Rosetta will teach us more about comets than we have learned in 50 years

August 8 2014, by Geraint Jones

Do you see a duck? Credit: ESA/Rosetta/MPS, CC BY

On August 6, millions of miles away from Earth, the firing of a rocket thruster signalled the end of a decade-long journey by a European spacecraft to reach its ultimate target – a comet.

The spacecraft is Rosetta, and its target is 67P/Churuymov-

Gerasimenko, named after its Ukrainian discoverers. The spacecraft will study 67P's nucleus at close quarters as it falls towards the sun, when it will come to life with a tail created by sun's warmth.

In November 2014, before activity levels rise too high, a small lander – Philae – will be released for a soft landing on the nucleus's frigid surface. The height of the comet's activity will be in August 2015, with Rosetta's mission drawing to a close at the end of that year.

This ambitious European Space Agency project was born from Europe's first planetary mission, Giotto, which provided a close-up "snapshot" of the Halley comet in 1986. Giotto's resounding success sparked a push by many European planetary scientists to carry out an even more ambitious comet mission. The resulting mission is by far the most scientifically capable and ambitious to date.

Comets are interesting to space researchers because they could reveal a less-understood story about the birth of the solar system. As far as is known, these icy bodies represent the least processed material remaining from that time.

At our planetary system's outer edge, it is believed that there lies a vast reservoir of countless frozen bodies ejected during the formation of planets. These contain varying proportions of dust and ices. These ices vary in their composition, depending on their birthplace in the early solar system. Studying them therefore provides an insight into the conditions that prevailed when Earth and the other planets came into being.

When one of these bodies is disturbed from its position it could start falling towards the sun, where it is heated, releasing gas and dust which create the comet's tails. It is only a few comets that are visible to the naked eye from Earth. Most, like 67P, require telescopes to be observed. Much has been learnt about comets from telescopic observations, but

spacecraft missions have already demonstrated that being close to a comet is vital to understand more.

Rosetta and Philae carry with them a comprehensive suite of instruments to study all aspects of the comet. Gases will be sampled, dust will be examined under microscopes, the nucleus will be studied from microwave to ultraviolet wavelengths, and its interior probed by radio waves. The experiments include hardware from Imperial College London and the Open University, with British scientists also contributing to other instrument teams. From these measurements, chemical and physical processes that occur on the nucleus and within the comet's tenuous atmosphere – the coma – will be deduced.

Over the past few weeks, the bizarre shape of 67P has gradually been revealed. It resembles a highly misshapen dumbbell measuring around 4km along its longest dimension. In the last days before arrival, the nature of the surface was resolved. It is a bizarre mix of hummocky terrain and a scattering of house-sized "boulders" on flat plains, all apparently covered in thick layers of dust. As expected, the nucleus's dusty coating reflects little of the sunlight that falls on it.

Despite arriving in 67P's vicinity, Rosetta isn't in orbit about the body just yet. As the gravitational field of this lumpy body isn't well established, the spacecraft is executing triangular paths around it, with its operators carefully monitoring deviations from that path to deduce the nucleus's mass and density. Once the nucleus is better understood, Rosetta will be moved closer to place it in orbit.

Rosetta's operators admit that November's landing of Philae on a body as small and strangely-shaped as 67P will be challenging. The mass, and hence the gravitational pull of the nucleus is extremely weak, and when close to the nucleus, the direction of "down" varies significantly over very short distances. Several busy months finalising the landing sequence

lie ahead.

The science return from Rosetta is expected to be immense. Already data gathered during arrival at the comet, when its activity is still weak, may well have amounted to enough to lead to a revolution in the understanding of comet nuclei. This is only the beginning. We may learn more about comets and the early solar system in the next 18 months than during the past 50 years.

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