



SCIENCE

Outer Planets Program Status

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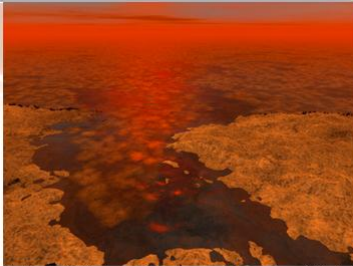
OPAG Meeting

July 15, 2013

Science Nuggets

- Science nuggets are single slide, layman descriptions of fascinating science results
- These nuggets are shared with senior management inside and outside of the agency
- Missions regularly generate these, but we are always in need of nuggets from R&A efforts
- Nuggets should generate a “wow” factor and be relatable to non-experts


Ice Skating on Titan



- Recent work by Cassini scientists suggests seasonal ice in Titan's hydrocarbon lakes probably floats*. Unlike water ice in Earth's oceans, the hydrocarbon ice in Titan's lakes and seas may float, sink and rise again to the surface as the temperature changes.
- Methane ice in Titan's methane-rich lakes will exist if the winter temperature is below the freezing point of pure methane (-297° F).
- In the case of Titan's larger ethane-rich seas, if the ice forms with at least 5 to 10 percent air, the ice will initially float but will sink if the temperature drops by just a few degrees. Seas could

Floating ice in Titan's reddish hydrocarbon lakes and seas is likely buoyant, as depicted in this artist's concept based on data from NASA's Cassini spacecraft orbiting Saturn.

Titan's Sky is Falling!



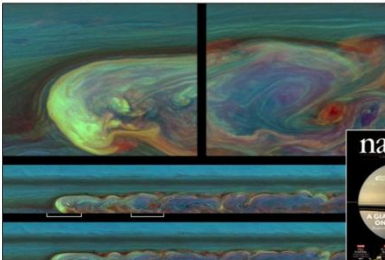
Saturn's moon Titan has a massive atmosphere laden with layers of photochemical haze/smog. Cassini cameras have measured a dramatic change in

Cassini Documents Largest Storm Ever Observed on Saturn

Storm wraps around planet and covers approximately 1.5 billion square miles

Fischer, G. et al. A Giant Thunderstorm on Saturn. *Nature* vol. 475, pages 75–77 (July 07, 2011)

The largest and most intense storm ever observed on Saturn has been captured by the Cassini spacecraft. The storm, currently still active, encircles the planet. From north to south, it covers a distance of about 9,000 miles (15,000 km). It encompasses an area approximately eight times the surface area of Earth and is 500 times larger than any storm previously seen by Cassini at Saturn. The storm is also a significant source of radio noise, which comes from lightning deep in the planet's atmosphere. As on Earth, the lightning is produced in water clouds, where falling rain and hail generate electricity. At its most intense, the storm generated more than 10 lightning flashes per second. It is a mystery why Saturn stores energy for decades and releases it all at once. This behavior is unlike that of Jupiter and Earth, which have numerous storms occurring at any one time.



The false-color image mosaic from Cassini, released July 6, 2011, documents a day in the life of a huge storm that developed from a small spot that appeared 12 weeks earlier in Saturn's northern mid-latitudes. The false colors show clouds at different altitudes. Clouds that appear blue are the highest and are semi-transparent. Those that are yellow and white are optically thick clouds at high altitudes. Those shown green are intermediate clouds. Red and brown colors are clouds at low altitude unobscured by high clouds, and the deep blue color is a thin haze with no clouds below. The storm clouds are likely made out of water ice covered by crystallized ammonia.

Feb. 23, 2011. Image taken about 12 weeks after the storm began.

9/11/2011

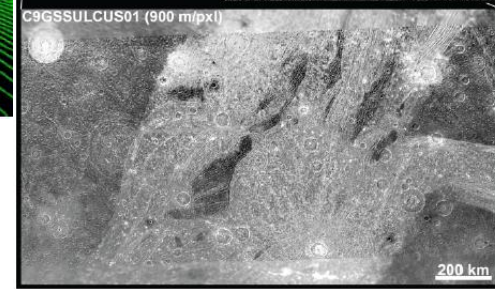
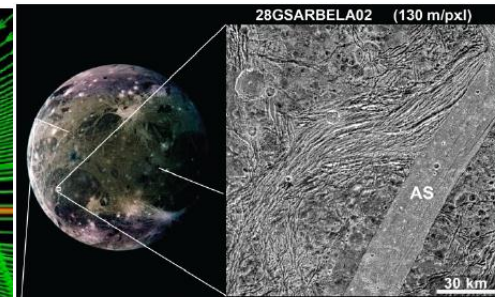
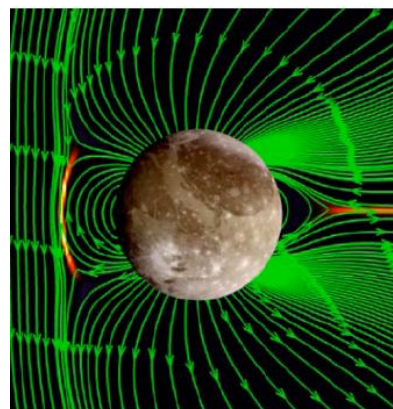
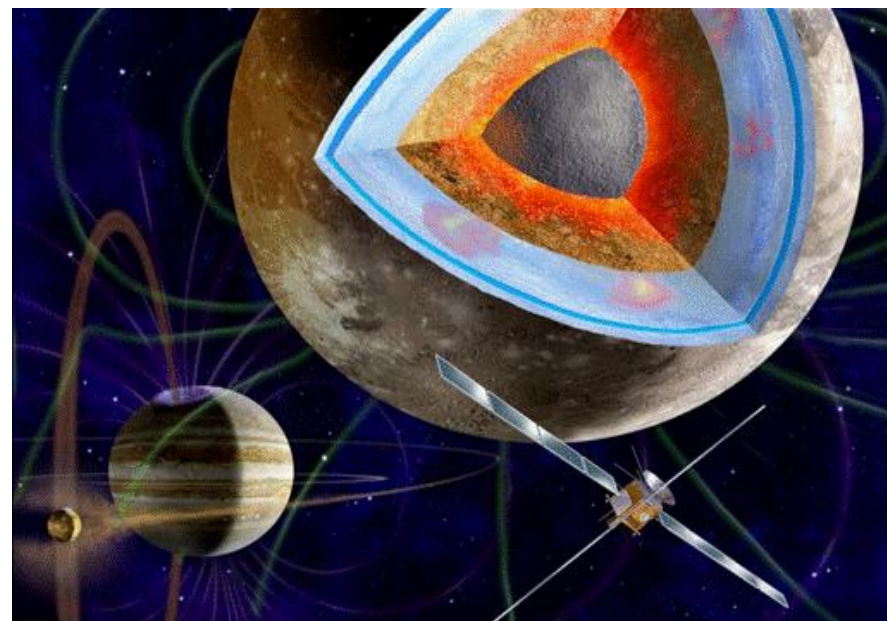
We are always in need of science nuggets. Want to brag a little?



The JUpiter ICy moons Explorer Mission



- On May 2, 2012, the ESA SPC formally selected JUICE as the first Large-class mission in ESA's Cosmic Vision Program
- The JUICE mission will investigate the emergence of habitable worlds around gas giants, characterizing Ganymede, Europa and Callisto as planetary objects and potential habitats, and will also explore the Jupiter system as an archetype for gas giants.
- JUICE will first orbit Jupiter for ~2.5 years, providing 13 flybys of Callisto and 2 of Europa, and then will orbit Ganymede for 9 months
- Launch is scheduled for 2022 with Jupiter arrival in 2030, Ganymede orbit insertion in 2032, and Ganymede impact in 2033
- NASA and ESA released coordinated AOs in June 2012 to solicit the JUICE payload

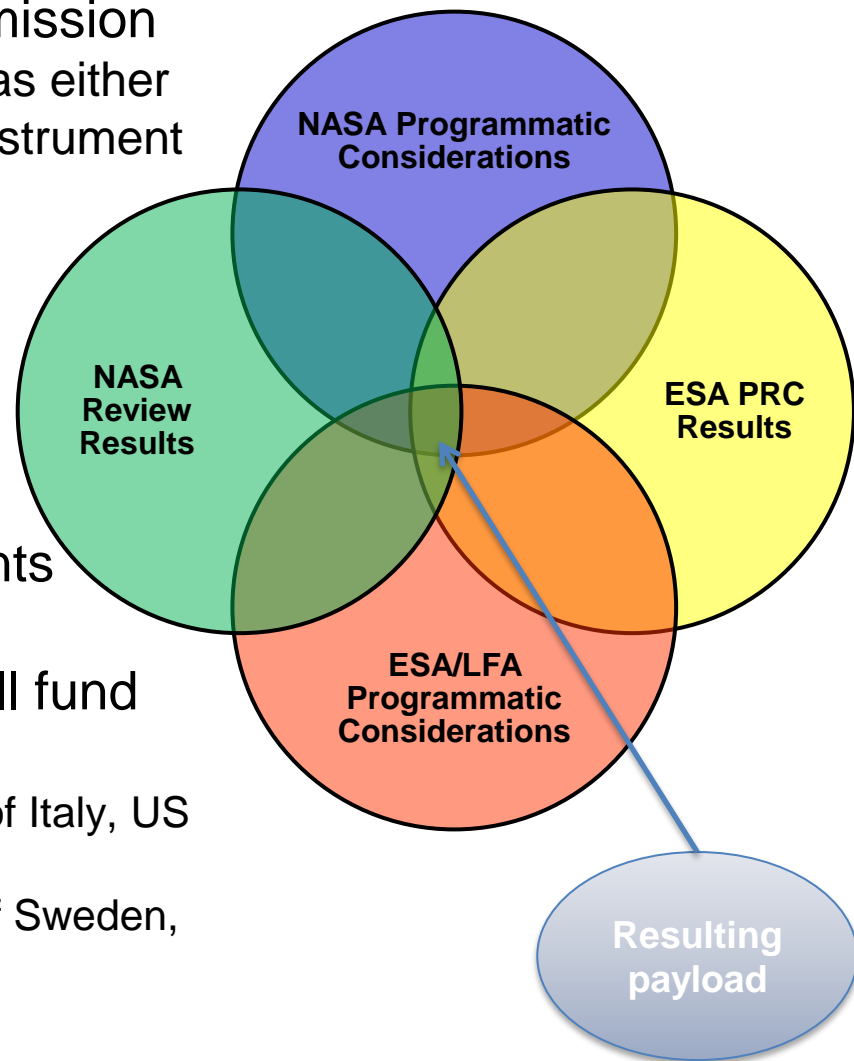




NASA Contributions to JUICE Mission



- In Feb. 2013 NASA and ESA announced the collaboratively selected payload for the JUICE mission
 - NASA offered to contribute up to \$100M as either NASA-led instrument(s), NASA-funded instrument component(s) provided to European-led instrument(s), and/or NASA-funded U.S. Co-Is on European-led instrument(s).
- NASA selected the Ultraviolet Spectrograph instrument investigation (PI Randy Gladstone, SWRI)
- The remaining 10 European-led instruments on the JUICE payload contained a total of ~\$190M in NASA contributions. NASA will fund contributions to
 - Radar for Icy Moon Exploration (PI Bruzzone of Italy, US Lead Jeff Plaut of JPL)
 - Particle Environment Package (PI Barabash of Sweden, US Lead Pontus Brandt of APL)

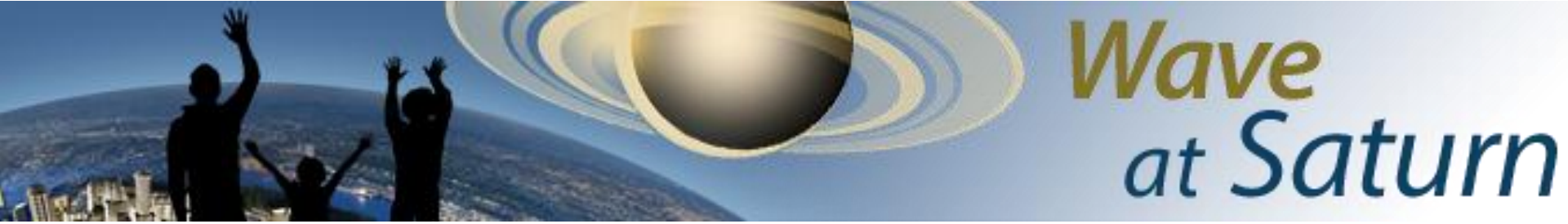


Cassini Mission Overview

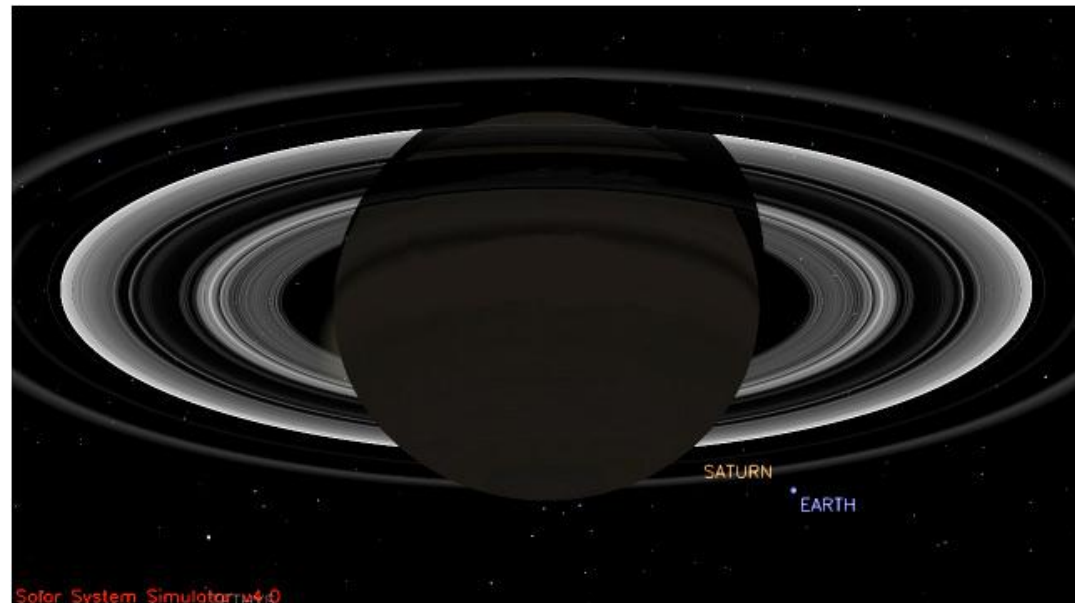
Four-Year Prime Tour, Equinox Mission, and Solstice Mission (Proposed), July 2004 - July 2017

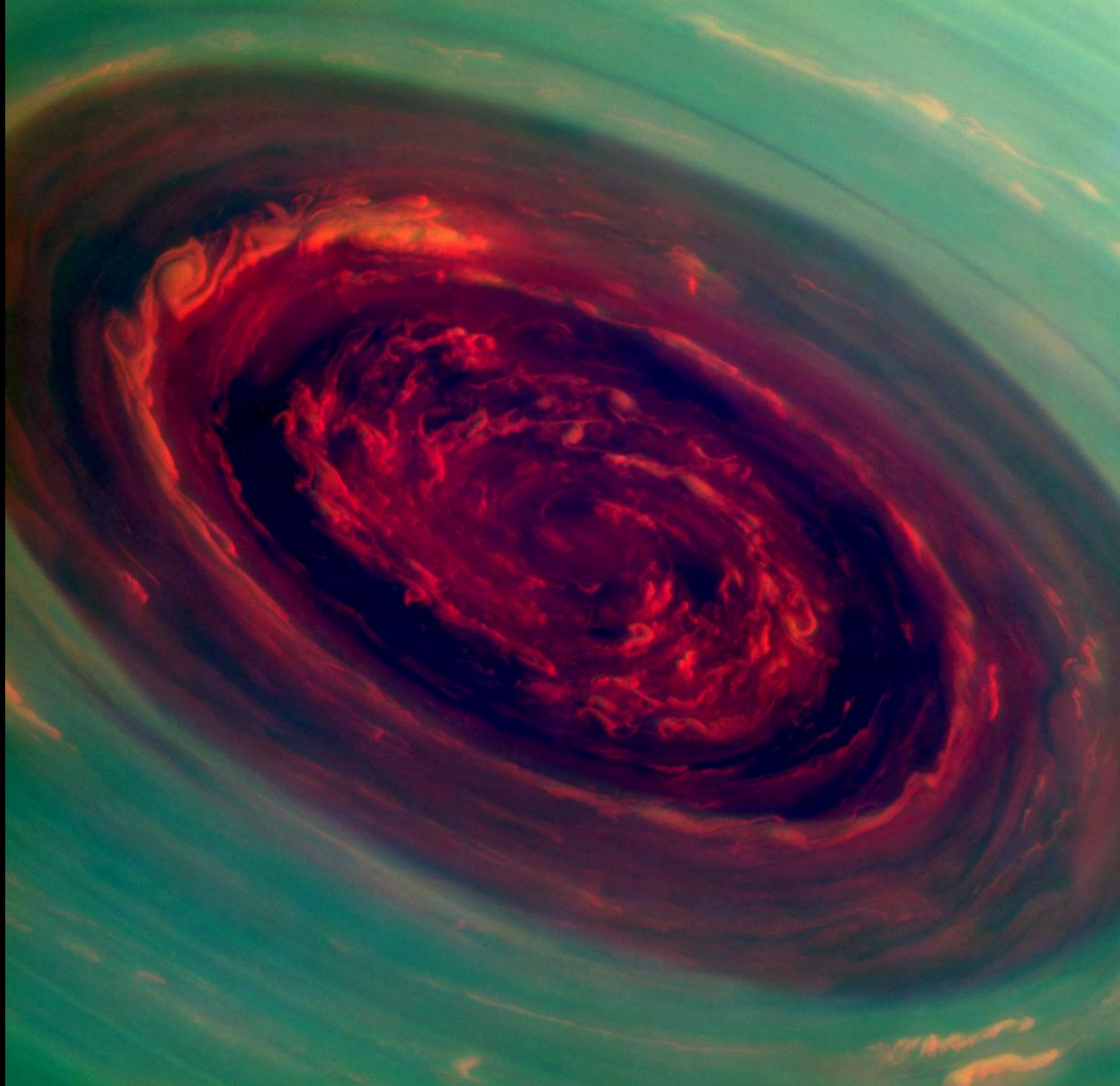


EOM
Sep 15,
2017



- This Friday Cassini will take its final mosaic of Saturn, its rings, and Earth
 - But this time we are giving everyone advance notice so they can be in the picture
- So on Friday, be outside from 5:27-5:42 pm eastern, look to the east, and **Wave at Saturn!**
- <http://saturn.jpl.nasa.gov/news/waveatsaturn/>



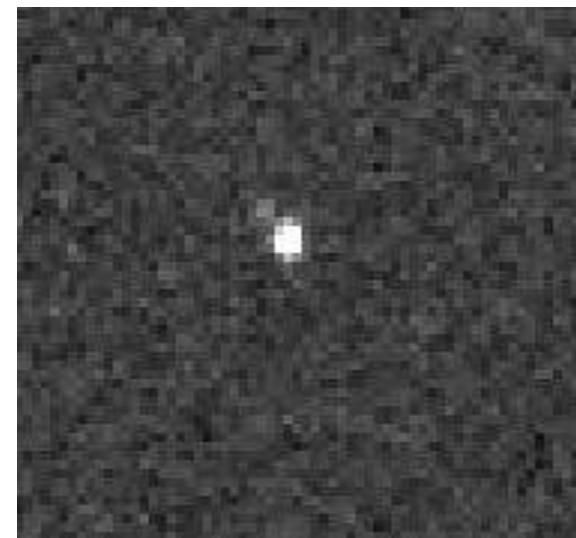




Mission Status – Juno and New Horizons



- Juno is in excellent health and operating nominally
- Spacecraft has covered ~45% of the 19-AU-long trajectory (12% further since last OPAG meeting)
- JOI in 3 years, and Earth flyby on Oct. 9, 2013
- New Horizons is in excellent health and operating nominally
- Spacecraft is 26.7 AU from the sun and 7.4 AU from Pluto system (1.5 AU closer than last OPAG meeting)
- Just completed successful rehearsal

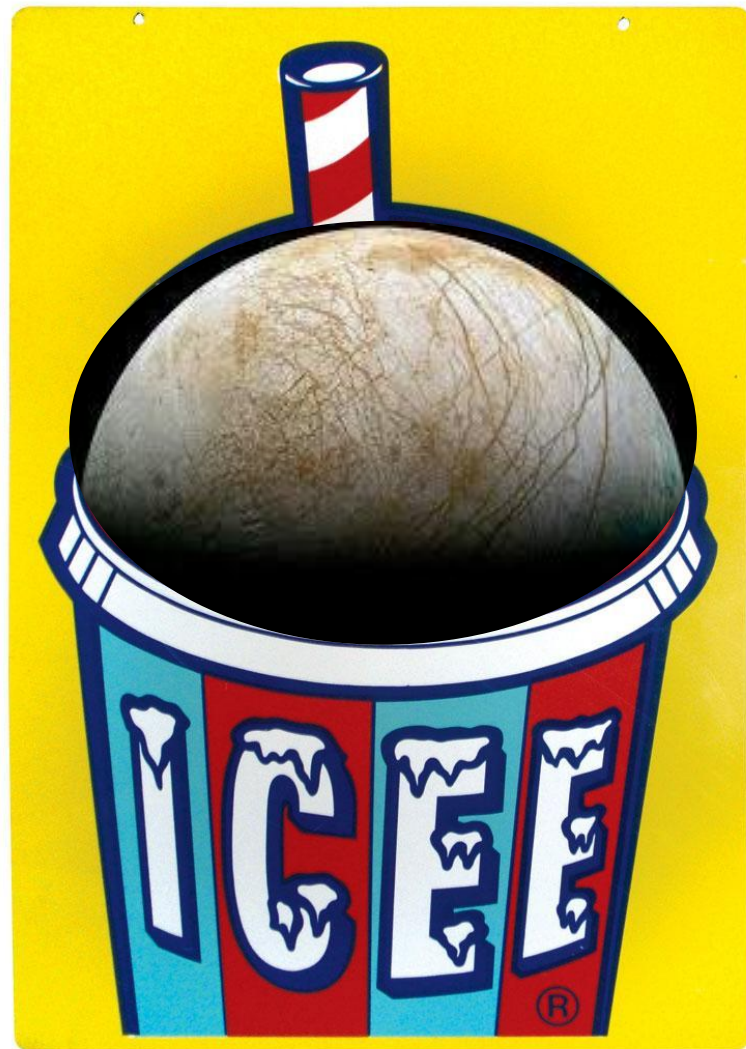


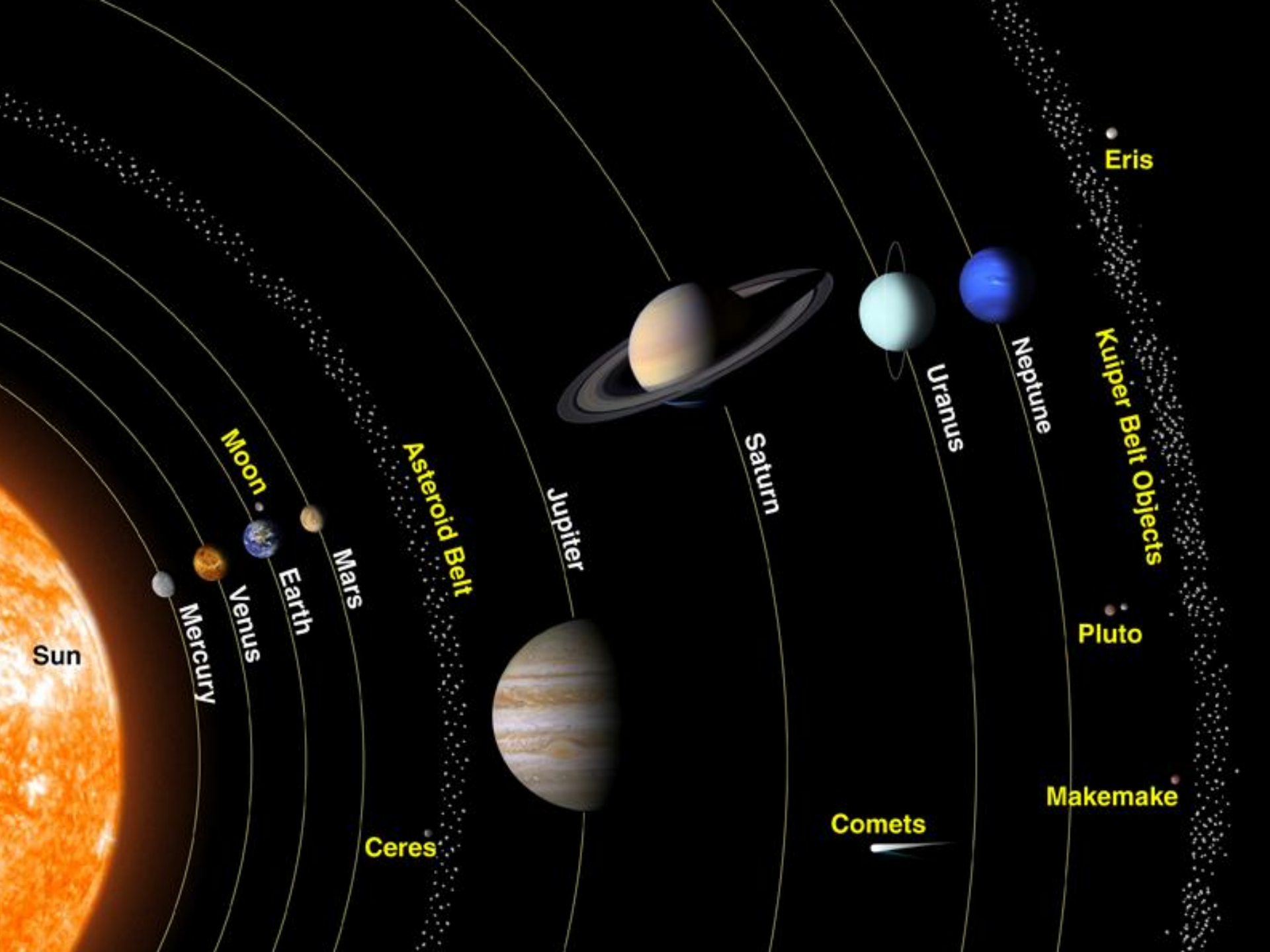


Europa Flagship Mission



- Congress provided funding in FY13 to continue study and formulation of Europa Clipper
 - We need to extend the funding into F responsibly
 - We need to wait and see what the P about Europa Clipper (~February 20 reacts (~spring 2014)
- Instrument Concepts for Europa E
 - Goal of the ICEE program is to matu risk of instruments for a potential futu point where they may be proposed ir announcement of flight opportunity (extensive technology development
- Clipper remains shovel ready!





Sun

Mercury

Venus

Earth

Moon

Mars

Asteroid Belt

Ceres

Jupiter

Saturn

Uranus

Neptune

Pluto

Kuiper Belt Objects

Comets

Makemake

Eris