A comet’s tale at Diamond

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A new picture of the composition of comets is emerging with the help of 21st century technology available at Diamond, the UK’s national synchrotron light source, in Oxfordshire.

We already know that comets played a significant role in ensuring that conditions were right for life on Earth. Most of the icy, small planetary bodies that otherwise became comets went into forming the gas giant planets in the outer Solar System but some were ejected from the vicinity of the largest planets. Of these, a fraction ended up in the inner Solar System bringing water and biogenic elements of interest to Earth. Without this cometary transport, life on Earth may never have had a chance to start.

Now, scientists from the Space Research Centre at the University of Leicester have, for the first time, brought samples of the Comet Wild-2 to Diamond. In doing so, using Diamond’s microfocus spectroscopy capabilities – bright and powerful X-rays with a beam size equivalent to one 25th of a human hair – they have discovered that the old model of comets as dusty iceballs is not the whole picture.

Dr John Bridges, from the Space Research Centre, explains the results, ‘Comets are starting to look a lot more complicated than the old dusty iceball idea. For one thing Wild-2 contains material, like chromium oxides, from the hot inner Solar System – so how did that material get mixed in with a comet which has spent most of its life beyond Neptune? It suggests that there has been major mixing of material from inner and outer parts of the Solar System in its earliest stages.

‘At Diamond, we have also been finding X-ray signatures of iron oxides. These are important because they show that on the Wild-2 nucleus there could have been small trickles of water that deposited these minerals. Similar grains are found in carbonaceous chondrite meteorites. This might mean that there have been localised heating events perhaps caused by impact on the Wild-2 nucleus that melted some of its ice.’

Their samples, which were born in the Kuiper Belt near Neptune, were collected by the Stardust space mission, which involved a seven year long, five billion km, journey. They then travelled by more conventional means (Fedex) from the US to the Space Research Centre. The Stardust mission was conceived so that comets could be studied directly as this will help researchers to find out more about the Solar System’s water and the dust that escaped planetary formation.

Dr Bridges adds, ‘It’s now becoming clear that not all comets are the same. For instance, Wild-2 may have more similarities to some asteroids and primitive meteorites than comets from the Oort Cloud, which extends to the outer limits of our Solar System and which are infrequent visitors to Earth.’

Diamond is capable of studying a huge variety of samples from every discipline of scientific research. Dr Fred Mosselmans, Principal Beamline Scientist for Diamond's microfocus spectroscopy beamline, says, ‘In the past year, example of samples studied have included wood chips from the Mary Rose warship, paint pigment samples from Tate Britain, brain tissue to further our understanding of Parkinson's disease, metal on metal hip replacements, stainless steel corrosion and the comet grains from the Stardust mission – a reflection of the huge breadth of research undertaken at Diamond.’

The University of Leicester team plan to study more cometary tracks at Diamond in the months to come, from which they will be able to establish accurate comparisons with meteorites and determine the processes – such as liquid water in the nucleus and mixing in material from the hot inner Solar System – that have gone towards forming comets.

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