BROOKHAVEN NATIONAL LABORATORY

Laboratory Link

January & February 2007

publisher: BNL Community Relations Office
P.O. Box 5000
Upton NY 11973
www.bnl.gov/community/lablink.asp
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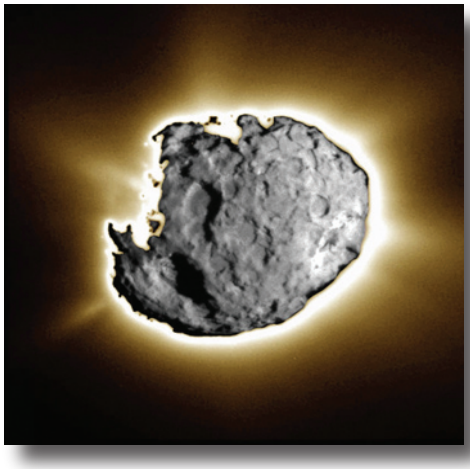
BNL's National Synchrotron Light Source Among First Earth-based Facilities to Analyze Material From a Comet

Light Source Findings Help Provide Insight Into Origins of Our Planet System

- Comets—small celestial bodies surrounded by a fuzzy halo of dust and gas that streams into a long tail—orbit our Sun, coming and going on their own trajectories. The great comets—such as Halley's—which venture near Earth and can be seen with the unaided eye have fascinated and frightened sky-gazers since before Aristotle.
- Because comets are made out of the space rubble from which planets grew, they are studied by professional astronomers for the clues they contain about the origin of our planetary system. As a result, an armada of spacecraft flew past Halley's when it last appeared in 1986, to take and analyze samples of the comet.



The comet Wild 2 as seen in space by NASA's Stardust spacecraft

- Twenty years later, analyses of comet dust—this time sampled by NASA's Stardust spacecraft from a less well-known, 4.5-billion-year-old comet called Wild 2—were for the first time performed at terrestrial labs—including the National Synchrotron Light Source (NSLS) at the U.S. Department of Energy's (DOE's) Brookhaven National Laboratory. NSLS operations are supported by DOE's Office of Science.
- The results—just published in the journal *Science*—include two major conclusions about the origins of comets—one expected and one unexpected.
- These major insights into our solar system's origins were only made possible because of "an incredible array of analytical firepower," notes Don Burnett of the California Institute of Technology in *Science,* referring to the advanced technology available at BNL's National Synchrotron Light Source and the other Earth-bound labs involved in the analyses—instrumentation and facilities that are not available onboard today's spacecraft.
- As scientists anticipated, it was found that Wild 2 is made up of a mixture of minerals from the inner solar system.
- What was surprising, however, is that some of the cometary material requires very high heat to be formed—minerals that could only have originated very close to the Sun.

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At a Brookhaven Lab Research Facility

Comet's Secrets Revealed Using NSLS X-ray and Infrared Light

- Performing experiments at four of the 80-plus beam lines at the National Synchrotron Light Source, researchers studied material from the comet Wild by shining very bright x-ray and infrared light onto one trillionth of a gram of the comet's material.
- The results of these NSLS studies combined with those from other synchrotrons and institutions have revealed new information about the makings of a comet that may help explain the beginnings of our solar system (see story above).
- In our everyday world, we are familiar with x-rays released from a machine at the doctor's or dentist's office, and infrared light from a heat lamp. X-ray and infrared light are just two examples of what

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NSLS X-ray and Infrared Light Reveal Comet's Secrets

continued

is called electromagnetic (EM) radiation.

- In the world of science, researchers use very intense x-ray, ultraviolet and infrared light to study the structure and function of nearly everything, from the AIDs virus to materials called zeolites—and a universe in between.
- The more intense this light is, the more detail that can be seen—and understanding the details of how things are structured and how they function can often lead to solutions to human problems, such as treatments for disease.
- Some of the most intense light in the world is emitted by a source with which most of us are not familiar—a "synchrotron" light source.
- A synchrotron is a type of circular particle accelerator. In a synchrotron light source, the particles being accelerated are electrons.
- With their velocity near the speed of light, the electrons are bent around the circular accelerator and focused into a beam.
- When any charged particle such as an electron is accelerated, it releases light. In a synchrotron light source, this very bright light is then let out of the accelerator through beam lines while the electrons are kept circulating in the machine.
- At the NSLS, not only were different wavelengths of intense light used to study material from comet Wild 2, but also different analytical techniques and their associated equipment.
- At NSLS beam line X26A, a physicist from the State University of New York at Plattsburgh led a group studying the chemical composition of the Wild 2 samples with x-rays and an x-ray microprobe.
- Another x-ray beam line at the NSLS—X1A1—employed its scanning x-ray microprobe to collect detailed images of the particles and gather information about their elemental composition.
- Infrared light at two beam lines—one using far infrared and the other employing mid-infrared—was used by a team led by a planetary scientist from the NASA Johnson Space Center to identify minerals.
- Mid-IR light was also used to find organic material, specifically the element carbon, which is essential for life on Earth.
- The results from the infrared studies will then be compared to astronomical observations of distant interstellar dust clouds, including those arising from the formation of our and other planetary systems.

(From left), George Flynn of the State University of New York at Plattsburgh, NASA's Lindsay Keller, and the NSLS's Larry Carr and Randy Smith examine samples of comet Wild 2 at an NSLS infrared beam line.

— Marsha Belford

Comet Analysis

continued

- This finding surprised scientists because Wild 2 was formed in what is called the Kuiper belt, in the coldest, deepest reaches of our solar system from Neptune and beyond.
- How material originating so close to the Sun was mixed across the solar system and into comets remains to be discovered.
- The samples studied at Brookhaven Lab's Light Source and elsewhere are available to the scientific community at large for further study.
- Comet material will also be preserved for future evaluation using more advanced analytical techniques that have yet to be developed—and may be available in the near future at BNL's proposed NSLS-II.

— Marsha Belford

Upcoming Open-to-the-Public Event at Brookhaven Lab

'Gathering of the Slides V' Concert, February 24

- "The Gathering of the Slides V," a blues concert featuring the Kerry Kearney Band, Little Toby Walker, the Kane Daily Band, and Dee Harris will be held at Brookhaven Lab on Saturday, February 24, at 7 p.m., in Berkner Hall.
- Tickets may be purchased in advance at www.ticketweb.com, or at Bobbique Restaurant, 70 West Main Street, Patchogue, Monday through Thursday, 11:30 a.m. to 10 p.m.; Friday, 11:30 a.m. to 11 p.m.; Saturday, 3 to 11 p.m.; or Sunday, 2 to 9 p.m.
- Sponsored by the BNL Music Club, the concert is open to the public, and tickets cost $15 each. Call (631) 344-3846 for more information. All BNL visitors age 16 and over must bring a photo ID.

Kerry Kearney