

Athena Coustenis

46 years old, born in Athens, Greece (French citizenship)
Place of work: Paris-Meudon Observatory, Meudon, France
Website: http://cosmicdiary.org/blogs/athena_coustenis/



15 Jan 2009

Athena is heavily involved in the Cassini-Huygens mission to Saturn and Titan, and has used a variety of large telescopes to conduct planetary investigations.

In January 2005 the eyes of the world turned to Saturn's largest moon, Titan, as the Huygens probe successfully landed and sent back the first images of the previously shrouded surface. This article takes a look at Titan, beginning with its discovery in 1655. The startling similarities between this moon and the early Earth are highlighted, raising an interesting question: could there be life on this world? Finally, there's a look into the future, with possible missions to further explore Saturn's moons, perhaps even featuring a high-tech balloon!

Looking at Titan: an Earth-like World

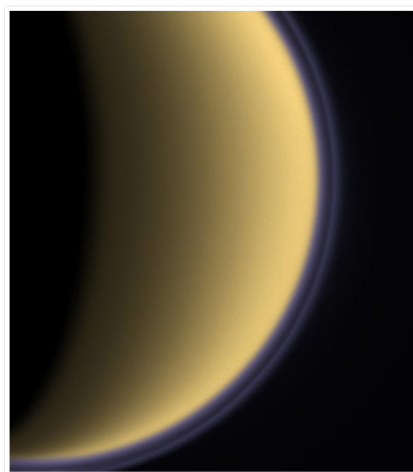
I am an astronomer and have been working for the past 20 years at the Meudon Observatory, halfway between Paris and Versailles. My field is planetology which means I study planetary objects, such as Jupiter and Saturn, and their moons. One of these, Titan, has been the focus of my research from my PhD years until today.

Titan is Saturn's largest satellite and is a unique world in the Solar System. It was discovered in 1655 by Christiaan Huygens. Since then we have found that it has an extensive atmosphere, more than four times denser at the surface than our own, and possessing a rich organic chemistry thanks to abundant nitrogen and some methane. Its surface pressure is also similar to the Earth's. So far, Titan is the only object in our Solar System — or anywhere for that matter — which has such characteristics.

A world like early Earth

The striking resemblance with the primitive Earth, when oxygen was not yet abundant and temperatures were lower, prompted the scientific community to study Titan with all available means.

I have been involved with many aspects of Titan's investigation during my career. I have observed Titan from the ground with large telescopes in Hawaii and Chile, used Earth-orbiting satellites like Hubble and even the data recovered during a flyby by Voyager 1 in 1980 to determine the temperature and composition of Titan.



This image taken by Cassini shows Titan's stratospheric haze.
Image credit: NASA JPL.



In this artist's impression, the Huygens probe is about to reach the surface of Titan. Image credit: NASA JPL.

A high-tech mission to find answers!

Cassini-Huygens is a large space mission that was put together through a highly efficient collaboration between the European Space Agency (ESA) and NASA. It comprises an orbiter with 12 instruments and carried a probe with six, into Titan's atmosphere, and landed on its surface. Cassini-Huygens is the most complex interplanetary spacecraft ever built, and the scientific tools represent the most advanced technological efforts of the countries involved in the endeavour. I was involved with the Cassini-Huygens mission almost from the beginning and helped with proposing three of the instruments that were approved.

Cassini-Huygens reached Saturn and performed a flawless orbit insertion at 10:30pm EDT on 30 June 2004, becoming trapped forever around the planet like one of Saturn's natural moons. On Christmas day 2004 Huygens was separated from Cassini and a little under a month later the probe became the first human artefact to descend through Titan's atmosphere. It reached the surface and returned several hours of data from an exotic landscape cut by channels and apparently soaked with the chemicals ethane and methane. I followed this event from the ESA control centre in Darmstadt, Germany and I can barely describe the thrill, the emotion and the excitement as we discovered the data little-by-little and then tried to reconstruct the surface of the satellite from high-resolution images.

The tremendous technological and scientific achievement of the Huygens mission will bear fruit for many years to come. It once more proves the fantastic capabilities brought about by international collaboration. Landing on a new world 10 times farther from the Sun than our own planet stands with taking the first step on the Moon. Humanity has taken a huge leap towards broadening its horizons.



15 Jan 2009

Mysterious methane

Several years of flybys by the Cassini orbiter have led to radar and near infrared maps that show dunes made of icy material and what appears to be chemical lakes at the north pole. Titan's methane cycle is indeed exotic – at least to me! On Titan methane can exist as a gas, liquid and solid. Playing a role similar to that of water on the Earth, methane is cycled between the atmosphere and the surface. Cloud systems the size of terrestrial hurricanes (1000km) appear occasionally, while smaller ones are there on a daily basis.



This artist's impression gives a good idea of what the Huygens probe looked like on the surface of Titan. Image credit: ESA.

Even with the detection of large lakes in the north, no viable source was detected by Cassini to re-supply methane. We also found that the balance of geologic processes is somewhat similar to the Earth's, more so than for Venus or Mars. Although temperatures on Titan are very low (-180°C on the surface), analogies can be made between the current chemistry on Titan and the chemistry which was active on the primitive Earth. Moreover, Titan is the only planetary body other than the Earth with long-standing bodies of liquid on its surface. Titan may well be the best analogue to an active terrestrial planet in the sense of our home planet, albeit with different working materials.

The ingredients for life

All ingredients that are supposed to be necessary for life to appear and develop – liquid water, organic matter and energy – seem to be present on Titan. Indeed, interior structure models and observations suggest that Titan, as well as some of Jupiter's moons called Europa, Ganymede and Callisto, have maintained internal liquid water reservoirs, probably mixed with some ammonia and more speculatively sulphur. At the beginning of Titan's history, this hypothetical subsurface ocean may have been in direct contact with the atmosphere and with the internal bedrock, offering interesting analogies with the primitive Earth.

Consequently, we can't rule out that life may have emerged on or in Titan. In spite of the extreme conditions in this environment, organisms could have been able to adapt and persist. Even the possible current conditions (pH, temperature, pressure, salt concentrations) are not incompatible with life as we know it on Earth. However, the detection of potential biological activity seems very challenging.

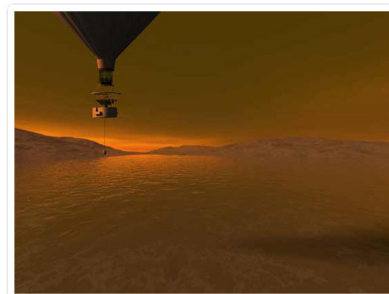
So what do I want to do now? I want to go back!

Grand plans

We need to find answers for many of the most outstanding questions that the international scientific community have raised after the Cassini-Huygens exploration. In 2007, ESA and NASA issued calls for ideas which ended in several proposals being selected for further study. I was heading an effort put together by more than 155 scientists and engineers from all over the world to propose a return in the Saturn system to study Titan and another of its fascinating moons, Enceladus. ESA selected that proposal for a mission called TandEM for further studies within a plan called Cosmic Vision 2015-2025.

Since then, our European proposal and a related American study for NASA (called Titan Explorer) have merged. The new mission is called Titan/Saturn System Mission (TSSM) and includes several elements: an orbiter that will go into the Saturnian system and make several Enceladus flybys before orbiting around Titan for several months. The orbiter will also deliver a balloon and a probe onto Titan which will land in a lake! We're all very excited about this perspective of taking a closer look at a far-away, yet so familiar world. And we're all working very hard to make it happen.

So, right now... I'm very busy!



Will a balloon help the next Titan probe float over seas of strange hydrocarbons? Image credit: ESA.

This feature article was written as part of the Cosmic Diary Cornerstone project for the International Year of Astronomy 2009. To find out more, check out www.cosmicdiary.org and www.astronomy2009.org.