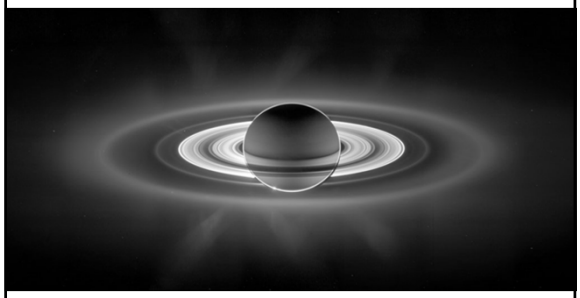
Lecture 29

The Children of Saturn



Astronomy 141 – Winter 2012

This lecture examines the moons of Saturn, in particular Enceladus and Titan.

Saturn has 61 known moons; 1 giant moon Titan, the rest a mix of spherical and irregular, mostly made of ice and rock.

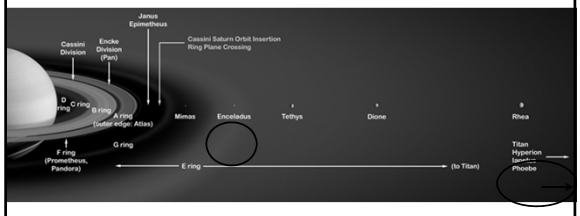
Enceladus is the brightest body in the Solar System, covered in fresh ices, and having spectacular ice fountains.

Tidal heating and radioactive decay heat Enceladus, hinting at significant sub-surface liquid water.

Titan has a heavy N_2 and CH_4 atmosphere, with weather and lakes of liquid methane.

Conditions on Titan are “pre-biotic” though very cold, but Enceladus might be a place to search for life..

Saturn is attended by a system of 61 moons.



Some moons (like the icy moon Enceladus) orbit just outside Saturn’s main rings.

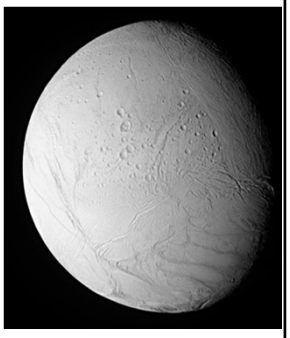
Others (like the giant moon Titan) have much larger orbits.

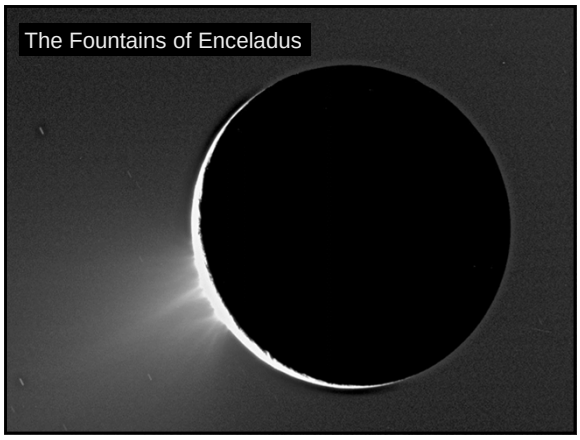
Enceladus is covered in fresh, clean ice.

Surface is lightly cratered, especially in the south.

Tectonic features include scarps, grooves, and ridges, showing geologic activity.

A thin H_2O-vapor atmosphere & fresh surface ices fed by fountains at surface cracks.

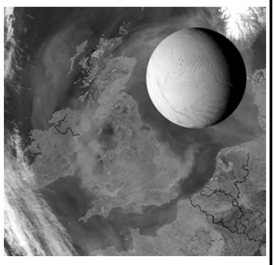




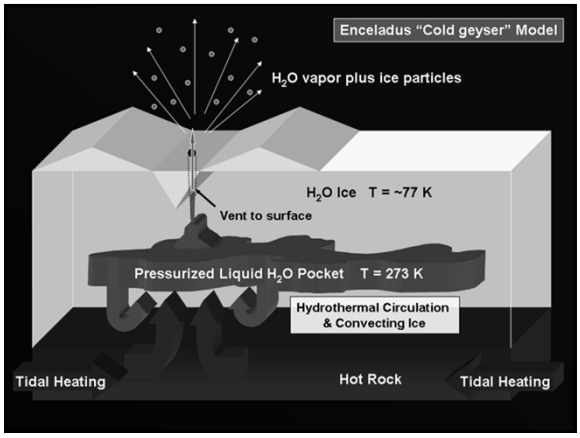
Enceladus is one of the 3 known volcanically active moons in the Solar System.

The fountains of Enceladus are powered by tidal heating. (Enceladus has an orbital resonance with Dione.)

Some of the fountains' material (water vapor & ice) reaches escape speed.

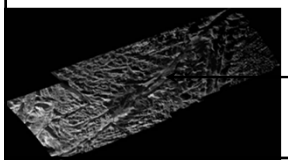


The ice plume feeds the faint E-ring of Saturn



Analysis by the *Cassini* spacecraft revealed water & organic compounds on Enceladus.

Ice particles tested by *Cassini* were frozen salty water with traces of organic compounds & carbon-rich grains.



Fountain-spewing cracks are as warm as 180 Kelvin.

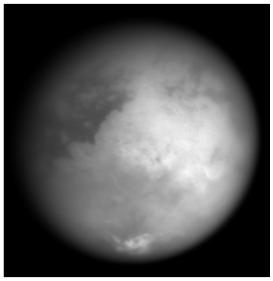
Titan is the giant moon of Saturn, and the only moon with a heavy atmosphere

Radius: 2575 km

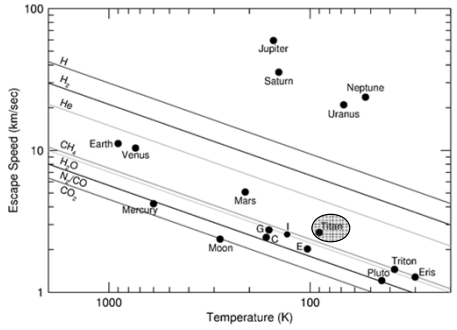
Density: ~1.9 g/cc
Icy mantle over a rocky core.

Cold enough to retain a heavy atmosphere of Nitrogen and Methane.

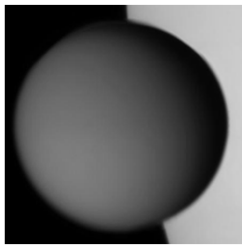
Pressure is high enough to have liquid methane on the surface.



Titan has an atmosphere because it is large enough and cold enough to retain it.



Titan has a dense Nitrogen and Methane Atmosphere



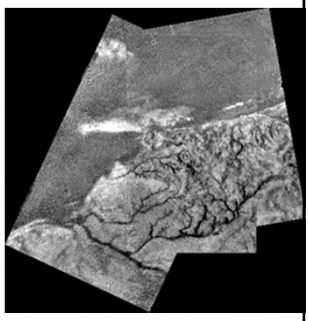
Composition:
- 90 – 97% N_2 (nitrogen)
- ~1.6% CH_4 (methane)
- Argon & hydrocarbons like Ethane

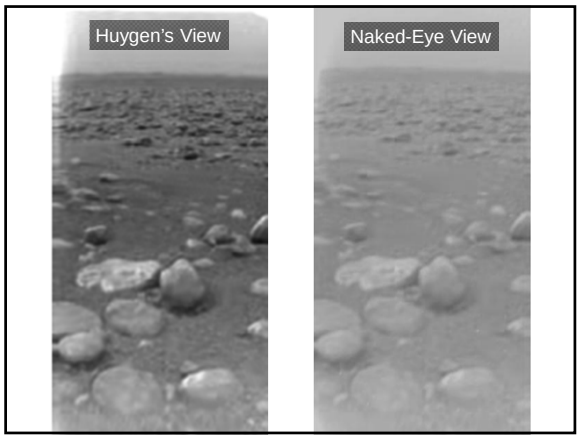
Cold and dense:
- Temperature: 94 K (–290º F)
- ~1.6 Earth atmospheres pressure
- Thick covering haze of brown photochemical aerosols (tholins)
- Clouds of methane and ethane

Titan' surface is young, with few impact craters, drainage channels and methane lakes.

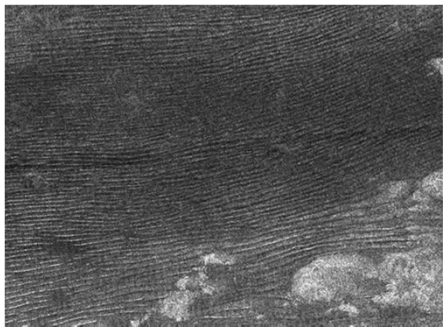
Terrain ranges from methane mudflats to rugged highlands.

Liquid methane features range from drainage channels to large methane lakes.

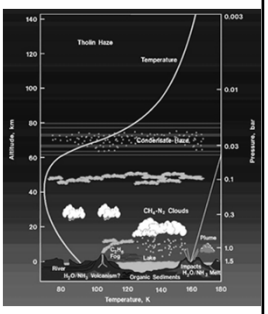




Titan's plains have vast dune fields made of grains of water ice and hydrocarbons sculpted by wind.



Methane (CH_4) plays the same role on Titan that water does on the Earth.

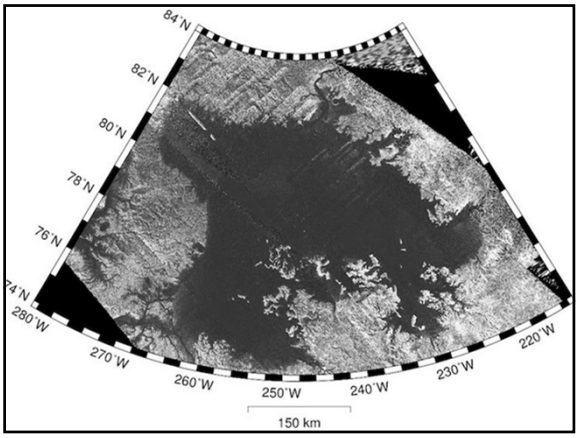


All three phases of methane exist at Titan's temperature & pressure

Atmospheric methane condenses into clouds that rain liquid methane.

Methane "Mud Flats" are water ice grains & liquid methane.

Liquid methane/ethane lakes found at the poles.



Titan's condition appears similar to the pre-biotic Earth, except much colder

Titan has abundant hydrocarbons and complex organics.

Has an atmosphere that supports a methane liquid cycle.

It could be a laboratory for pre-biotic organic chemistry.

Titan balloon probe concept for a 2030 visit.