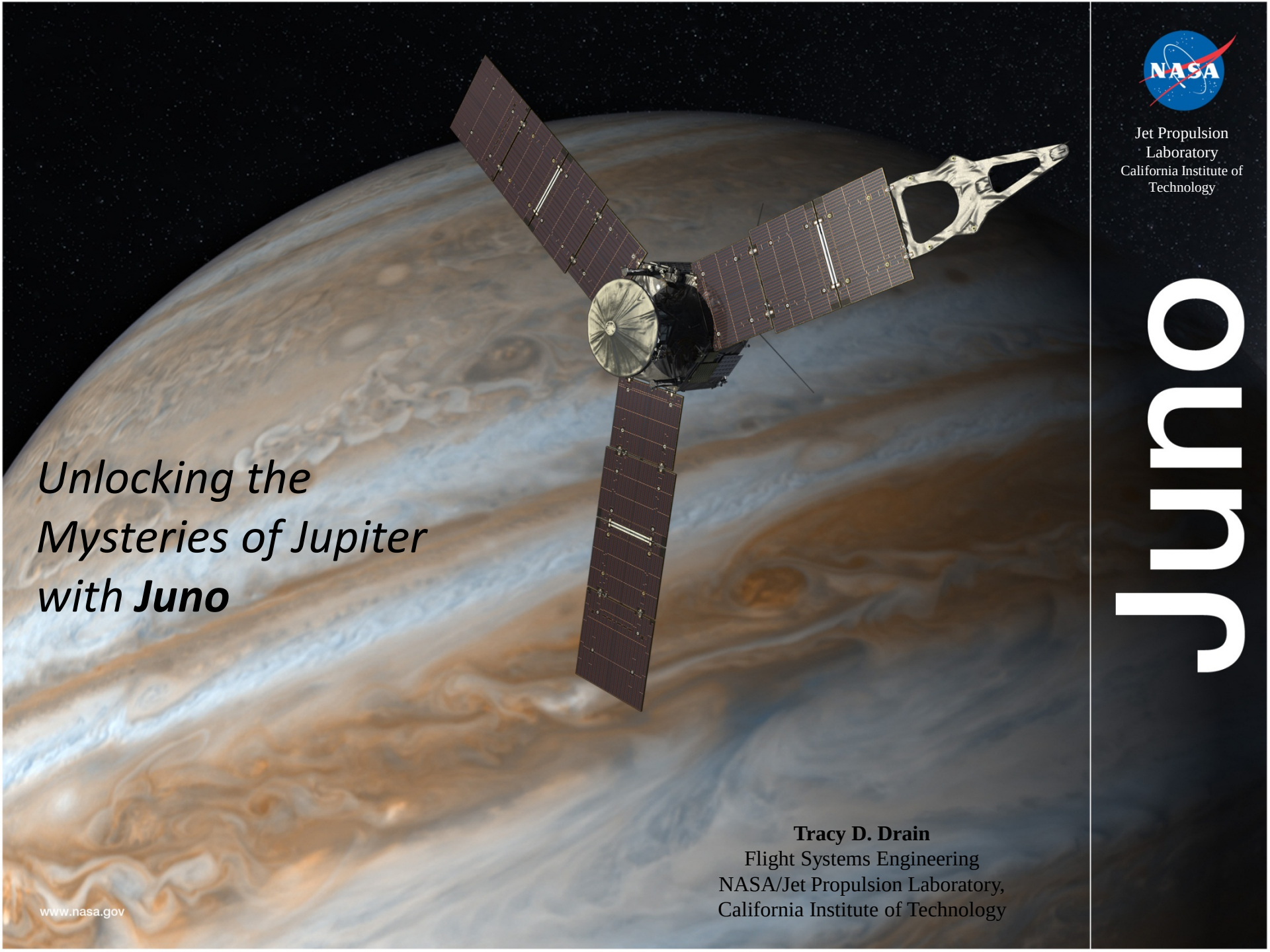


Jet Propulsion Laboratory
California Institute of Technology

Juno

*Unlocking the Mysteries of Jupiter with **Juno***

Tracy D. Drain
Flight Systems Engineering
NASA/Jet Propulsion Laboratory,
California Institute of Technology

NASA’s Jet Propulsion Laboratory
Pasadena, California

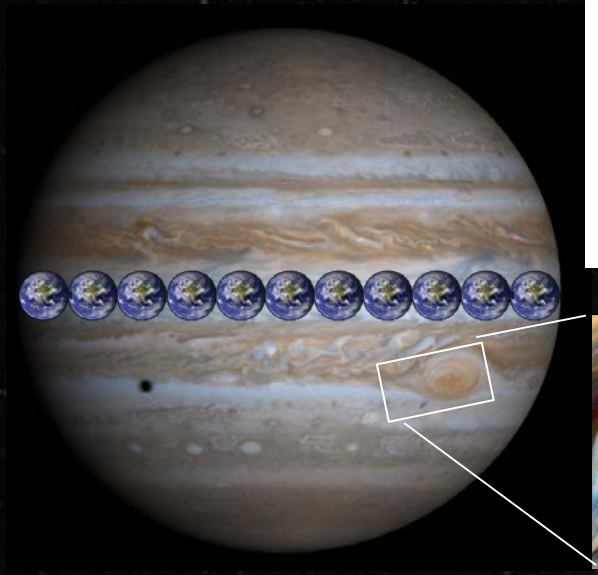
What is JPL?

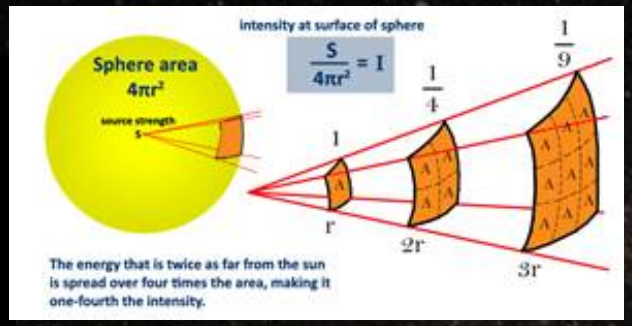
- **The Jet Propulsion Laboratory**
  - One of the 10 NASA centers in the USA
  - Began as a **remote location to test rockets** in the 1930's
  - Built the U.S.'s first satellite, **Explorer 1** (launched in 1958)
  - **Now**: lead US center for **robotic exploration** of the solar system

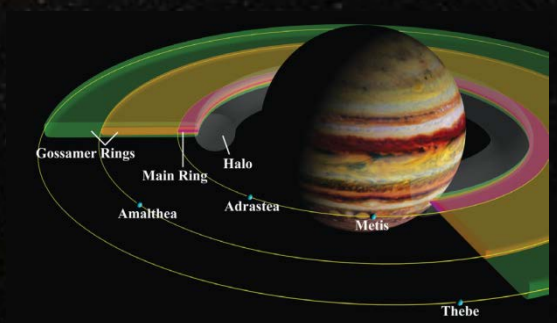
- **Examples of current missions include:**
  - Orbiters at Planets
    - Cassini at Saturn
    - Mars Recon. Orbiter
    - OCO-2 at Earth
  - Landers and Rovers
    - Mars Exploration Rover
    - Mars Science Lab (Curiosity)
  - Astrophysics Platforms
    - Spitzer
    - Kepler

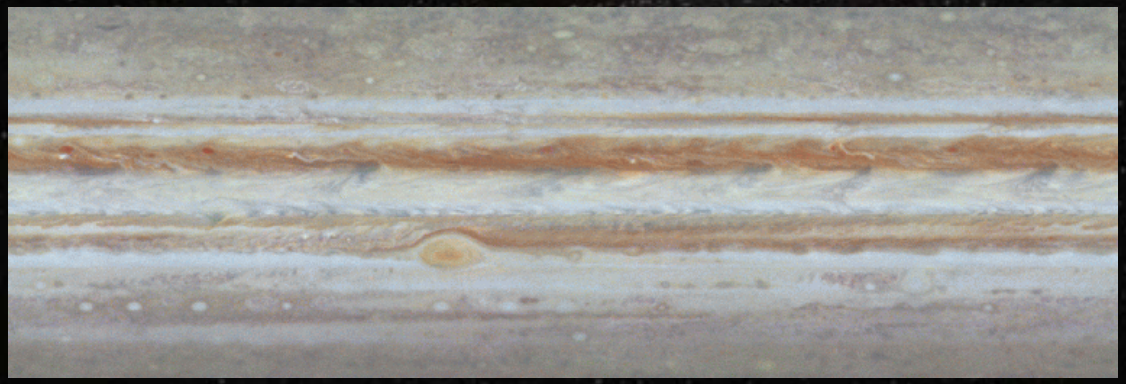
Some Jupiter Fun Facts

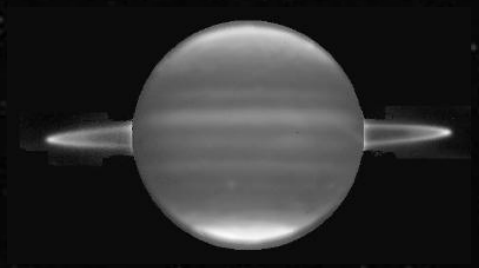
- Distance from Sun
- Size & The Great Red Spot
- Number of Known Moons
- Rings (Yes, It Has Rings!)



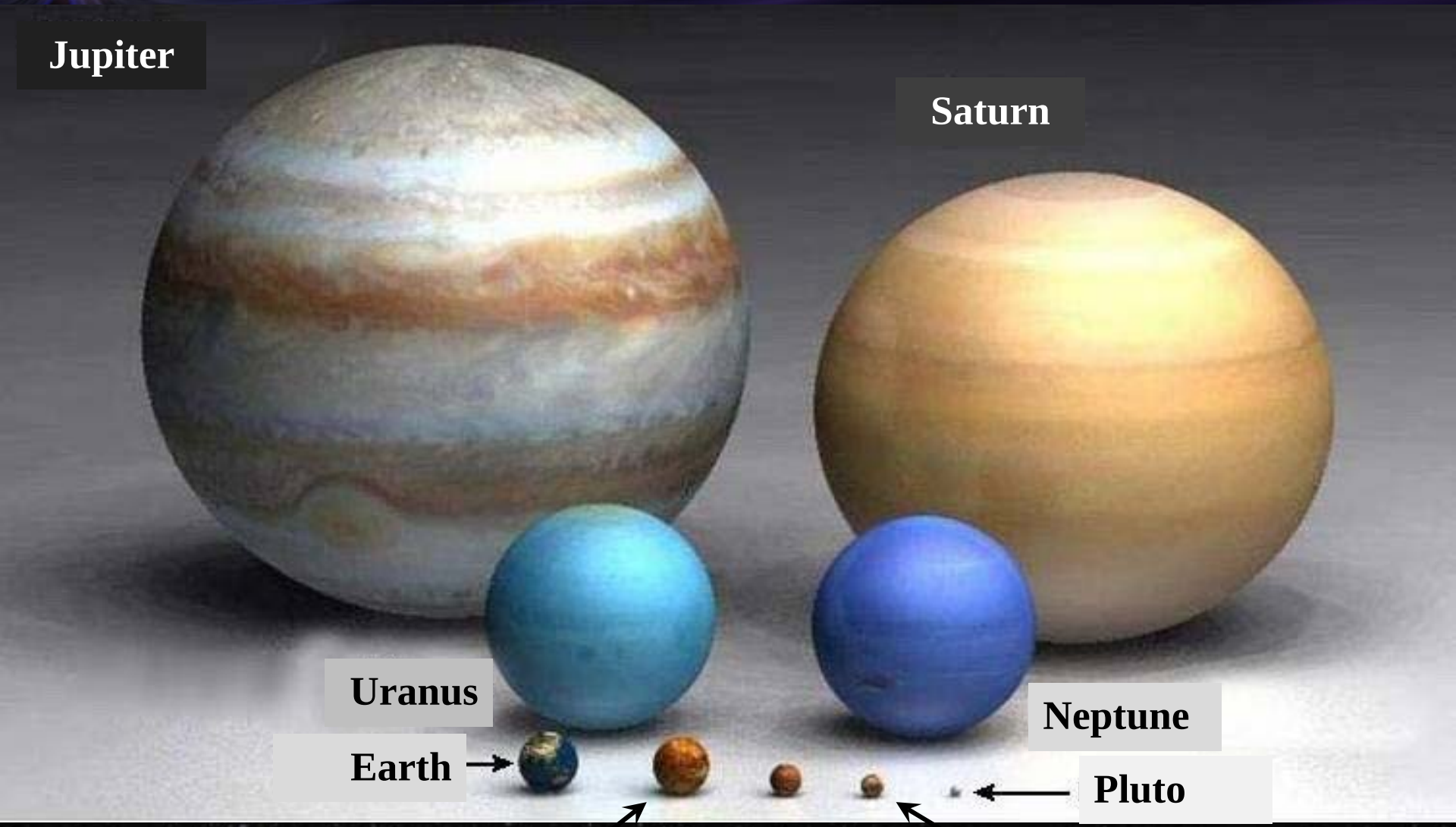






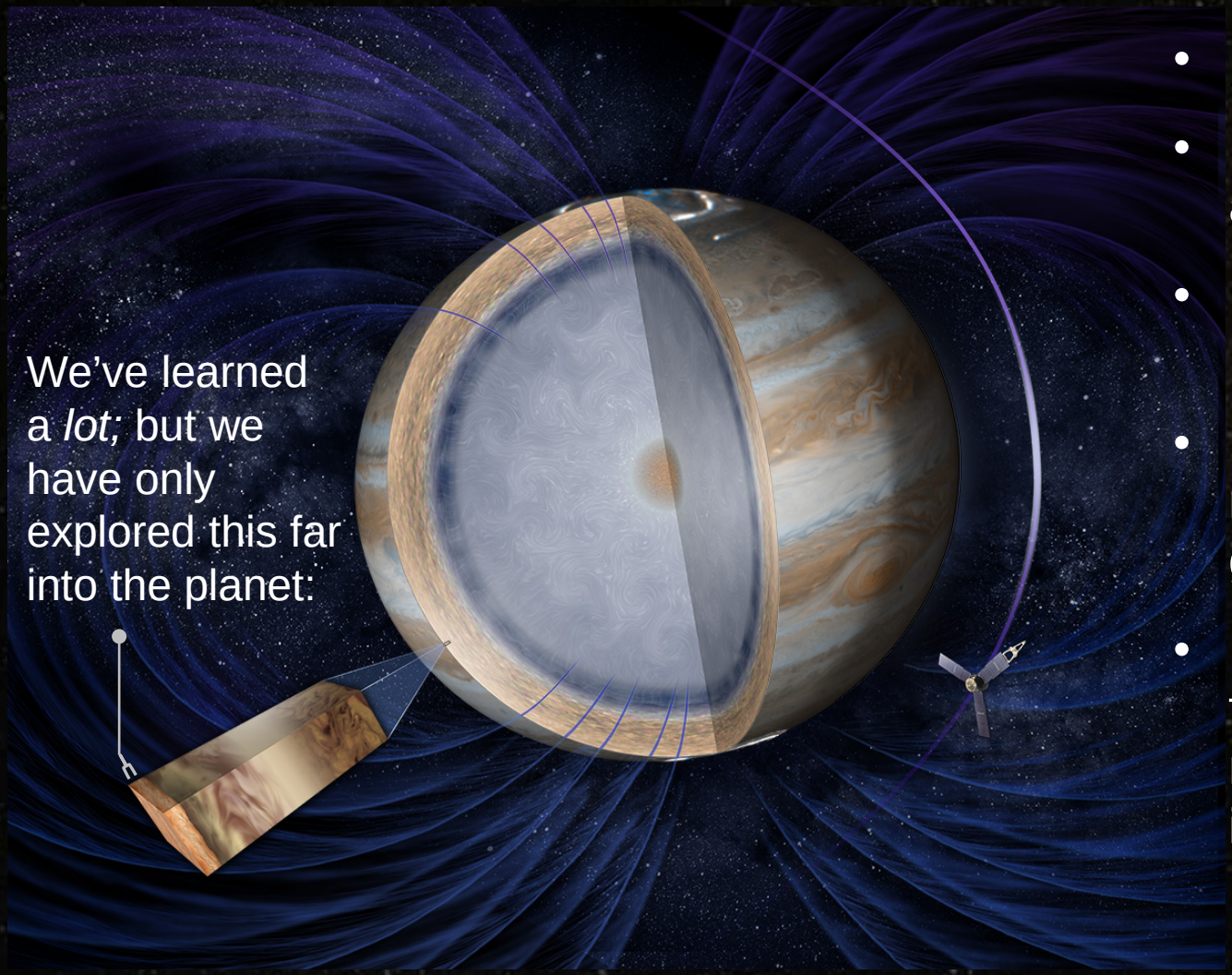


Visual Size Comparison



Why Send Another Spacecraft to Jupiter??

Galileo orbited Jupiter from Dec.1995 to Sept. 2003

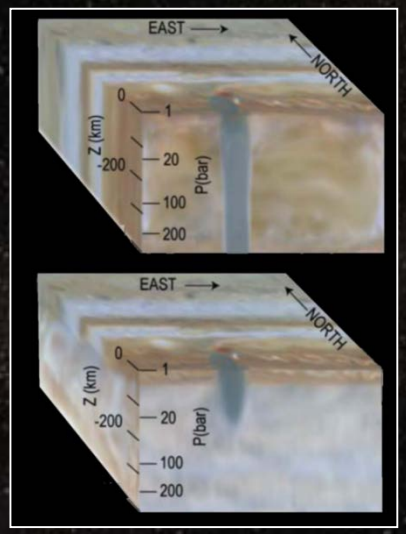


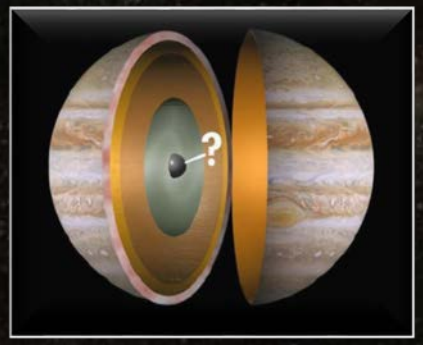
Unanswered Questions:

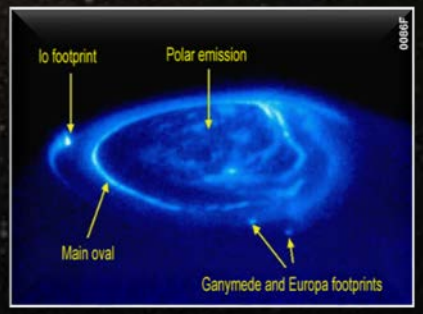
- How did Jupiter form?
- How is the planet arranged inside?
- Is there a solid core? How big is it?
- How is Jupiter's huge magnetic field generated?
- How are atmospheric features related to the movement of the deep interior?

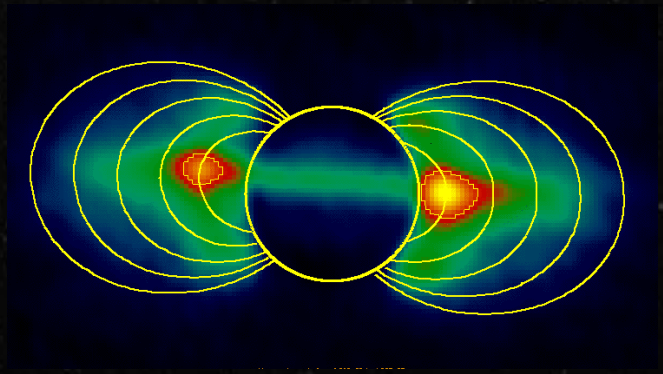
Science Goals at Jupiter

- Origin
  - Determine the **water abundance** and constrain the core mass (to decide among alternative theories of origin).
- Interior
  - Understand the **interior structure** and dynamical properties by mapping its gravitational and magnetic fields.
- Atmosphere
  - Map variations in **atmospheric composition, temps, cloud opacity** and dynamics to depths > 100 bars.
- Polar Magnetosphere
  - Explore the 3D structure of Jupiter's **polar magnetosphere and aurorae.**



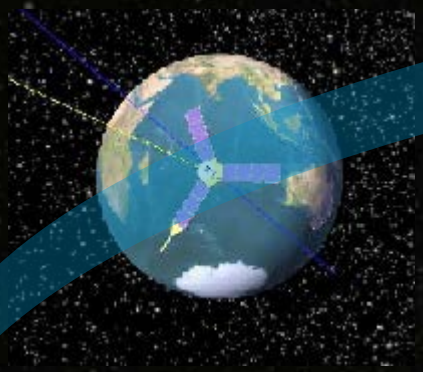




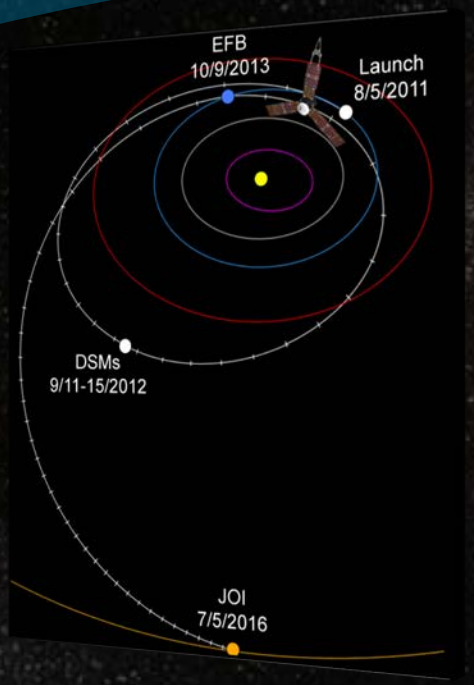


Juno Mission Overview

Earth Fly-By Oct 2013

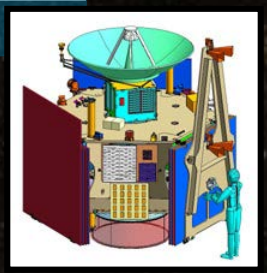


Deep Space Maneuvers
Aug/Sept 2012



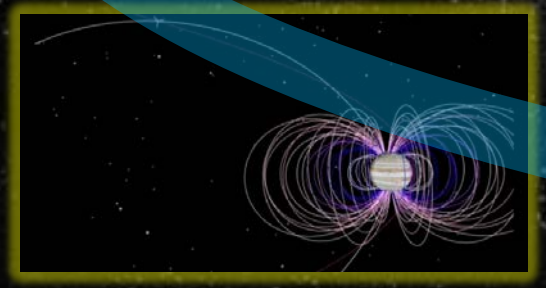
Launch Aug 5. 2011

Kennedy Space Center



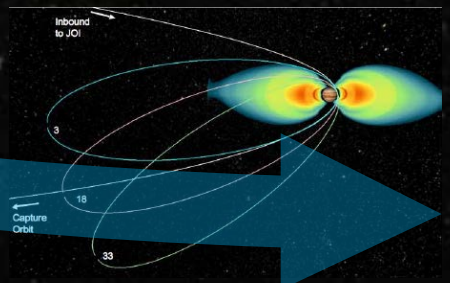
Atlas V-551

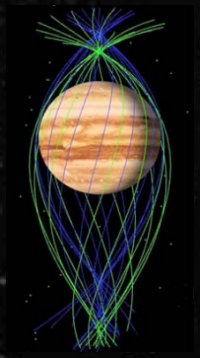
Jupiter Orbit Insertion
July 2016



53.5 Day Capture Orbit

Science Phase
Nov 2016 to Oct 2017

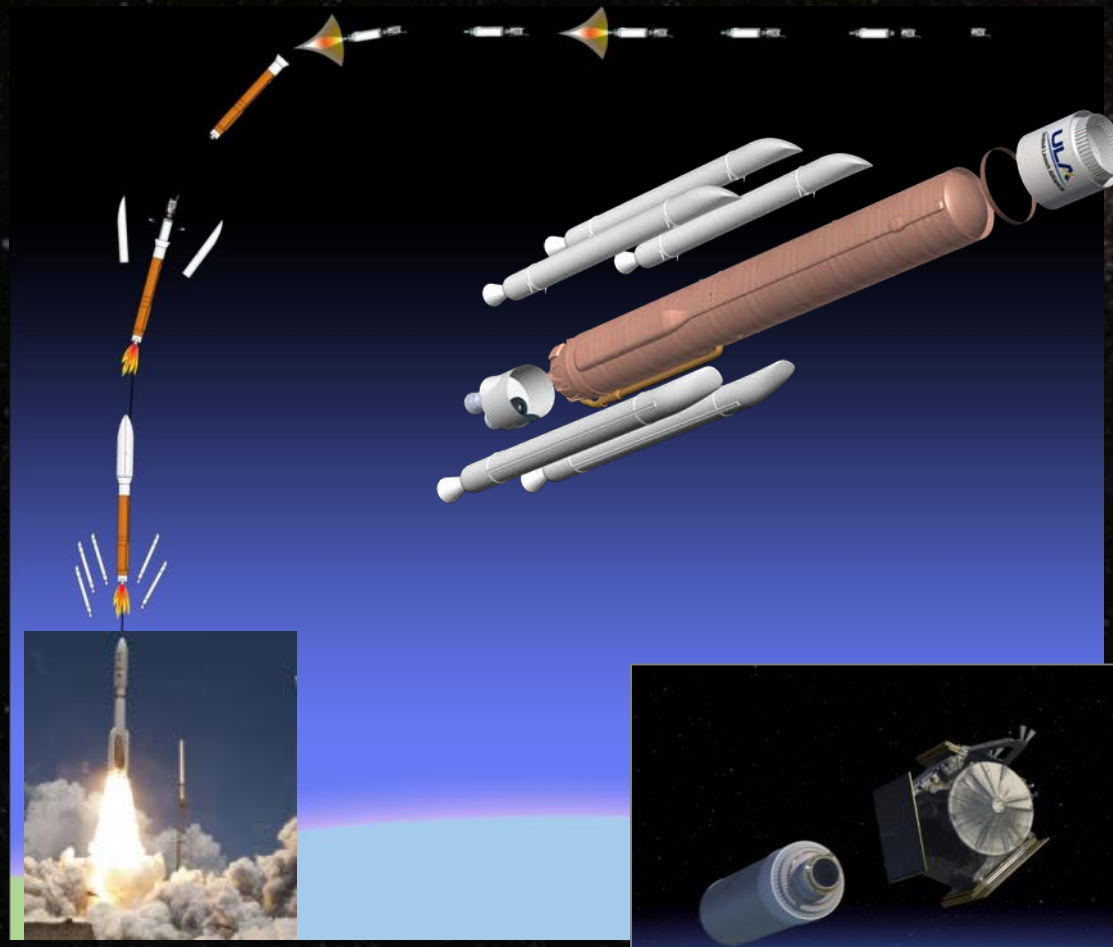


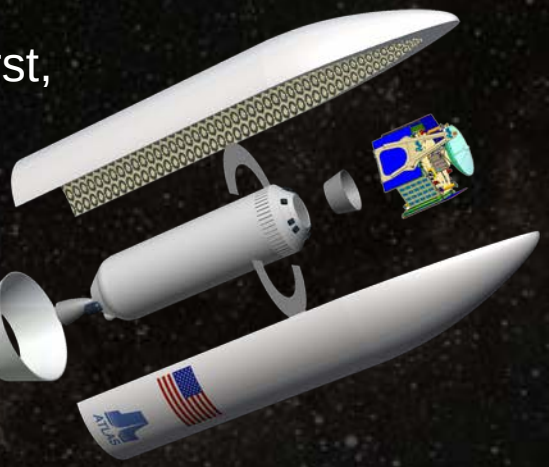


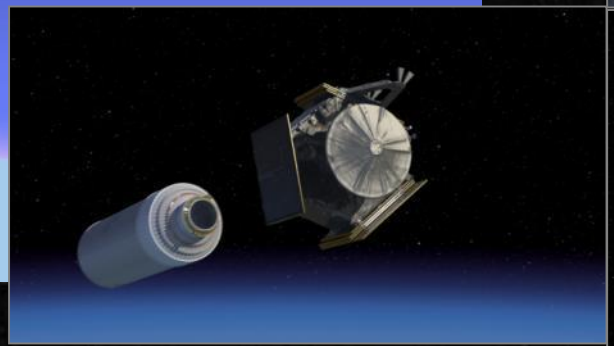
Images: NASA/JPL-Caltech

Launch Details (Aug 5th 2011)

Juno Launched on an Atlas V 551 rocket
The Solar Arrays were folded up inside nose cone at first,
and then deployed after separation

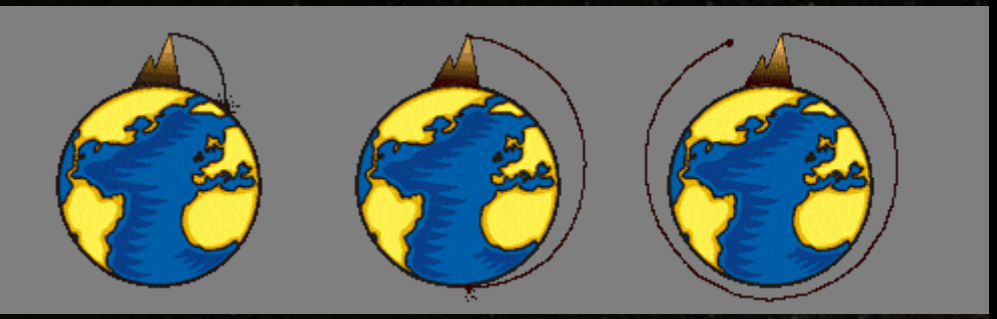






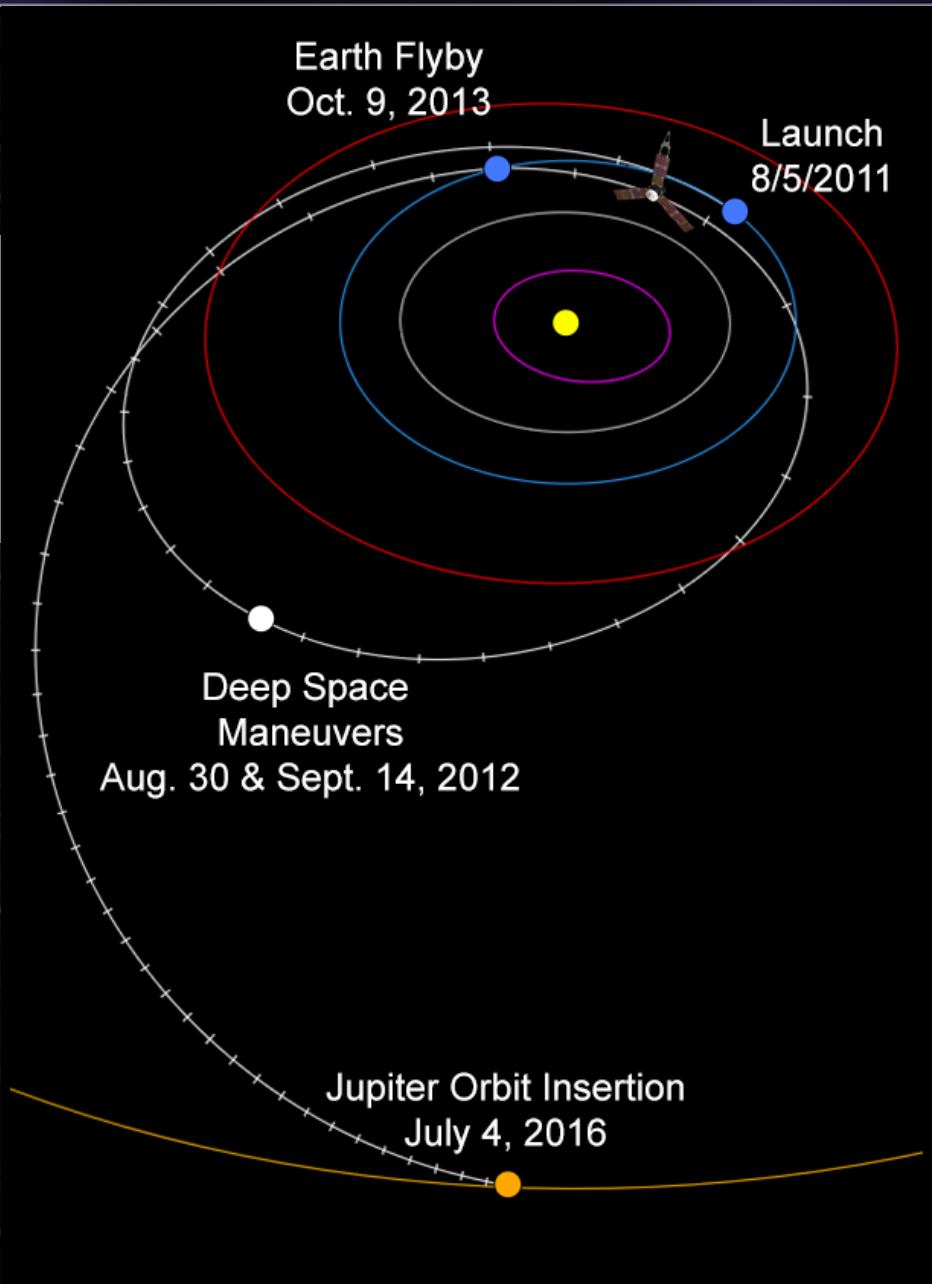
Juno's Earth Flyby Gravity Assist

Imagine shooting a cannonball from a mountain top…



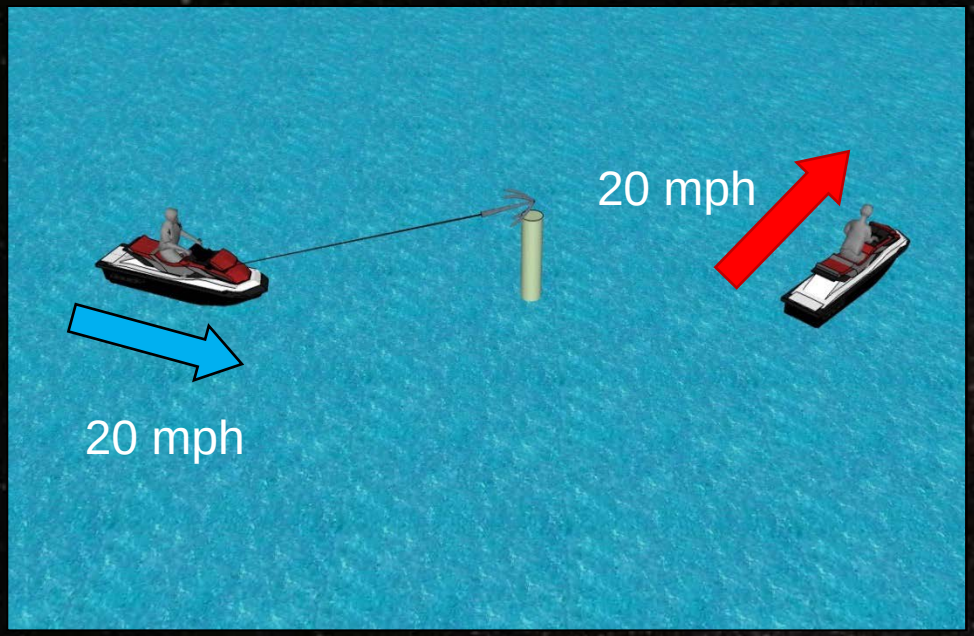
If you shoot it *fast* enough, by the time it falls "to the ground", the curve of the Earth means the ground has "moved" out of the way.

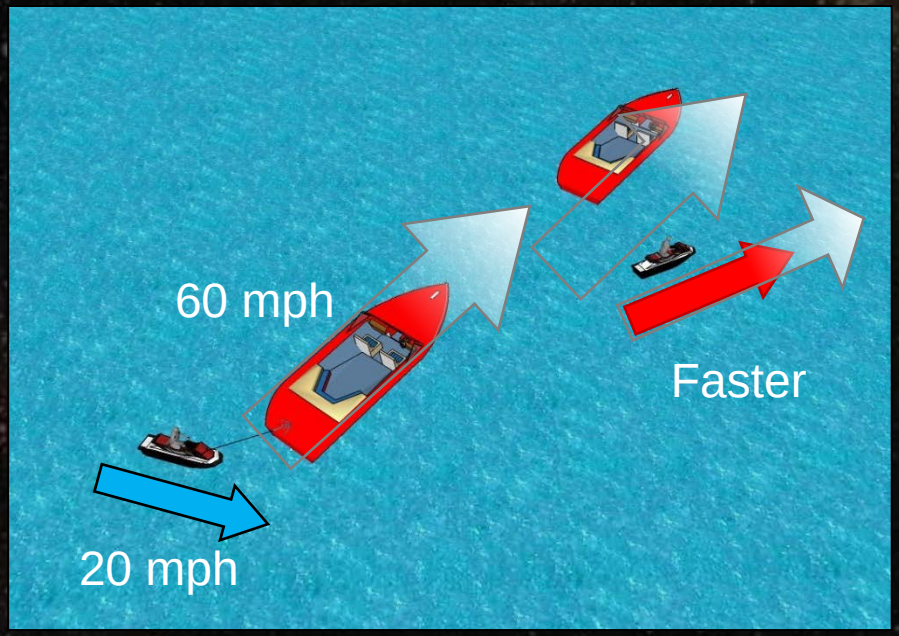
A boost from our planet's gravity makes Juno (just barely) fast enough to reach its destination before falling back toward the sun.



Earth Flyby Gravity Assist: How It Works

A Jet Ski rider could change her direction of travel by firing a grappling hook at a stationary post (and holding on for dear life, then letting go!).



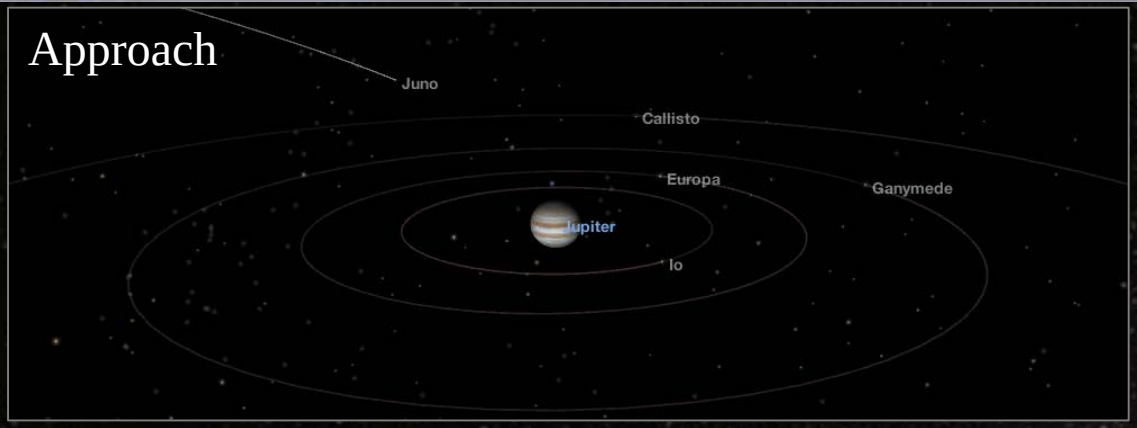


But if she fires the hook at a moving speed boat, she will pick up some of the boat's speed in the direction the boat is moving. When she lets go, she heads off in a new direction, going faster than before.

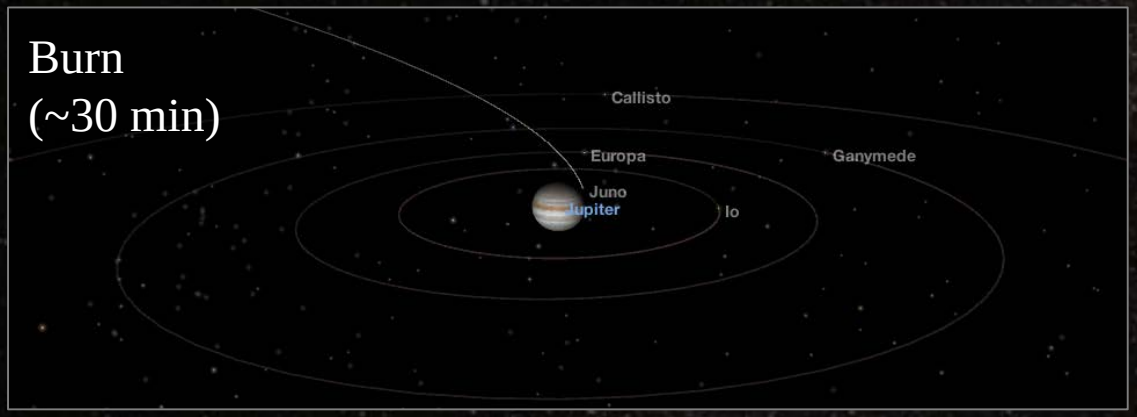
The same thing happens with Juno… The spacecraft is the Jet Ski, the Earth is the Speed Boat, and GRAVITY is the grappling hook.

Jupiter Orit Insertion (in just 291 days!)

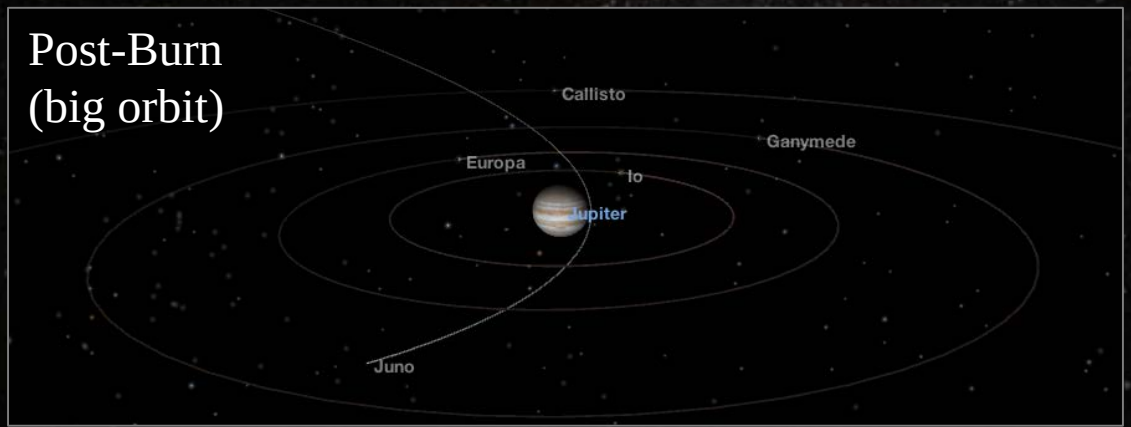
Approach



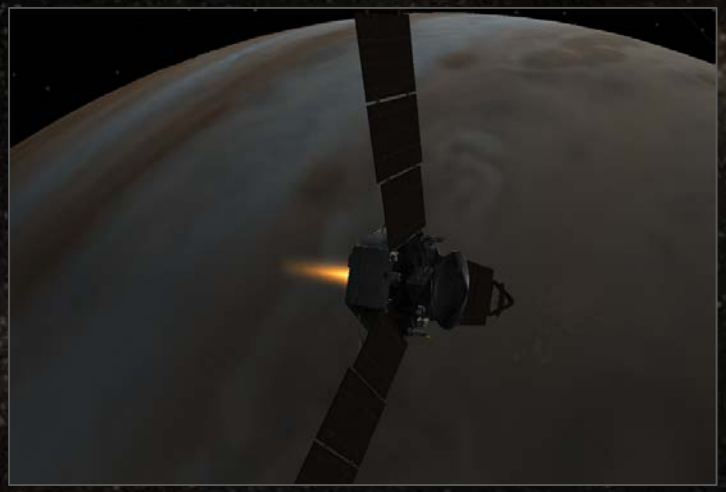
Burn
(~30 min)



Post-Burn
(big orbit)



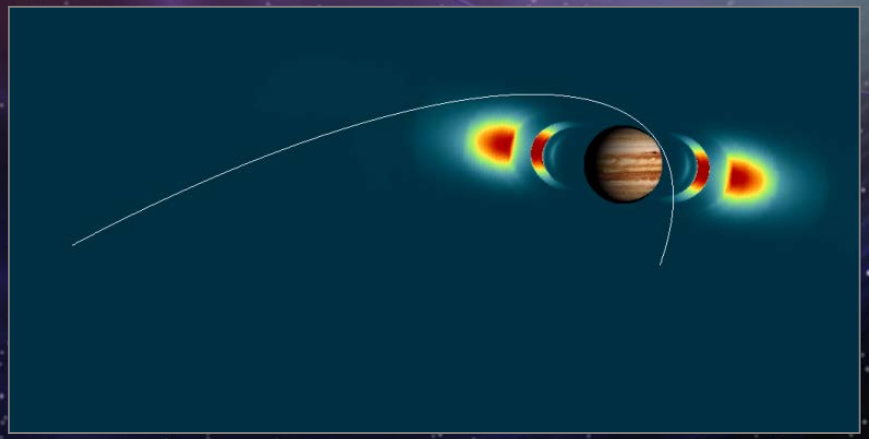
Slowing Juno Down

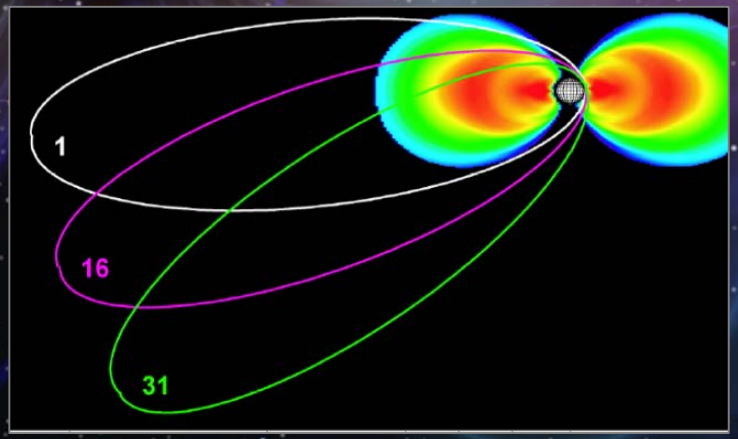


View from Aft Deck

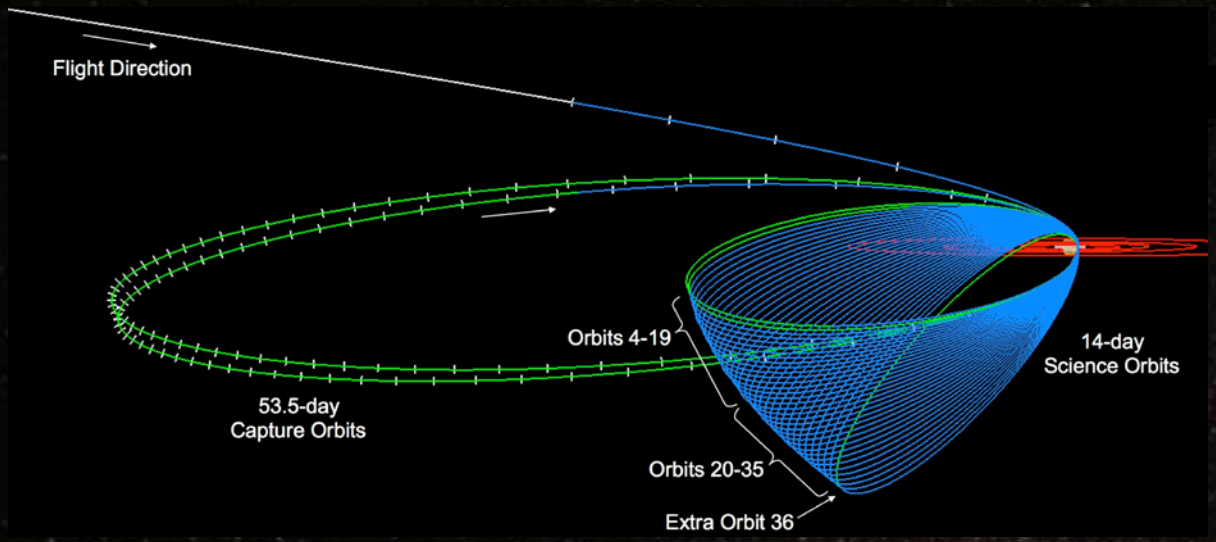
Juno’s Science Orbit (1 of 2)

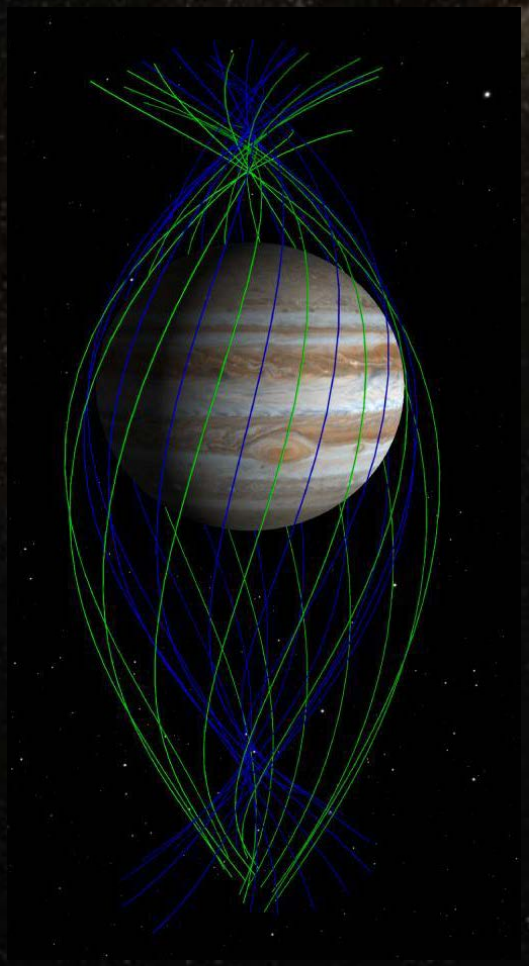
- Juno will be placed into an 14-day Orbit for the Science Phase
- Every 14 days it will pass very close to Jupiter to take measurements
- Juno will “thread the needle” through an area of lower radiation
- But the orbit path will “walk” into areas of greater and greater ration; this limits the mission duration

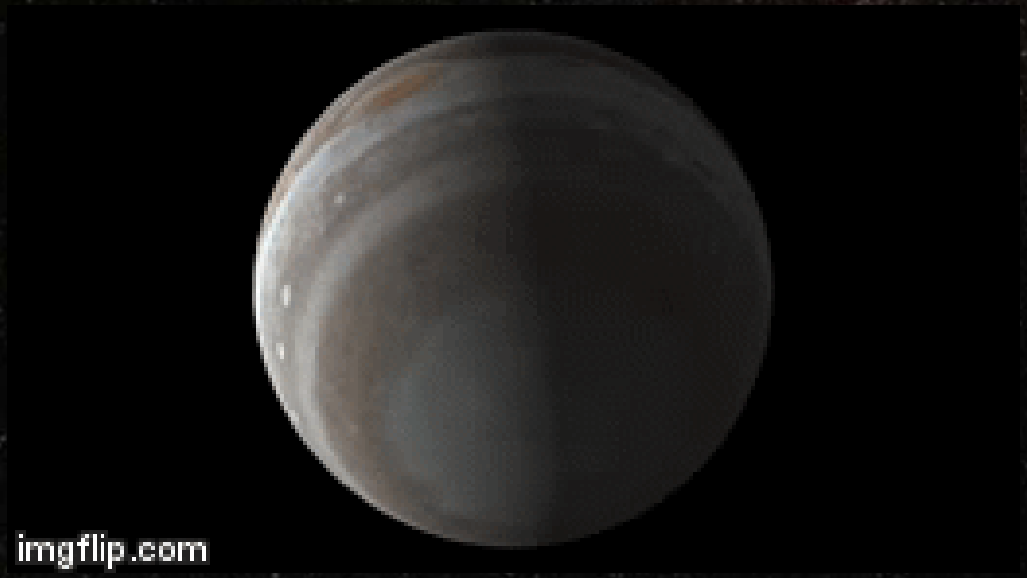




Juno's Science Orbit (2 of 2)





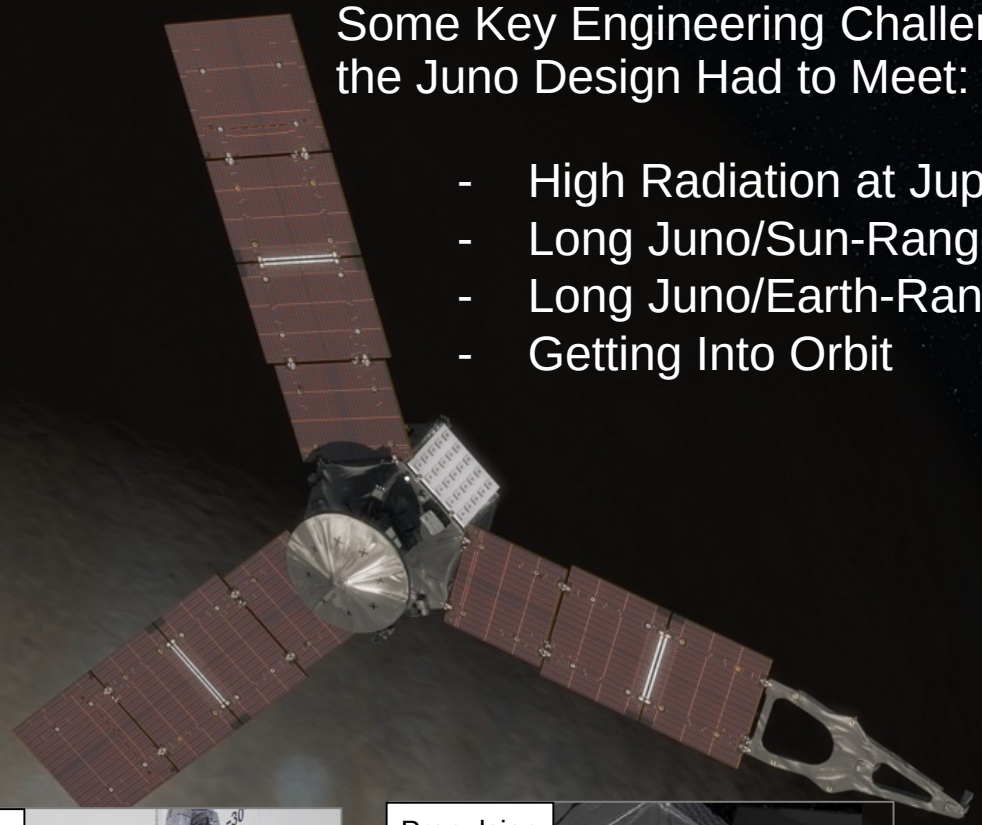


Simulated View from JunoCam

The Juno Spacecraft: Details

Radiation Vault

Solar arrays



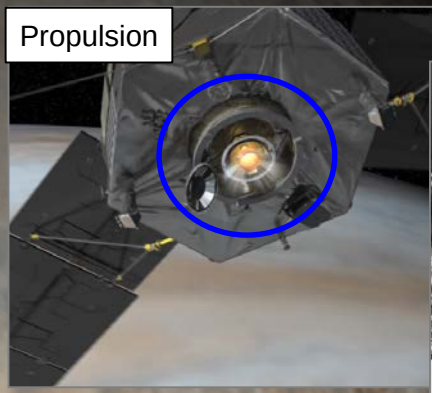
Some Key Engineering Challenges the Juno Design Had to Meet:

- High Radiation at Jupiter
- Long Juno/Sun-Range
- Long Juno/Earth-Range
- Getting Into Orbit

Thermal blankets

Telecom

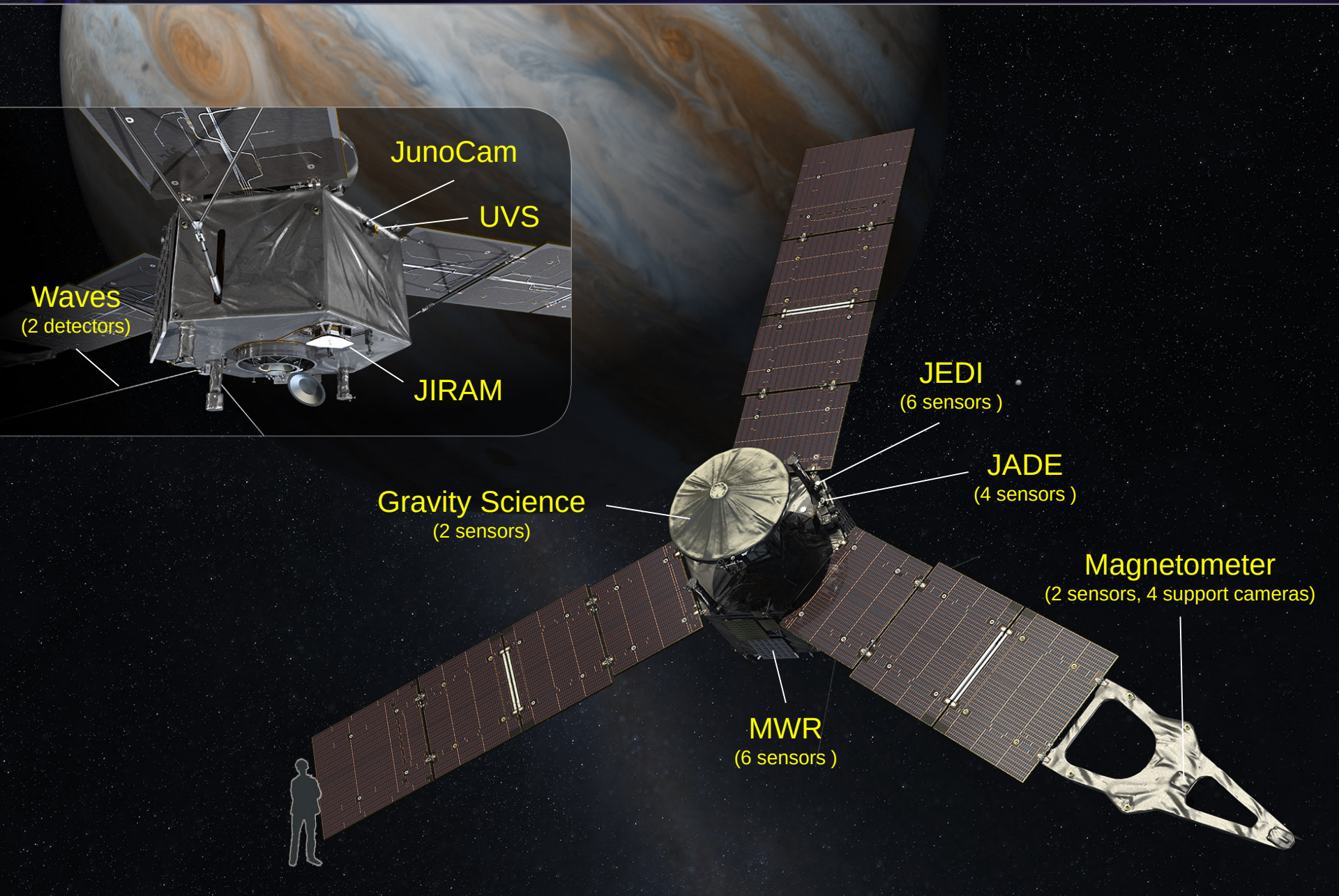
Propulsion



The Juno Spacecraft: Close-up

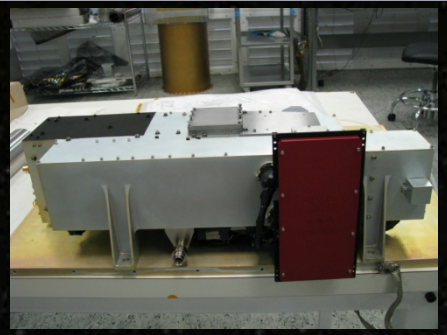
One of Juno's Three Solar Wings

Location of Juno's Science Instruments



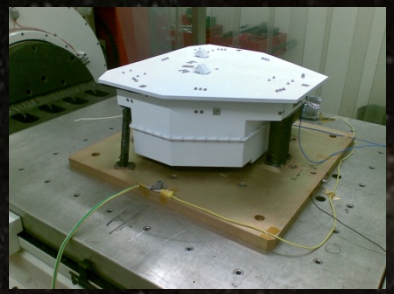
Juno Science Instruments: Details

JADE – Jovian Auroral Distributions Experiment

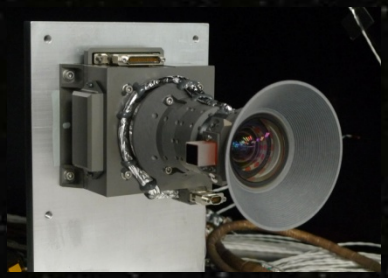


UVS – Ultraviolet Spectrograph

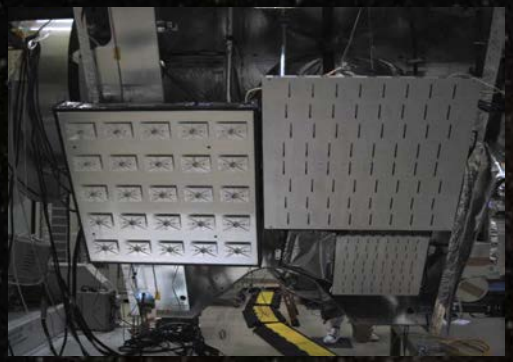
MAG – Flux Gate Magnetometer



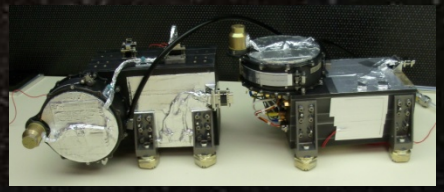
JIRAM – Jovian Infrared Auroral Mapper



JunoCam – Juno E/PO Camera

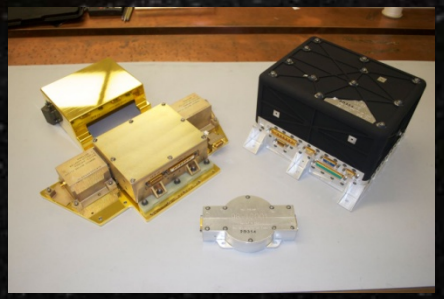


MWR – Microwave Radiometer



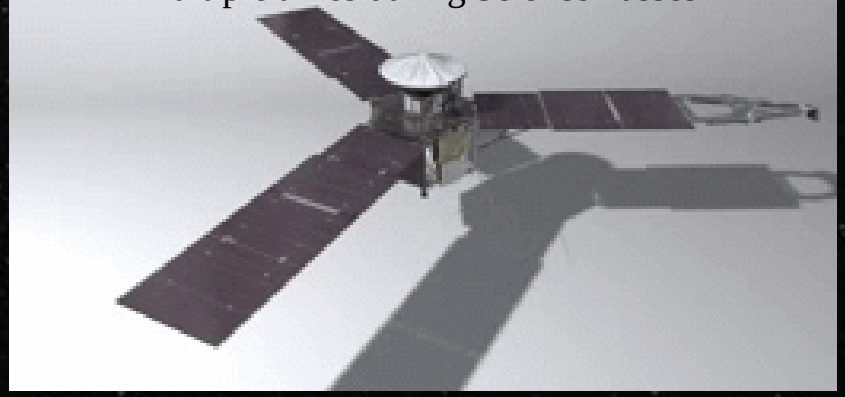
JEDI – Jupiter Energetic-particle Detector Instrument

GRAV - X/Ka-Band Gravity Science

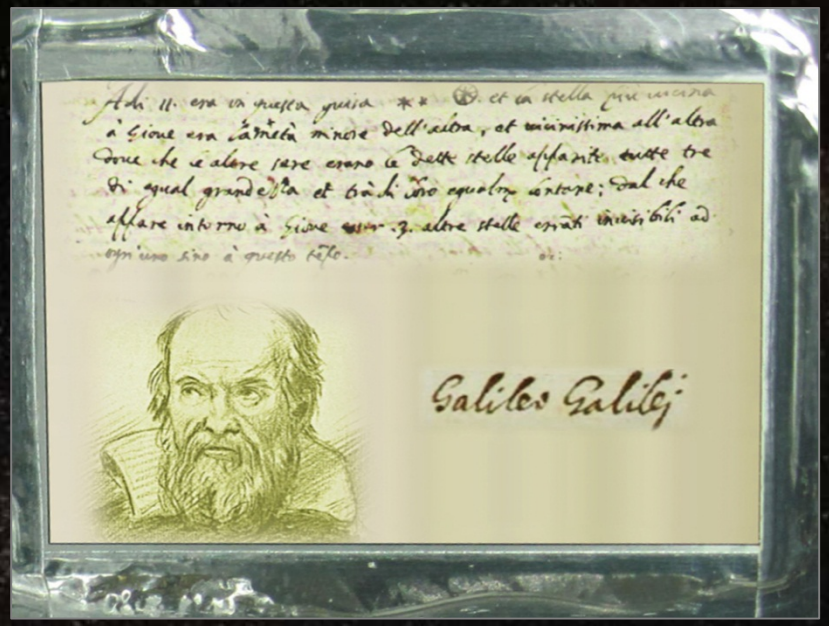


Waves – Radio and Plasma Wave Experiment

Juno rotates so all the instruments get to view Jupiter multiple times during Science Passes



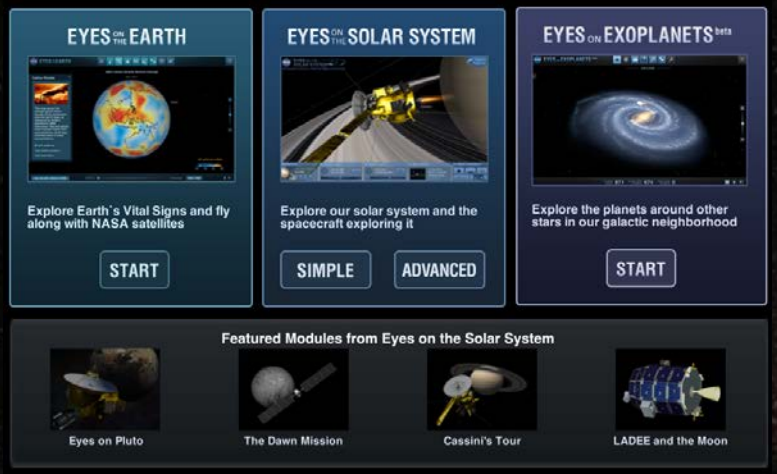
Juno’s Special Passengers

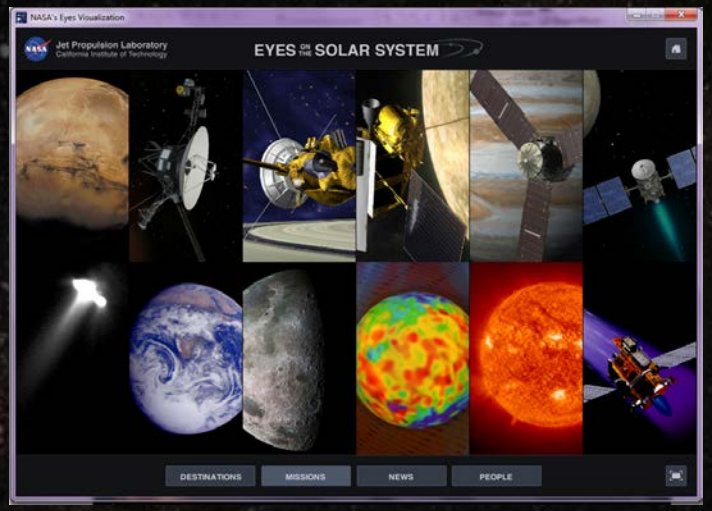


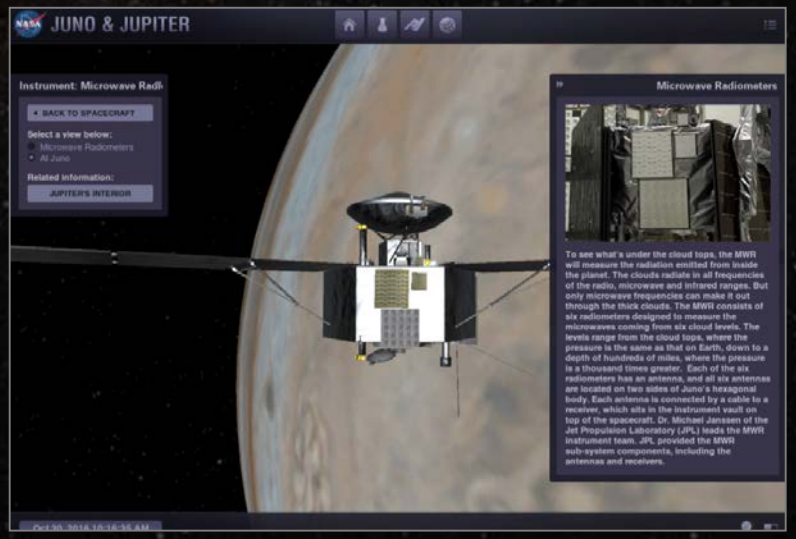
Galileo, Juno and Jupiter

You Can Fly Along With Juno!

Visit NASA's interactive, ***Eyes on the Solar System***:
http://eyes.nasa.gov/

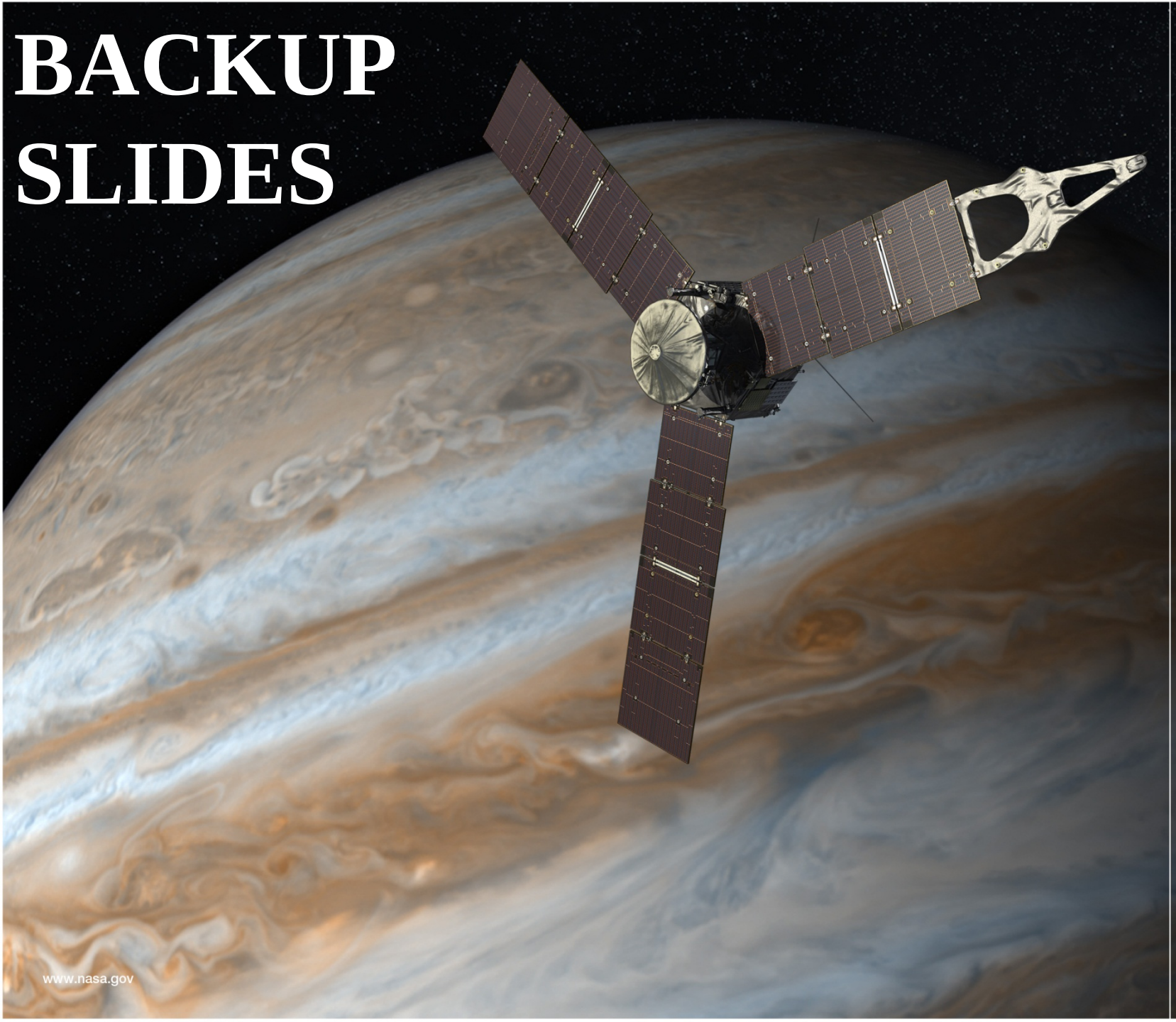






Any Questions?

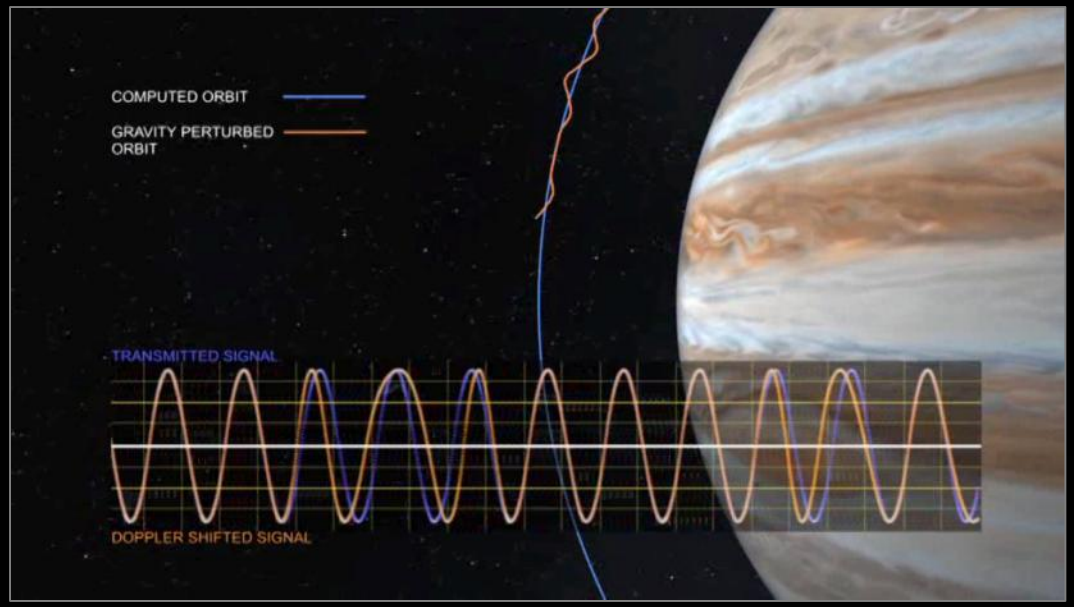
BACKUP SLIDES



Jet Propulsion Laboratory
California Institute of Technology

Juno

Mapping Jupiter's gravity

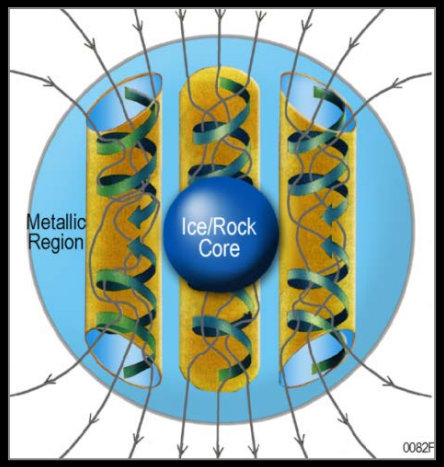


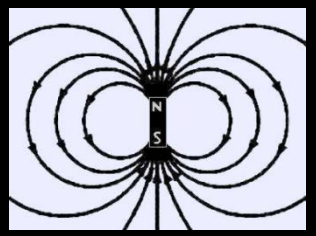
Tracking changes in Juno's velocity (speed and direction) will reveal Jupiter's gravity (and how the planet is arranged on the inside).

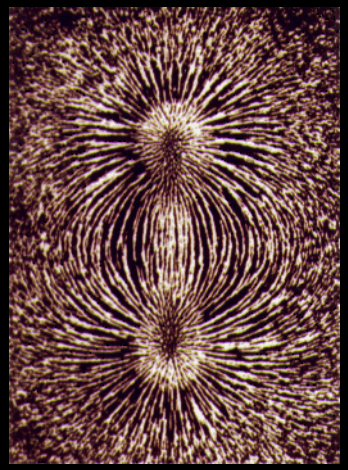
Precise Doppler measurements (think about the sound of a fire engine going by) of spacecraft motion will reveal details about the gravity field.

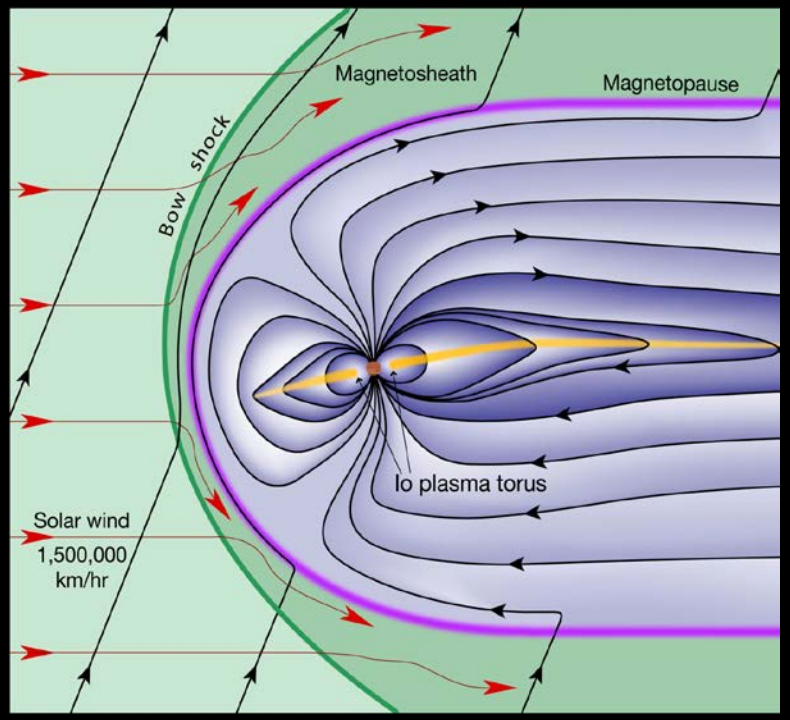
Jupiter's magnetic field

Jupiter's magnetic field is the BIGGEST structure in the entire Solar System (the side away from the sun goes out beyond the orbit of Saturn!)

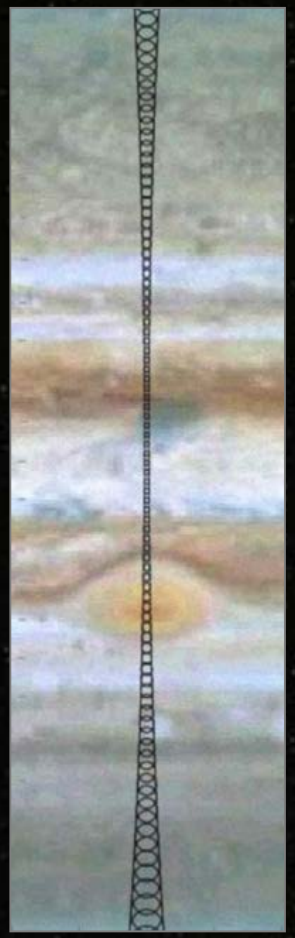


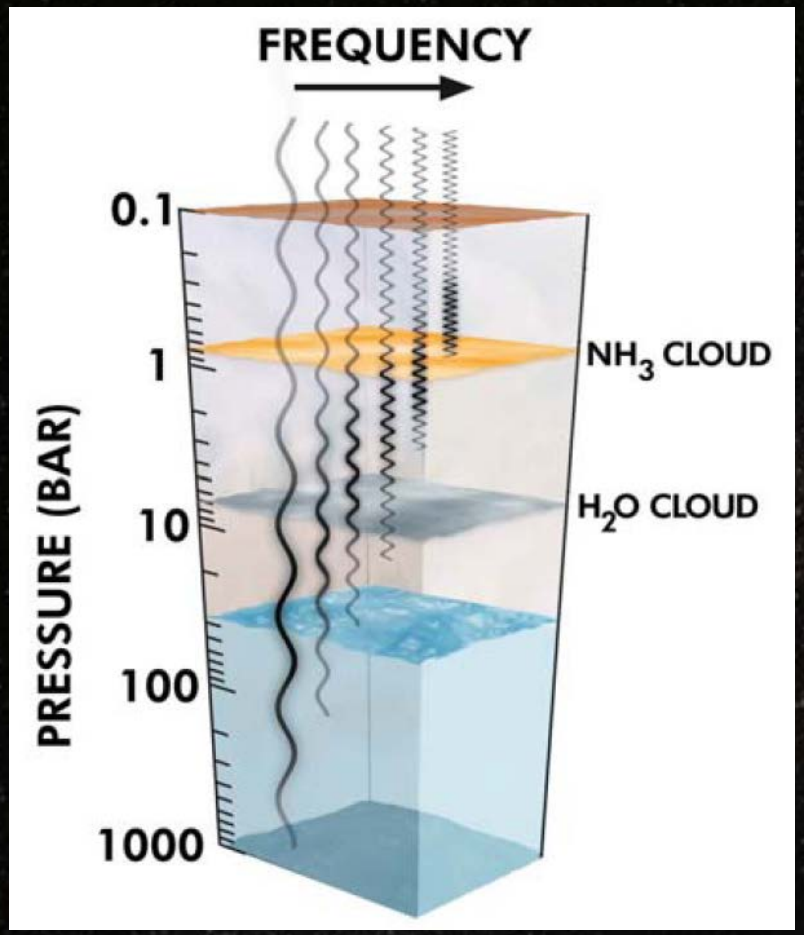




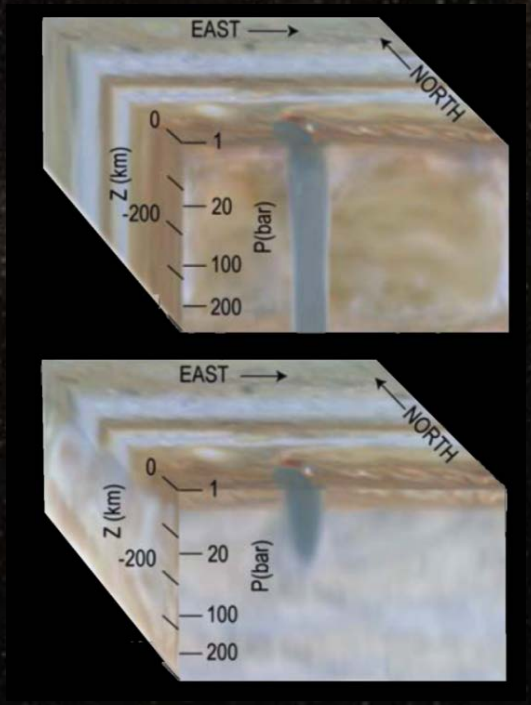


Sensing the deep atmosphere





How deep is Great Red Spot?
How deep are those swirling bands of clouds and smaller storms?



Juno's Microwave Radiometer will measure thermal radiation from the atmosphere to as deep as 1000 atmospheres pressure (~500-600km below the visible cloud tops).

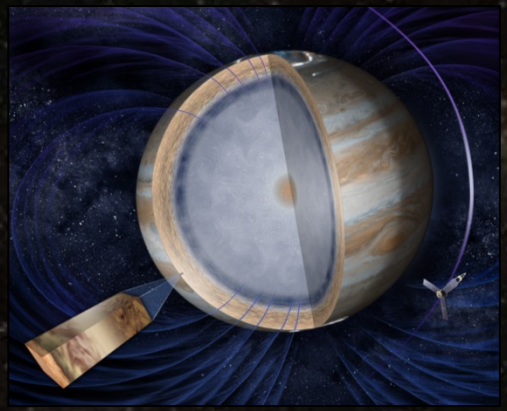
This will determine water and ammonia abundances in the atmosphere

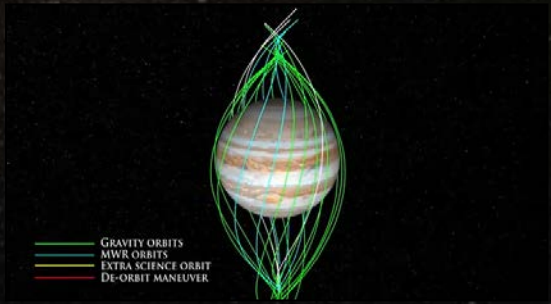
Juno Science Summary

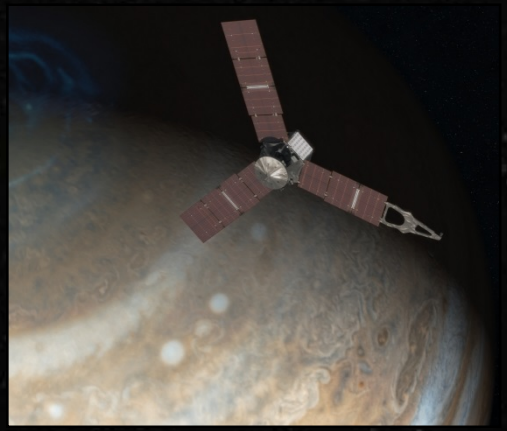
Science Objectives

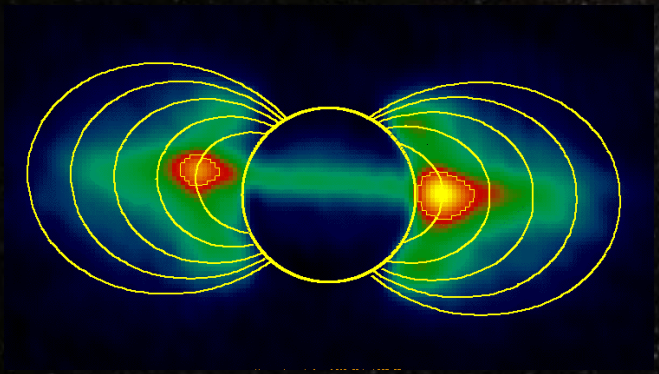
- ***Origin*** – Determine the abundance of water and place an upper limit on the mass of Jupiter's dense core to decide which theory of the planet's origin is correct
- ***Interior*** – Understand Jupiter's interior structure and how material moves deep within the planet by mapping its gravitational 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

			Instruments
■	■	■	Gravity Science
■	■		Magnetometer (MAG)
■		■	Microwave Radiometer (MWR)
			Jupiter Energetic Particle Detector (JEDI)
			Jovian Auroral Distributions Experiment (JADE)
			Plasma Waves Instrument (Waves)
			Ultraviolet Spectrometer (UVS)
		■	Infrared Camera (JIRAM)
			Visible Camera (JunoCam)









http://youtu.be/fGKSISOWDXQ