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DATELINE LOS ALAMOS

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U N I V E R S I T Y O F C A L I F O R N I A

TRAPPING THE WILY NEUTRON

LOS ALAMOS COLLABORATION SUCCESSFULLY CONFINES NEUTRONS IN THREE-DIMENSIONAL MAGNETIC TRAP

Neutrons are a wily lot. Scientists have been struggling to capture one since the 1940s. Not only do neutrons lack electrical charges and refuse to interact strongly with surrounding materials, they exist as free, unbound, neutrons for only minutes. All this makes the particles difficult to capture for study.

Neutrons are one of the basic building blocks of atomic matter. Scientists believe that in the first moments after the Big Bang fundamental particles coalesced into neutrons and protons.

Some of these particles then combined to form atoms of helium and other light elements, while the remaining free neutrons began to steadily decay.

Dateline: Los Alamos

As part of an atom, neutrons are stable, but as free particles they will eventually decay into an electron, a proton and an antineutrino. By determining the length of a neutron lifetime, the time it takes free neutrons to completely decay, researchers should be able to determine both the initial ratio and concentration of light elements in the universe.

Despite their seemingly elusive nature, neutrons are gradually being mastered by science. For nearly two decades physicists have been able to trap atoms in magnetic fields or bottles, but neutrons have only been confined magnetically in two dimensions as part of a tenuous stream of neutrons, never in three dimensions.

A significant step in understanding the nature of neutrons came recently when a collaboration that included Steve Lamoreaux, a Los Alamos physicist, successfully confined neutrons in a three-dimensional magnetic trap. For Lamoreaux, it was a satisfying step in an investigation that began back in 1993.

In 1993, physicist John Doyle (now a tenured professor at Harvard) and Lamoreaux (then a faculty member at the University of Washington) proposed an experimental technique for storing and detecting neutrons and described the method in a paper published in 1994. Led by Doyle, the collaboration was extended to include the Hahn-Meitner Institute in Berlin and the National Institute of Standards and Technology.

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DATELINE: LOS ALAMOS

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The Levitron® Anti-Gravity Top is sold as an educational toy, but can be used to show how a spinning motion will stabilize a magnetic top trapped within a magnetic field. Because neutrons also are spinning magnets, the concept works equally well on the subatomic level.

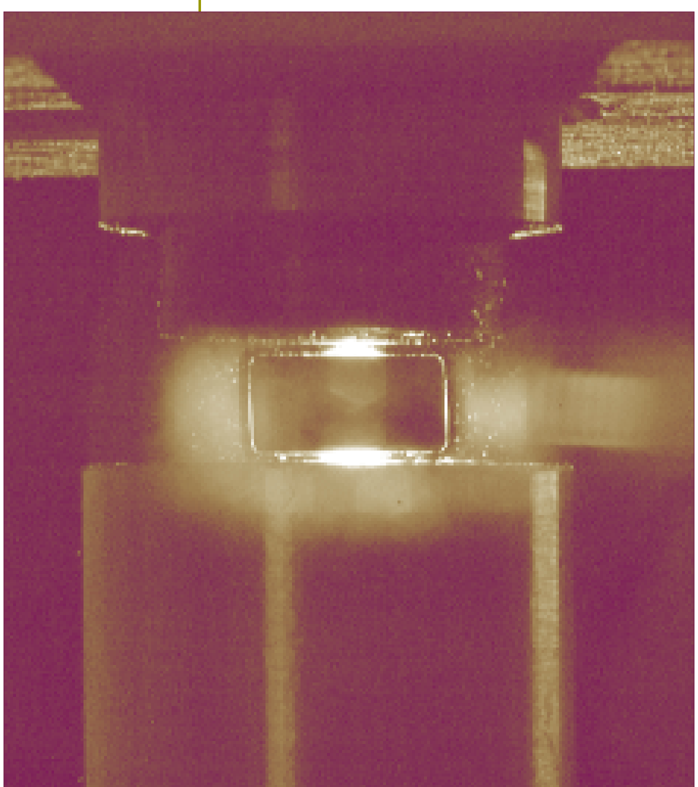
In 1995, the National Science Foundation awarded one of its most substantial grants (with Doyle as principal investigator) to carry out the experimental program. Lamoreaux came to Los Alamos in 1996, and continued working on the project as a principal co-investigator with Doyle, mostly giving theoretical and some experimental support.

The researchers used the reactor at the NIST Center for Neutron Research in Gaithersburg, Md., to produce cold neutrons that were then directed down the beamline of the reactor into the neutron trap filled with helium chilled to approximately minus 460 degrees Fahrenheit. Helium becomes a fluid at that supercooled temperature.

Only a fraction of the billions of neutrons created by the reactor beam would be confined in the long, narrow trap created of magnets positioned at right angles to each other. The magnetic field of the trap then held the neutrons in the supercold helium until they decayed. Lamoreaux and his colleagues used the electrons emitted from interactions with helium atoms to detect and measure the neutrons decaying in the trap.

The experiment showed that it is possible not only to hold low-energy neutrons in a magnetic trap, but also to detect their decay. The work will provide scientists with a more accurate measurement of the neutron lifetime and help improve their understanding of the weak force. The weak force controls radioactive decay and is one the four forces that order the universe — the other three forces being gravity, electromagnetism and the strong force. Cosmologists eventually could use the more exacting decay value to refine future models of the early formation of the universe.

In addition to the significant achievement of creating the trap, another important result of the study was the confirmation of the ultracold neutron production rate in superfluid helium. Until recently there had been some controversy over the rate, primarily because previous experiments had required extrapolating the ultracold neutron rate indirectly.



↑ A magnet can float in free space held only by the magnetic fields produced by the nearby bismuth.

The net effect of this controversy was that the apparent rate of ultracold neutron production was reduced by a factor of anywhere from 10 to 100. This lower rate led some researchers to question the validity of the basic theory in the interactions between cold neutrons and superfluid helium, even though Lamoreaux and other physicists had simply attributed the reduction to system losses.

Because of this work, scientists now have a direct measurement of the rate. The lifetime of a neutron in the trap, by the way, is roughly 12 minutes.

Lamoreaux and his team are particularly interested in the ultracold neutron production rate as they plan for an experiment at Los Alamos using neutrons from the Manuel Lujan Jr. Neutron Scattering Center. This experiment will attempt to measure the electric dipole moment of the neutron. The electric dipole moment is that tenuous combination of separated positive and negative charges within a neutron, atom or molecule that literally holds much of the subatomic world together.

Proof of the existence of an electric dipole moment in the neutron could provide unambiguous evidence for a new physics not included in the Standard Model and may even help us understand why the universe contains more matter than antimatter.

This new experiment bears directly on the techniques and physics developed for the neutron trapping experiment and might also provide evidence of microscopic time-reversal asymmetry — the idea that the processes of the subatomic world would not look or behave the same if time were reversed.

One way to visualize this is using the concept of a video of a vase falling from a table and crashing onto the floor. Playing the video backward has the vase reassembling itself and leaping back into place on the table. Physicists theorize that time itself, at least on a subatomic level, does not work in the same manner. That is, playing time backward would not be like running a video in reverse. The vase, in a video running under time-reversal asymmetry theory, would not reassemble itself exactly as it before, but rather in some unpredictable shape and position.

Obviously, proof of time-reversal asymmetry in the subatomic world could change physics as we know it.

In addition to NSF and other institution funding, the neutron trapping experiment relied closely on Lamoreaux's association with the Laboratory. His involvement in the project was fully funded by the Laboratory Directed Research and Development Program, first by Director's Reserve funding and more recently by Exploratory Research funds. In addition, the Lab provided the ultrapure helium storage system used for the neutron trapping experiment.

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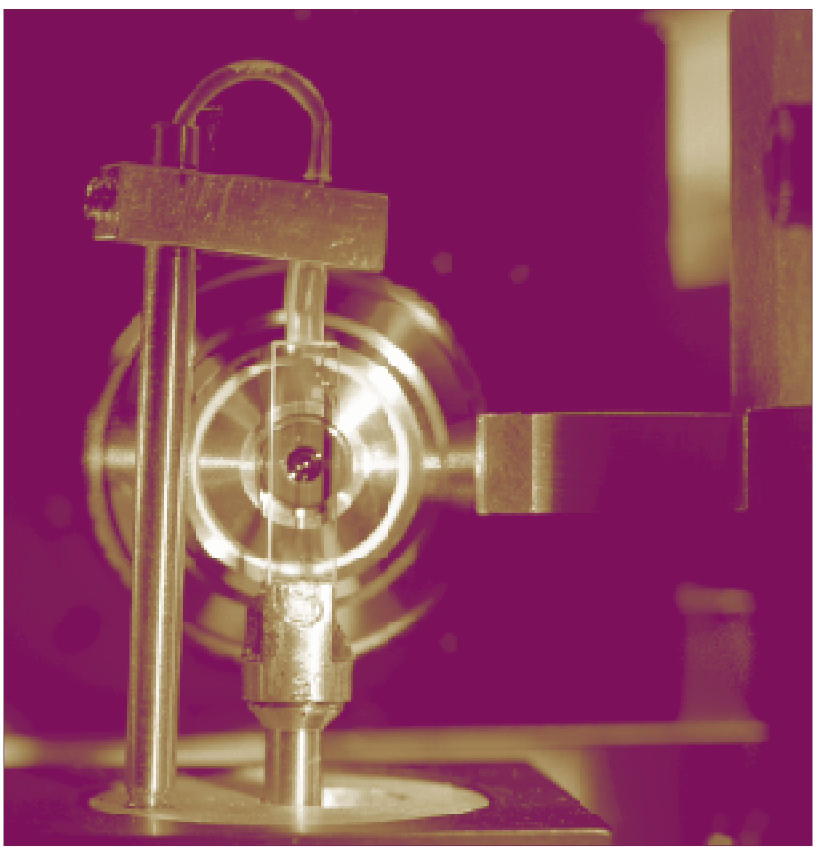
DATELINE: LOS ALAMOS

RESEARCHERS DEVELOP METHOD FOR RAPID FINGERPRINTING OF BACTERIAL DNA

NEW FLOW CYTOMETER HAS APPLICATIONS IN MEDICINE, DEFENSE, FOOD SAFETY

Researchers have developed a desktop-sized instrument that identifies the DNA fingerprints of bacteria, including biological threat agents The new ultrasensitive flow cytometer is 100 times faster and 200,000 times more sensitive than conventional gel electrophoresis at analyzing DNA samples. And the process requires only minute quantities of DNA to obtain a reliable result.



← The microscope lens focuses fluorescent light on the DNA sample in the flow cytometer.

Dateline: Los Alamos

The new flow cytometer has applications beyond defense and counter-bioterrorism, according to its developers. In the food industry, for example, it can be used to detect the presence of salmonella and other bacteria. Public health and medical diagnostic workers will be able to use the flow cytometer to analyze outbreaks of *E. coli*, staph and other infectious diseases. The instrument also will aid in studies of the human genome.

"If there should be an outbreak of a bacterial disease, we need to know immediately what the pathogen is to be able to rapidly initiate treatment," said researcher James Jett. "We wouldn't have days to figure out what we're up against. This flow cytometer may help us to determine the proper treatment much faster than we normally would."

First developed at Los Alamos more than 30 years ago, flow cytometers use lasers to analyze, characterize and sort thousands of biological cells, chromosomes or molecules in minutes. Applications include analysis of white blood cells, DNA and RNA as well as biological functions.

Researchers currently use pulsed-field gel electrophoresis to separate large DNA fragments according to their size. Although sizes can be determined with 90 percent accuracy, this method requires relatively large amounts of DNA — roughly one-millionth of a gram — and 14 to 24 hours to obtain a fingerprint from a prepared sample, especially for fragments larger than 10,000 base pairs.

The new flow cytometer determines the fingerprint of DNA fragments with 98 percent or better accuracy in less than seven minutes from a prepared sample, regardless of the length of the fragments. Less than two-trillionths of a gram of DNA is required to perform the analysis.

Sample preparation in both methods takes the same amount of time — several minutes for isolated small fragments or several hours for a whole bacterial genome digest. The big difference is the time it takes to obtain a result. Flow cytometry can deliver results in one clinical shift, which will be especially valuable to hospital workers, compared with 24 hours for gel electrophoresis.

Once the DNA is purified from the bacterial cells, researchers introduce an enzyme into the sample that chops up the pathogen's DNA into a defined set of fragments. The fragments then are stained with a fluorescent dye, the amount of which is directly proportional to the fragments' size. The larger the fragment, the more dye is bound to it.

The stained fragments are passed through the flow cytometer. As the laser strikes the fluorescent dye molecules that are bound to the

↑ A closeup of the DNA sample holder.

fragment, a photon "burst" occurs. Because the number of photons in each burst is directly proportional to the fragment's size, the cytometer counts the photons in a burst to obtain an accurate fragment size measurement.

The resulting distribution of fragment sizes in the sample is its DNA fingerprint. The researchers then simply compare the fingerprint to those from a Los Alamos-developed database to identify the pathogen.

"The new flow cytometer also has the potential to identify specific strains of bacterial species," noted Jett. This is crucial in epidemic tracing and for forensics, as well as for responding to a bio-agent attack where being able to identify the specific strain of an organism aids in tracing its origin.

An earlier version of the flow cytometer was awarded a 1997 R&D 100 Award by the Illinois-based *R&D Magazine* as one of the 100 most significant products, materials or processes with commercial promise for that year.

Researchers are developing a smaller, portable version of the tool and are seeking an industrial partner to manufacture it. A patent has been granted.

Funding has come from many sources, including the Laboratory-Directed Research and Development Program, the Department of Energy's Office of Biological and Environmental Research and Office of Nonproliferation Research and Engineering, and from the National Institutes of Health. Los Alamos has been designated as the National Flow Cytometry Resource by the National Center for Research Resources, a branch of NIH.

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DATELINE: LOS ALAMOS

TRACKING WARHEADS FROM DISMANTLEMENT TO STORAGE

NEW TECHNOLOGY CREATES A MORE COOPERATIVE ENVIRONMENT

When it comes to problem solving, the usual rule of thumb is: The simplest solution is the best. Los Alamos researchers are applying this rule to the complicated problem of verifying with high confidence that nuclear warheads have been dismantled as promised by signatory countries of future arms reduction treaties.

← An Integrated Tamper-indicating Device. A small camera focused on a barcode tag attached to a container of declared nuclear material transmits a live image to a central monitoring station.

The Los Alamos-developed technology, called the Integrated Facility Monitoring System, consists of commercially available hardware and software specially developed at Los Alamos that tracks nuclear warheads from dismantlement to storage. The IFMS minimizes the extent to which inspectors must be physically present during dismantlement operations, further simplifying security, access and safety concerns.

The IFMS has two components. The first, called the Integrated Tamper-indicating Device, consists of off-the-shelf, reusable cameras, tamper-indicating seals and infrared barcode tags that are placed on the sides of containers holding declared nuclear warheads. The camera transmits a live image of the barcodes and monitors the containers and seals.

The infrared tags continuously transmit the barcode numbers that identify a particular declared warhead to a receiver, which passes it in real time to treaty inspectors inside a central monitoring station that can be located within or outside the dismantlement facility. The receiver is part of the Integrated Monitoring Station, a "box" that is placed outside the rooms where actual dismantlement take place. The IMS includes video cameras that observe containers as they travel from one location to another and monitor objects entering or leaving various dismantlement rooms.

The second component is the Magazine Transparency System, which uses magnets and other sensors to monitor dismantled weapons, a typical laptop computer and magnetic field detectors called magnetometers. The magnets can be placed inside, outside or near the weapons containers and serve as identification tags for individual containers. Each magnet can have its own "fingerprint," a unique magnetic-field strength.

The strengths and positions of the magnets' magnetic fields remain constant so long as the magnets are not moved. If someone moves the magnets or the containers (depending on the configuration), the magnetometers instantly detect the change in magnetic fields and feed that information to a laptop computer inside the storage facility, warning inspectors of a possible breach. In all other cases, the Los Alamos-developed software allows the laptop to periodically send signals to the inspectors letting them know that everything is secure.

One possible MTS configuration being considered is a "blanket" laden with magnets that simply is draped over the weapons container. For added security, a camera is placed in the storage facility that overlooks the entire storage area.

Los Alamos researchers have a thorough understanding of the U.S. warhead dismantlement process and know that the process in Russia must be similar. Based on that knowledge, the Los Alamos researchers envision that the IFMS would work as follows:

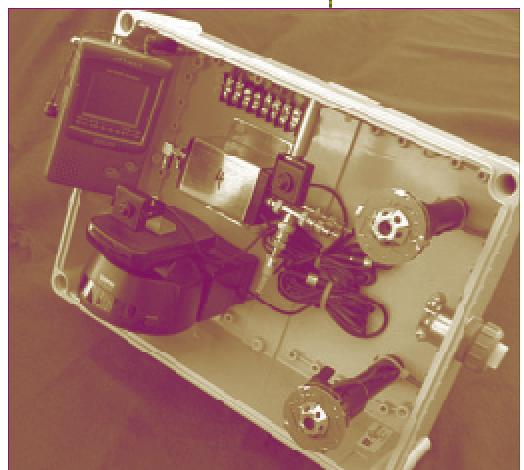
As a weapons container is removed from the pre-dismantlement storage area, it is fitted with a camera, seal and tag. As the container moves through the dismantlement process, facility personnel may perform a "live verify" and do something in the camera's field of view –- such as signaling with a hand — to verify to inspectors that the camera is providing a live feed.

Cameras are not allowed inside the rooms where actual dismantlement takes place, so the camera and tag are removed from the container just n before entrance and taken to the monitoring station for inspection, inventory and reuse.

As containers with still-intact nuclear components, dismantled nuclear components or non-nuclear components emerge from the room, those with nuclear components are refitted with new seals, tags and cameras. Containers with still-intact nuclear components are transported to the next room for further dismantlement, and the process begins anew.

Containers with dismantled nuclear components are transported to the storage facility. Once there, the tags and cameras again are removed and sent to the central monitoring station for inventory. The containers then are fitted with magnetic tags and seals and permanently stored.

Containers with non-nuclear materials are not fitted with cameras. However, to verify that no nuclear components are inside, an inspector may perform a "challenge inspection" and scan the container with a hand-held radiation detector capable not only of detecting nuclear materials, but providing sensitive information about them as well, such as their composition and weight.



↑ A look inside an Integrated Monitoring Station, the box with cameras that sits outside the dismantlement bay to watch comings and goings.

Altogether, Los Alamos' IFMS represents a radically different approach to warhead dismantlement verification, one that shifts the burden of proof from the inspectors to the signatory countries.

For example, the live-verify technique demonstrates that facility personnel have not tampered with the cameras. Scanning containers holding non-nuclear components shows that facility personnel did not sneak nuclear materials inside for diversion later. In other words, the burden of proof is on signatory countries to prove that they are not cheating.

The Los Alamos researchers believe that the IFMS creates a more cooperative environment for treaty verification and compliance, and that it may help set the stage for future dismantlement agreements.

The researchers have successfully tested the IFMS and protocols at the Nevada Test Site and Pantex Plant in Texas. Los Alamos plans to install the system at its new Applied Monitoring and Transparency Center some time this year.

The researchers have submitted an application for the MTS component of the IFMS for U.S. patent protection.

Initial funding for the project came from Los Alamos' Laboratory-Directed Research and Development Program. DOE's Office of Nonproliferation and National Security provided additional funding.

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DATELINE: LOS ALAMOS

INSTITUTE FOR COMPLEX ADAPTIVE MATTER

PROMOTING COLLABORATIONS IN MATERIALS SCIENCE

In the policy world, think tanks are a dime a dozen. In the scientific world, "institutes" are equally common, focusing on solving problems in major disciplines such as physics or biology. But an institute based at Los Alamos is different, because it promotes collaboration in cutting-edge materials science among researchers at many research universities, national laboratories and other institutions.

➔ An example of an organic-inorganic multilayer. This is an ultrafast photorefractive material consisting of (from top to bottom): transparent polymer, fullerene acceptor, nonlinear optical polymer and conducting polymer. Organic-inorganic multilayers are one of the areas under study in the Institute for Complex Adaptive Matter.

The Institute for Complex Adaptive Matter isn't confined within bricks and mortar, but seeks to gather scientists who see materials-driven research across the traditional disciplines as an exciting frontier in which they can develop shared intellectual concepts and experimental research.

The institute is located at Los Alamos but is a unit of the University of California, reporting to the UC Office of the President. Created formally last spring, ICAM's national, experiment-based scientific agenda is the study of complex adaptive matter — the search for the organizing principles that govern emergent behavior in matter, be it animate or inanimate.

"ICAM seeks to identify, stimulate and conduct collaborative research and scientific training that draws from the biological, chemical and physical viewpoints on complex adaptive materials," said Don Parkin, co-director of ICAM with David Pines.

The institute doesn't have its own research facilities. Rather, said Pines, "activities initiated by ICAM include multidisciplinary workshops devoted to promising research themes, communicating workshop results to the broader scientific community and catalyzing the formation of polydisciplinary experiment-based research teams at leading research universities."

The study of complex adaptive matter covers a remarkably broad range of topics, from understanding how proteins fold to unraveling the mysteries of high-temperature superconductivity.

DATELINE: LOS ALAMOS

Initial workshops conducted at Los Alamos this past summer and fall received enthusiastic response and the University of California committed $100,000 in start-up funds and an additional $100,000 this year. ICAM also has received $150,000 in Laboratory Institutional Program Development funds.

The UC umbrella has allowed ICAM to pursue National Science Foundation support, private foundation support and corporate support. The Institute recently received its first two foundation grants: $25,000 from the David and Lucille Packard Foundation in support of its workshop program and $45,000 from the Alfred P. Sloan Foundation to fund the rapid formation of nascent research groups.

ICAM's 28-member board of trustees include Laboratory scientists and researchers from Rutgers, the University of Chicago, the Salk Institute, the University of Illinois at Urbana-Champaign, Stanford, Oak Ridge National Laboratory, Lawrence Berkeley National Laboratory, Florida State and six UC campuses. Fourteen of the trustees are members of the National Academy of Sciences.

At a workshop held last July, some 20 attendees discussed adaptive atoms and fundamental problems in chemistry, physics and biology in which adaptive (intermediate valence) atoms play a significant role.

A second workshop in September was devoted to identifying the origins and role played by mesoscopic organization — organization that falls between microscopic and macroscopic levels — in soft, hard and biological matter. Among the topics discussed were how one might hope to establish the structure-energy landscape-dynamics function connections in biology that will make possible the predictive design and synthesis of biomolecules.

In fact, ICAM is an ideal venue for biologists, according to Parkin. "ICAM says complexity is the common thread. Biologists have been working with complexity all along. We can learn from biologists. Conceivably, scientists could come here for months to use ICAM to infuse state-of-the-art thinking and develop new interactions and new perspectives."

Pines noted that an important fall-out from these initial workshops was some 16 proposals for the funding of nascent multi-institutional research groups on topics ranging from pattern formation in films to understanding the behavior of heme proteins.

"When we talk about chemistry, physics and biology, we talk about them as equal partners in the development and pursuit of complex adaptive matter," Parkin said. "That's why we think it's so right at Los Alamos. Every one of these things is part of Los Alamos' future."

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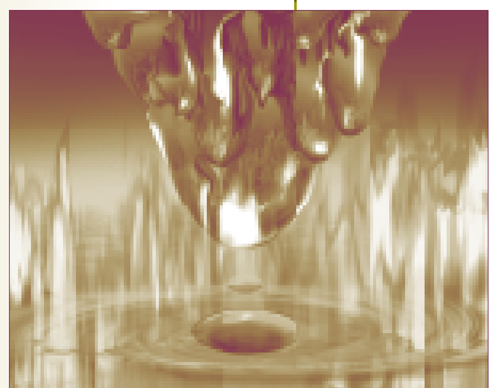
DATELINE: LOS ALAMOS

SCIENCE DIGEST

STEELING THE SHOW

Los Alamos researchers used their computer modeling expertise to develop a model-based, adaptive controller that efficiently regulates natural gas flow to steel company blast furnaces. The new controller, which now runs all three hot blast stoves at Ispat Inland's No. 7 blast furnace, automatically calculates the current states of the stoves to precisely determine the flow rate and amount of natural gas needed for efficient stove operation. The controller reduces natural gas usage by at least 5 percent, saving one steel manufacturer at least $360,000 annually. Because less natural gas is burned, carbon dioxide emissions from the furnaces also are reduced. The Los Alamos researchers also are developing software that will help operators predict and avoid cold hearth and "hanging" conditions in the furnace, preventing financial losses from such incidents that can reach $1 million daily. The work is part of a three-year cooperative research and development agreement between Los Alamos, the Department of Energy's Office of Industrial Technologies and Ispat Inland Steel Co. in East Chicago, Ind. CONTACT: DOMINIC CAGLIOSTRO, (505) 667-8500, E-MAIL: djc@lanl.gov

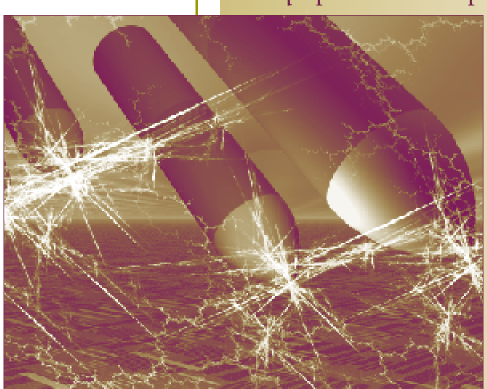


TITANIUM STRUTS ITS STUFF

Scientists have refined a technology to create high-strength pure titanium implants by changing the size of the titanium grain. Alloys of titanium, aluminum and vanadium have been used for medical implants for decades because of the material's high strength. However, there have been concerns about the toxicity of the alloy elements because they have the potential to cause cancer and neurological disorders. Recent experiments have also shown that implants made of the alloy do not fix to the bone tissue as well as pure titanium implants. This new material has the potential to replace the current alloy as a material for medical implants. Pure titanium is chemically inert and compatible with human tissue, but large-grained pure titanium lacks the strength needed for implants. This new fine-grained titanium has the advantage of being able to fix to the bone tissue well while possessing much greater strength than coarse-grained titanium. Although the FDA has approved pure titanium for medical implants, tests are planned to ensure the ultrafine-grained materials are biologically compatible with the human body. Currently, Los Alamos is collaborating with the Russian institute that initially developed the process and U.S. companies seeking to commercialize the ultrafine-grained titanium for making medical implants. There also are plans to use ultrafine-grained titanium to make heart valves and pacemakers. CONTACT: Y. THEODORE ZHU, (505) 667-4029, E-MAIL: yzhu@lanl.gov

MEGATONS TO MEGAWATTS

Los Alamos scientists have contributed a key technology to help monitor the enrichment and flow of uranium from surplus Russian nuclear weapons as the material is converted to reactor fuel. Los Alamos' device measures the enrichment of gaseous uranium in pipes, providing U.S. monitoring personnel evidence that the uranium blending process is taking place at agreed-upon levels. The equipment underpins the Highly Enriched Uranium Purchase



Agreement between the United States and the Russian Federation, whose aim is removal of weapons-grade material from global supplies. Under this agreement, the United States will buy 500 metric tons of highly enriched uranium extracted from Russian nuclear weapons over a 20-year period. Russia will dilute the HEU to low-enriched uranium, which the U.S. will make into fuel for commercial nuclear reactors. This program will be converting former weapons-grade nuclear material to peaceful purposes. The Department of Energy has developed the monitoring process to track the HEU as it is blended with low-enriched uranium, ensuring compliance with the agreement. Los Alamos and Oak Ridge national laboratories jointly developed the overall monitoring system. CONTACT: DON CLOSE, (505) 665-5923, E-MAIL: dclose@lanl.gov

DATELINE: LOS ALAMOS

PEOPLE IN THE NEWS

THE MAGNIFICENT SEVEN

Seven Los Alamos researchers have been named Fellows of the American Physical Society. APS is a worldwide organization of more than 40,000 physicists that holds scientific conferences, provides standards of professional conduct and engages in physics education and outreach programs. The APS also publishes some of the world's leading physics research journals, including Physical Review Letters and Reviews of Modern Physics. This year Los Alamos had more researchers inducted as APS Fellows than any other institution in the world.

The APS Fellowship Program recognizes APS members who have made advances in knowledge through original research and publication or made significant and innovative contributions in the application of physics to science and technology. APS Fellow recognition is a prestigious honor because each year no more than one-half of one percent of the total American Physical Society membership are elected to the status of Fellow.

GREG CANAVAN, who works in the Physics Division Office, was elected an APS Fellow through the Forum on Physics and Society for his contributions leading to the improvement of military science and technology and for leadership in the transfer of remote sensing and communications technologies to the scientific, civilian and commercial sectors.

ALAN GLASSER was elected to fellowship through the Division of Plasma Physics for his contributions to the theory of toroidal ideal and resistive magnetohydrodynamic instabilities and their applications to plasma confinement for magnetic fusion energy research. He has been leader of the Plasma Theory Group at Los Alamos since 1995.

TERRANCE GOLDMAN was elected an APS Fellow for his contributions to the understanding of the structure and interactions of hadrons, particularly for his work on the charge dependence of nuclear forces. Goldman was a postdoctoral researcher at Los Alamos from 1975 until 1978. He joined the Medium Energy Theory Group in 1978 and has served as that group's leader since 1991.

RICHARD HUGHES, acting deputy group leader of the Neutron Science and Technology Group, was elected an APS Fellow through the Division of Atomic, Molecular and Optical Physics for his work in the application of fundamental quantum mechanical principles to practical situations, including quantum computation and quantum cryptography, and for the development of experimental techniques in quantum information theory.

Dateline: Los Alamos

People in the News

MICHAEL E. JONES was elected through the Division of Plasma Physics for his work in the development of novel particle-in-cell simulation methods and their use in the study of the generation, transport and stability of intense charged-particle beams and plasmas. Jones is the leader of the Plasma Physics Applications Group in the Laboratory's Applied Physics Division.

ALBERT MIGLIORI was elected an APS Fellow through the Forum on Industrial and Applied Physics for the development of resonant ultrasound spectroscopy and its application in materials physics and technology. Migliori came to the Laboratory as a Director's postdoctoral researcher in 1973 and became a staff member in 1976. Migliori recently moved from the Condensed Matter and Thermal Physics Group to the National High Magnetic Field Laboratory at Los Alamos.

SEPPO PENTTILA, also a member of the Neutron Science and Technology Group, was elected a Fellow through the Division of Nuclear Physics for his work on the development of polarized targets and beams leading to greater understanding of the nucleon-nucleon interaction at medium energies, nuclear structure and parity violation in compound-nuclear states. Penttila came to Los Alamos in 1985 from the University of Turku, Finland.

FIRST-EVER LANSCE DIRECTOR'S AWARD PRESENTED

GREGORY SMITH of the Los Alamos Neutron Science Center has received the first LANSCE Director's Award for Scientific Excellence. Smith was nominated by colleagues outside Los Alamos who come to LANSCE to use its neutron scattering facilities, learn neutron scattering techniques or collaborate on projects. The 12-year Los Alamos veteran received a plaque and a $2,000 cash prize. Smith is known worldwide for his expertise in several neutron scattering techniques, most notably neutron reflectometry, in which neutrons are reflected off the surfaces of biological materials and soft-condensed matter to further the understanding the materials' surface structures at the molecular level. Smith designed and built Los Alamos' first neutron reflectometer and accompanying software in 1988. The reflectometer has been a part of Los Alamos' user program at the Manuel Lujan Jr. Neutron Scattering Center, a Department of Energy national user facility, since 1989. He also designed and built an innovative humidity-controlled oven that allows neutron reflectometry to be used to characterize free-standing, multilayer membranes. Among Smith's current collaborations is a study of the structure of molecules in advanced-delivery drug systems with the University of California, Santa Barbara.

DATELINE: LOS ALAMOS

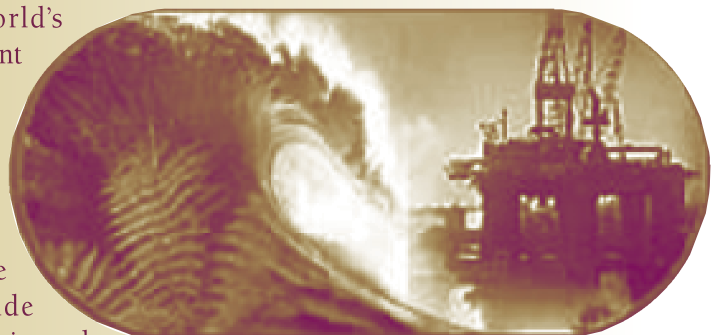
SCIENCE FOR THE 21ST CENTURY

CARBON SEQUESTRATION

CRADLE TO GRAVE CARBON MANAGEMENT MAY CONTRIBUTE TO CONTINUED ECONOMIC PROSPERITY

There is growing concern about the potential worldwide environmental impacts from the vast amounts of carbon dioxide that are released from the combustion of fossil fuels. Possible impacts range from global warming to acidification of the ocean.

Unless action is taken, future carbon dioxide emissions will dwarf those to date. Los Alamos leads a number of scientific efforts to isolate and dispose of carbon dioxide before it ever reaches the air and also to directly remove carbon dioxide from the atmosphere.



The stability of the world's economy depends on abundant energy. For economic reasons, the energy supply has been, and in all likelihood will continue to be, dominated by fossil fuels, which are still plentiful. Limiting energy use to curtail carbon dioxide emissions would stifle economies and leave the majority of the world impoverished, as energy use is the enabling agent for wealth.

Left unchecked, however, the atmospheric concentration of carbon dioxide will double in the next 50 years, as poorer nations of the world seek the standard of living enjoyed by today's richer nations.

This doubling will take atmospheric carbon dioxide levels well beyond the highest levels recorded in geologic strata dating back 10 million years, with the potential for severe global impacts.

Los Alamos scientists are actively engaged in research and development to achieve carbon sequestration, the capture and secure storage of carbon dioxide emitted from the combustion of fossil fuels, and have developed a number of innovative concepts combining expertise in earth sciences, chemistry and biology.

Scientists are investigating the use of reactors for achieving low-cost, high-efficiency hydrogen production from natural gas. Hydrogen fuels release no carbon dioxide and can be used in fuel cells to produce electricity. In another effort, scientists are investigating a zero-emission, coal-fueled power plant, which involves a carbon dioxide acceptor process for hydrogen production coupled with high-temperature, solid oxide fuel cells.

Others at Los Alamos are developing hydrogen separation membranes to yield pure hydrogen streams.

To deal with diffuse carbon dioxide emissions such as those from cars, trucks and aircraft, Los Alamos scientists are investigating the direct chemical extraction of carbon dioxide from the atmosphere. Other scientists are addressing the same issue by improving the natural process by which Earth's biomass takes carbon dioxide from the atmosphere. They are investigating how to enhance plant growth and soil retention of carbon.

For permanent sequestration of carbon dioxide, Los Alamos proposes enhanced mineral carbonation. This is an accelerated version of the natural process that has maintained the atmospheric carbon dioxide levels on geological time scales.

Los Alamos has pioneered research in joining carbon dioxide with naturally occurring magnesium and calcium silicates to form stable carbonates, either by an industrial, above-ground process or the injection of supercritical carbon dioxide into appropriate geological strata.

Enormous deposits of such silicates in the form of serpentinite rocks are found in a number of locations, notably near the high-energy-using coasts of the United States. Future power plants could be located near these deposits, allowing for immediate, permanent disposal of their carbon dioxide emissions.

In the 21st century, all these methods used in some combination could enable human-dominated systems to continue to grow while maintaining the natural environmental balance of the planet.

DATELINE: LOS ALAMOS

BRIEFLY ...

ON THE FRONT COVER: Shown with what may one of the best desktop analogies for neutron trapping, Steve Lamoreaux watches a Levitron® Anti-Gravity Top in his Los Alamos laboratory. The Levitron, sold widely as an educational toy, uses a spinning motion to stabilize a magnetic top trapped within a magnetic field created by a magnetized base. Because neutrons are also spinning magnets, Lamoreaux and his team used a long, narrow trap made of magnets positioned at right angles to each other to trap neutrons produced by a reactor at the Center for Neutron Research in Gaithersburg, Md. The magnetic field of the trap held the neutrons in the supercold helium until they decayed, allowing scientists to measure their lifetimes.

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IN THIS ISSUE:

Trapping the Wily Neutron
PAGE 1

Rapid Fingerprinting of Bacterial DNA
PAGE 6

Tracking Warheads
PAGE 9

Institute for Complex Adaptive Matter
PAGE 12

Science Digest
PAGE 14

People in the News
PAGE 16

Science for the 21st Century
PAGE 18

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