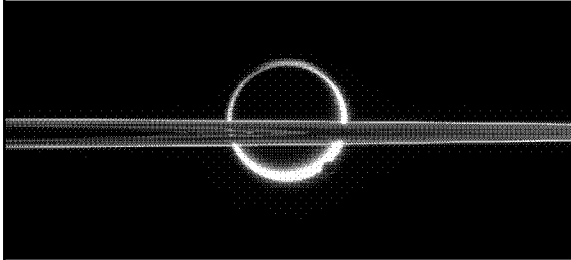


Wednesday, November 3
Life on Titan (?)
Life on Enceladus (?)

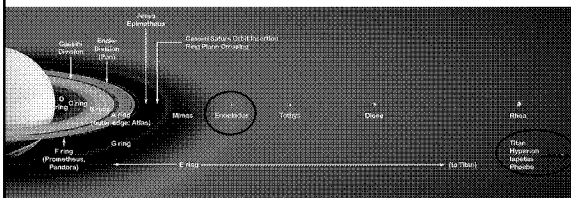


Quiz #3 will be on Friday.

Life on Titan (?)
Key Concepts

- 1) Saturn's moon **Enceladus** has a fresh icy surface and spectacular ice geysers.
- 2) Saturn's moon **Titan** has a nitrogen/methane atmosphere, and liquid methane lakes.
- 3) Conditions on Titan are "pre-biotic", but very cold; Enceladus might be more life-friendly.

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



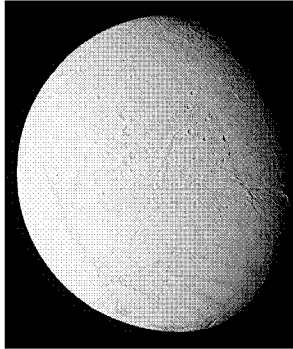
Others (like the giant moon **Titan**) have much larger orbits.

Enceladus is covered with fresh bright ice.

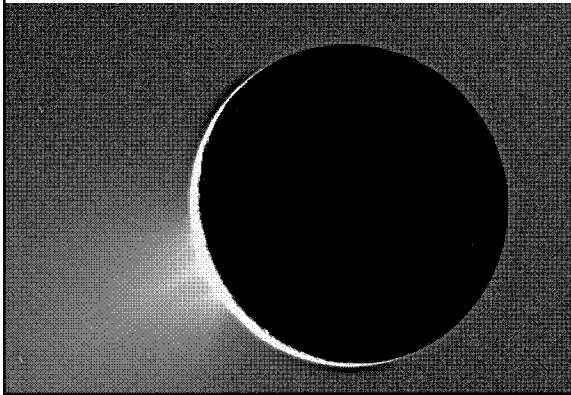
Features such as grooves & ridges indicate recent geological activity.

Much of the surface is only lightly cratered.

A thin water vapor atmosphere is fed by fountains at surface cracks.



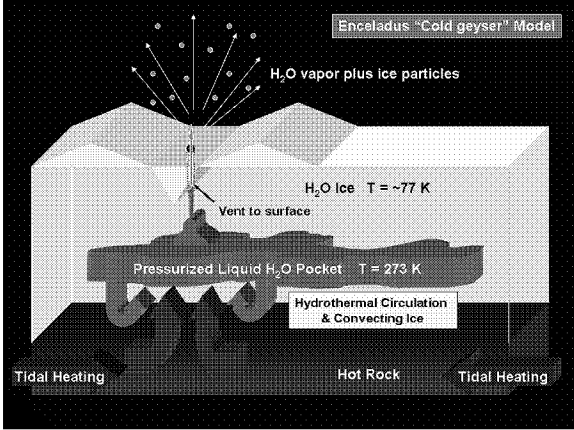
The Fountains of Enceladus



Enceladus is one of 3 known volcanically active moons. (Io & Triton are the others)

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.



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

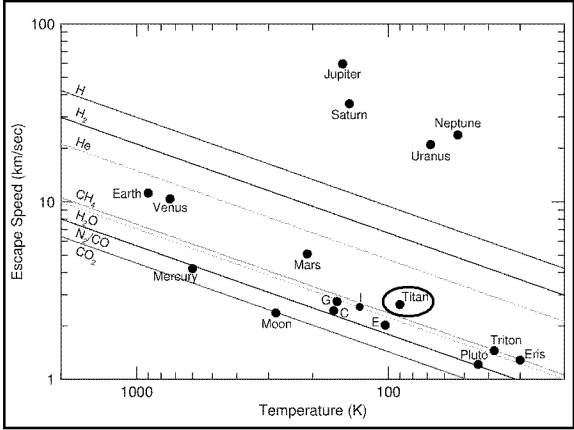
Ice particles tested by *Cassini* were frozen salty water. They also had traces of organic compounds & carbon-rich grains.

Enceladus Flyby
Cassini Touches the Plumes
March 12, 2008

Fountain-spewing cracks are as warm as 180 Kelvin.

Titan, the giant moon of Saturn, is the only moon in the Solar System with a thick atmosphere.

Air pressure is high enough, and temperature low enough, for methane lakes to exist on Titan.

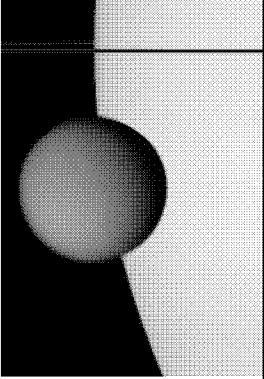


Titan has a dense nitrogen & methane atmosphere.

- nitrogen (N_2)
- methane (CH_4)
- plus smaller amounts of argon (inert gas)
- ethane (C_2H_6)

94 Kelvin (-290°F)

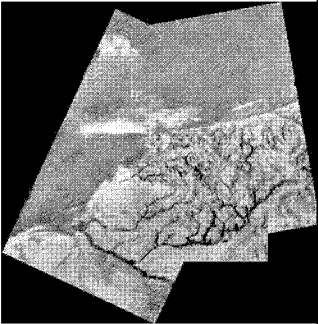
60% higher pressure than Earth's atmosphere.



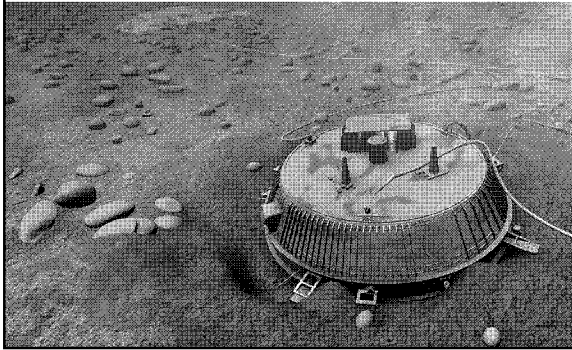
Titan's surface is very young: few impact craters, but many features related to liquid methane.

Terrain ranges from methane mud flats to rugged highlands.

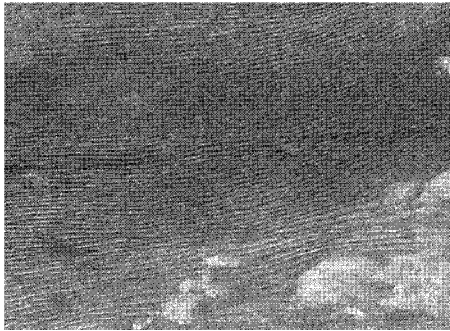
Liquid methane features range from drainage channels to lakes.



The *Huygens* probe was parachuted to the surface of Titan in 2005, and survived 2 hours.



The plains of Titan have vast dune fields made of grains of solid hydrocarbons.

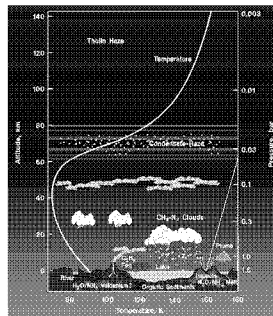


Methane is to Titan as Water is to Earth.

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

Atmospheric methane condenses into clouds that rain liquid methane.

CH₄ "Mud Flats": water ice grains & liquid CH₄



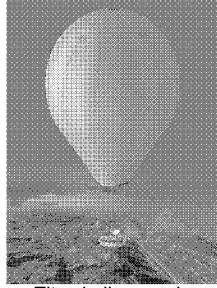
Liquid methane/ethane lakes exist at the poles.

Titan is similar to the "pre-biotic" Earth, except that it is much colder.

Titan has abundant hydrocarbons and complex organics.

It 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.

Tomorrow's Lecture:
Goldilocks & the Habitable Zone



This Week's Reading:



Chapters 9 & 10
