1 Lee Mottram plays clarinet while Ekaterina Smirnova paints. (Brian Schmitz)

67P in art and science

Ekaterina Smirnova explains how she, as an artist, has interpreted the Rosetta mission in several different media.

The Rosetta mission of the European Space Agency (ESA) to comet 67P/Churyumov-Gerasimenko is remarkable. The scientific investigation of the comet's composition, atmosphere, dust, vapour, surface and internal structure are crucial to help researchers understand the origin of the solar system and our own planet. The whole world has been following the mission; I am one among the many, but I have also been exploring the comet in my own way – as a visual artist.

Rosetta involved collaboration between many scientists around the globe, on complex and intriguing research. Yet, when the discoveries finally make their way to the general public, the sheer amount of work behind them is not always clear. In order to reveal how elaborate and detailed the Rosetta mission is, I wanted to show my personal view, based on a subset of the scientific data collected by the spacecraft: spectroscopy, magnetometry and molecular analysis. My project is called *67P*.

I began work on *67P* on 12 November 2014, the day Rosetta released the robotic probe Philae to land on the comet – an event that amazed me. From a humble start, my work evolved into a complex art project in different media: large-scale watercolour paintings, sculptures, a musical collaboration and even an augmented reality project.

"I eventually matched the water from 67P by adding a drop of pure D_2O (heavy water)"

Paintings

Water is predominant in many of the various artistic techniques that I employ, so when ESA announced that water on Rosetta's comet did not match the isotopic composition of water on Earth, I wanted to look into this more deeply. As measured with the ROSINA–DFMS instrument on Rosetta (Altwegg 2015), water on the comet contains approximately three times more hydrogen-deuterium oxide – HDO – with respect to ordinary water molecules (H_2O) than water in Earth's oceans. I decided to replicate the comet's HDO-enriched water and use only this water to paint my watercolours.

The question arose: how to enrich H_2O with HDO? I started by using electrolysis to concentrate the level of HDO in ordinary tap water. I was using a home-made, rather primitive electrolyser and realized that reaching the desired level of HDO would take a lot of electric power and time. I eventually matched the water from 67P by adding a drop of pure D_2O (heavy water) to the electrolysed water.

The paintings are based on images from the Optical, Spectroscopic, and Infrared Remote Imaging System (OSIRIS) and the navigation camera (NAVCAM) on Rosetta. I found the monochromatic, minimal photographs that feature three components – rock, water and space – extremely appealing. I

2 *67P* at Ekaterina's art studio. Watermedia on paper, 90″ x 258″, 2015. (E Smirnova)

used the chiaroscuro technique (contrasting treatments of light and dark) to accentuate the desired subject, for example, water vapour. Splashing techniques let me create the effect of water vapour and dust jetting into the dark vacuum of space. I painted much of the work in this way, without touching the paper with a brush, and applied 30–40 layers to produce a complex texture.

All these works were created with a hand-mixed water media on watercolour paper using only the water enriched with D_2O. Although deuterium-enriched water may not have any visual impact on the artwork, I maintain that it carries an extra layer of information: as I share my creative process with observers, I am therefore able to introduce them to this extraordinary information that changed our perspective about the origins of water on Earth.

Sculptures

I continued my exploration of the comet using other media, which allowed me to express other aspects of the physical information that Rosetta explored. Through sculpture, for example, I began to explore the comet's three-dimensional form, expanding on the visual sense to also include the sense of touch. By forming the shape of the comet's body, and then exploring it with my fingers, I constructed a different sort of appreciation of 67P in my mind. Working in three dimensions also led me to focus more deeply on the composition of the comet itself.

Stoneware clay and my glaze both included iron oxide; iron is common in meteorites and also present (albeit in minor quantities) in comets. Iron allowed me to impart a black, slightly metallic look to the comet, just as it appears in the Rosetta photographs. Comet nuclei are indeed very black, and comet 67P has an average albedo of only 6% (Sierks *et al*. 2015).

Focusing anew on the water content of the comet, I chose to feature white cones in the sculptures, representing water in its various states (figure 3). The white cones are made of pure porcelain and are unglazed. Their shape is reminiscent of icicles, to suggest water found on the comet in its solid form. By piercing the comet with cones from different directions, I invite the viewer to observe the different orientations of the water vapour leaving the nucleus and the comet's movement on its curved path around the Sun. By combining stoneware with porcelain, I mean to accentuate the difference between the comet's components, the amalgamation of rock, dust and water.

"I featured white cones in the sculptures, representing water in its various states"

Music

When I heard the exciting audio piece *A Singing Comet* (http://soundcloud.com/esa/a-singing-comet), compiled by German composer Manuel Senfft, based on the Rosetta Plasma Consortium (RPC) data, I was inspired to make another artwork – a musical piece. The RPC-Mag recording of oscillations in the magnetic field of the comet's environment was made audible to the human ear by increasing the frequencies of the oscillations. I was fascinated by this recording – so unique, abstract, alien and contemporary at the same time.

I invited clarinetist Lee Mottram from Wales, who was able to mimic the comet's sounds, going through different phases of 67P's cycles. In my art studio, we created the work together extemporaneously, fueling each other's expression of sound and colour. Later, in the sound studio, Japanese composer Takuto Fukuda created an electro-acoustic composition, manipulating the performance by the clarinetist and fusing it with other sounds, such as a recording of my own heartbeat and sounds of water recorded on Earth. We tell the story of comets visiting our solar system, repeating their cycle, curving around the Sun and releasing water, carrying away dust to form their tails. During the composition, the rhythms of the heart and the magnetic field frequencies are aligned, symbolizing

3 *67P I, III*, stoneware, porcelain, rock, 6″ x 6″ x 6″, 2015. (E Smirnova)

the possible ingredients of life that are carried throughout the universe via comets. Brian Hekker, a video editor from New York, put together a 5:30-minute video piece that synchronized the music with the visuals. Toward the end of the composition, the audience hears the sound of the ocean tide – water, which possibly arrived on our planet via impacting asteroids and comets, suggesting its importance to us as living creatures.

Interacting

While the Rosetta mission was scheduled to end on 30 September 2016, my artistic practice continues. At the time of writing, I am working on implementing augmented reality into the paintings. This is based on the spectroscopic data by the OSIRIS scientific imaging system on Rosetta, which captures images in different wavelengths (red, green, blue) that are displayed in false colour. My watercolour paintings are primarily monochromatic, but with augmented reality using a specially developed smartphone app, viewers can reveal additional, virtual layers of colour.

This experiment creates a parallel between particular information that is accessible only through the data collected by a special instrument on Rosetta (in this case, the combination of OSIRIS images taken at different wavelengths) and my work, which uses the viewer's personal special instrument – a smartphone.

The smell of the comet

The Open University (Milton Keynes, UK) invited me to collaborate on a project to create a rendition of the smell of comet 67P. The smell was recreated by combining several molecules that were found in the comet's coma with the ROSINA instrument: in particular, hydrogen cyanide, ammonia and hydrogen sulphide. Together, these create a pungent smell comparable to a mix of cat urine, bitter almonds and rotten eggs.

For this project, the Aroma Company (http://www.aromaco.co.uk) created a set of postcards with a strong scent, approximating the smell of 67P, featuring one of my watercolour paintings of the comet. The postcards were first presented at the exhibition *A Comet Revealed*, curated by the Open University and other partners for the Royal Society Summer Science Exhibition in London in July 2016.

Conclusion

I was fortunate to get close to the scientific community behind the Rosetta mission during my participation in the 50th ESLAB symposium "From Giotto to Rosetta" (http://sci.esa.int/rosetta/56356-from-giotto-to-rosetta-50th-eslab-symposium). The scientists present appreciated my art project, starting a dialogue about the relationship between science and art.

New ideas often originate when two approaches or vocabularies are meshed together. I hoped that exploring a scientific subject via artistic techniques might open up new perspectives. I explored Rosetta's comet via many of our senses: sight, touch, hearing and smell, which allowed me to understand 67P more fully. Through my art, I study the relationship between humans and the universe – understanding the connection, the influence and the effect they have on one another. Scientists having the ambition to explore a distant cosmic object with this ESA mission empowered me to create and refine my personal vision. This is the way I would like to share the comet 67P with the world. Not only did I become a stronger artist through this process, but I also gained tremendous respect for the dedicated work of the scientists who contributed to this mission. ●

AUTHOR

Ekaterina Smirnova is a visual artist based in New York; k.a.smirnova@gmail.com

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MORE INFORMATION

View the paintings http://www.ekaterina-smirnova.com/67p
View ceramic sculptures http://www.ekaterina-smirnova.com/67p-sculptures
View full music/video recording http://www.ekaterina-smirnova.com/67p-music

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