission1959



Radio Bursts Triggered by Io!

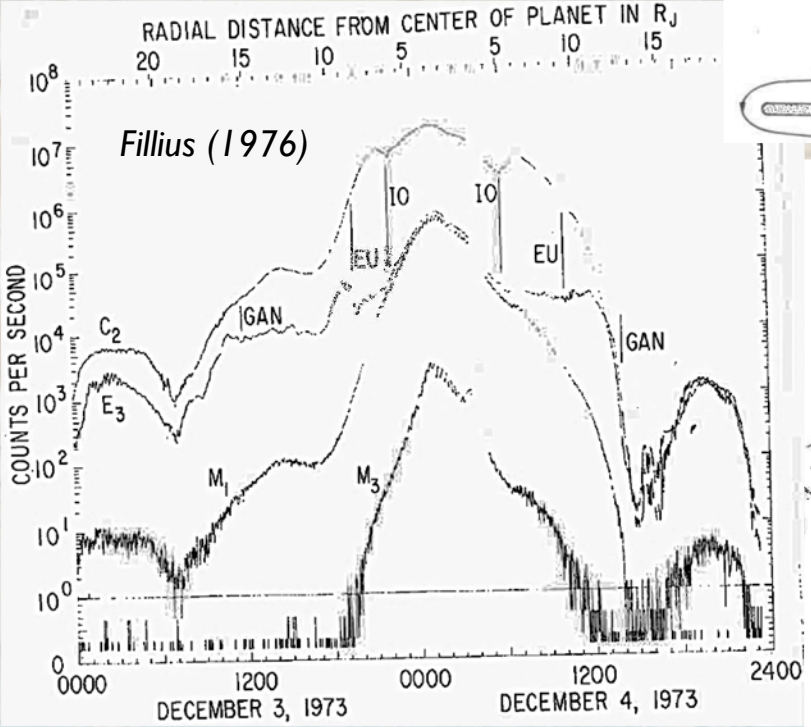


Jupiter has Magnetic Field Trapping Electrons

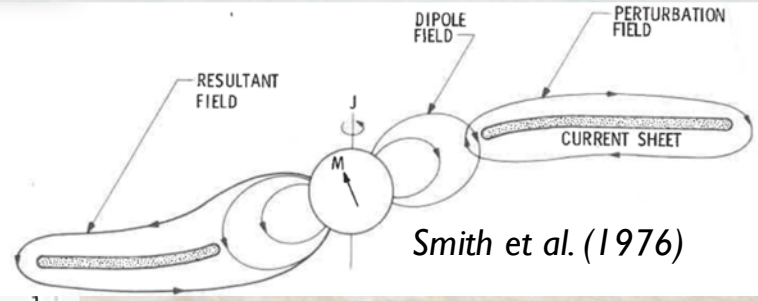
Pioneer 10 Dec 1973 & 11 Dec 1974

Magnetosphere

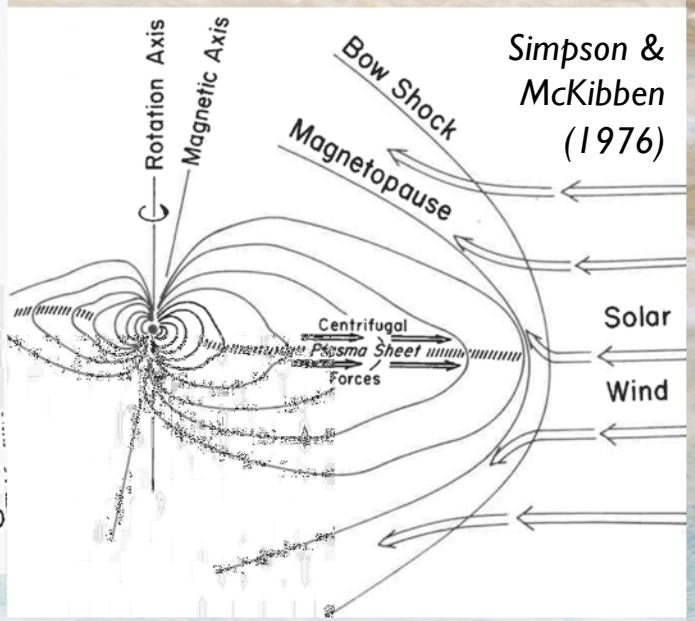
- Size=huge
- Rotation dominated
- Strong radiation Belts
- Satellite absorption



Fillius (1976)



Smith et al. (1976)

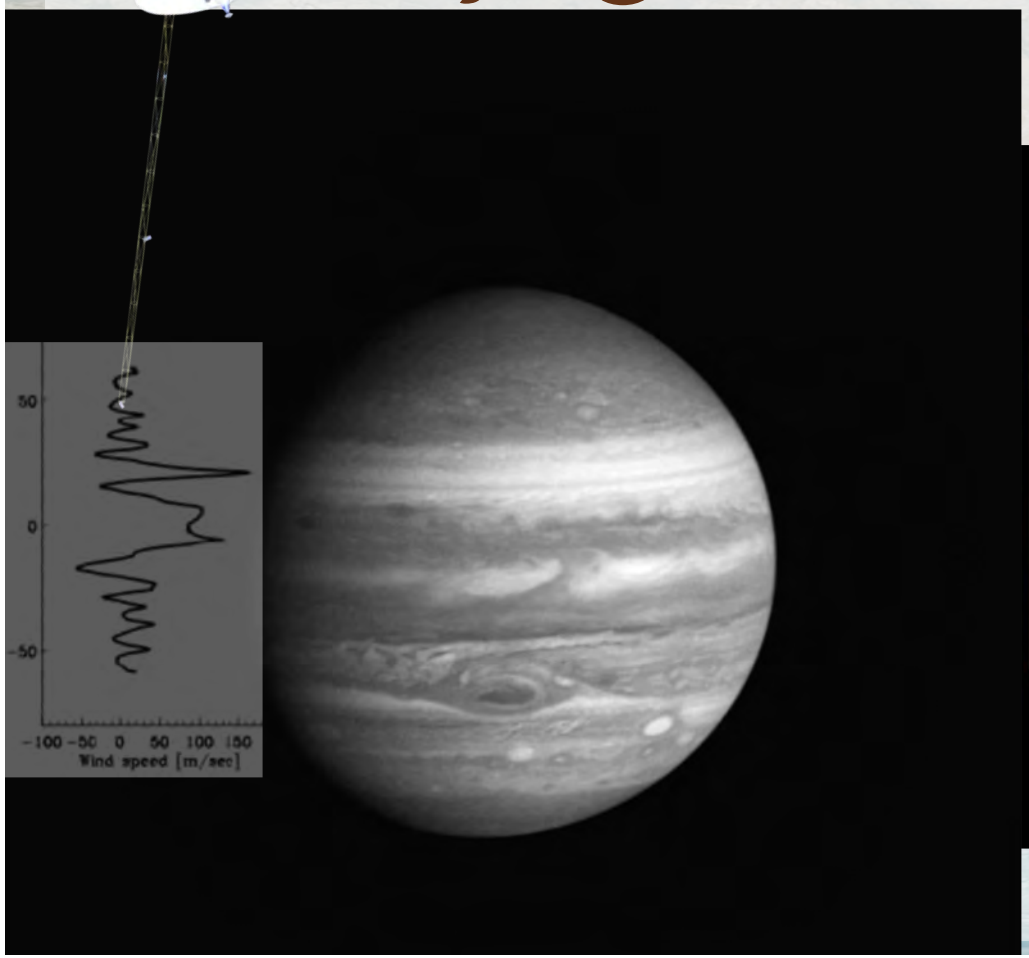


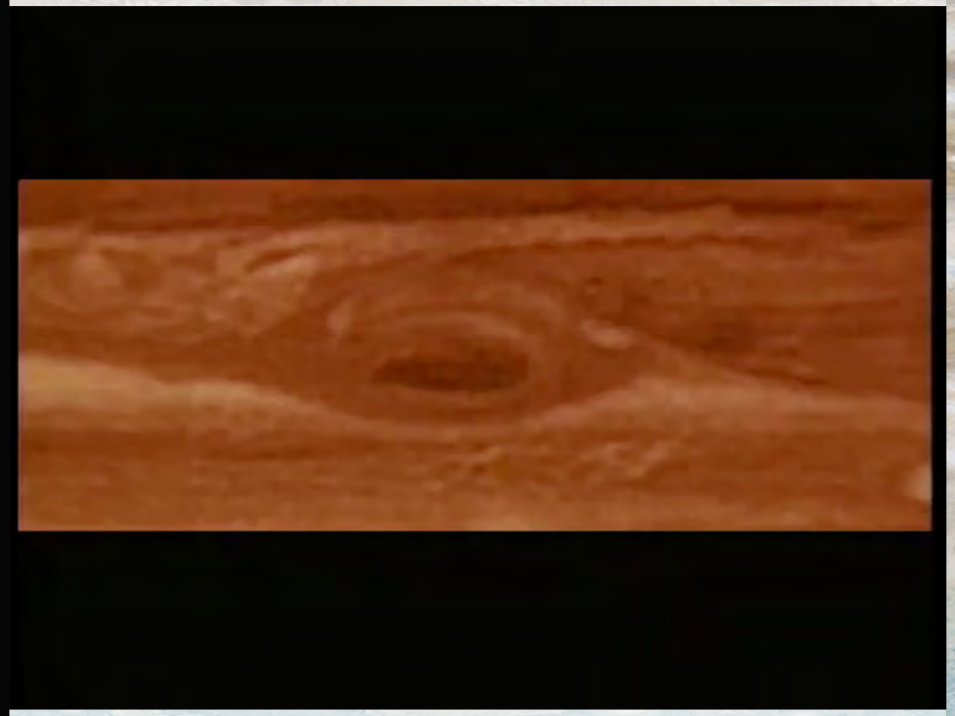
Simpson & McKibben (1976)

Pioneer 10 Dec 1973 & 11 Dec 1974

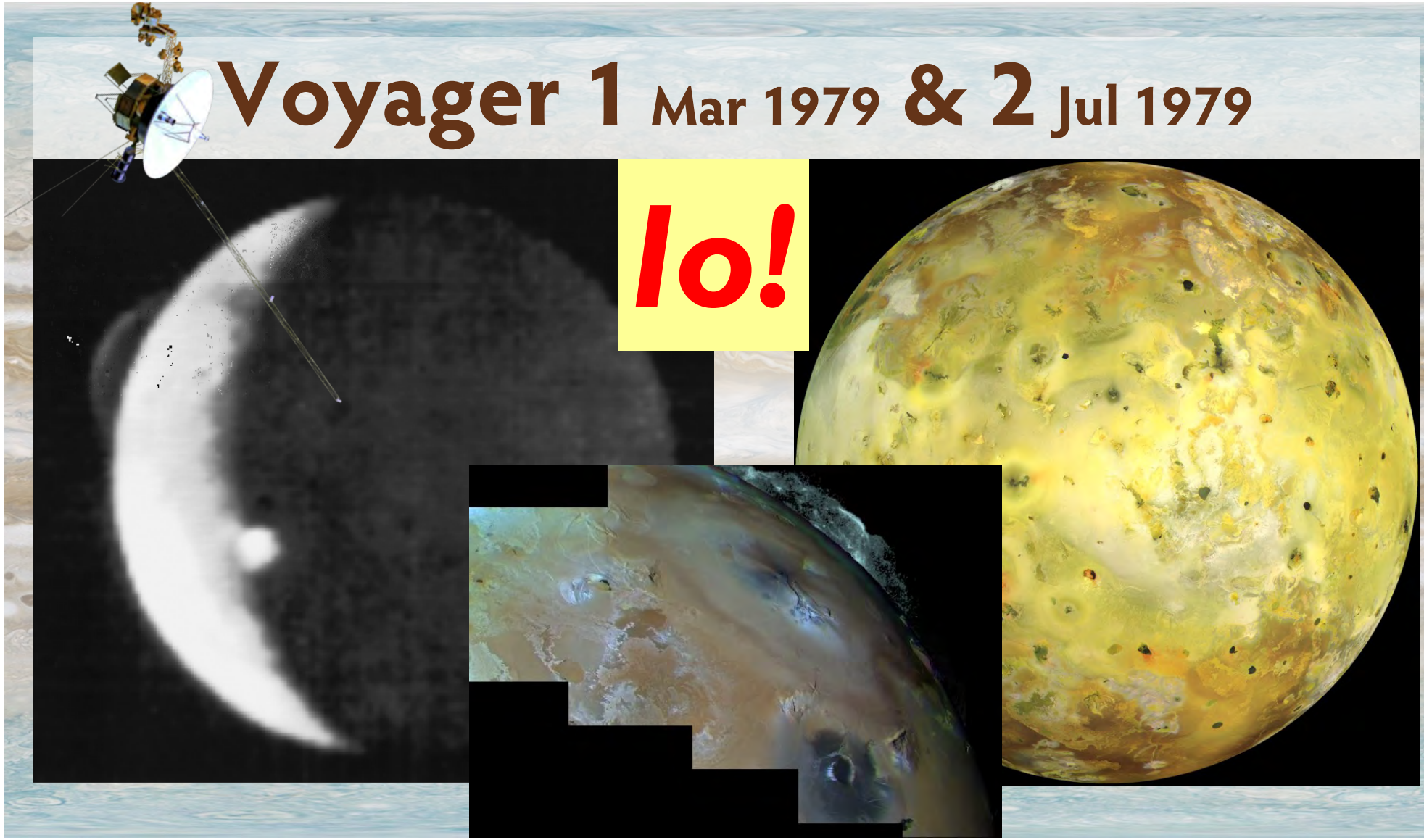
Voyager 1 Mar 1979 & 2 Jul 1979

Atmosphere Dynamics





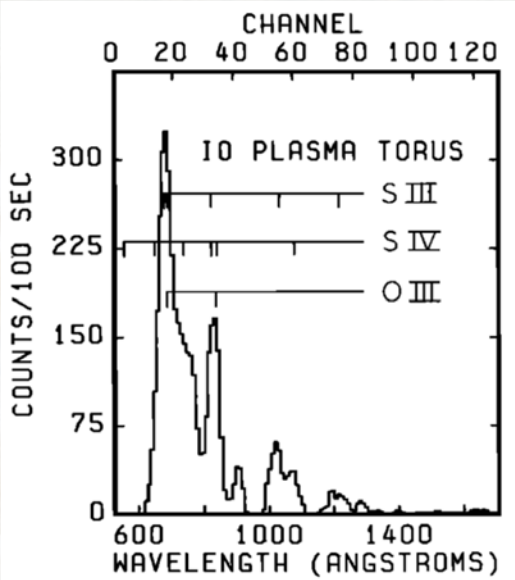
Voyager 1 Mar 1979 & 2 Jul 1979



Telescopes & Voyager- Io Plasma Torus

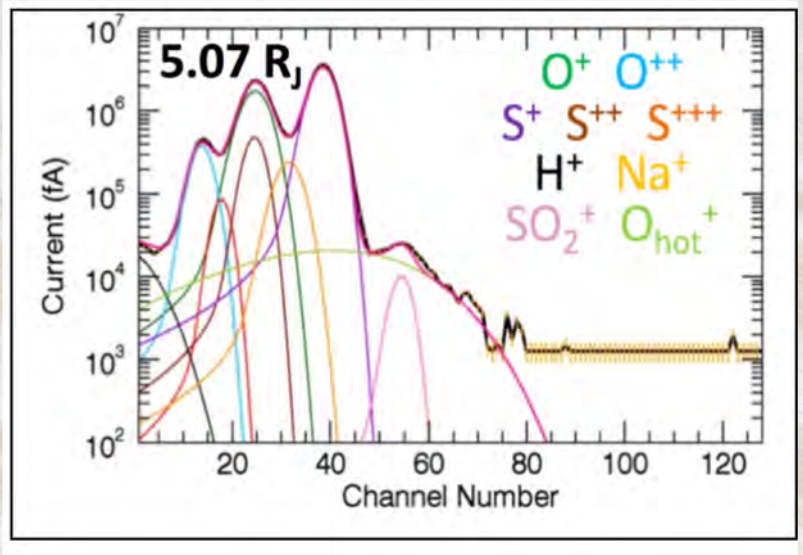
Voyager UVS Ion Emission

Broadfoot et al. (1979)



Voyager PLS In situ Ions

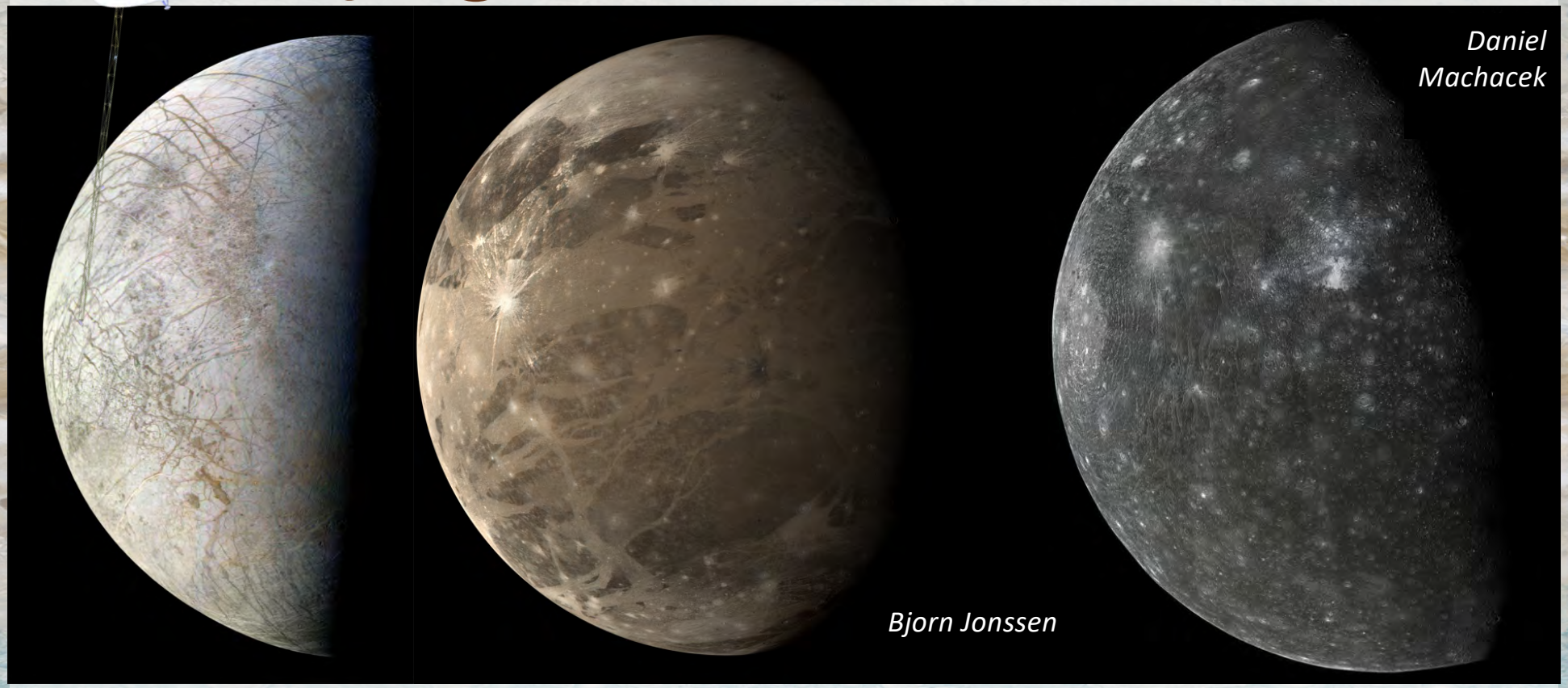
Bridge et al. (1979)



S^+ optical emission

First observed Kupo et al. (1976)

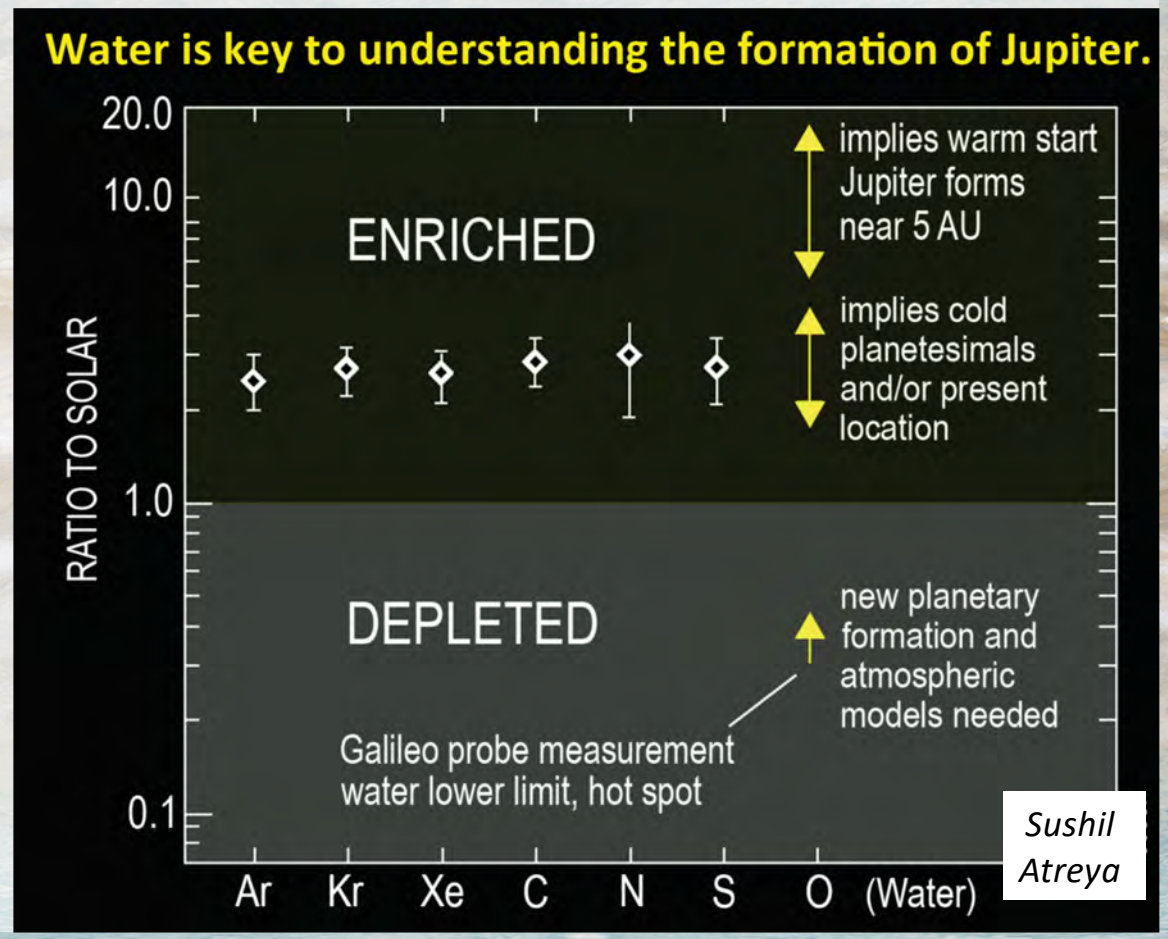
Voyager 1 Mar 1979 & 2 Jul 1979



Europa Ganymede Callisto

Galileo Probe Dec 1995

- Lack of Water
  - Local?
  - Global?

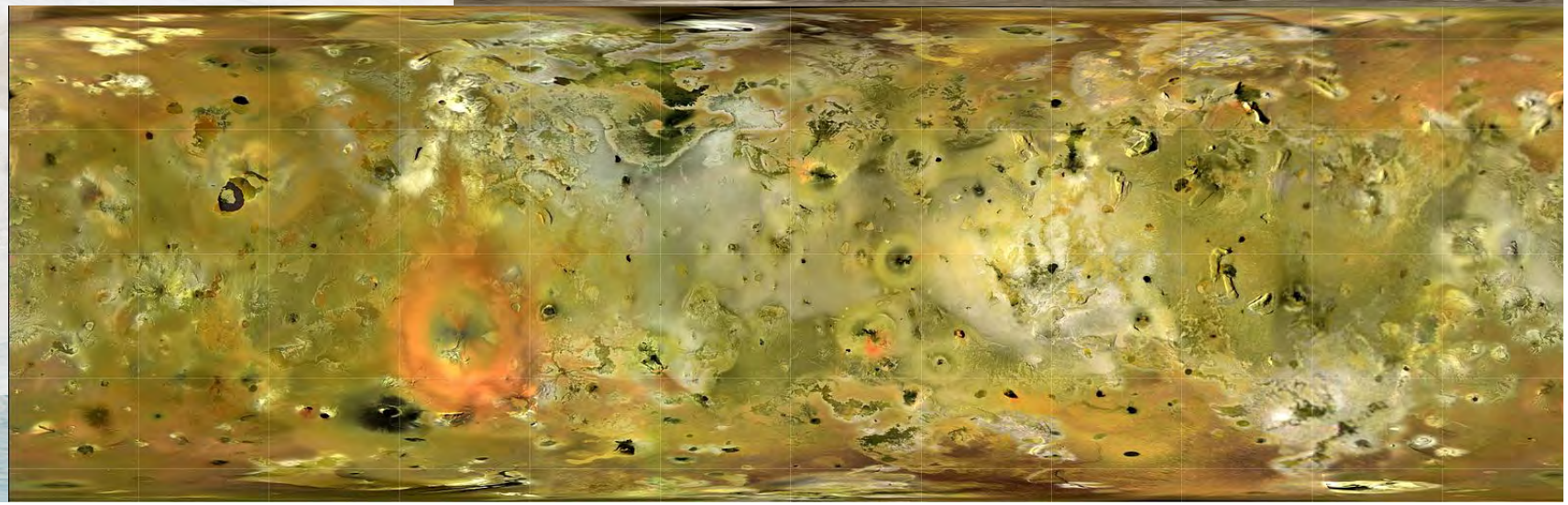


Sushil Atreya

Galileo

34 orbits:
Mar 1995 – Sep2003

Maps of Callisto & Io

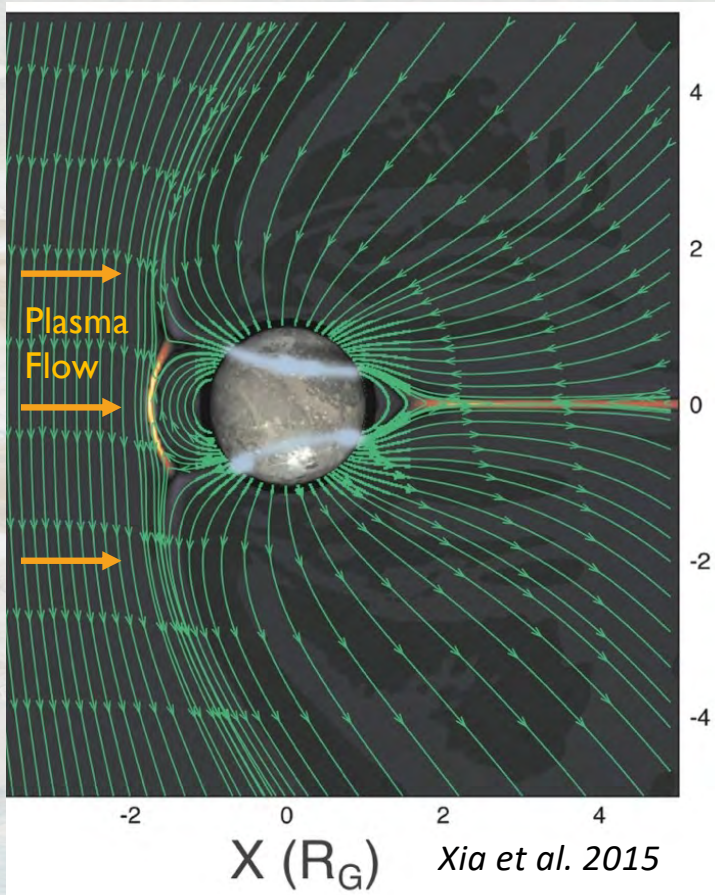


USGS

Galileo 34 orbits: Mar 1995 – Sep2003

Ganymede Magnetic Field!

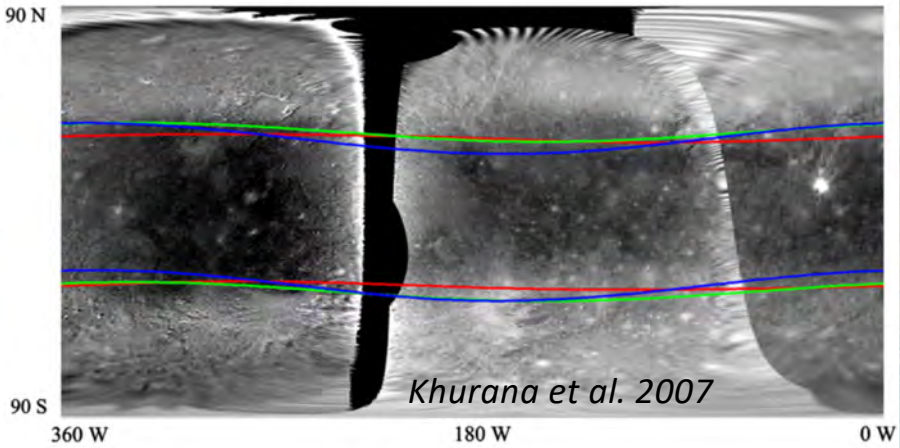
Kivelson et al. 1996



Xia et al. 2015

HST
O emission
UV aurora

McGrath et al. 2013



Khurana et al. 2007

Galileo 34 orbits: Mar 1995 – Sep2003

Europa

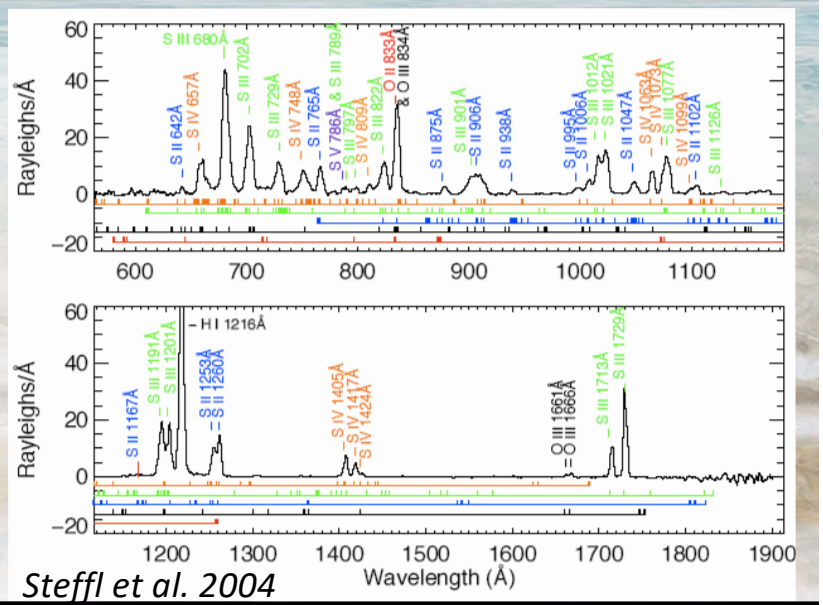
- High resolution images
- Ocean detected via currents

NASA/JPL/SETI Institute

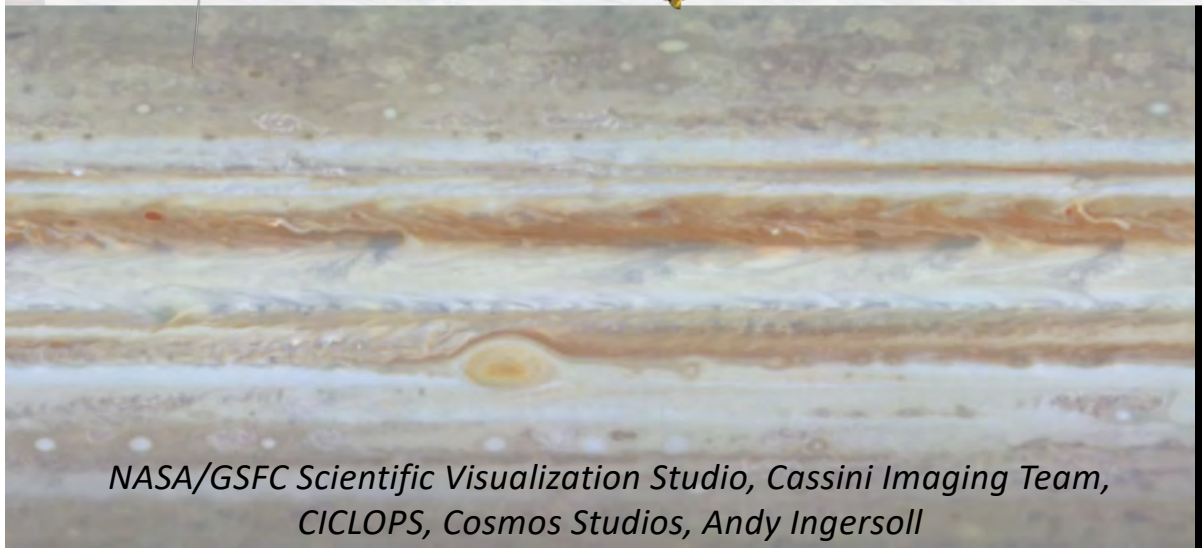
Cassini Dec 2000

Gravity assist flyby

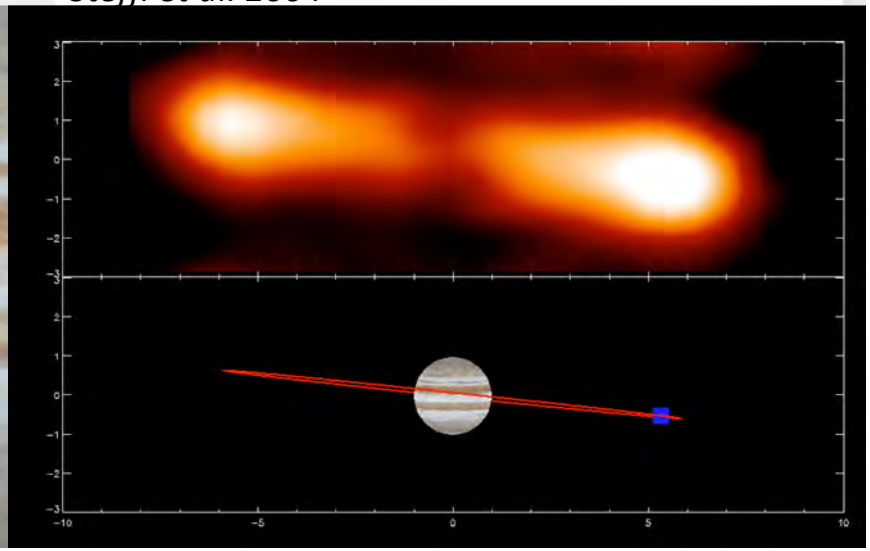
- High resolution cloud movie
- UVIS variations of Io Plasma Torus

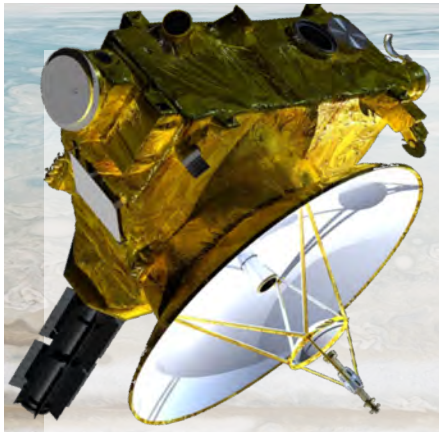


Steffl et al. 2004



NASA/GSFC Scientific Visualization Studio, Cassini Imaging Team, CICLOPS, Cosmos Studios, Andy Ingersoll

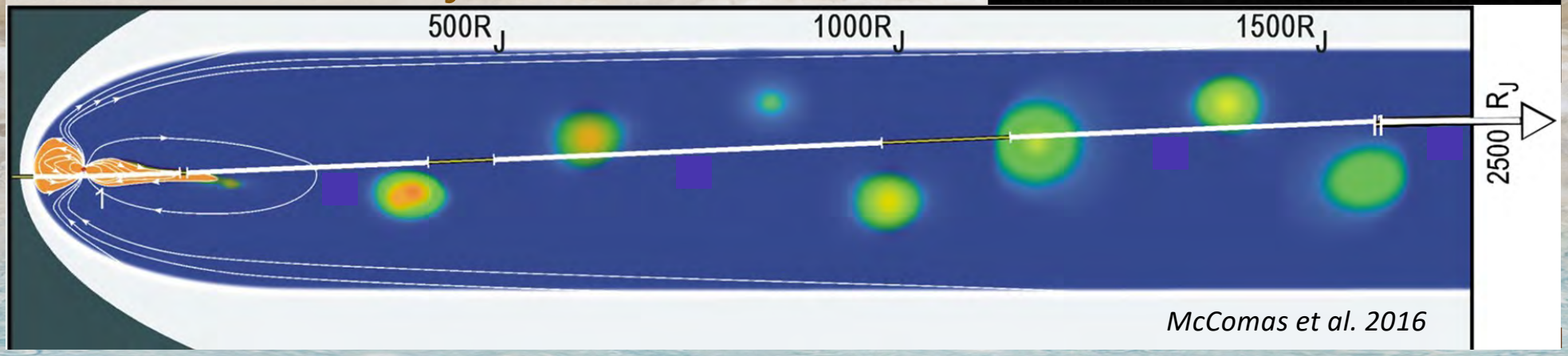


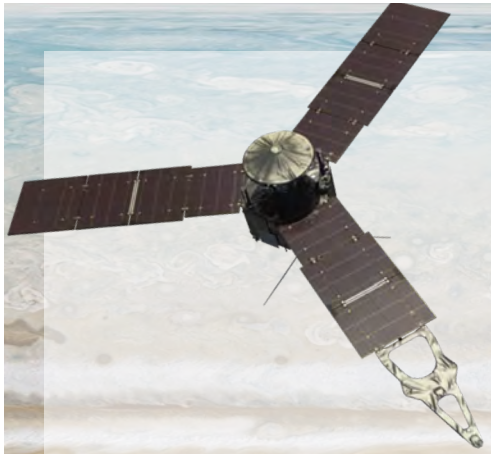


New Horizons

Feb 2007

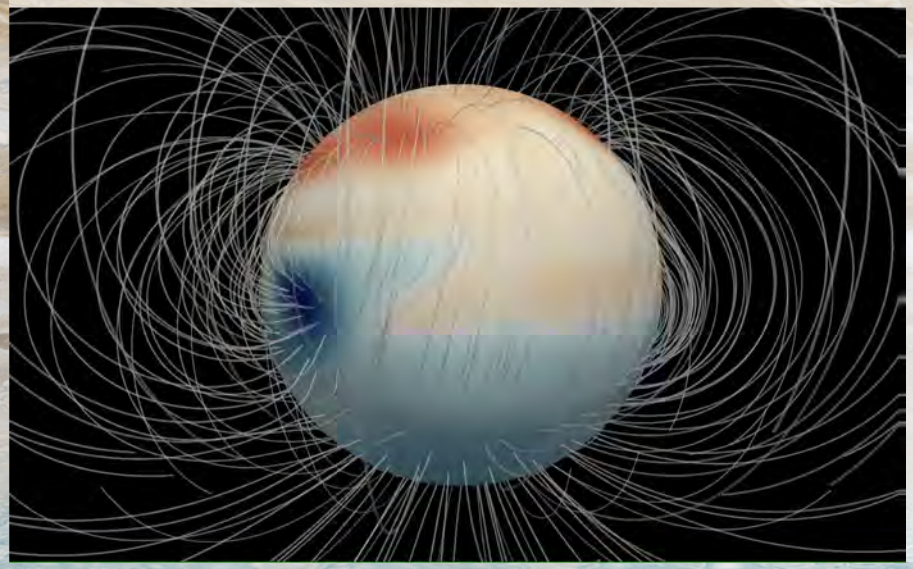
- Tvashtar volcanic eruption
- Passed 2500 R_J down magnetotail



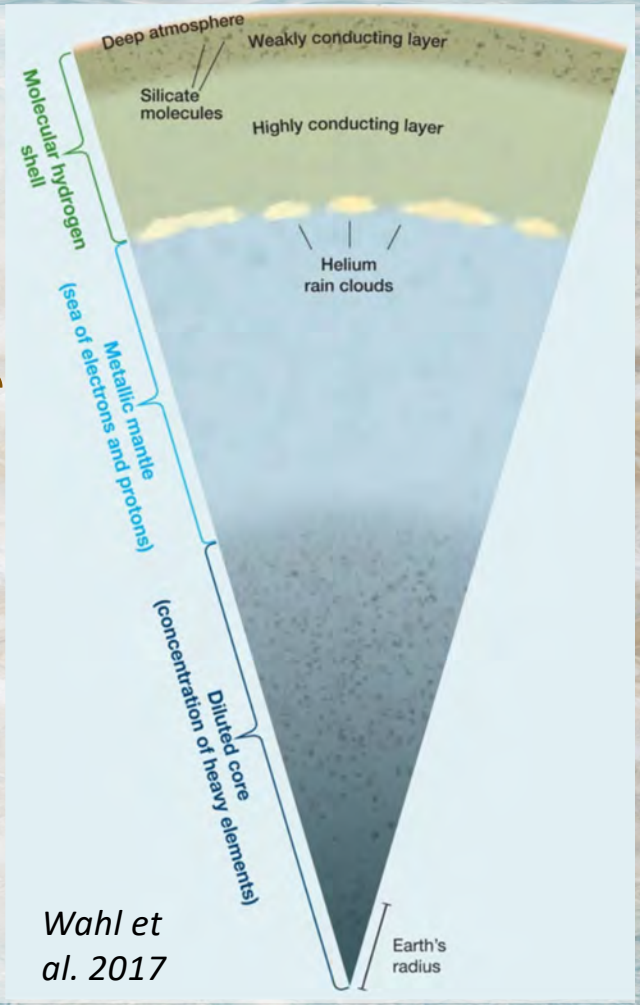


Juno Jul 2016+

- Gravity: core diluted heavy elements mixed
- Magnetic field structure



Connerney et al. 2018
Moore et al. 2018



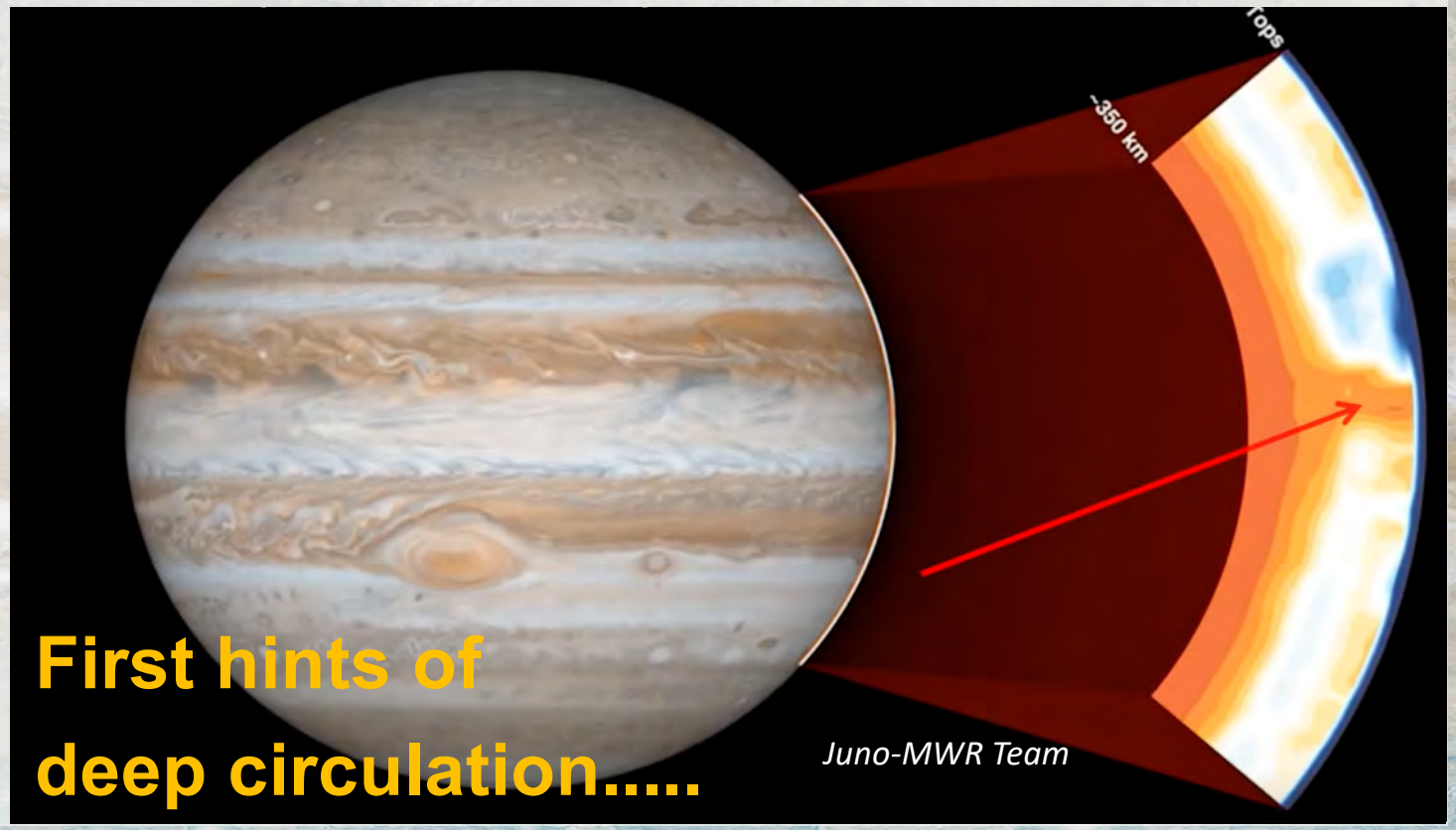
Wahl et al. 2017

Juno Jul 2016+

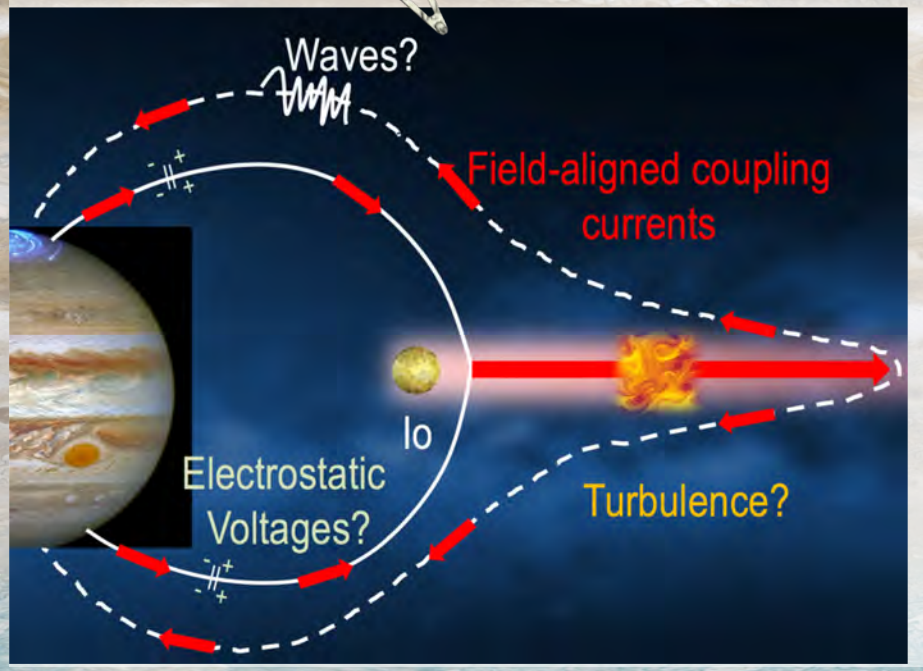
NH_3 Concentration

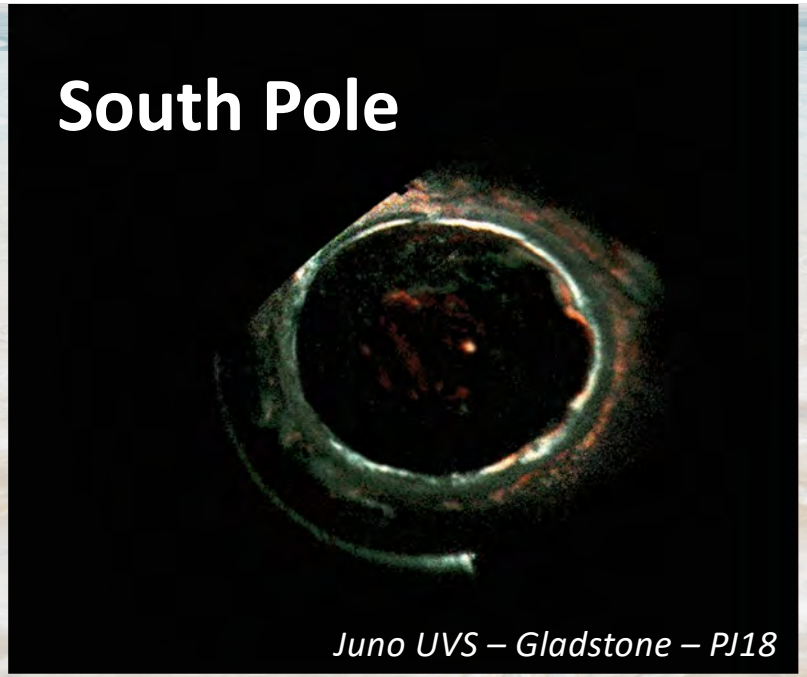
- Deep convection
- It's complicated!
- Water next....

Juno-MWR Team



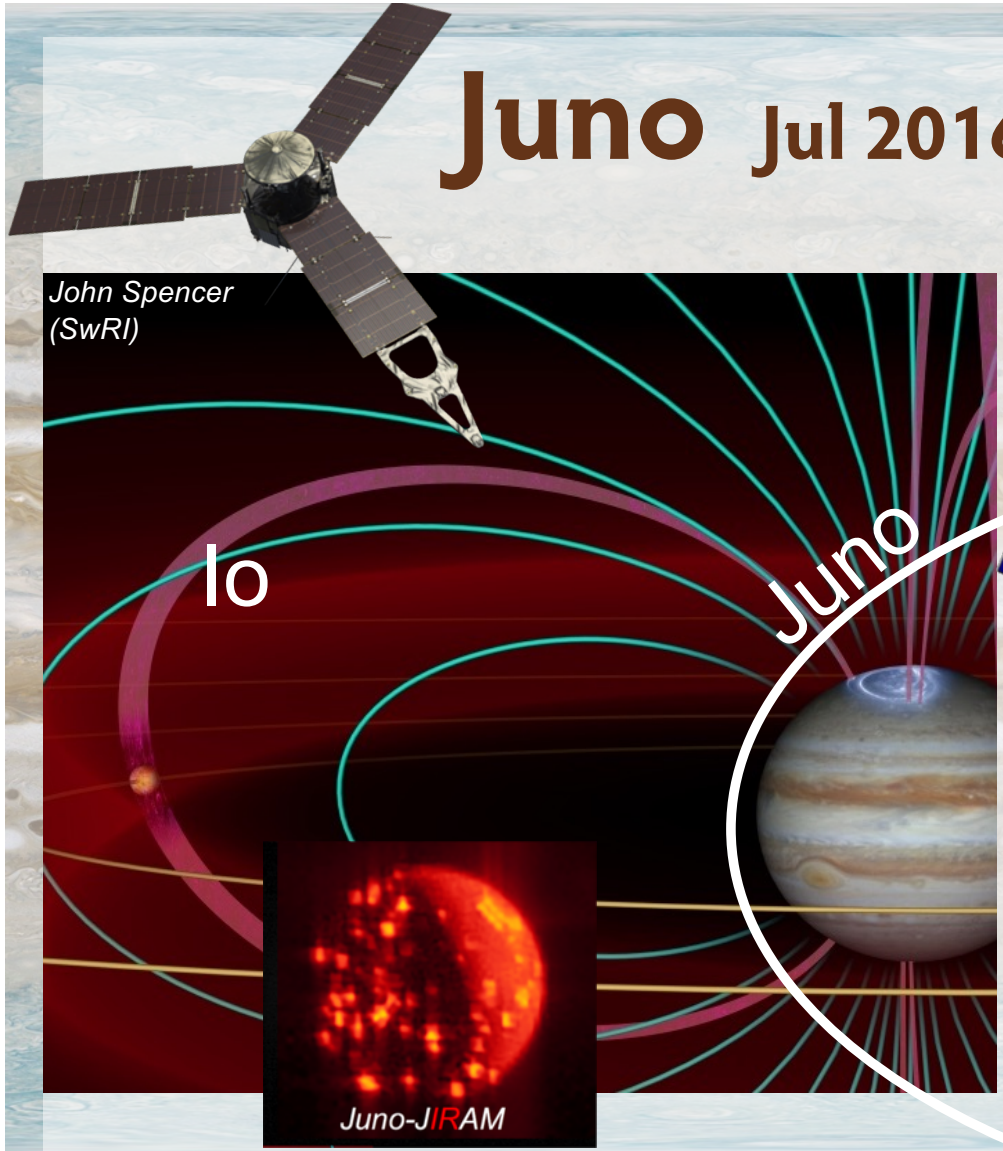
Juno Jul 2016+



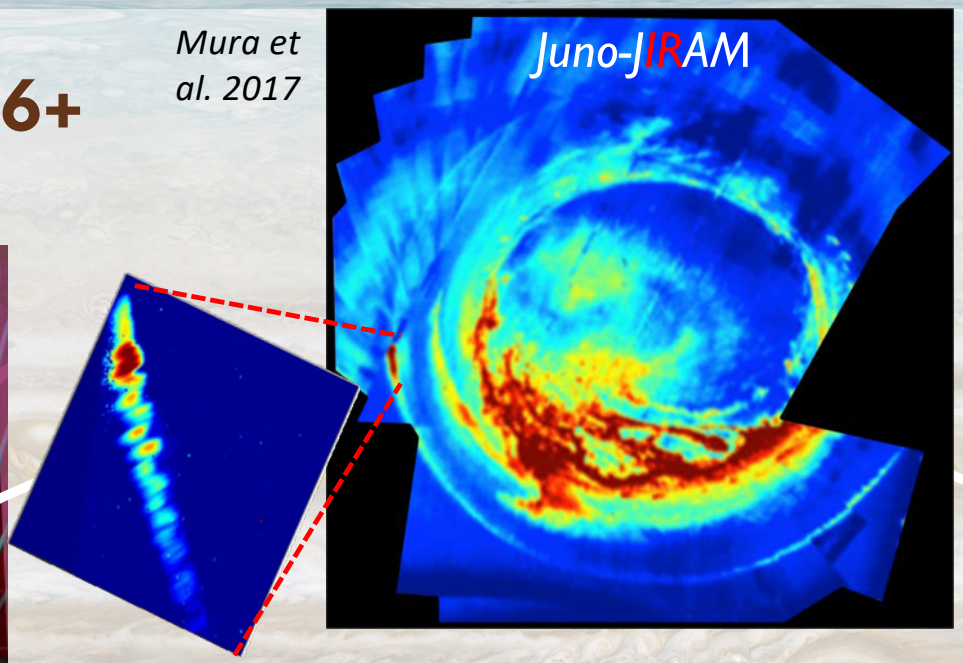


Juno is testing ideas of how charged particles that bombard Jupiter's atmosphere are accelerated

Juno Jul 2016+



Mura et al. 2017

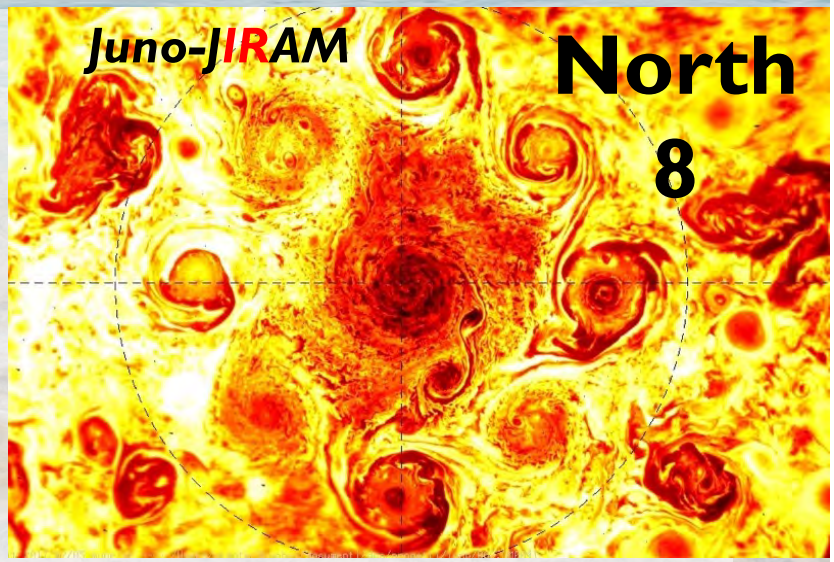


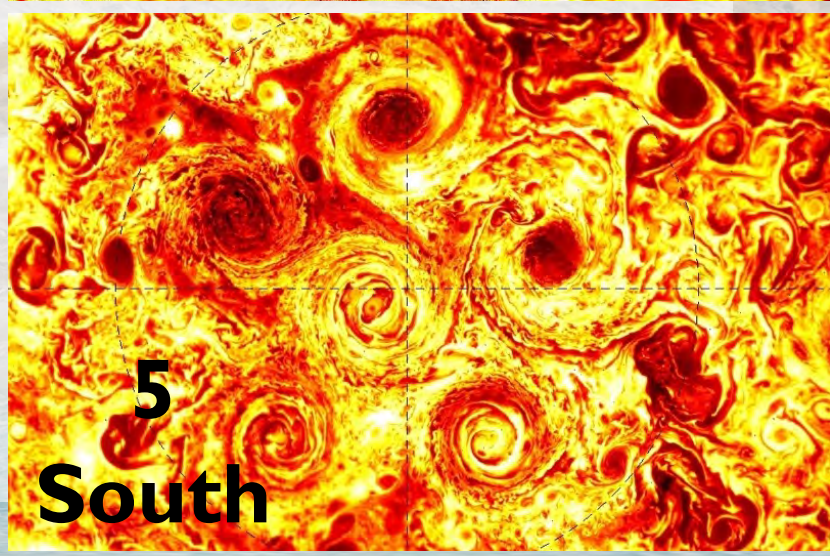
- Io Footprint Aurora
- Juno flew through fluxtube with mega-Amp currents
- Fluxes of ions & electrons both up and down

Juno Jul 2016+

- Polar vortices
- Persisted 20 months

JunoCam Citizen Science - Great success!

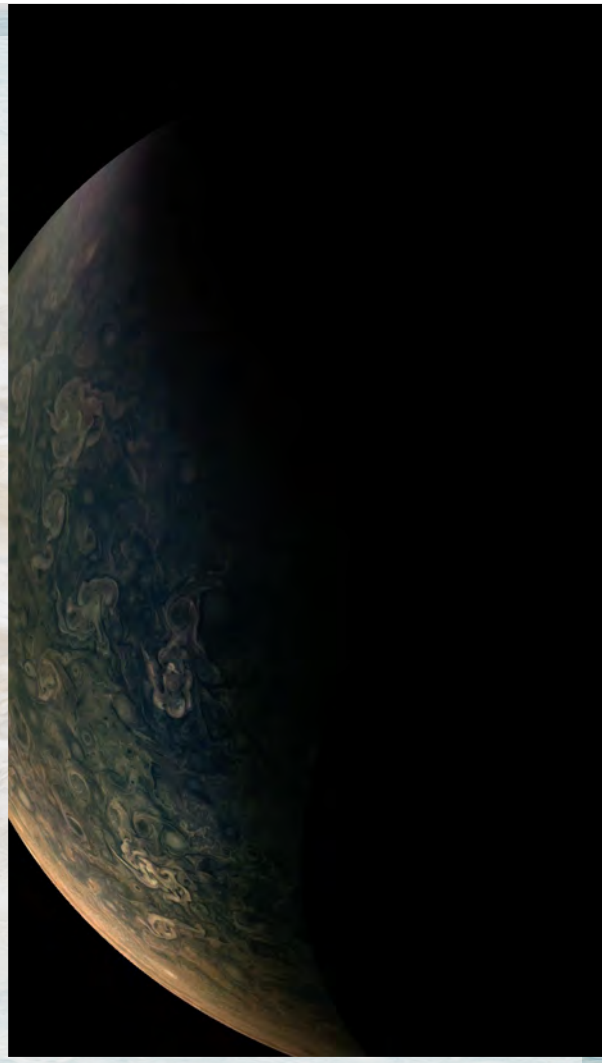




Future Exploration of Jupiter
JUICE & Clipper

Summary

- Now 79 Moons!
- 7 flyby missions, 2 orbiters, 1 probe
- Interior & atmosphere highly structured
  need modeling
- Galilean moons very different worlds
- Europa most likely place to find life
- Io – major science – **mission please!**
- Magnetosphere temporal/spatial variations
  need multiple spacecraft
- Next 50 years??!!



NASA/SwRI/MSSS/Gerald Eichstädt/Seán Doran