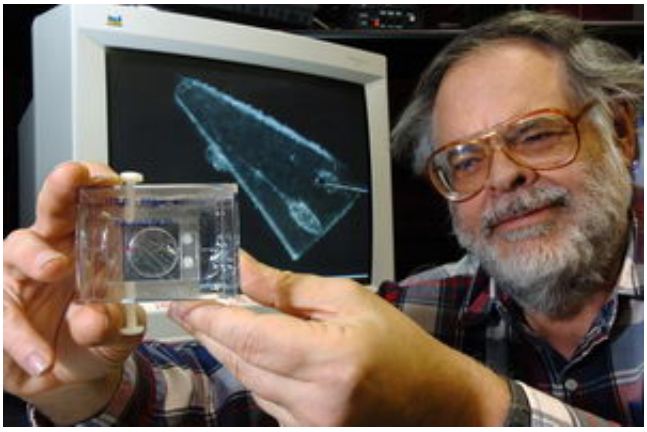
Traveling space particles reveal secrets of comets

March 11 2006



George Flynn of SUNY Plattsburgh displays a sample from the Stardust mission, which collected samples of comet dust and returned them to the Earth. The sample was analyzed at the Advanced Photon Source at Argonne. Photo by George Joch.

Particles of comet dust that traveled from the far reaches of the solar system to Earth are traveling the United States, including a stop at Argonne, where scientists are studying the particles to learn more about comets and possibly the creation of our planet.

They came from outer space.

And now, particles of comet dust that traveled from the far reaches of the solar system to Earth are traveling the United States, including a stop

at the Advanced Photon Source at the U.S. Department of Energy's Argonne National Laboratory. Scientists there are studying the particles to learn more about comets and possibly the creation of our planet.

The particles are the first pieces of a comet to have ever been plucked from outer space and returned to Earth. The collection was part of the National Aeronautics and Space Administration's (NASA) Stardust sample return mission which launched in February 1999. The primary goal of Stardust was to collect dust and carbon-based samples during its closest encounter with Comet Wild 2. The Stardust sample-return canister parachuted onto the desert salt flats of Utah on Jan. 15, following a journey of nearly three million miles, bringing with it thousands of particles from the edge of the solar system.

Four of those samples recently spent a few days at Argonne, and almost that entire time they were bombarded by the high-precision X-ray beams from the Advanced Photon Source (APS). The samples are so small that several particles fit across the width of a single human hair. By using the APS to map the samples, researchers hope to determine their chemical makeup and to gain a better understanding of the composition of comets and other planetary bodies, including the Earth. The studies were done at GeoSoilEnviroCARS, a research facility at the APS operated by the University of Chicago.

"Comets form far out in the solar system," explained researcher George Flynn of State University of New York Plattsburgh who is working on the project with Steve Sutton and Matt Newville of the University of Chicago. "They have trapped original parts of the solar system in ice for four and a half billion years. We have material that we think is the original dust that the solar system formed from. And if we want to understand the Earth, we need to understand what it's made of."

The particles were captured in aerogel, a special type of foamed glass,

made so lightweight that it is barely visible and almost floats in air. Looking at the aerogel microscopically, Flynn said, it would resemble a spider web. The particles travel through it, hitting individual strands of the web, slowing with each impact, and eventually standing still, embedded in the gel. The comet particles make carrot-shaped tunnels in the aerogel as they are stopped. At the pointed tip of each tunnel, a tiny particle will be found.

Researchers are analyzing the particles while they are still embedded in the aerogel. They use the APS to map the elements along the track left by the comet particles. The aerogel is abrasive, and as the particles travel through it, parts of them are scraped off and embedded in the track.

"If we just remove the particle and analyze only that," Flynn said, "it might not be a true representation of the particle composition." Researchers will map the elements along the path as well as the particle, and "then we'll add them up and see what we get," Flynn said.

Flynn and his colleagues will also compare the data collected from these comet particles to data on particle samples that NASA routinely collects from the Earth's upper atmosphere. Researchers have long believed that some of those particles are, indeed, from comets, but without confirmed comet samples to compare to, there's been no way to know for sure. This project finally gives scientists the opportunity to determine the unique characteristics of a comet. Flynn says researchers hope that if a comet is sufficiently uniform, then by collecting such tiny pieces of it we can understand a lot.

Prior to landing at Argonne, the samples were analyzed at the Advanced Light Source at Lawrence Berkeley National Laboratory and the National Synchrotron Light Source at Brookhaven National Laboratory. Using the APS, the samples can be studied at much higher energies allowing researchers to detect heavier elements and map the samples at

smaller scales.

After the samples leave Argonne, Flynn said, they will be returned to the Johnson Space Center in Houston where the particles will be extracted from the aerogel. Scientists there have the capability to extract particles down to about 4 microns in size. Researchers will slice the particles in half and analyze them. Some of the particles will then make a return trip to the APS where researchers will examine individual minerals in the particles at the submicron scale.

Once all research is finished, the samples will be housed at the Johnson Space Center and remain available for researchers around the world to study. Sutton pointed out that's why non-destructive studies such as this one are so valuable: The samples can be studied again in the future when even more refined methods become available.

Stardust is the first U.S. mission designed to return rock samples since the Apollo missions to the moon. " Nobody would have imagined back when Apollo returned with the first space samples the types of studies that would be possible today," Flynn said. "During the early years of space exploration samples needed to be much larger, and measurements could not be done with the sensitivity that is available today."

The real benefit of sample return, Flynn points out, is that the instruments used to study the material could not be taken into space. "We could never send a synchrotron to the comet," he laughed.

Flynn and Sutton, who have been studying space particle samples together for nearly two decades, will present preliminary findings at NASA's lunar and planetary science conference in March. They hope to have their studies complete in six months.

Source: Argonne National Laboratory, by Donna Jones Pelkie