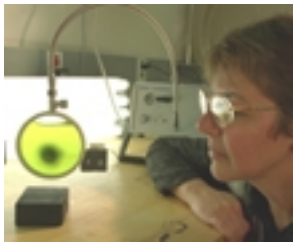

Maria Ghirardi studies chlorophyll.

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Research Highlights . . .

DOE Pulse

Science and Technology Highlights from the DOE National Laboratories

Number 86 July 30, 2001

Are the digits of pi random?

Pi, the familiar constant whose first few digits are 3.14159, is irrational—its expansion goes on literally forever and never cycles—but are its digits really random? Or in more precise mathematical terms, is pi "normal?" No natural constant has ever been proved normal. Now David Bailey of the National Energy Research Scientific Computing Center (NERSC) at Lawrence Berkeley National Laboratory and his colleague Richard Crandall of Reed College have proved that pi and some other constants are indeed normal—IF a certain plausible hypothesis from chaotic dynamic theory is valid. Their work may have application in generating unbreakable pseudorandom keys in cryptography.

[Paul Preuss, 510/486-6249, paul_preuss@lbl.gov]

DNA-based system spots plague's presence

Disappearances of prairie dog colonies in northern Arizona often signal an outbreak of plague - even though tests have usually required seven to ten days to confirm the disease's presence. But no more. In May, a team of Northern Arizona University researchers, using a DNA-based detection system developed by Lawrence Livermore National Laboratory biomedical scientists, confirmed the presence of plague within four hours. The finding, by a team led by NAU microbiology professor and plague expert Paul Keim, represents the first time the LLNL system has been used to detect a public health disease in the environment.

[Stephen Wampler, 925/423-3107, wampler1@llnl.gov]

Remote systems link technology

DOE's Idaho National Engineering and Environmental Laboratory and Russian scientists combined technologies to show the potential for improving decontamination and decommissioning operations at the INEEL. Those improvements could include increased worker safety, reduced costs and shorter project schedules. The technologies link an INEEL robot with a Russian-developed Gamma Locating Device and Isotopic Identification Device. All three systems are controlled remotely and the information collected can be used to plan decontamination and decommissioning work while keeping worker exposures to radiation to a minimum.

[John Walsh, 208/526-8646, jhw@inel.gov]

Solid-state optical limiter saves eyes from lasers

Working with academic, commercial and military partners, scientists at DOE's Los Alamos National Laboratory have developed a device for protecting human eyes from dangerous laser light. The optical limiter, which resembles a plain, lightly tinted lens, can reduce the intensity of laser beams as much as 400-fold. The solid-state device works much like photochromic eyeglass lenses, which automatically darken or lighten in response to changing daylight conditions, but has a reaction time of less than a picosecond. The Army Research Office funded the work under a Small Business Technology Transfer grant . The technology recently won a 2001 R&D 100 Award.

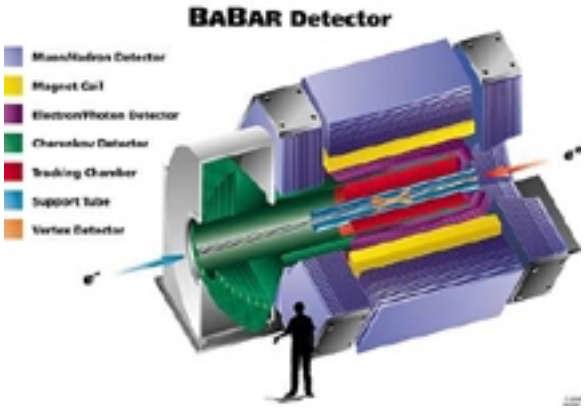
[Todd A. Hanson, 505/665-2085, tahanson@lanl.gov]

DOE Pulse highlights work being done at the Department of Energy's national laboratories. DOE's laboratories house world-class facilities where more than 30,000 scientists and engineers perform cutting-edge research spanning DOE's science, energy, national security and environmental quality missions. ***DOE Pulse*** (www.ornl.gov/news/pulse/) is distributed every two weeks. For more information, please contact Jeff Sherwood (jeff.sherwood@hq.doe.gov, 202-586-5806).

BaBar announces CP violation in B mesons is real

On June 6, following analysis of 32 million pairs of B-mesons created in the Asymmetric B Factory, the international BaBar collaboration announced that 640 pairs of these exotic particles exhibited unmistakable differences in the way that their matter and antimatter forms decayed—a phenomenon known as CP violation. A March announcement by the 600-member collaboration had pointed to CP violation but stopped short of confirmation.

The Asymmetric B Factory and the BaBar detector were built at the Stanford Linear Accelerator Center (SLAC) by a three-lab consortium including Lawrence Berkeley National Laboratory and Lawrence Livermore National Laboratory.



In 1987, Berkeley Lab's Pier Oddone proposed that B and anti-B mesons created by colliding beams of electrons and positrons could be studied independently, revealing CP violation—given beams of unequal energy to allow different particles to travel different distances downstream from the collision point. Supported by DOE's Office of Science, the B Factory was completed in 1998.

Even before the bottom quark that gives the B meson its name was discovered, theorists proposed that if it existed, some of its decay modes would exhibit very large CP violations. Weak CP violation had already been observed in K mesons, which incorporate a strange quark—violating the assumption that particle reactions are identical to their oppositely charged antiparticle reactions as "seen in a mirror" (that is, with parity reversed).

BaBar has now shown definitive CP violation in B-meson decays. Despite the enthusiasm of many reporters who heralded the finding, however, the result cannot by itself explain our existence. Matter and antimatter were made in equal amounts in the Big Bang, and somehow, for every billion matter-antimatter annihilations, a particle of matter survived. CP violation cannot explain that degree of asymmetry unless BaBar or other B-meson detectors find additional decay modes not predicted by the present theory.

Submitted by DOE's Lawrence Berkeley National Laboratory

Study of photosynthesis a researcher's dream

Maria Ghirardi studies chlorophyll.

Using algae to separate hydrogen from water is a potentially efficient source of clean, renewable energy. However, practical implementation of hydrogenase catalyzed photosynthetic algal hydrogen production has been hampered by the extreme sensitivity of the hydrogenase enzyme to oxygen, one of the byproducts of photosynthesis.

Maria Ghirardi, a principal investigator with DOE's National Renewable Energy Laboratory is looking for a way around this roadblock by bioengineering the algal hydrogenase to make it more tolerant of oxygen.

"I've been interested in photosynthesis my entire college life," Ghirardi said.

Ghirardi earned her Ph.D. at the University of California at Berkeley and searched for a project that would give her the chance to study the ability of plants to extract energy from sunlight. She came to NREL in 1991 to work as a post doc after three years at the Department of Agriculture. While there, Ghirardi studied the turnover of proteins involved in photosynthesis. "Coming to NREL allowed me to develop skills other than the ones that I had been using at the USDA, " Ghirardi said.

In 1995, Ghirardi received funding from the DOE Hydrogen Program for a feasibility study on algal hydrogen production, a project expanded in 1998 to include a new process developed jointly by NREL and Berkeley.

This new process involves partial inactivation of the photosynthetic oxygen evolution capacity of the algal cells by depriving them of sulfur. Such inactivation leads to the synthesis of the hydrogenase enzyme and production of hydrogen.

"At this point, not enough hydrogen is produced to make the process commercially viable but, this is one aspect that we are currently addressing in our research," Ghirardi explained.

Submitted by DOE's National Renewable Energy Laboratory