Planetary scientist explains the significance of the historic Rosetta satellite mission

November 12 2014

After 10 years and four billion miles NASA's Rosetta satellite is poised make space science history tomorrow when it launches its Philae lander onto the surface of the ancient comet, 67P/Churyumov-Gerasimenko.

The small probe is expected to touch down at about 3.30pm (GMT) and fix itself to the two-mile long, high-speed comet using harpoons and drills.

It will then begin to analyse the ice, organic material and chemicals present in the comet's nucleus – and later, as it gets closer to the Sun and begins to heat up – the emissions of gases such as water and carbon dioxide.

It is the first time that scientists will have had the opportunity to directly analyse the composition of a comet from its surface.

Planetary scientist Professor Stanley Cowley, of the University of Leicester's Department of Physics and Astronomy, has worked on a number of missions aimed at learning more about comets – including the planning stages of the Rosetta mission – and said 67P/C-G could hold the key to learning about the origins of the solar system.

He said: "The Philae lander is the first attempt to land a spacecraft on the surface of a comet nucleus. The main new thing here is the ability to directly sample the surface material using a 9-inch drill, and to analyse that material using a series of experiments looking at the chemicals present.

"The wider context is that comets, like 67P/C-G, represent bodies which were 'left over', essentially unprocessed, from the formation of the solar system some 4.5 billion years ago.

"It is therefore an interesting relic from that otherwise inaccessible epoch."

At about 8.35am (GMT) tomorrow, Rosetta will release the Philae lander at a distance of about 22.5km from 67P/C-G and the small probe will land approximately seven-hours later.

However, the distance between Earth and the satellite means that mission control will not find out whether the landing has been a success for 28 minutes and 20 seconds – due to the amount of time it will take the radio waves to travel and transmit the data.

Professor Cowley said: "Comet impacts are thought to have been one of the principal means by which water was delivered to the early Earth, around 3.6 billion years ago, possibly contributing half the water in our oceans. The other half would have come from the Earth's interior.

"Furthermore, the comet material is also known to contain simple organic molecules which may also have seeded Earth with the material from which life emerged.

"So lots of good reasons to look at these objects carefully!"

Professor Cowley will be especially keen to see how the £800 million European Space Agency (ESA) mission unfolds.

In 1994, he proposed the original case for the inclusion of a magnetic field instrument on the Rosetta satellite, which was accepted and became the Fluxgate Magnetometer (MAG) - one of a bank of five hi-tech instruments, known as the Rosetta Plasma Consortium (RPC), onboard the satellite.

Now, he works mainly in outer planet research – with NASA's Cassini mission to Saturn, NASA Juno and the ESA JUICE programme to explore Jupiter's moons.

However, he was also a member of the first ever mission to study a comet.

In September 1985, the NASA International Cometary Explorer (ICE) spacecraft passed through the plasma tail of comet Giacobini-Zinner. Its main objective was to study the interactions between comets and the solar wind.

Professor Cowley was a member of one of the ICE teams and spent four years analysing the data sent back by the probe. Numerous more comet missions followed.

In 1986, a fleet of Russian and Japanese satellites arrived at Halley – probably the best known of the comets - as did the European Giotto mission, which then went on to visit comet Greig-Skjellerup in 1992.

Another landmark moment was the NASA Stardust mission which was the first to collect dust from a comet coma (Wild 2), in 2004.

The NASA Deep Impact mission used an impactor to strike the surface of comet Tempel 1 at high speed in 2005, the effects of the resulting cloud of debris being observed in X-rays by a team from the University of Leicester using the Swift spacecraft.

Professor Cowley said: "There has been quite a lot of work prior to Rosetta, including direct dust collection and return to Earth (Stardust) and impactors (Deep Impact), as well as images of the nucleus and sampling of the dust and gas emitted, and the resulting plasma interaction with the solar wind.

"However, all of these involved rapid fly-throughs of the comet system, for example 70 km per second for Giotto at Halley and 6km per second for Stardust at Wild 2."

Professor Cowley said that Rosetta is unique in that it is flying in formation with 67P/C-G at a distance of about 30km and a speed of 34,000mph (55,000km per hour).

"One key thing about Rosetta is the matching of the orbit of the spacecraft with that of the comet.

"The satellite has been put into a close orbit around the nucleus, and will now move with it as the nucleus moves inward towards the Sun."

The comet will make its closest pass to the Sun in August 2015.

The probe's sensors will allow scientist to measure the nucleus and coma of the comet as it approaches the Sun and begins to release gas and particles which have been trapped since around the time the solar system was formed.

Professor Cowley said: "As the nucleus warms up as it gets closer to the Sun (more-or-less "room" temperature at its closet point), Rosetta will be able to observe the beginning and evolution of the outgassing of volatile components from the nucleus, principally water gas from the deep-frozen ice within.

"However, comet 67P/C-G is an old and very weak comet, purposely chosen so that the material – the water, gas and embedded dust that comes out of the vents at 1km per second – doesn't sandblast the spacecraft to death too quickly."

Provided by University of Leicester