

29:52 Exploration of the Solar System
Class Notes for April 30, 2008
Titan: A Moon with Atmosphere

Titan is the 3rd of the objects we have studied that is thought to have hints for the processes involved in the origin of life elsewhere in the universe.

Titan is the largest moon of Saturn, and the second largest moon in the solar system. It is only a tad bit smaller than Ganymede.

As long ago as 1944, it was found that the spectrum of Titan showed absorption lines of methane, thus demonstrating that it has an atmosphere.

The first good, close-up look came in 1979, when the Voyager spacecraft flew through the Saturnian system. Look at the picture in the online notes. At visual light, we see only the top of the haze layer. The Voyager spacecraft also showed that the atmosphere of Titan is predominantly molecular nitrogen, with smaller amounts of methane, ethane (C₂H₆), and trace amounts of other organic compounds.

The Voyager data also showed that the surface temperature is 94 K, not much warmer than liquid nitrogen, but the atmospheric pressure is 1.5 atmospheres. The surface of Titan is close to the *triple point* of methane and ethane, and so can have a “hydrology” based on these substances.

Cassini-Huygens

Our knowledge of Titan was enormously improved with the arrival of the Cassini spacecraft at Saturn in 2004. Cassini carried a secondary spacecraft, Huygens, which parachuted down to the surface of Titan. Meanwhile, Cassini studied Titan from orbit, based on close passes of the moon.

The Huygens spacecraft took pictures of the “landscape” of Titan on its way down. These are shown in Figures 14.32 and 14.33. They show dry river channels, similar to those we have seen on Mars. On Titan, however, these must have been formed of liquid natural gas, not water.

The Huygens spacecraft survived for an hour and 12 minutes on the surface of Titan. A picture of its landing site is shown in Figure 14.34. The site where it landed is on a dry lake bed.

A mapping radar instrument on Cassini showed picture 14.34. The dark areas are bodies of liquid, again methane, ethane, or a combination of the two.

Titan and the Origin of Life Elsewhere in the Universe

There are a number of reasons why Titan is of interest for the question of whether life has arisen elsewhere in the universe. It may resemble the primitive Earth, with

a nitrogen atmosphere, and an environment filled with organic chemicals. According to this viewpoint, Titan has remained in a “deep freeze” for 4.5 billion years, so biological life never took off.

A more general reason of interest is that Titan may be a showcase for the organic chemistry which can occur in outer space, even if that organic chemistry never developed to the point of forming life. Finally, it is possible, although only remotely possible, that a form of life has evolved on Titan in which liquid methane and ethane play the role of water for life here on Earth. One of the many arguments against this is that the extreme cold of Titan means that chemical reactions would go very slowly.