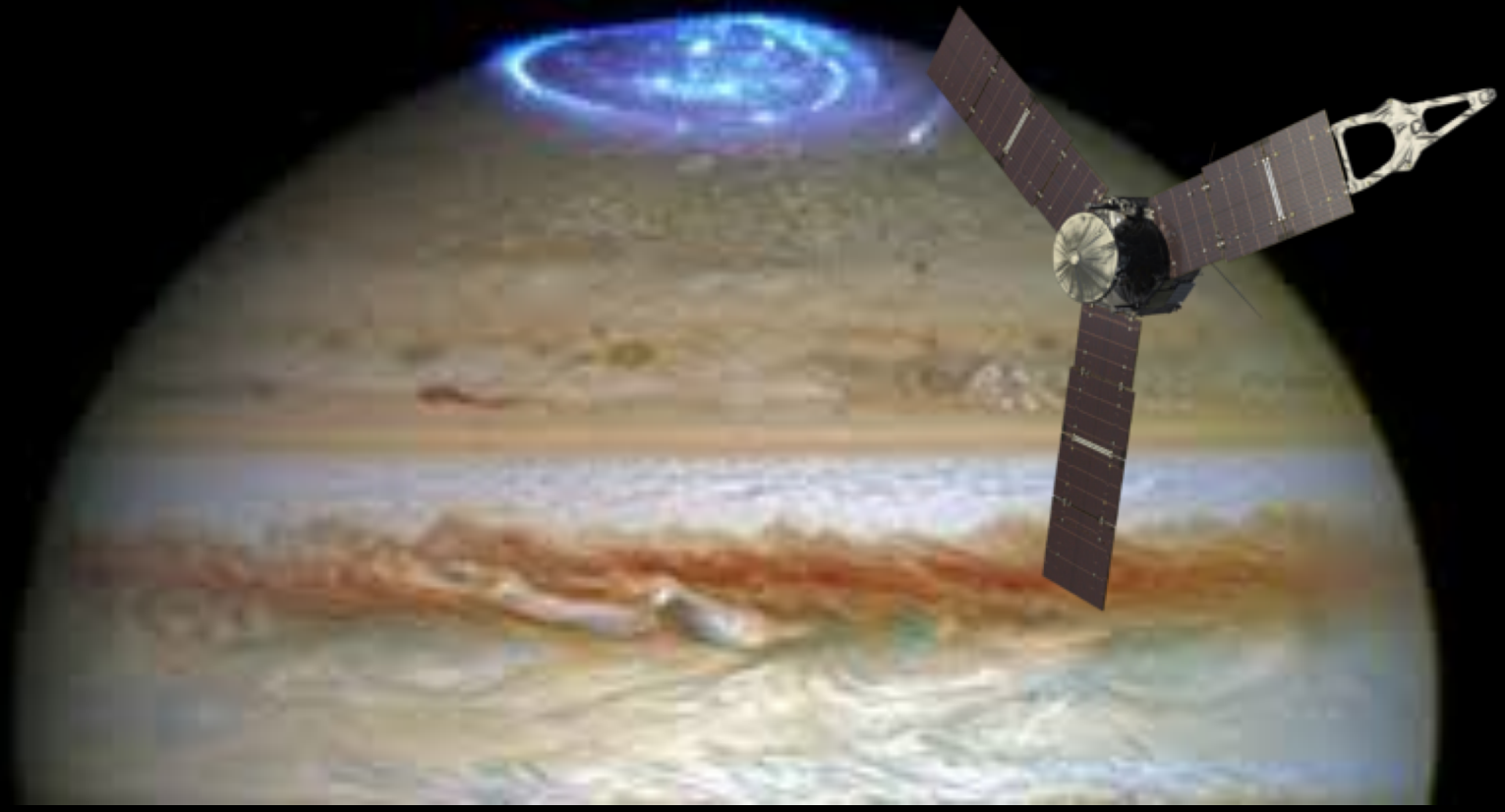


Jupiter's Aurora and the JUNO Mission

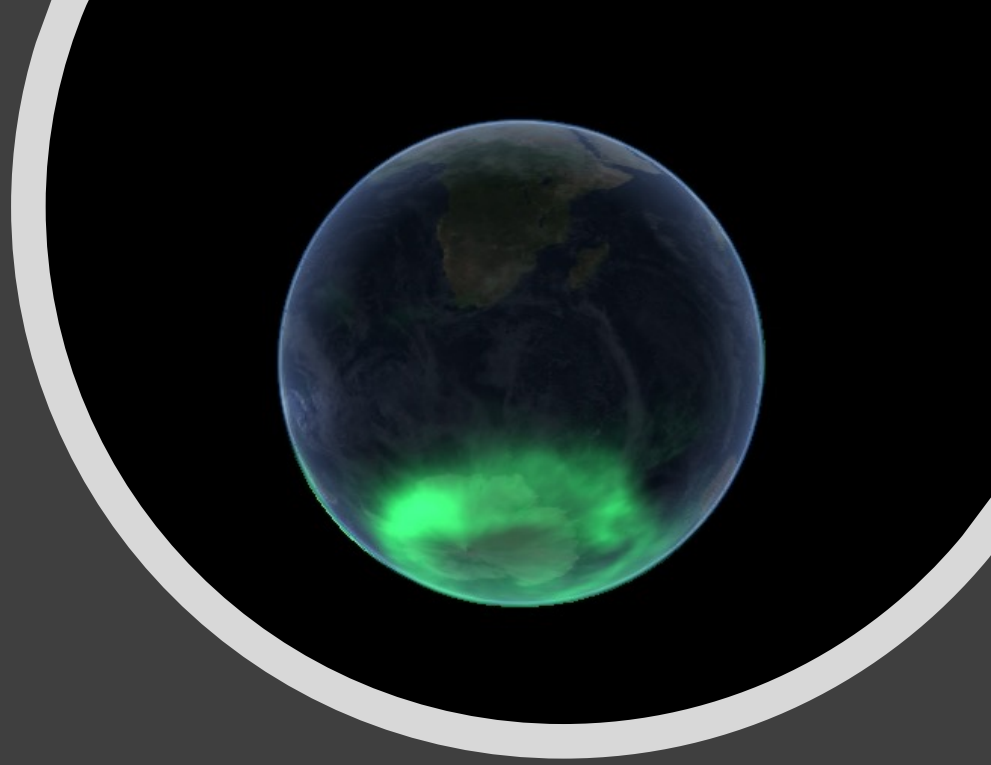
Dave Falkner - NASA Solar System Ambassador

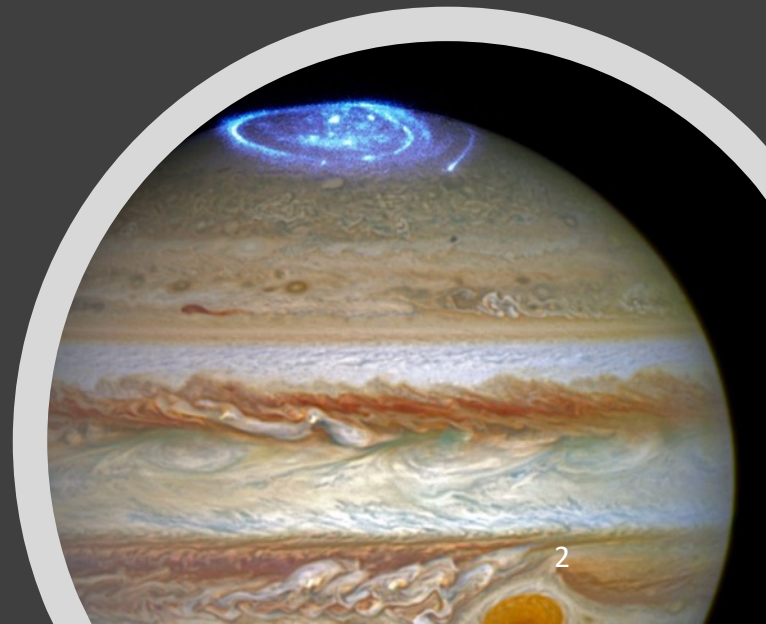
The Aurora Summit

November 3, 2018

Agenda

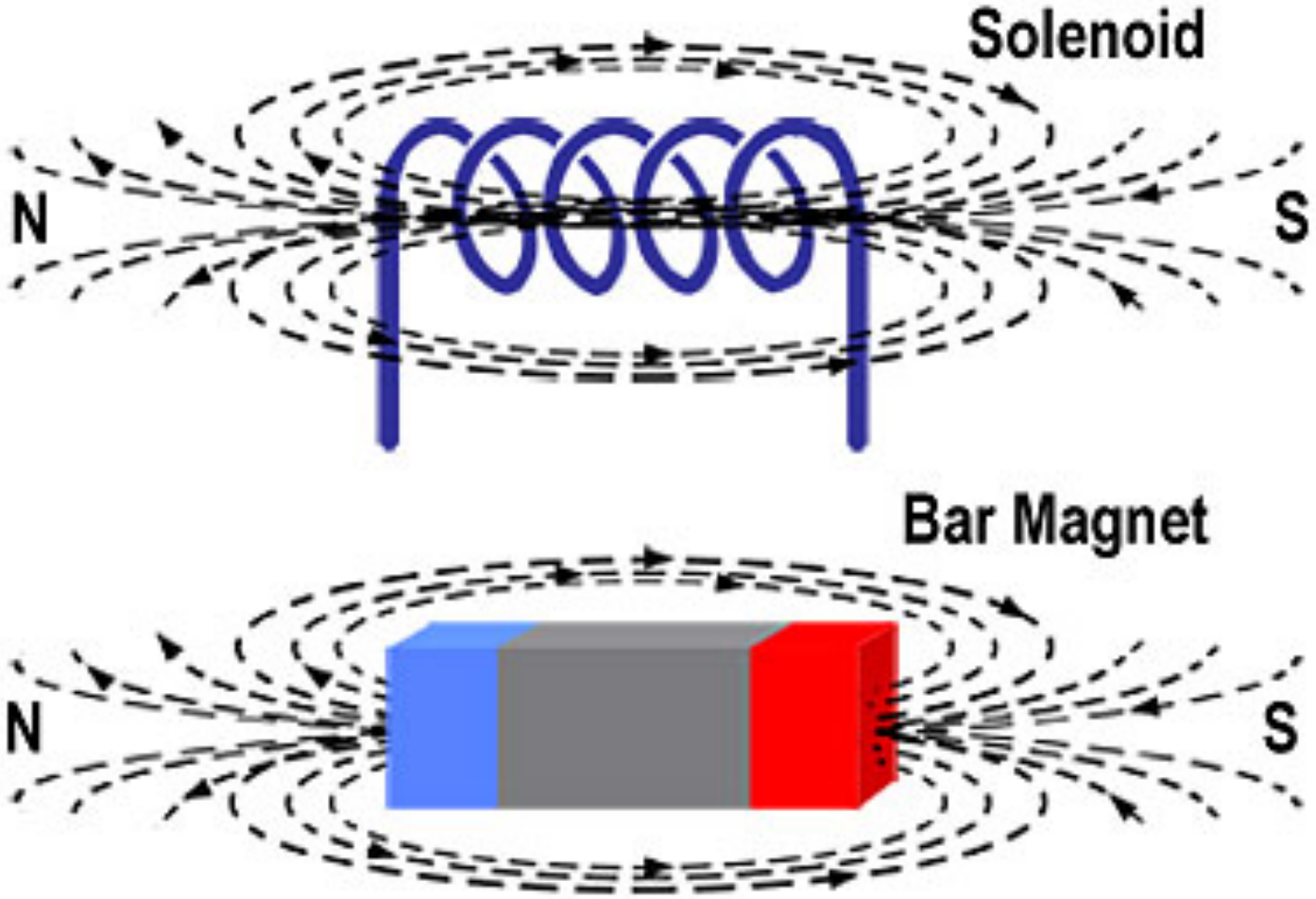
- Review Earth Aurora Physical process
- The Juno Mission
- Jupiter’s Aurora and the Physical Processes associated with it.





THE PHYSICAL PROCESS OF EARTH'S AURORA

Induced Magnetic and Electrical Fields

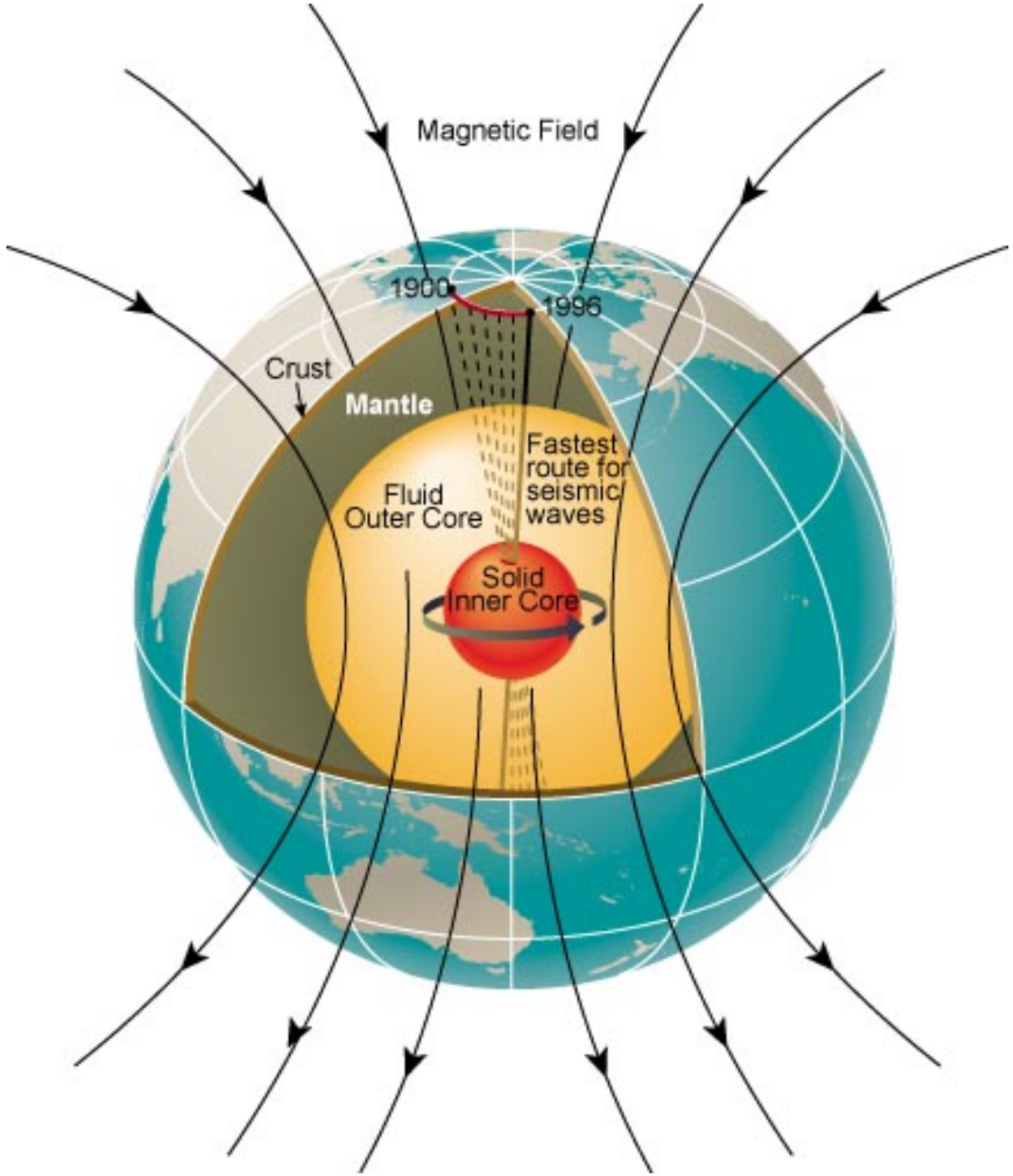


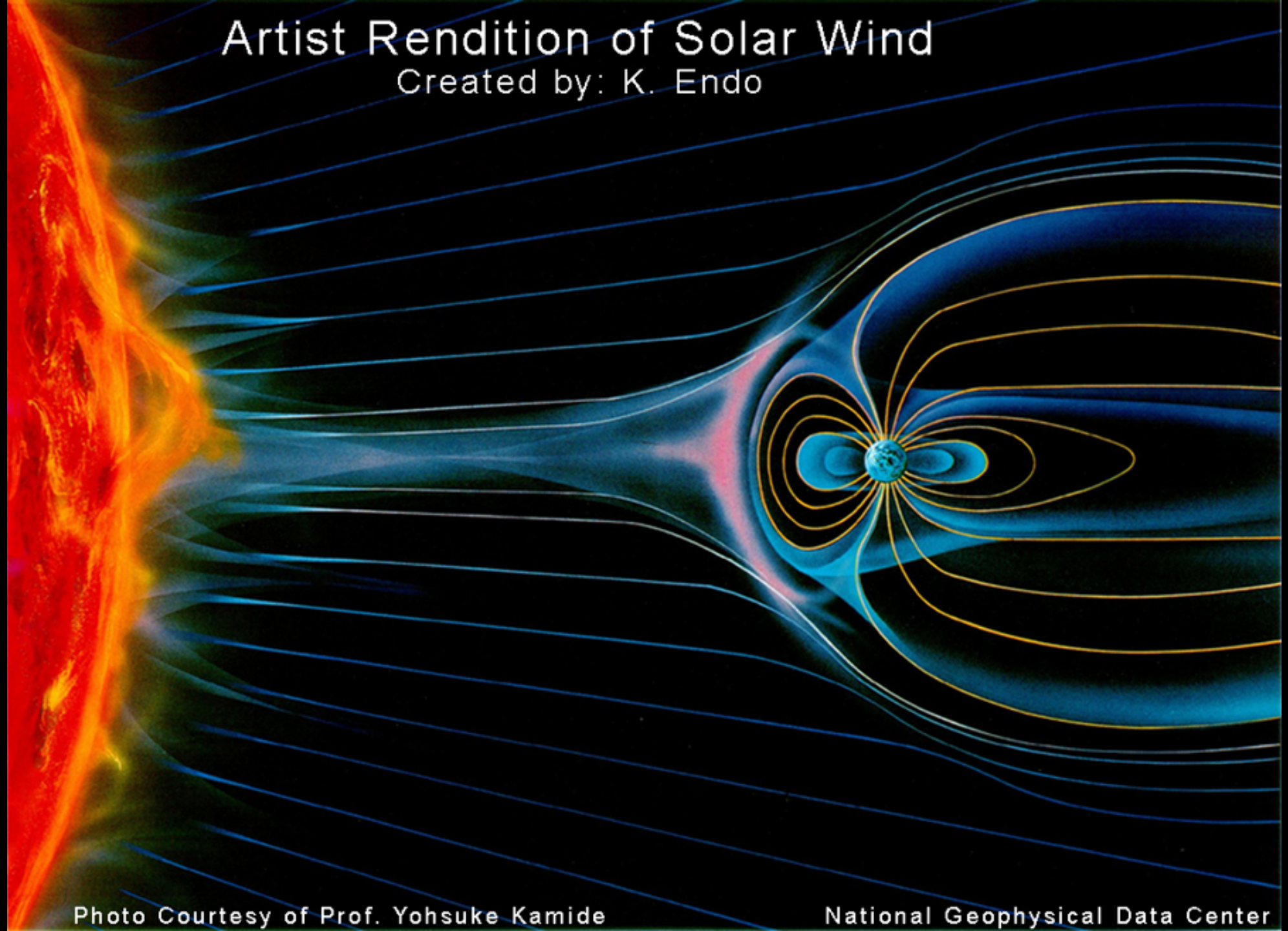
Earth's Dynamo Effect

Earth has a solid nickel-iron inner core surrounded by a liquid outer core

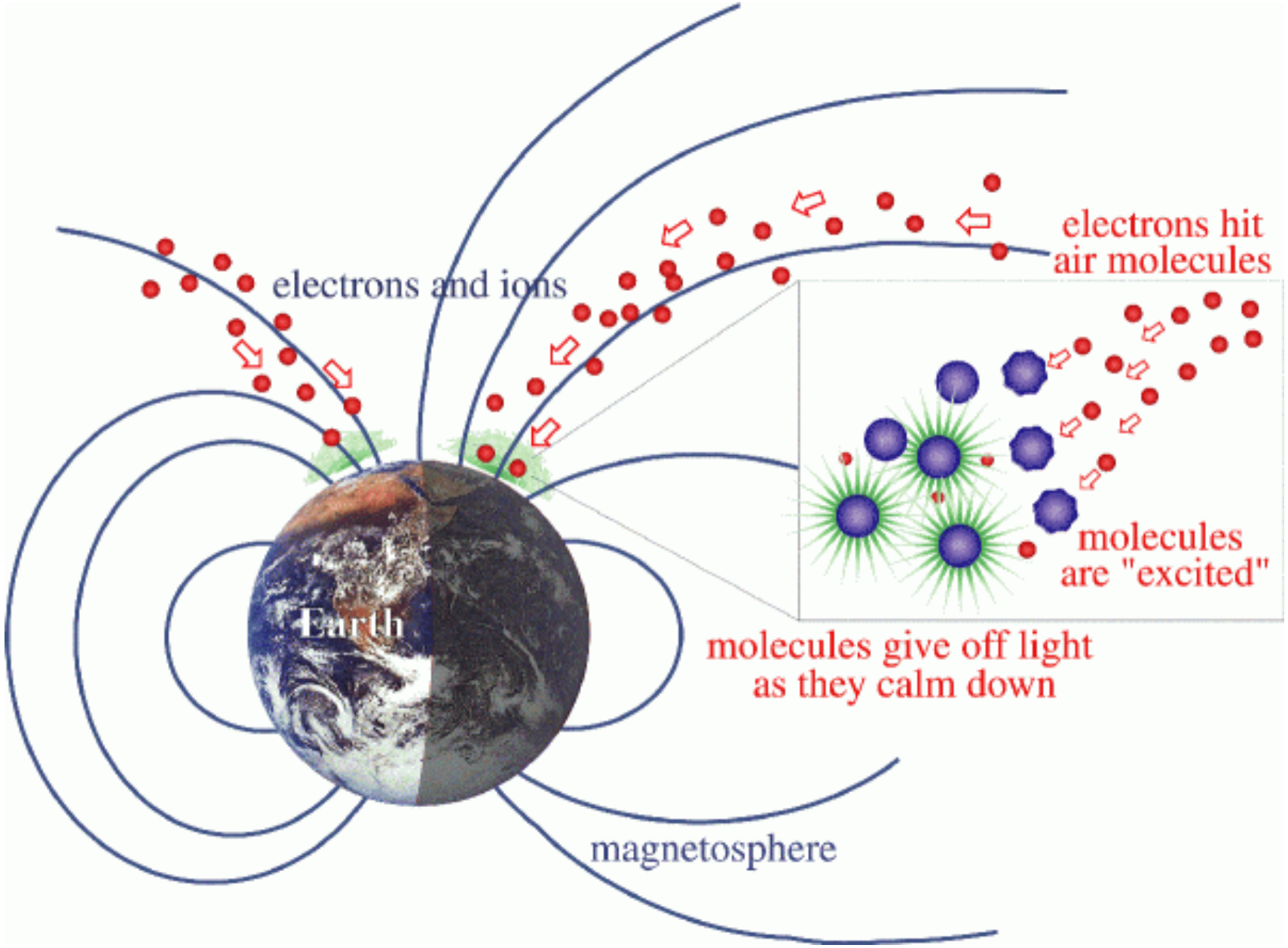
The differential motion of the outer core with the inner core and mantle generates an electric current

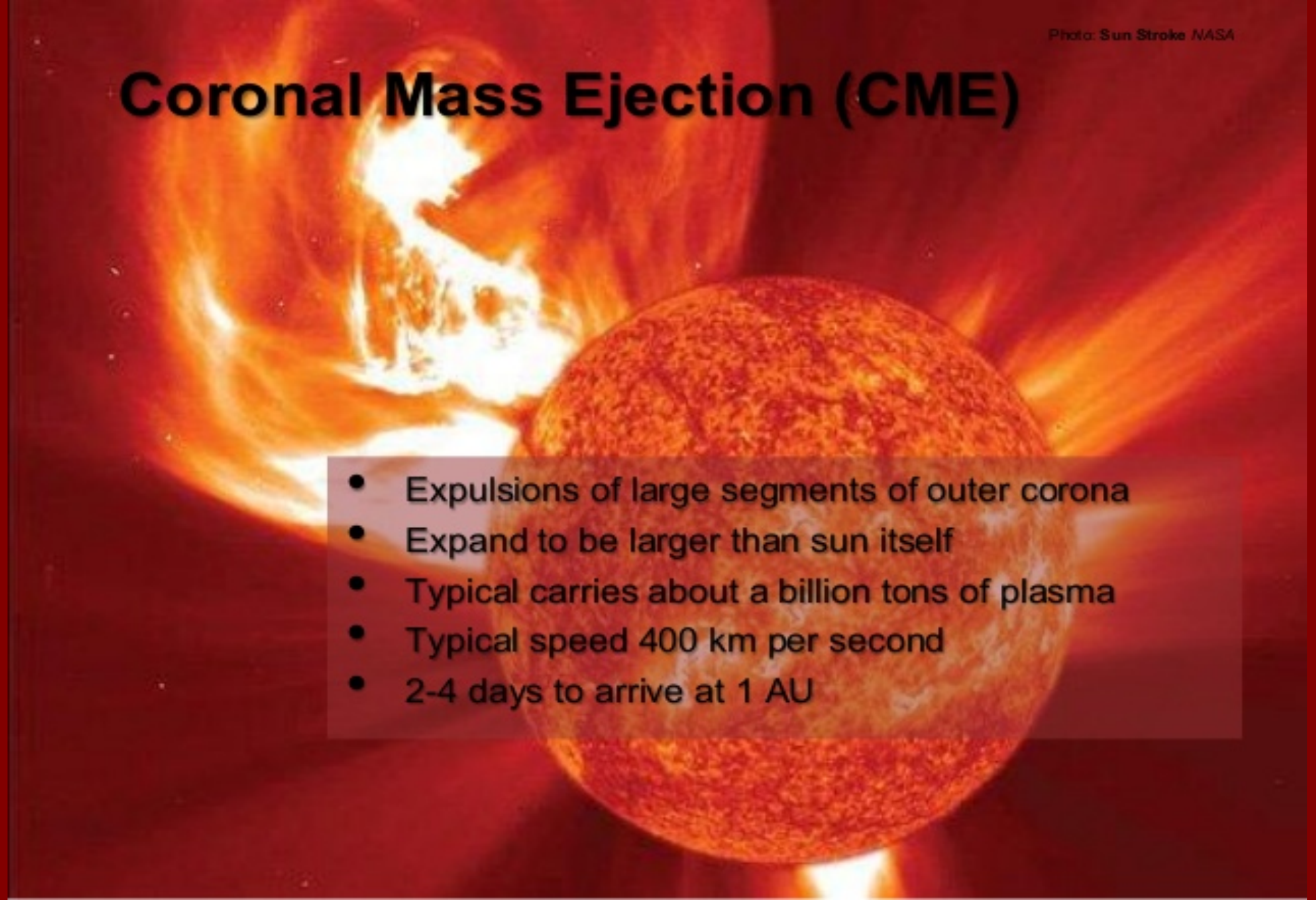
This current in turn generates our planet's magnetic field




Artist Rendition of Solar Wind
Created by: K. Endo
Photo Courtesy of Prof. Yohsuke Kamide
National Geophysical Data Center

Interaction of Solar Wind and Atmosphere

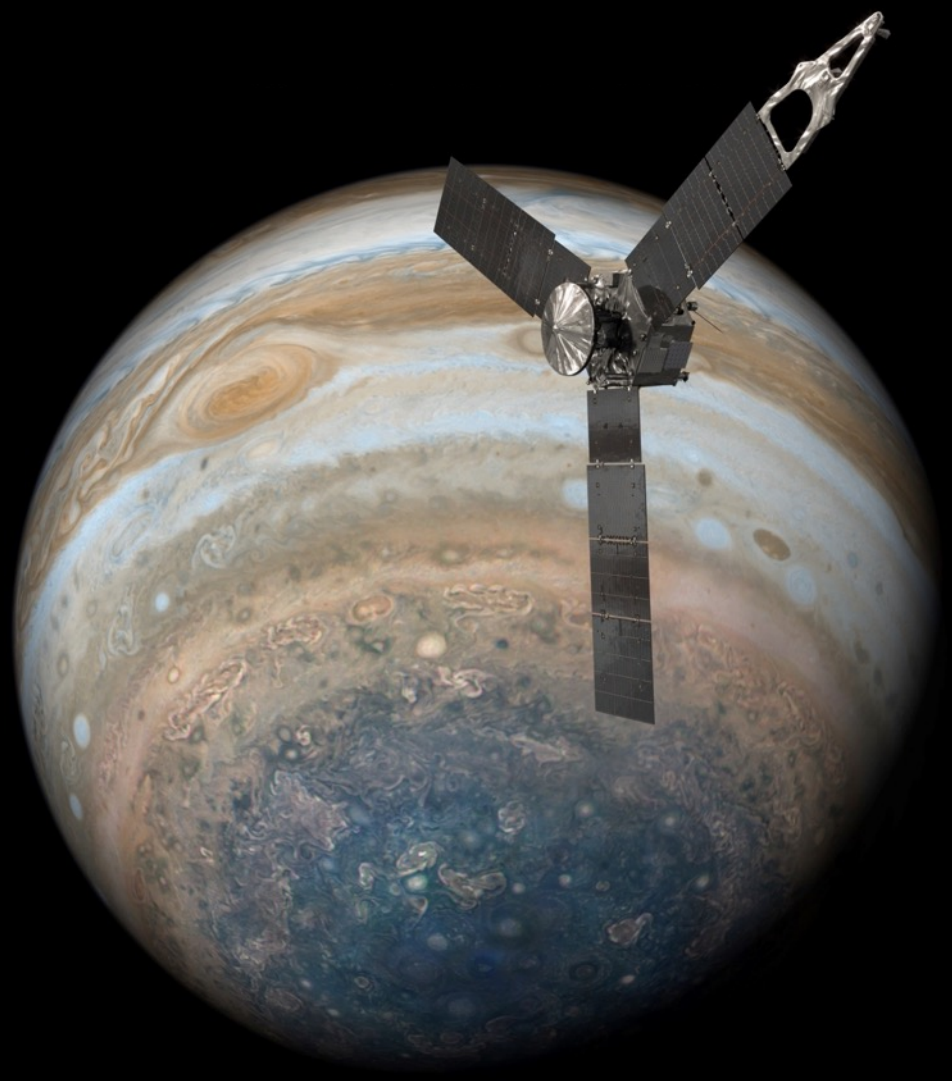




Coronal Mass Ejection (CME)

- Expulsions of large segments of outer corona
- Expand to be larger than sun itself
- Typical carries about a billion tons of plasma
- Typical speed 400 km per second
- 2-4 days to arrive at 1 AU


THE CARRINGTON EVENT
THE LARGEST KNOWN GEOMAGNETIC STORM
CAUSED BY A MASSIVE SOLAR FLARE IN 1859
AURORA AUSTRALIS WAS OBSERVED
AS FAR NORTH AS QUEENSLAND, AUSTRALIA
AURORA BOREALIS AS FAR SOUTH
AS THE CARIBBEAN AND HAWAII
PEOPLE IN THE NORTHERN US COULD
READ THE NEWSPAPER AT NIGHT
FROM THE AURORA'S LIGHT AND
TELEGRAPH SYSTEMS WENT HAYWIRE



Juno

Mission to Jupiter

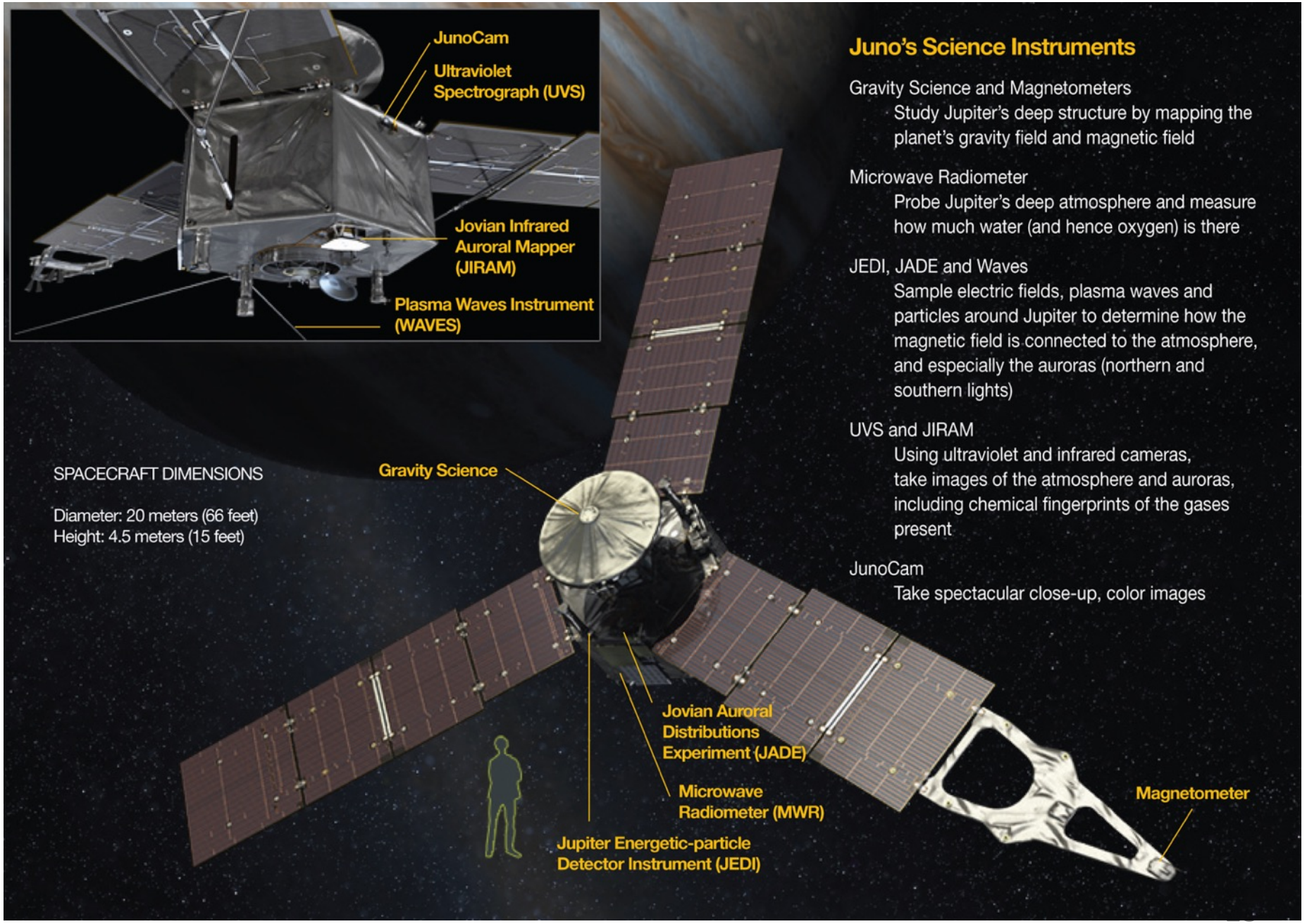
NASA Missions to Jupiter

There have been nine missions to Jupiter

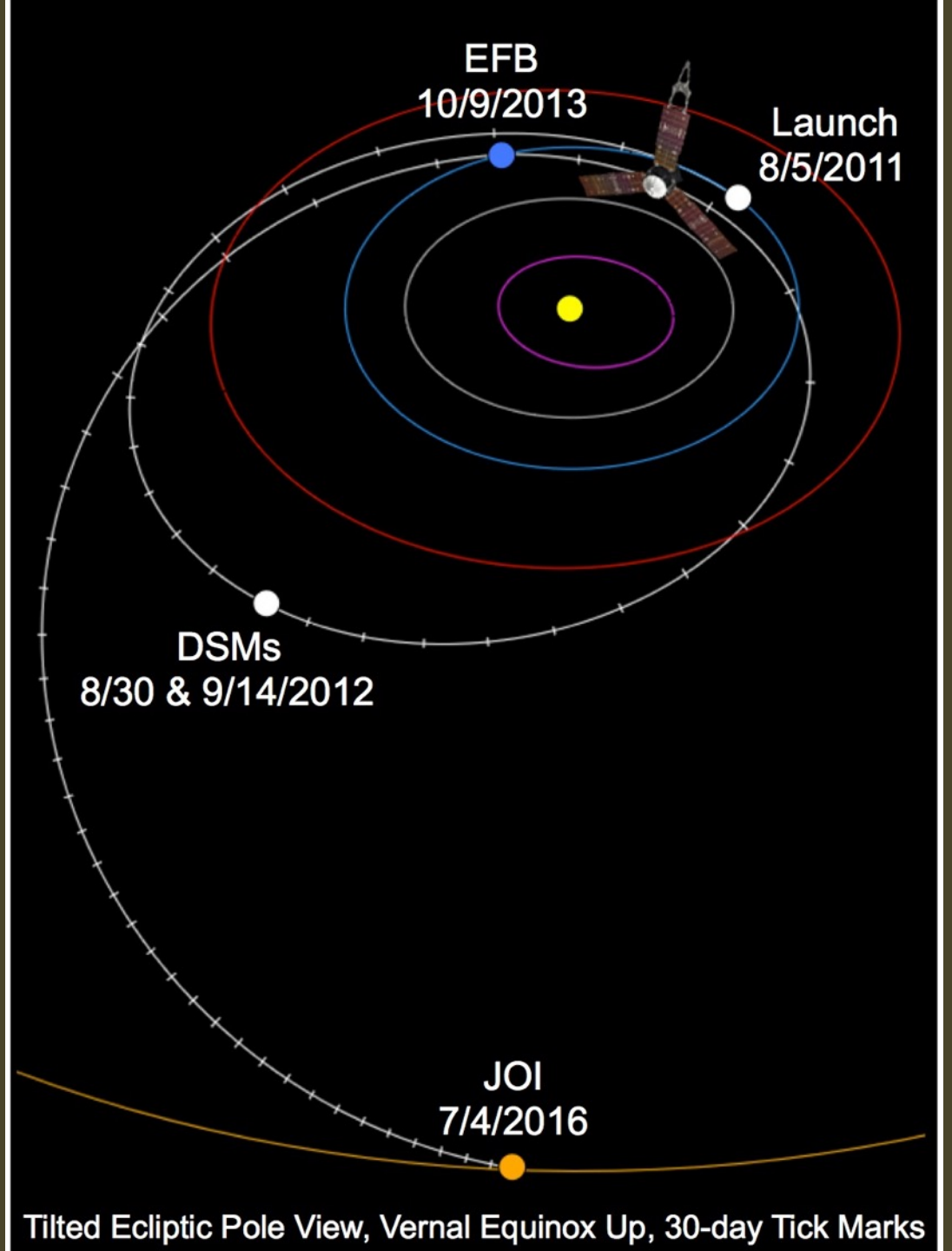
- Pioneer 10 (1972) - Flyby
- Pioneer 11 (1973) - Flyby
- Voyager 1 (1977) – Flyby
- Voyager 2 (1977) – Flyby
- Galileo (1989) – First orbital mission
  - Investigated moons and atmosphere
- Ulysses (1992) – Flyby
- Cassini-Huygens (2000) – Flyby
- New Horizons (2007) – Flyby
- Juno (2016) – Currently orbiting Jupiter

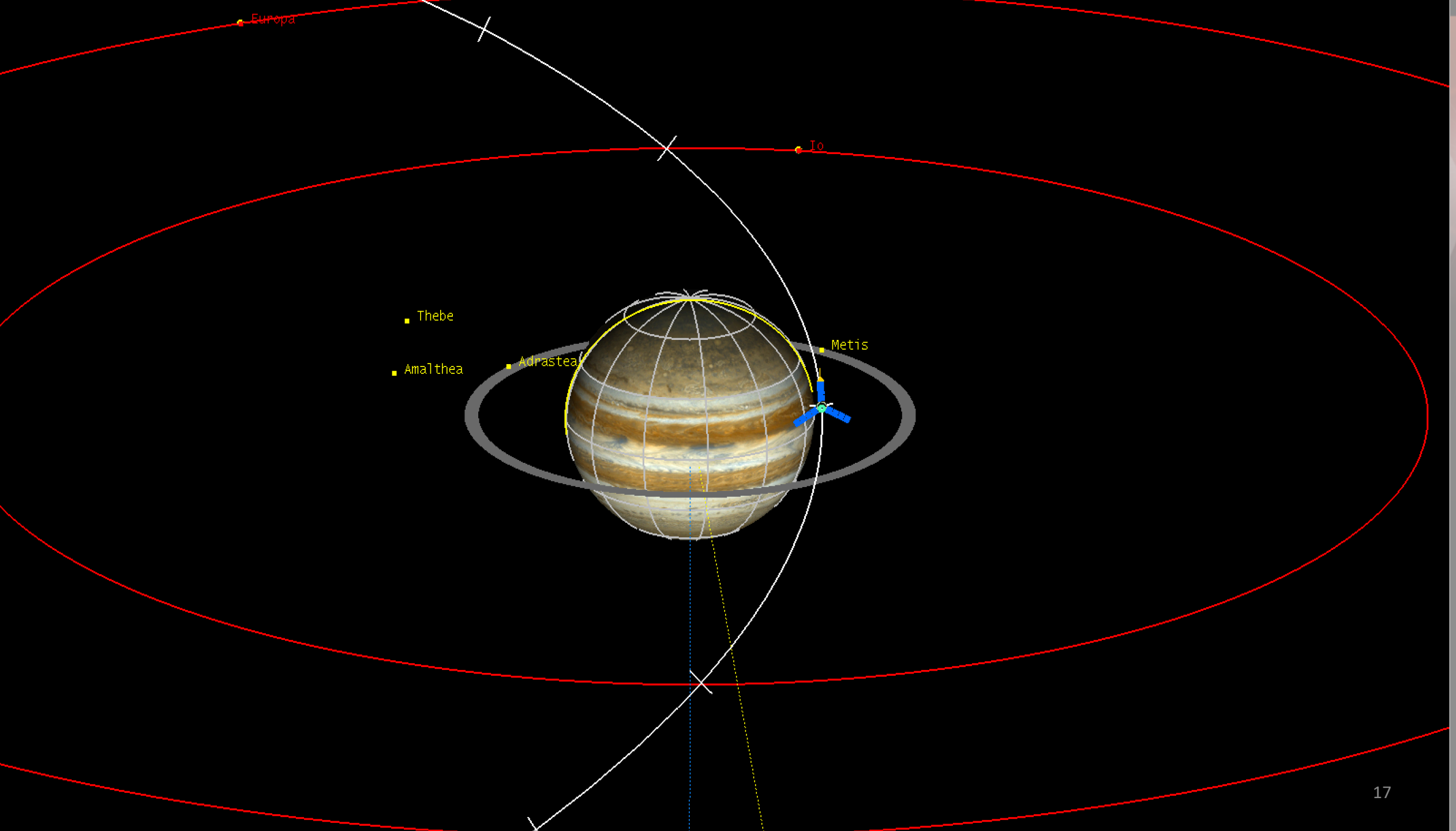
Launch of Juno – August 25, 2011

Spacecraft & Payload

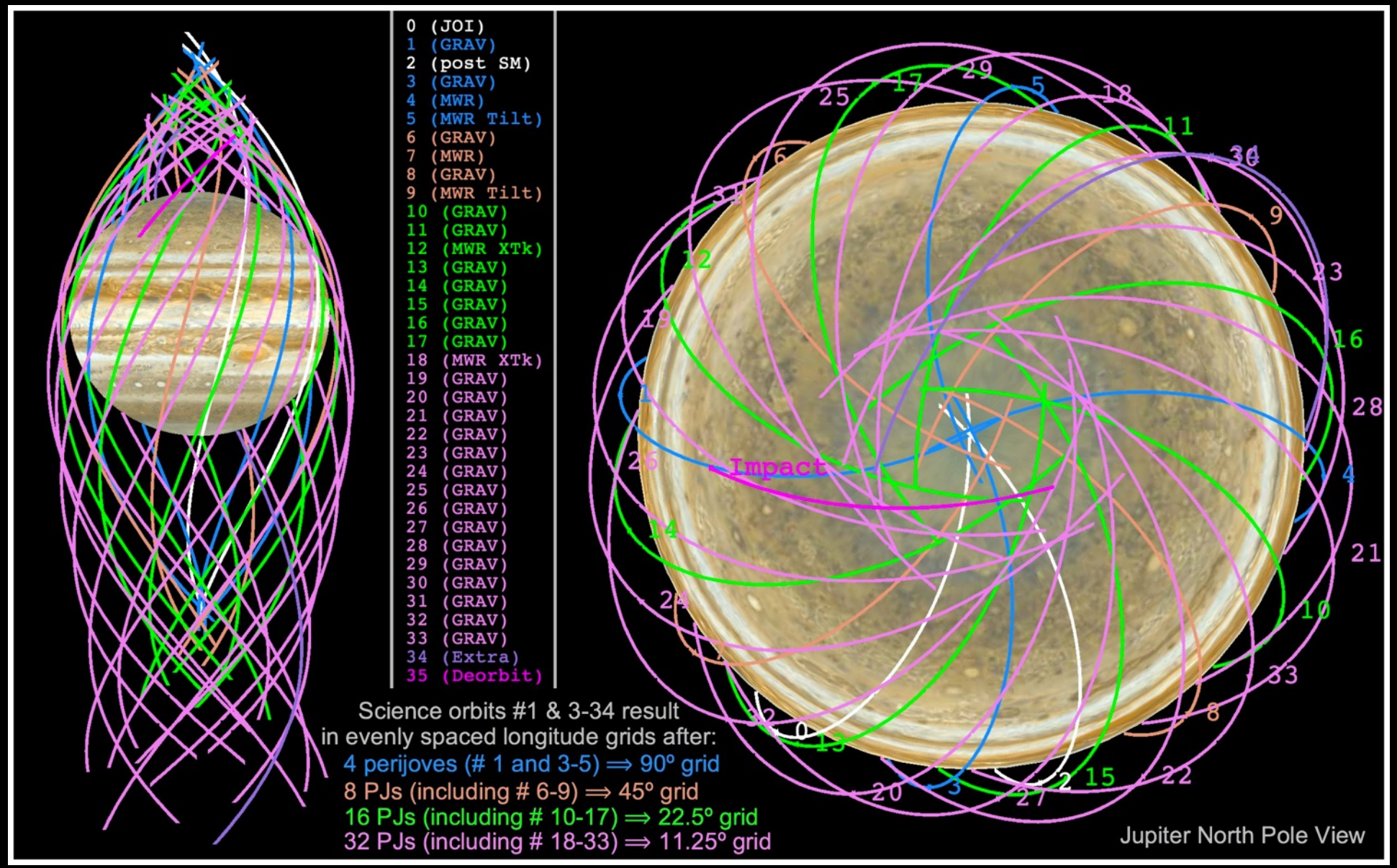


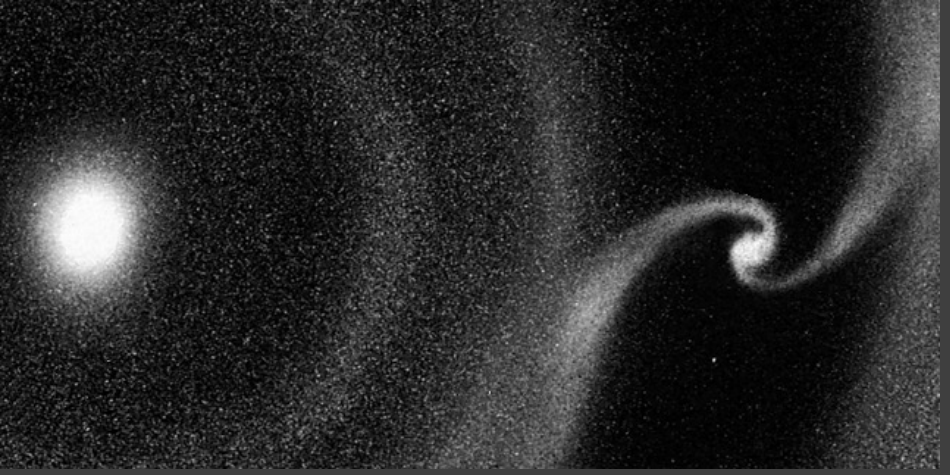
Juno's Flight Plan, or Trajectory

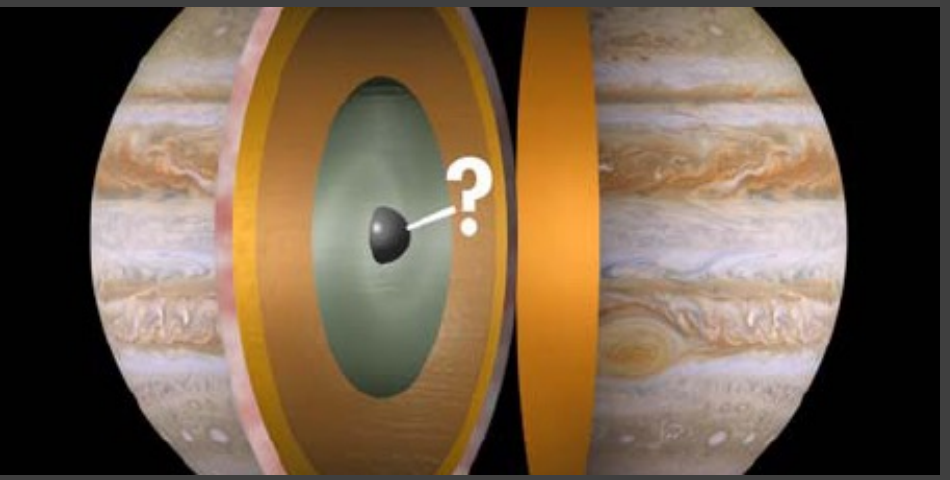



Europa
Io
Thebe
Amalthea
Adrastea
Metis

Longitude Map after 32 (+1) Orbits







Juno’s Science Objectives

Origin

Determine O/H ratio (water abundance) and constrain core mass to decide among alternative theories of origin.

Interior

Understand Jupiter's interior structure and dynamical properties by mapping its gravitational and magnetic fields

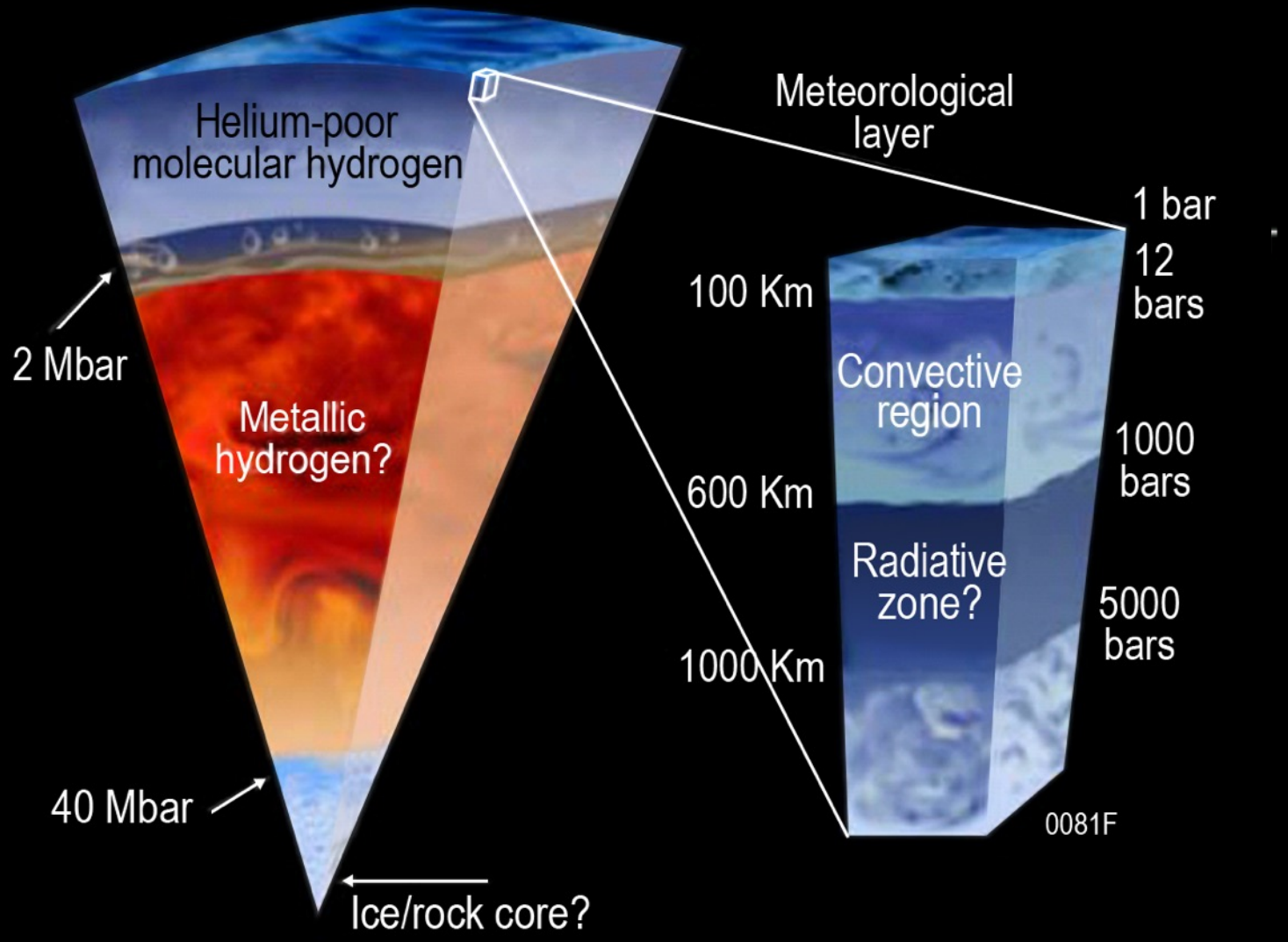
Atmosphere

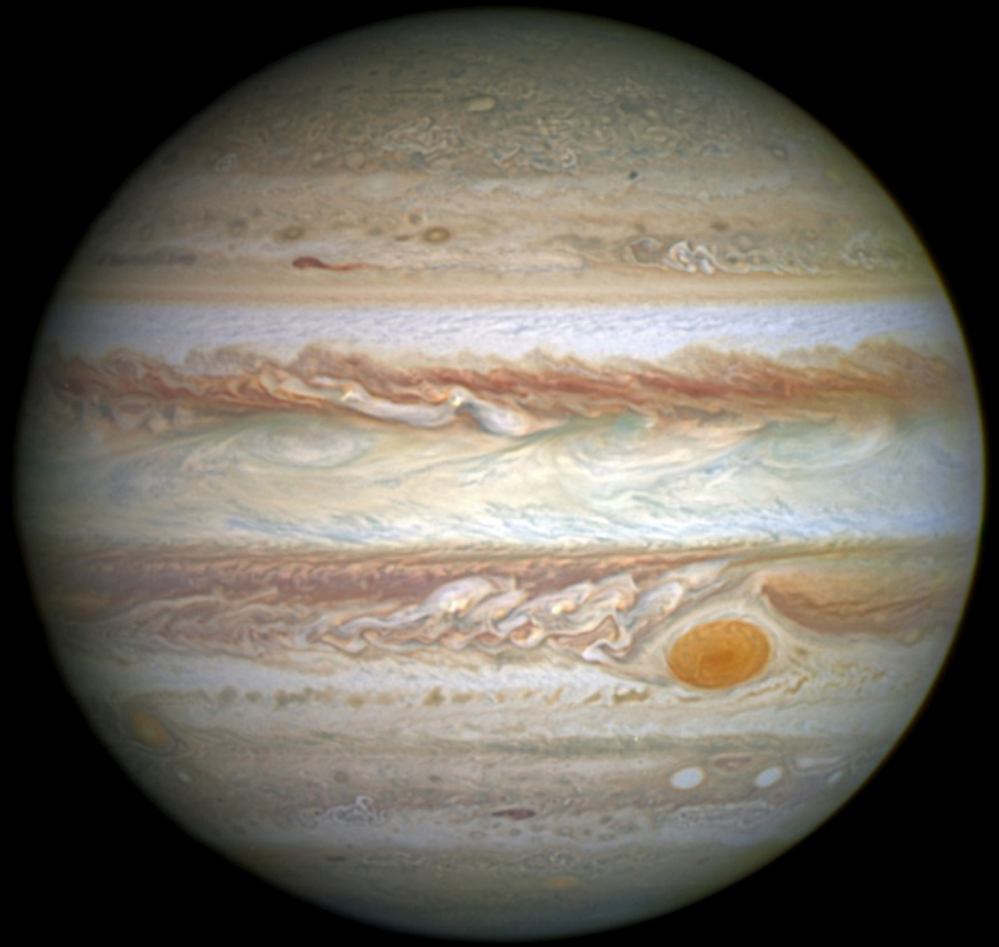
Map variations in atmospheric composition, temperature, cloud opacity and dynamics to depths greater than 100 bars at all latitudes.

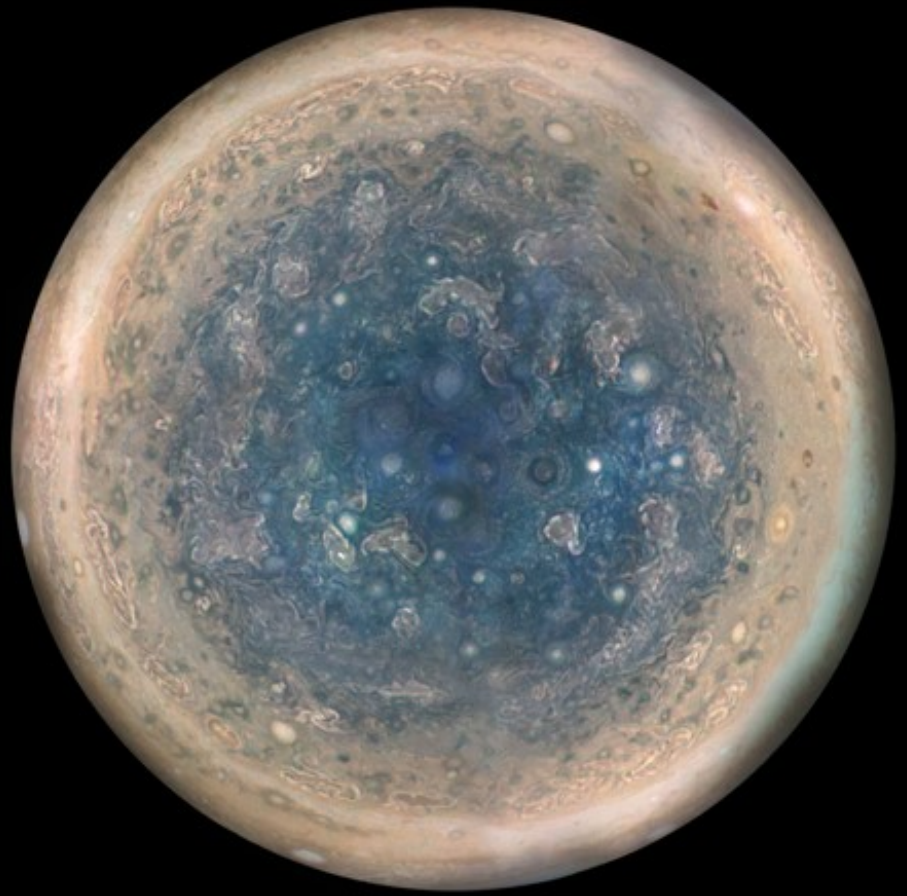
Magnetosphere

Characterize and explore the three-dimensional structure of Jupiter's polar magnetosphere and auroras.

Probing Deep and Globally







Juno Cam Observations

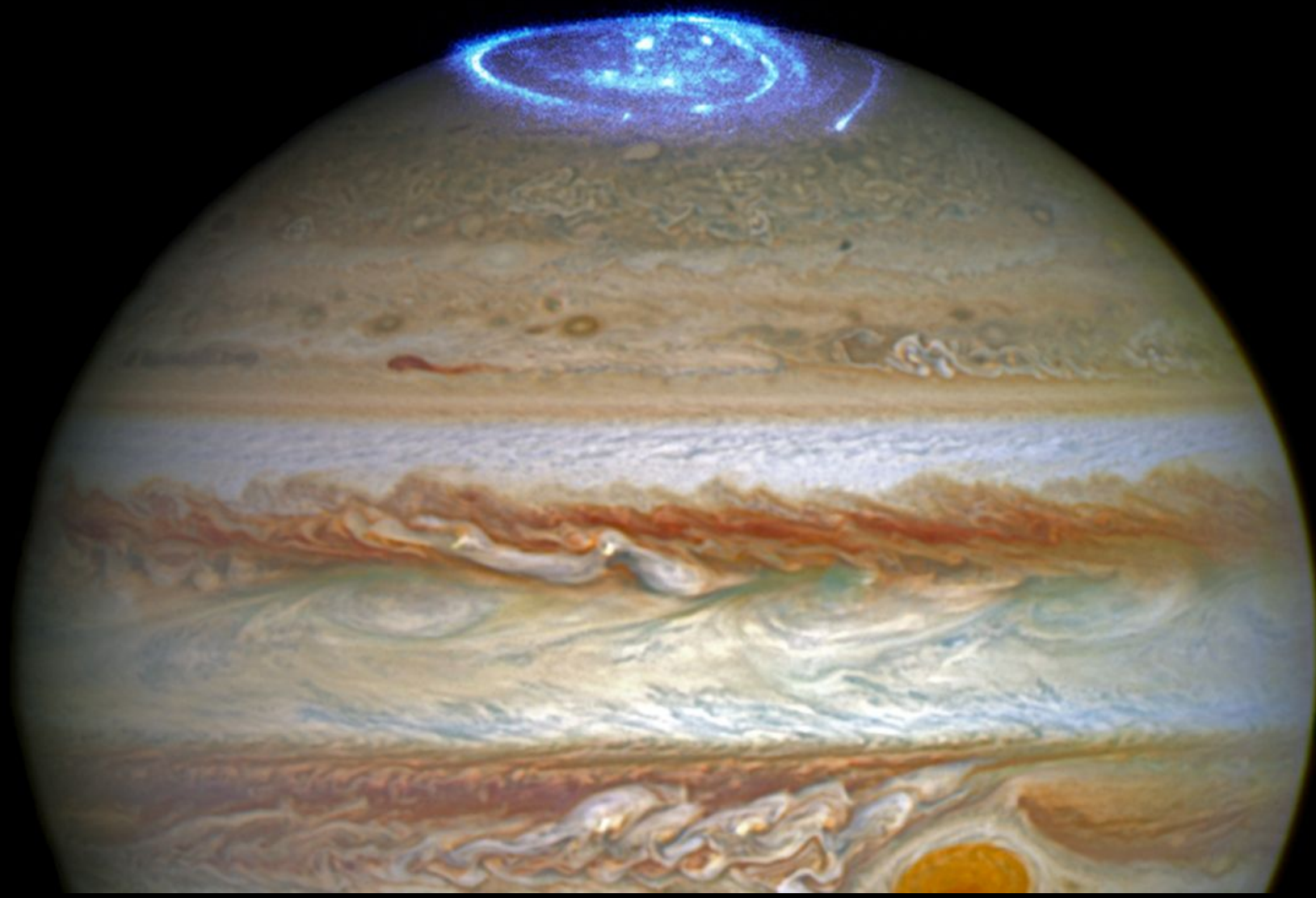

NASA / SwRI / MSSS / Jason Major

SOUTH POLE

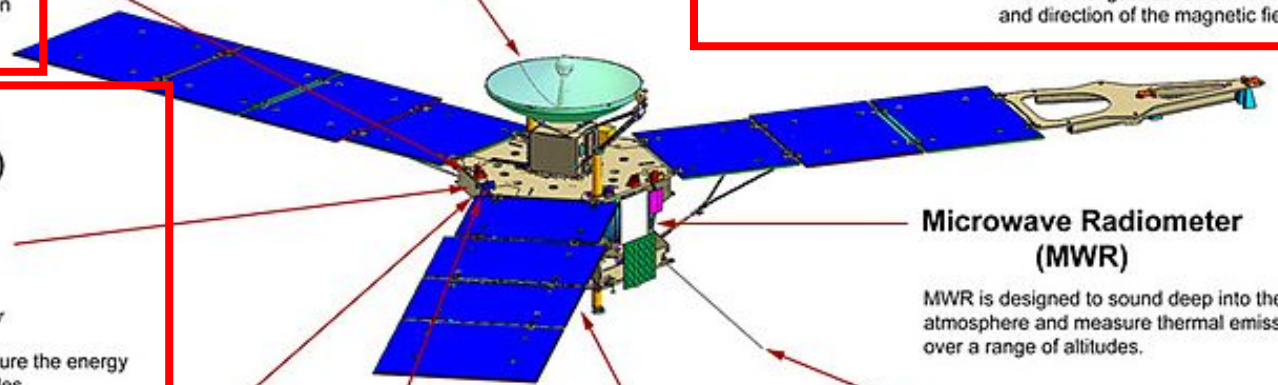
Juno End of Mission

- Original mission was to February, 2018
- It has been extended to July 2021
- At the end of mission it will be plunged into Jupiter’s atmosphere and be destroyed

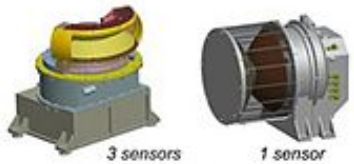
JUPITER AURORA



JUNO Aurora Instrumentation



Jovian Auroral Distributions Experient (JADE)



JADE will measure the distribution of electrons and the velocity distribution and composition of ions.

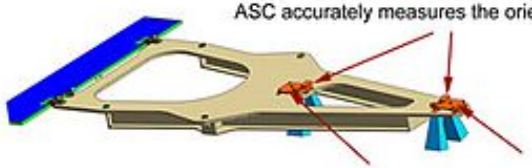
Gravity Science (GS)

The Juno Gravity Science Investigation will probe the mass properties of Jupiter by using the communication subsystem to perform Doppler tracking.

Magnetometer (MAG)

Advanced Stellar Compass (ASC)

ASC accurately measures the orientation of the magnetometers.



Fluxgate Magnetometer (FGM)

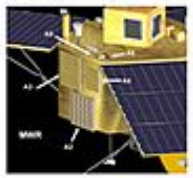
The two fluxgate sensors will measure the magnitude and direction of the magnetic field in Jupiter's environment.

Jupiter Energetic-particle Detector Instrument (JEDI)

JEDI is a suite of detectors that will measure the energy and angular distribution of charged particles.

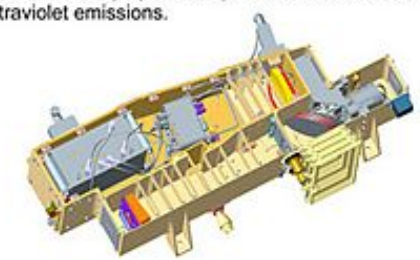
Microwave Radiometer (MWR)

MWR is designed to sound deep into the atmosphere and measure thermal emission over a range of altitudes.



Ultraviolet Spectrograph (UVS)

UVS is an imaging spectrograph that is sensitive to ultraviolet emissions.



JunoCam

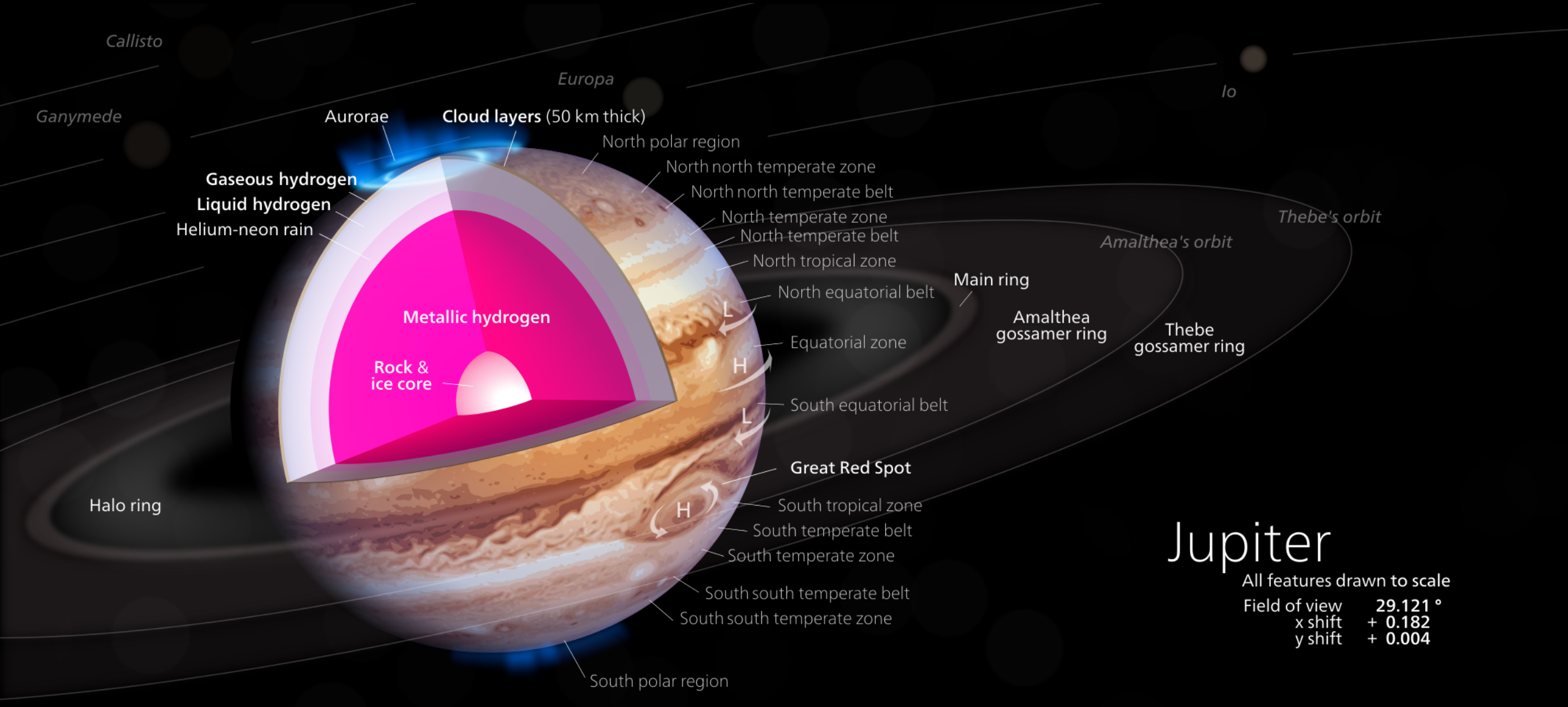
JunoCam will provide visible-color images of the Jovian cloud tops.

Jovian Infrared Auroral Mapper (JIRAM)

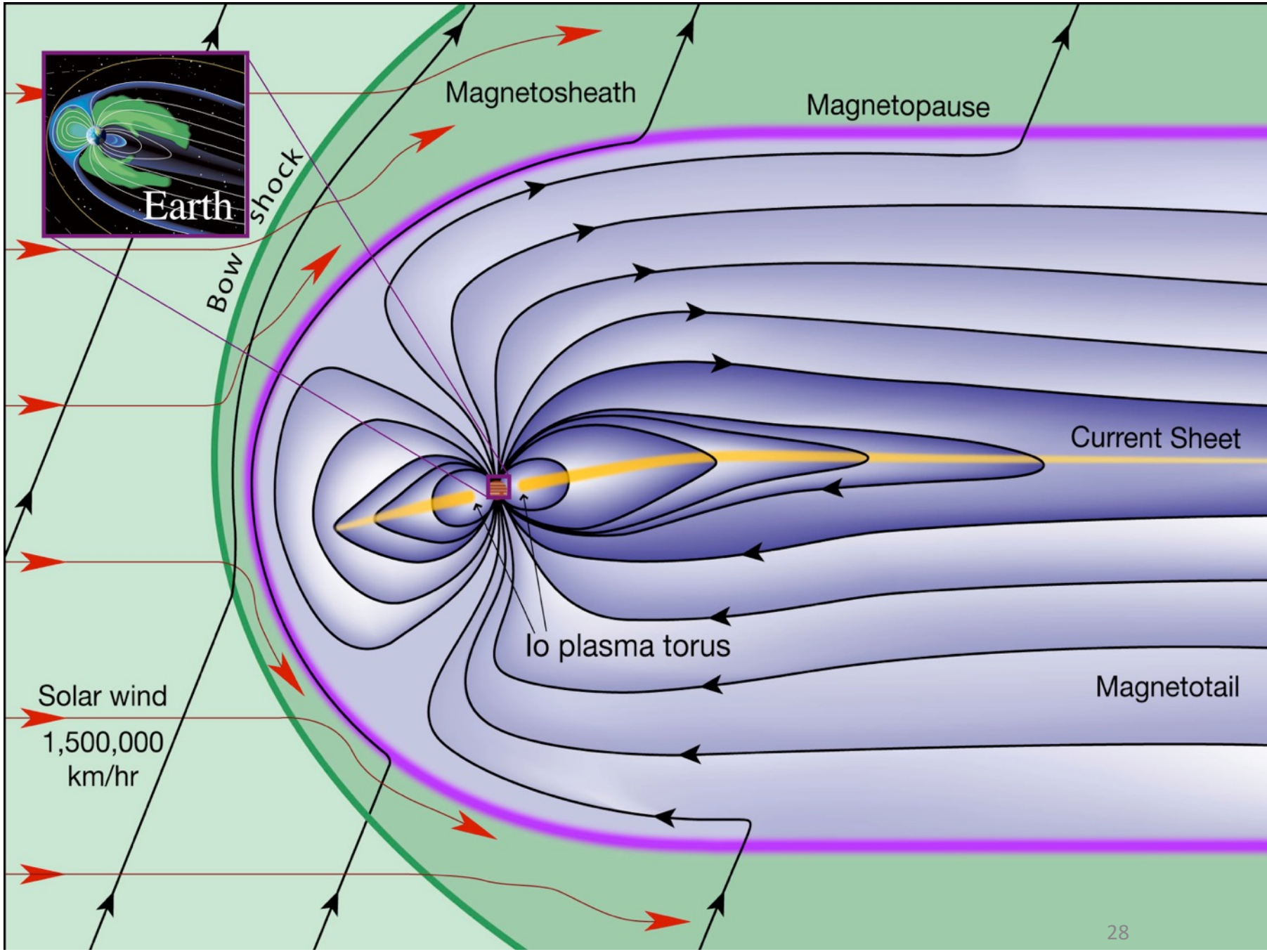
JIRAM will acquire infrared images and spectra of Jupiter. JIRAM is located on the aft/bottom deck.

Plasma Waves Instrument (Waves)

Waves will measure plasma waves and radio waves in Jupiter's magnetosphere.



Jupiter's Magnetosphere



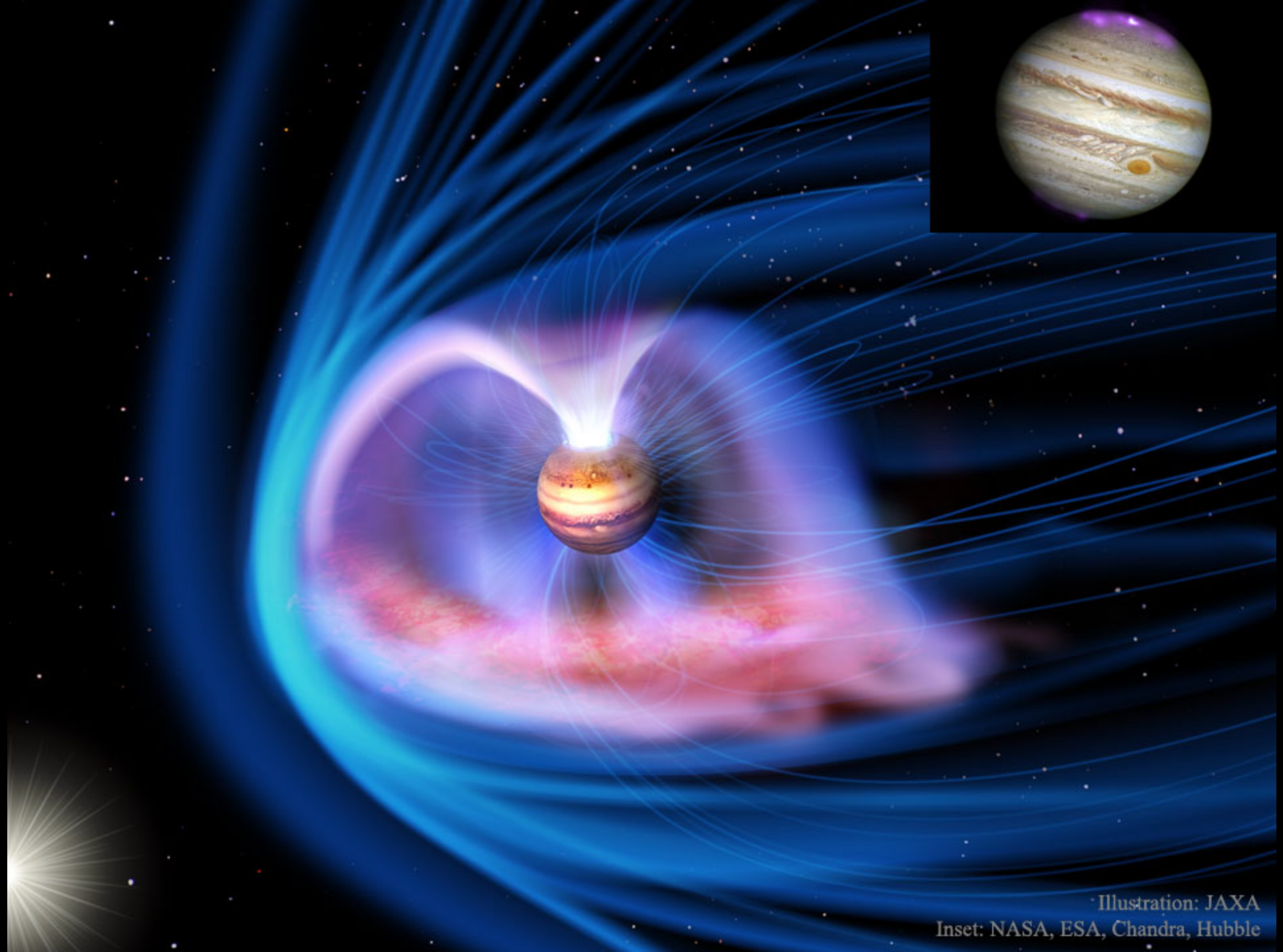
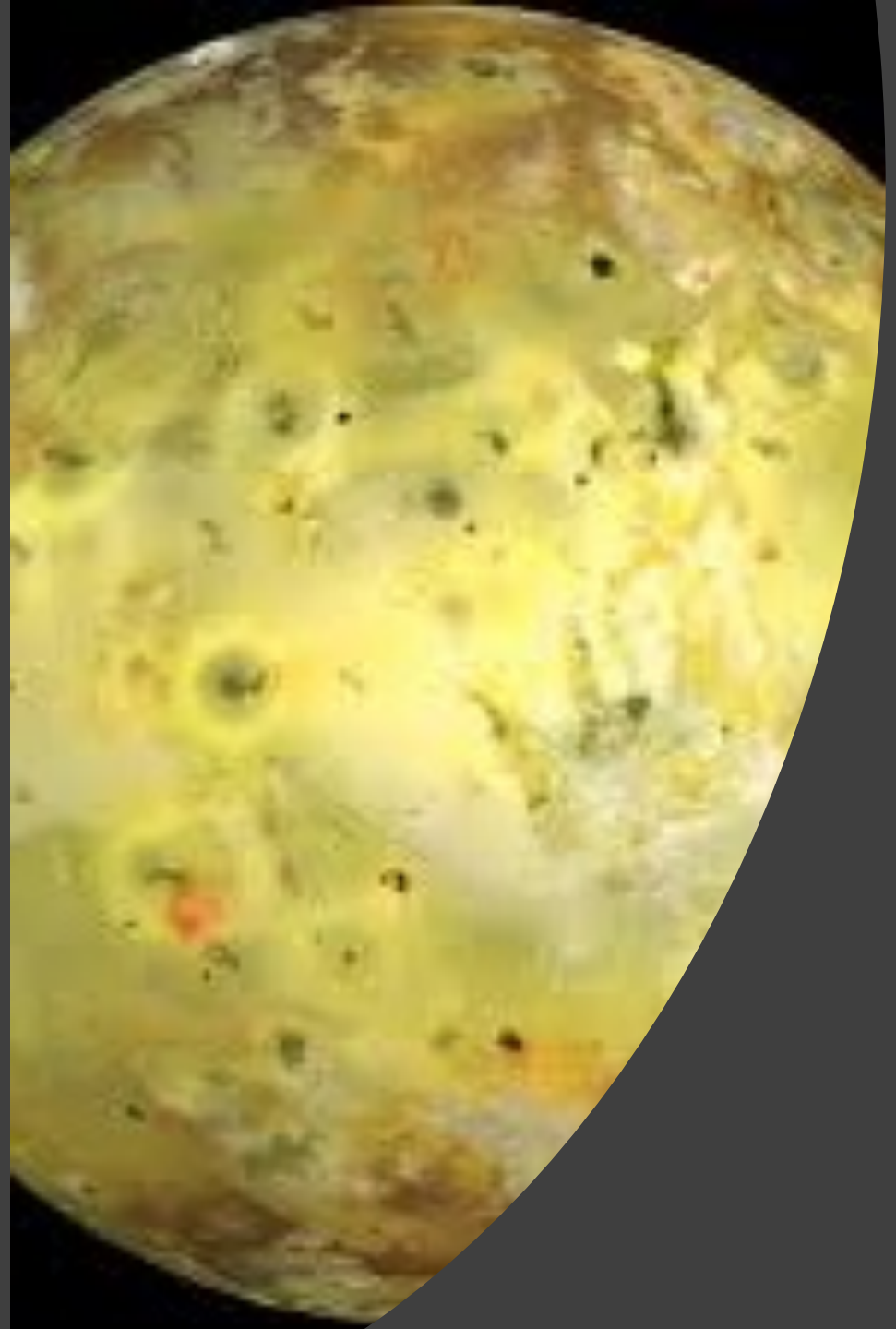


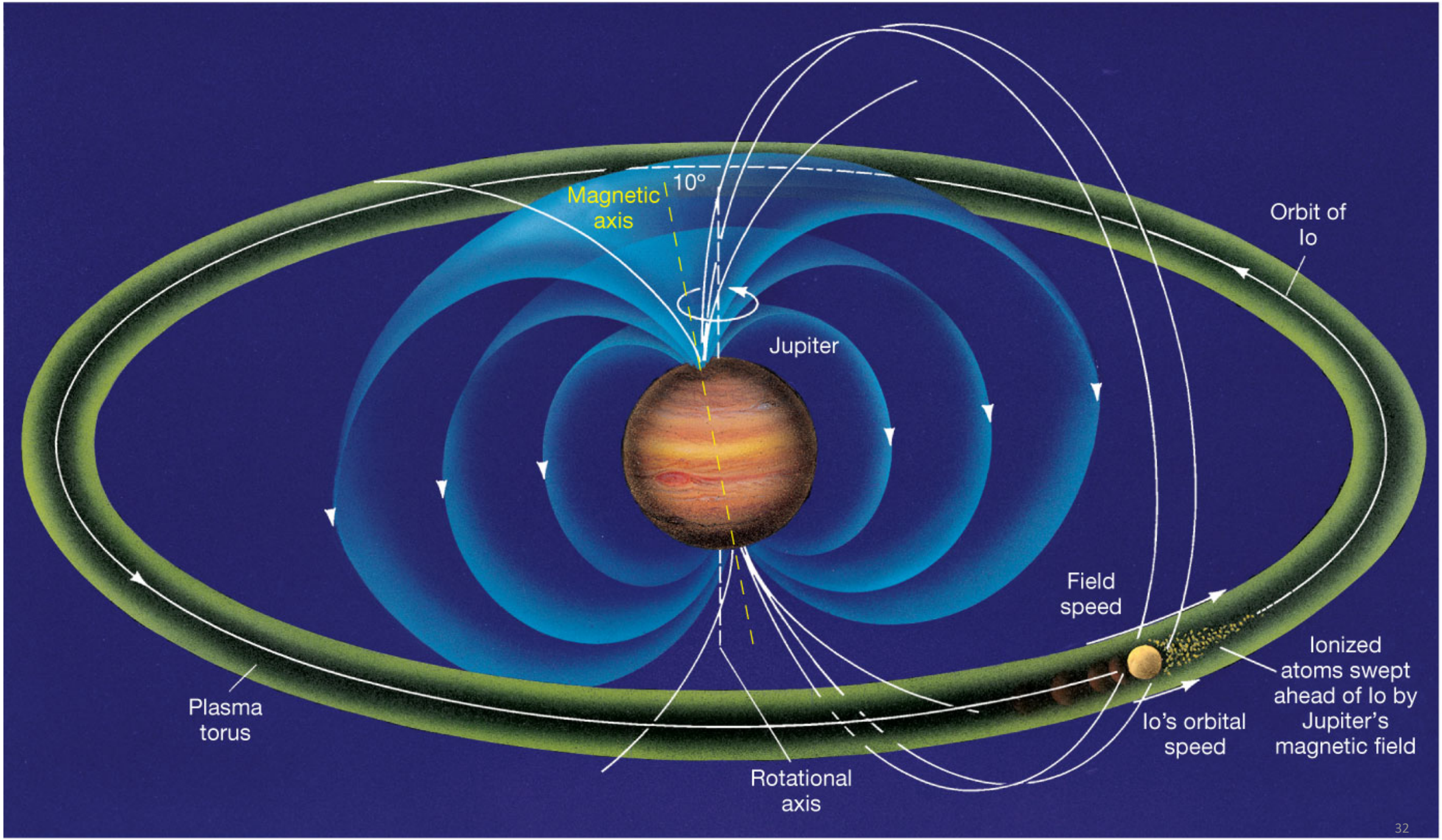
Illustration: JAXA
Inset: NASA, ESA, Chandra, Hubble



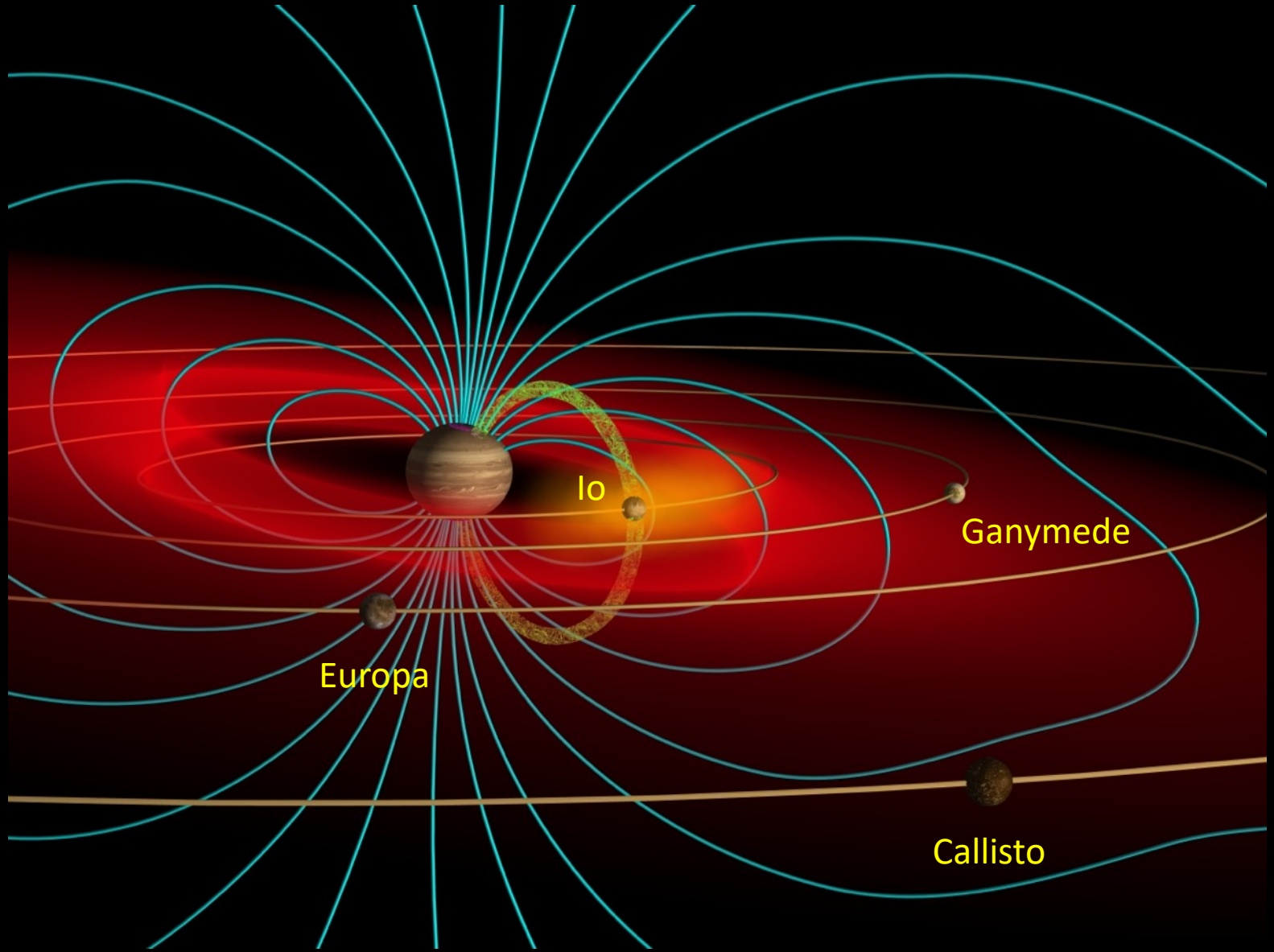
Jupiter’s Moon Io

Volcanoes on Io

- Originally imaged by Voyager 1 during its flyby in 1979
- It has been determined since then that Io has over 400 active volcanoes
- The interior stays molten due to tidal friction caused by changes in the gravitational pull of Jupiter
- Volcanic activity spews Sulphur frost onto the surface and ionized Sulphur into space



Plasma Disk and Galilean Moons



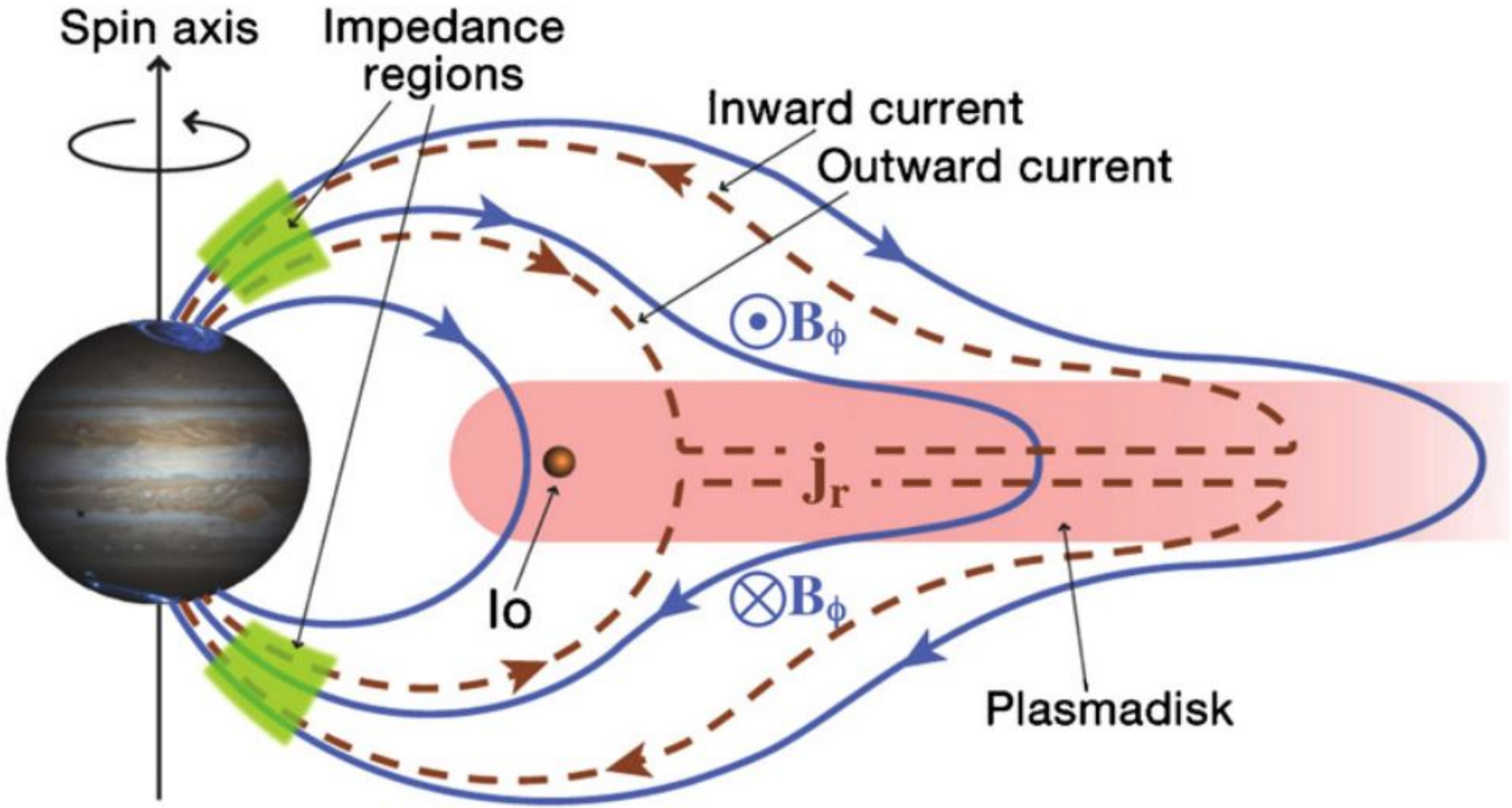
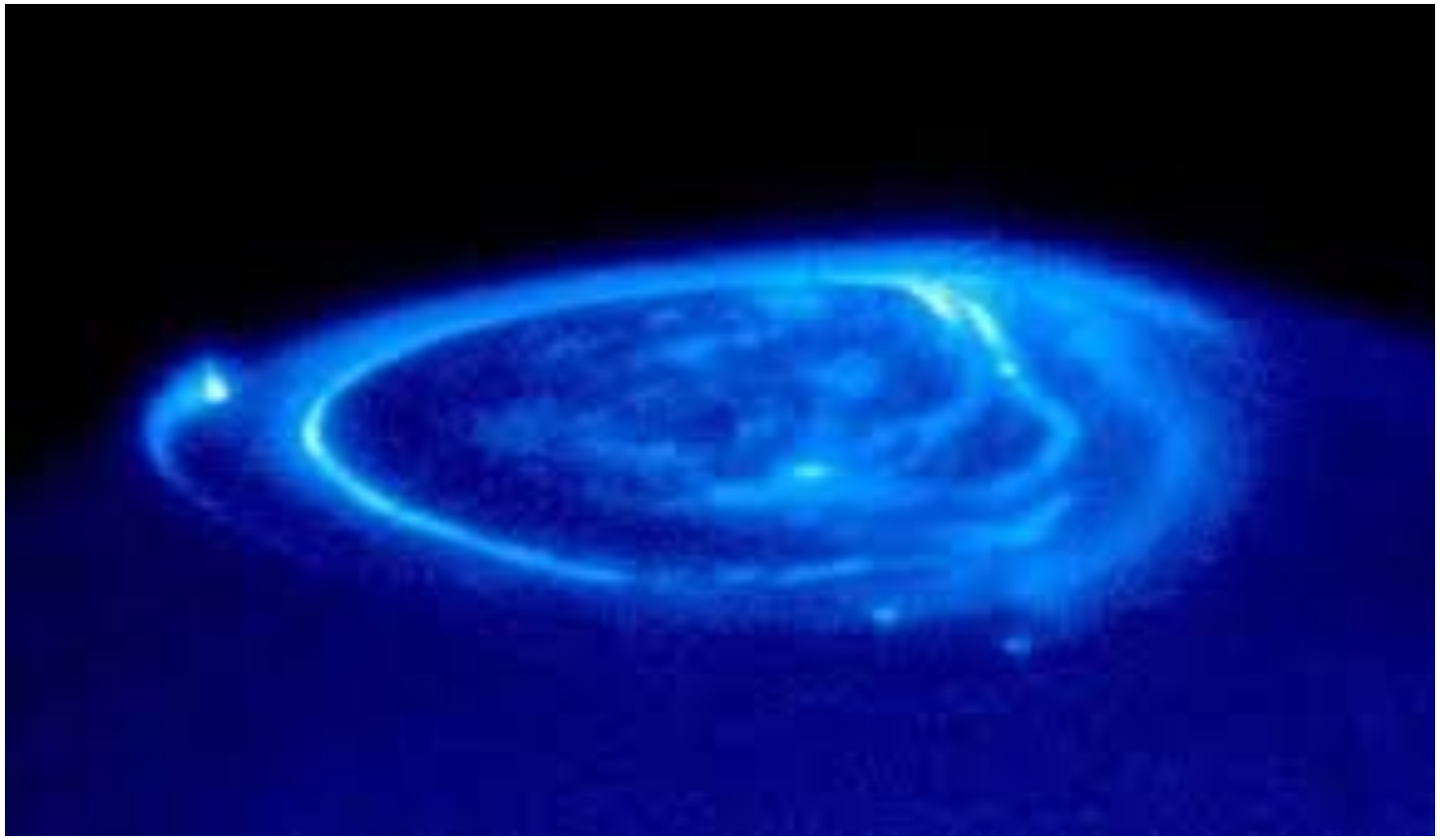
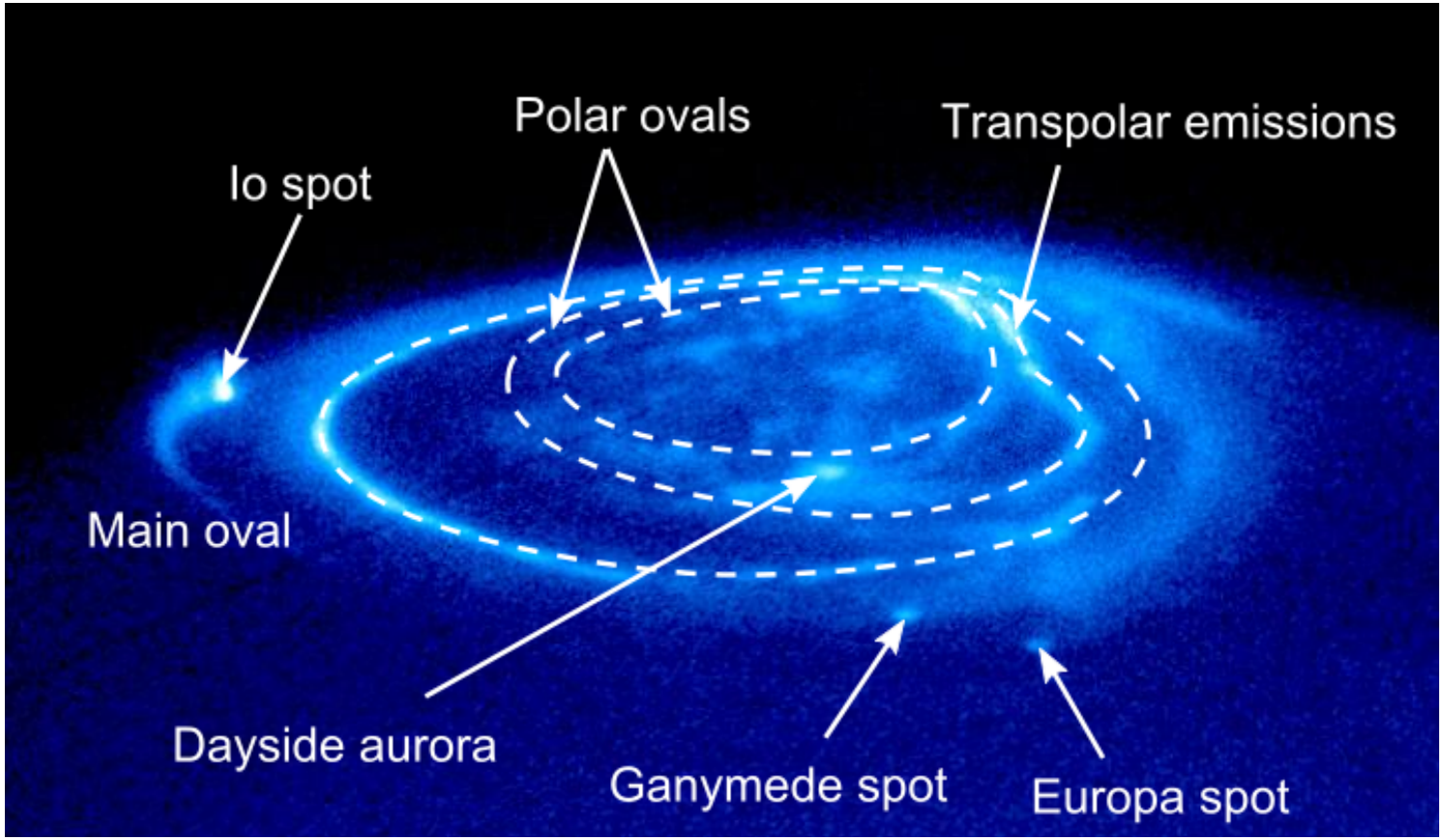


Image credit: *The magnetosphere of Jupiter: Coupling the Equator to the Poles,* Fran Begenal, 2006



- Unlike Earth the aurora on Jupiter is permanent and persistent around both poles
- The aurora are caused by the strong direct current in the ionosphere
- The solar wind can affect the intensity of the aurora

Aurora Visibility

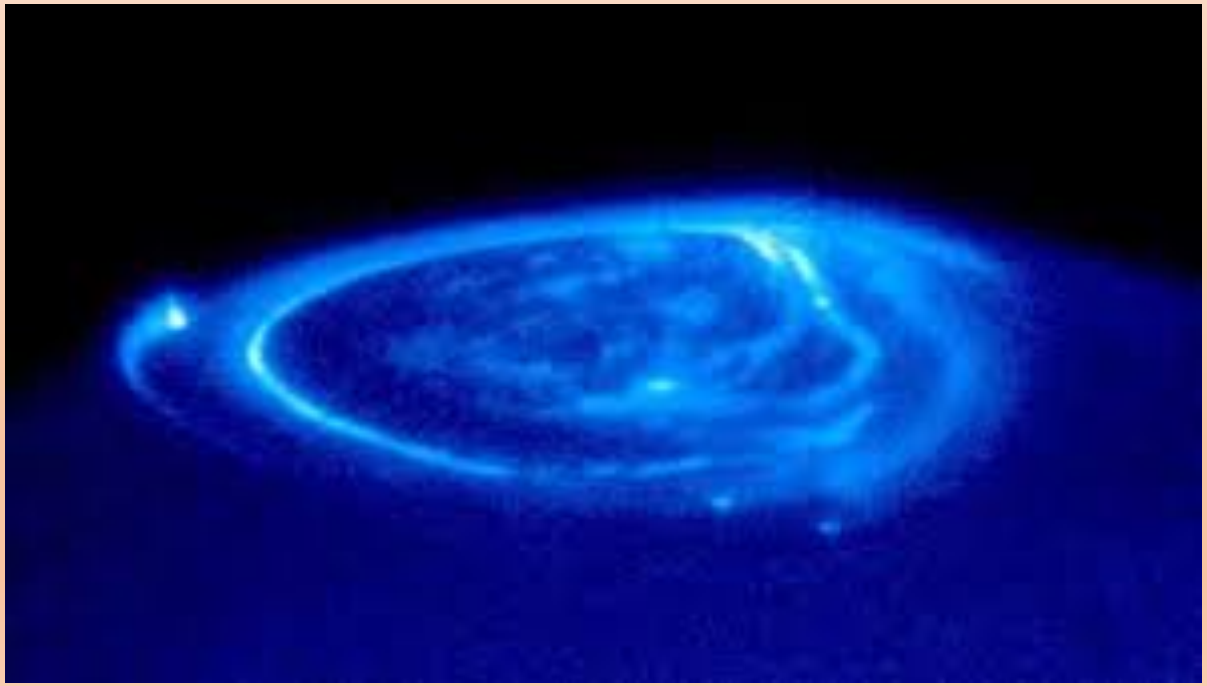


Anatomy of Jupiter's Aurora

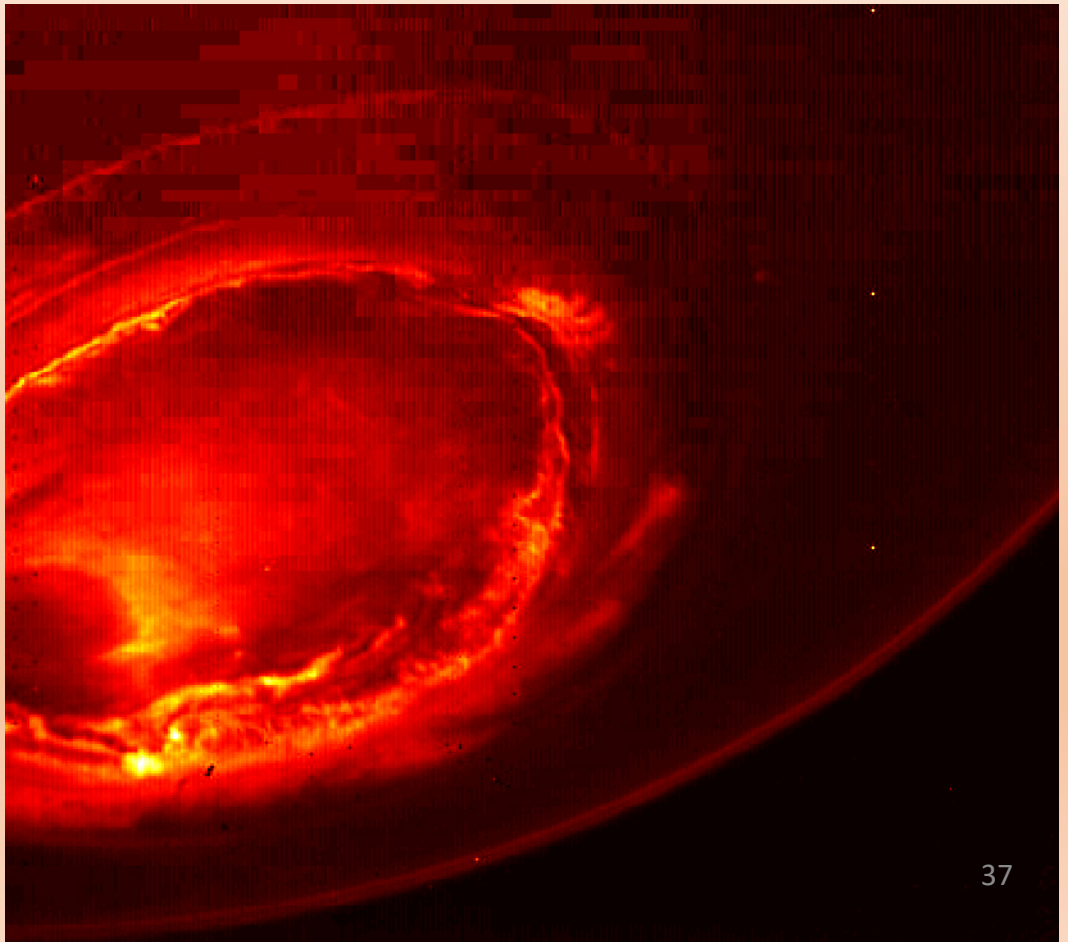
- Jupiter has 3 main ovals that are stable and are the dominant part of Jupiter's aurora
- Their intensity is influenced by interaction with the solar wind pressure
- Bright dots corresponding to the moons Io, Ganymede and Europa can also be seen

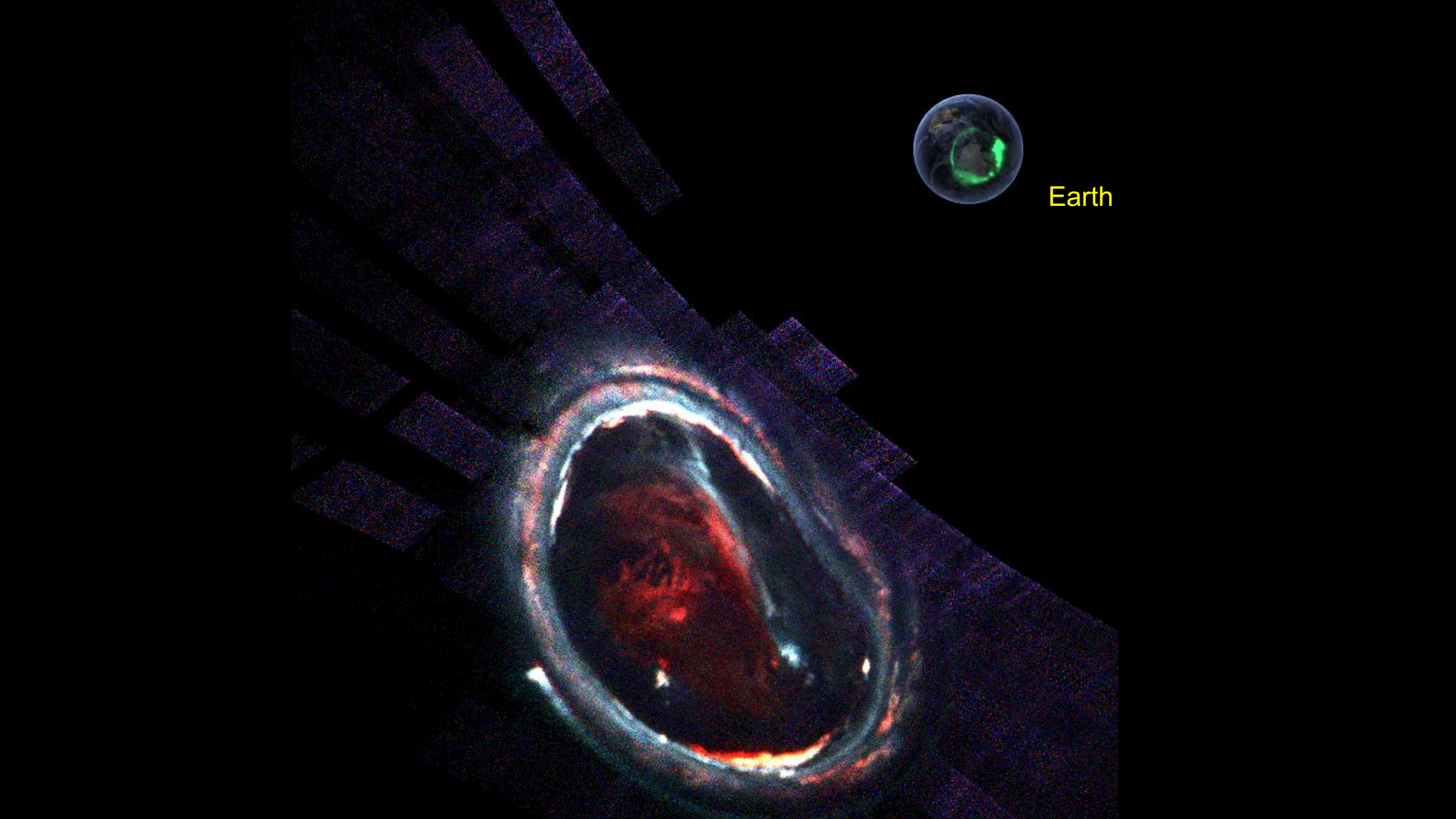
Ultraviolet and Infrared

Jupiter's northern aurora showing Ultraviolet Radiation caused by ionizing Hydrogen

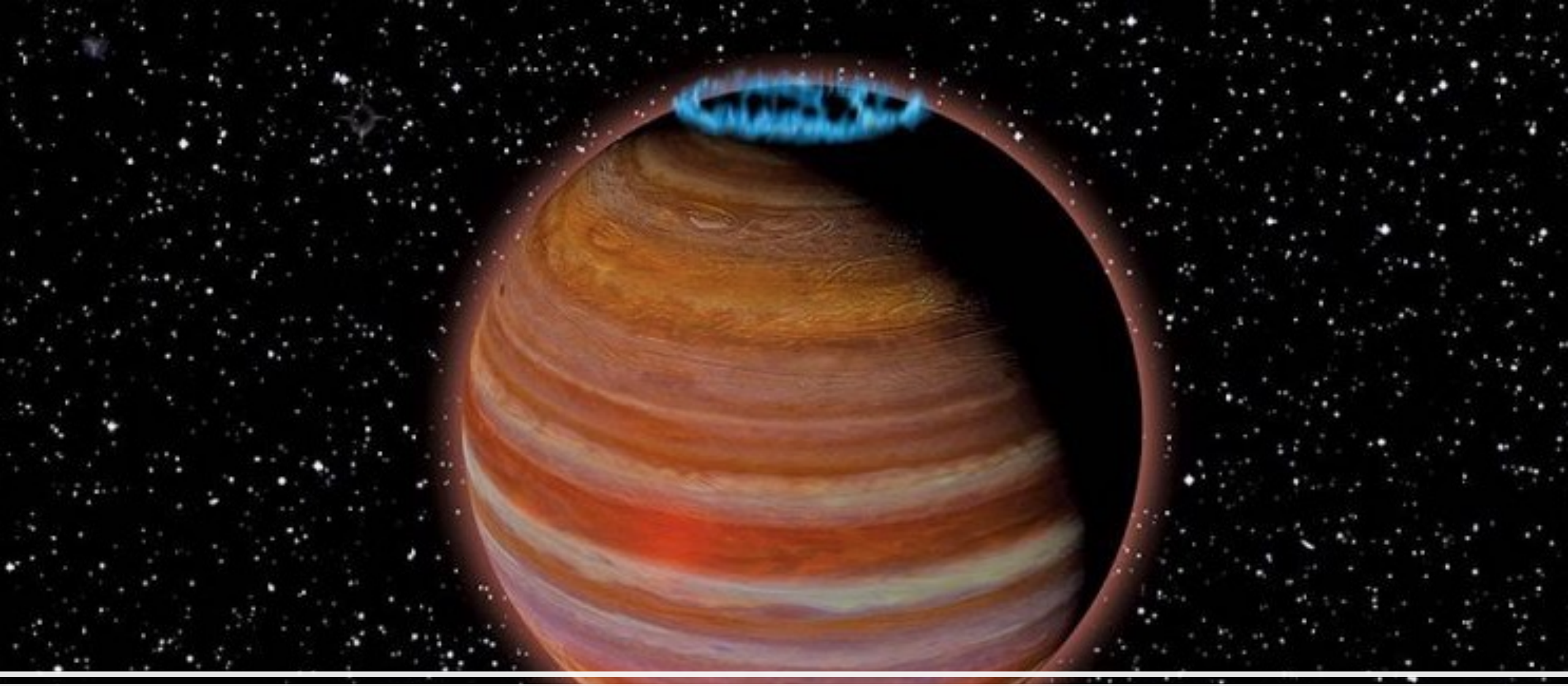


Jupiter's southern aurora showing Infrared Radiation generated by Joule Heating




Earth

AURORA ON EXOPLANETS



Rogue planet SIMP J01365663+0933473 was first observed in 2016

Questions ???

www.nasa.gov/juno