Cassini's Coolest Results for Icy Moons during the Past Year

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Overview of New Results

1. Complex hydrocarbons detected on Iapetus (Cruikshank et al. 2014): important characterization of the dark material in the outer Solar System

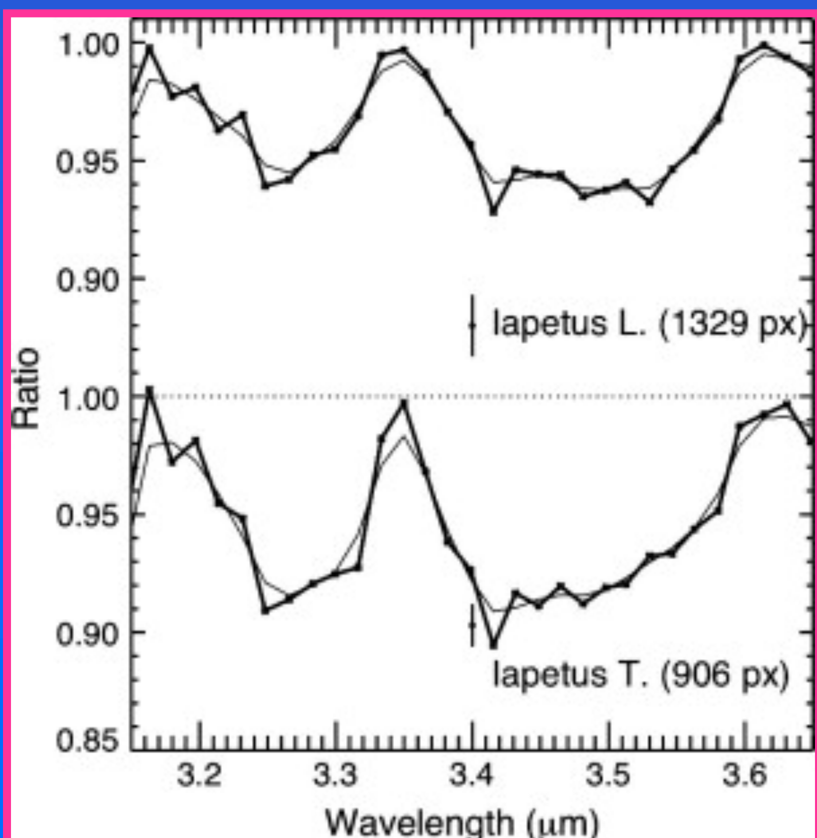
2. Enceladus has a subsurface liquid ocean (Iess et al. 2014): confirms source of plumes

3. Plumes are emitted from small, hot regions in S. Pole of Enceladus (2013): Confirmed by ISS images with identification of 101 plumes; Porco et al. (2014); Nimmo et al. (2014).

4. ISS sees Phoebe ring: Tamayo et al. (2014).

Complex Hydrocarbons on Iapetus (Cruikshank et al., 2014)

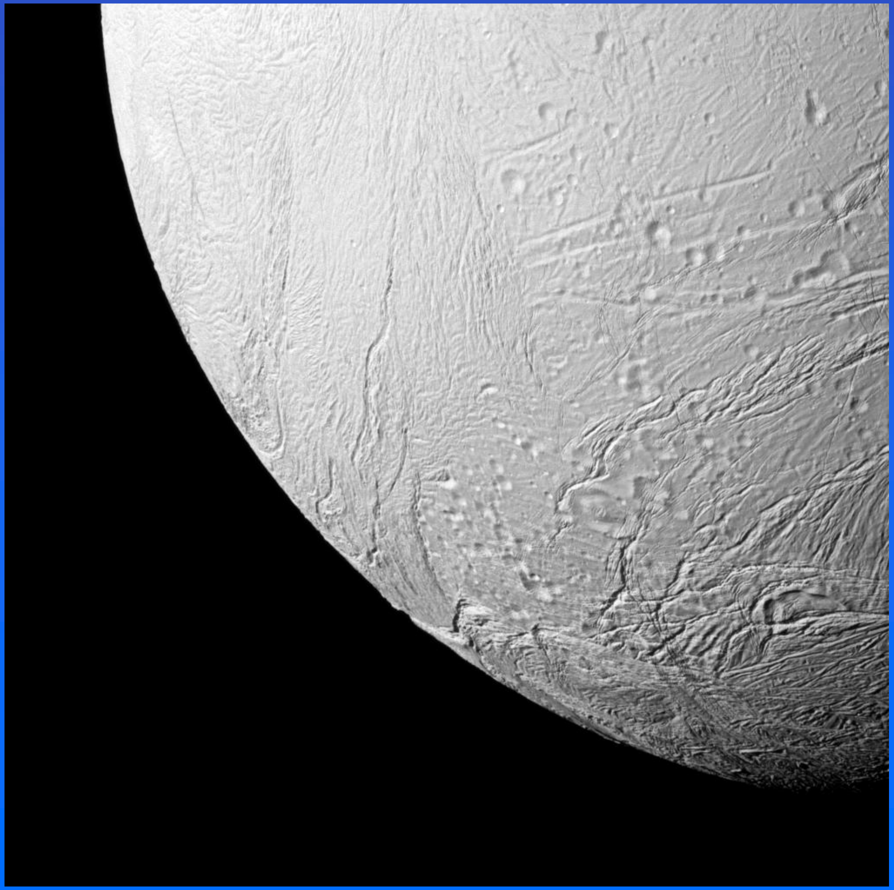
"Aromatic and aliphatic organic materials on Iapetus: Analysis of Cassini VIMS data" Cruikshank et al. (2014) *Icarus* 233, 306.



Analyzing data gathered throughout the mission, Cruikshank and his colleagues have identified the spectral bands near near 3.2-3.4 microns that are characteristic of polycyclic and aromatic hydrocarbons. This complex molecules are thought to be some of the building blocks of life. They have previously been detected in the interstellar medium.

This result answers one of the prime questions of the Cassini mission: to characterize the dark material in the outer Solar System.

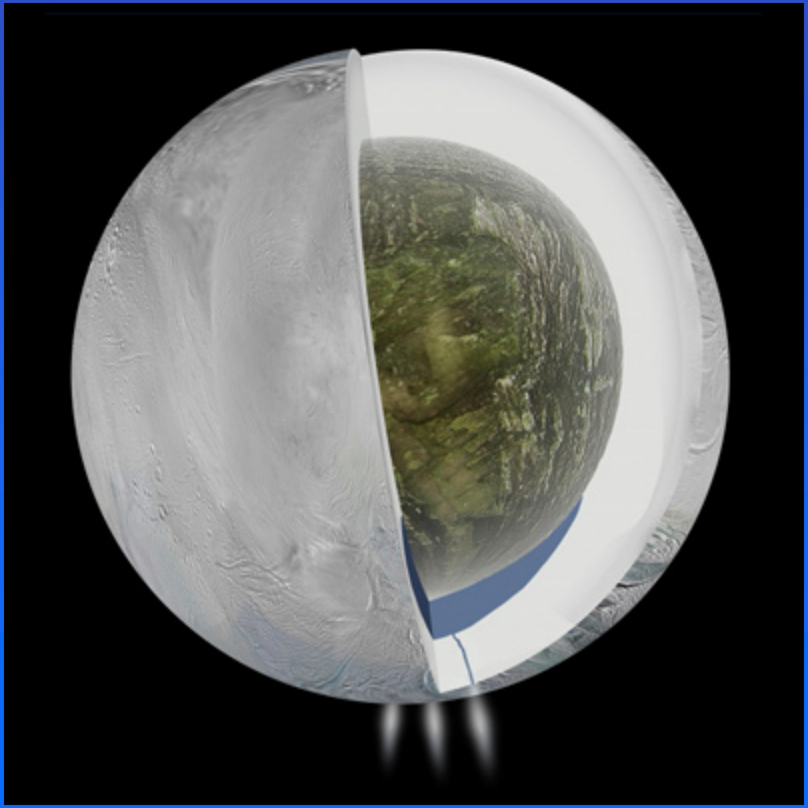
Confirmation of Subsurface Ocean on Enceladus



"The Gravity Field and Interior Structure of Enceladus" Iess et al. 2014 *Science* 344, 78.

Previous results suggested a liquid ocean underneath the surface of Enceladus. Salts in the plume particles implied the contact of liquid water with a rocky mantle; velocities of plume particles implied supersonic speeds compatible with liquid jetting; hot temperatures near the melting point of water were all factors in favor of a liquid source for the plumes.

Confirmation of Subsurface Ocean on Enceladus, cont'd.



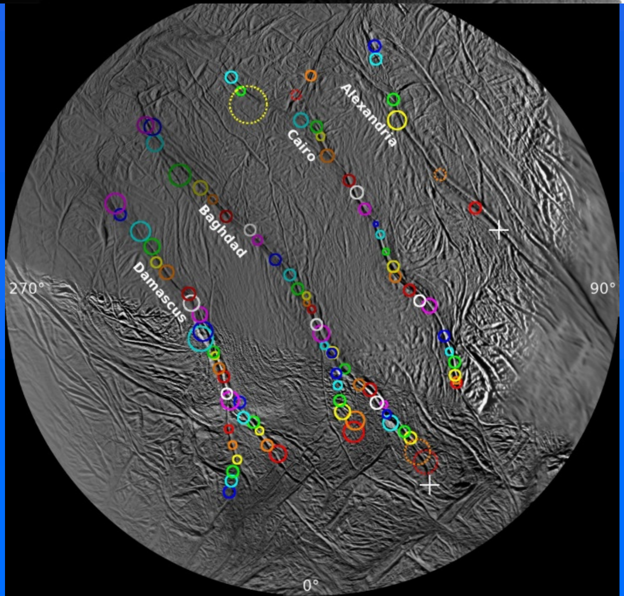
"The Gravity Field and Interior Structure of Enceladus" less et al. 2014 *Science* 344, 78.

Analyzing data gathered during three gravity flybys of Enceladus, the Radio Science Team derived the interior structure of Enceladus. They analysed the "tug" exerted on Cassini by the tiny moon. Their results indicate the presense of a "positive subsurface anomaly compatible with the presence of a regional subsurface sea at depths of 30 to 40 kilometers and extending up to south latitudes of about 50°". Their resultsalso suggest a differentiated body with a low-density core.

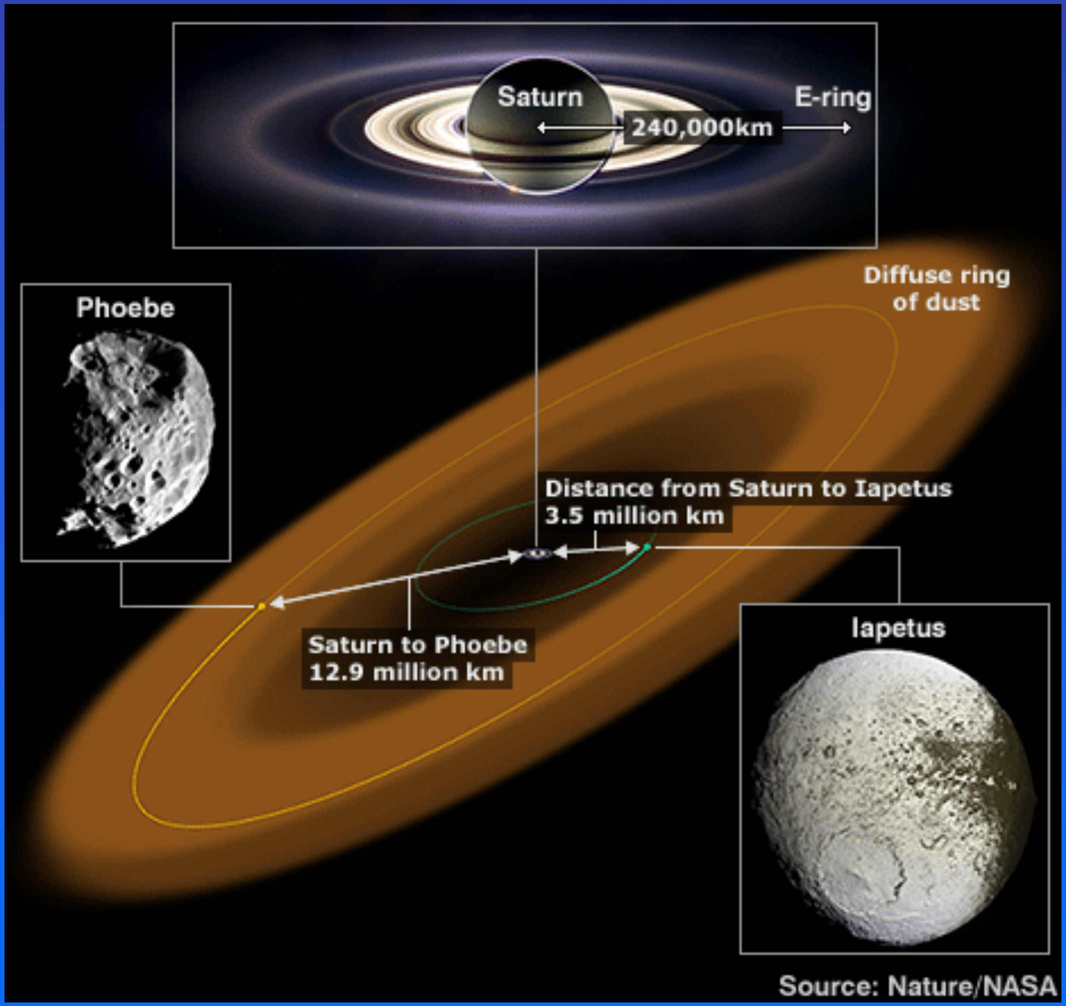
The 101 Plumes of Enceladus

1. Porco et al. How the Geysers, tidal stresses and thermal emission across the S. polar terrain of Enceladus are related; 2. Nimmo et al. Tidally modulated eruptions on Enceladus (2014) A. J. 148.

Triangulation of 101 plumes of Enceladus has placed them near hot spots previously identified by CIRS and VIMS. In addition, the heat is transported in the form of latent heat, from a sub-ice-shell sea of liquid water, with vapor condensing on the near-surface walls of the fractures. VIMS discovery of modulation by tidal stresses is confirmed and tidal model expanded. Stresses are capable of opening water-filled cracks all the way down to the sea.



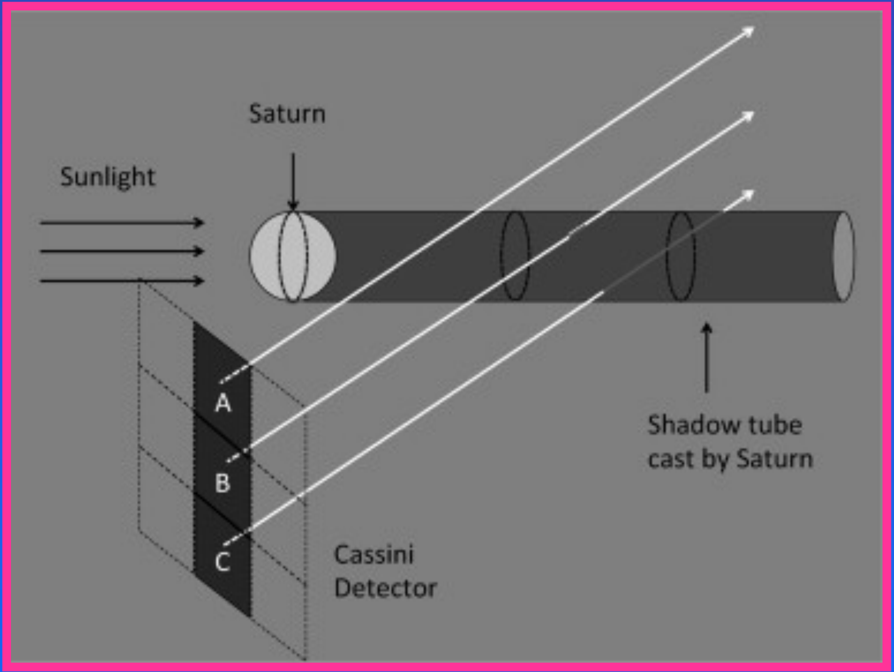
ISS Detects the Phoebe Ring

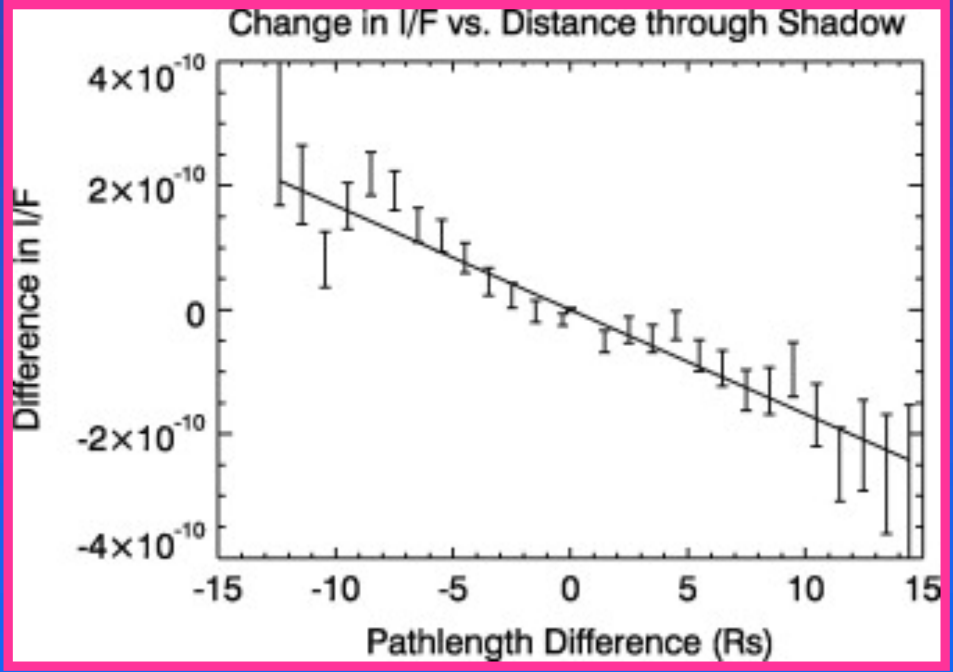


Infrared *Spitzer* observations obtained in the region of Phoebe's orbit detected a vast tenuous ring that could provide the particles for the low-albedo side of Phoebe.

Verbiscer et al. (2009)

ISS Detects the Phoebe Ring, cont'd





ISS obtained images that targeted the Phoebe ring; the pathlength of each image contained a different fraction of Saturn's shadow. Differences in intensity (I/F) vs. differences in pathlength through the shadow were analyzed. As expected, pixels that see through more of the shadow than average have lower I/F values than pixels that see through less. Material between ≈130 and 210 saturnian radii (R_S) from the planet produces an I/F of $1.7 \pm 0.1 \times 10^{-11}$ per R_S of the line-of-sight distance through the disk.

Tamayo et al., 2014, *Icarus* 233, 1.

Upcoming excitement

Because *Cassini* is in an inclined orbit to study the rings and the polar regions of Saturn, there have been no significant icy moon flybys in 2013 and 2014.

But on June 16 and August 17, 2015, there are two close (~500 km) flybys of Dione to determine its internal structure and particle environment. Then in October 2015 is the first of three remaining Enceladus flybys