

# DATELINE LOS ALAMOS

## MODERN COMPUTERS ARE A NEW WEAPON IN THE FIGHT AGAINST WILDFIRES

COMPUTER TECHNIQUES DEVELOPED  
FOR NUCLEAR WEAPONS RESEARCH  
WILL PREDICT A FIRE'S PROBABLE COURSE

→ This summer's Dome Fire in the Jemez Mountains of Northern New Mexico threatened the town of Los Alamos and the Laboratory for several days as fire fighters worked around the clock to contain the blaze.

From the forests of Yellowstone to the brush lands of California, the combination of fire and wind can produce massive environmental and structural damage and tragic loss of life. Los Alamos researchers believe the power of modern computers can help save lives and mitigate the damage caused by wildfire propagation.





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Los Alamos researcher Rodman Linn works on a computer model of wildfire propagation.

Los Alamos scientists are developing a computer model to help battle wildland blazes. Using computer techniques originally developed for nuclear weapons research, the scientists believe their model ultimately will provide valuable information that firefighters can use to determine optimal deployment of fire-fighting resources.

Traditional techniques used to battle an out-of-control wildfire include deployment of fire fighters, chemical fire

retardants dropped from airplanes, and the construction of fire breaks. Experienced fire marshals are skillful in using their available resources and their knowledge of current conditions such as fuel distribution, moisture, terrain, and wind to determine the best fire-fighting strategy.

The advantage of using a modern computer in conjunction with traditional fire-fighting techniques is its ability to calculate the probable course of a wildfire much faster than the actual unfolding of events. The computer model takes into account weather data, fuel conditions, and terrain to show the most probable



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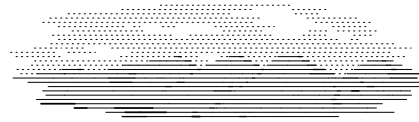
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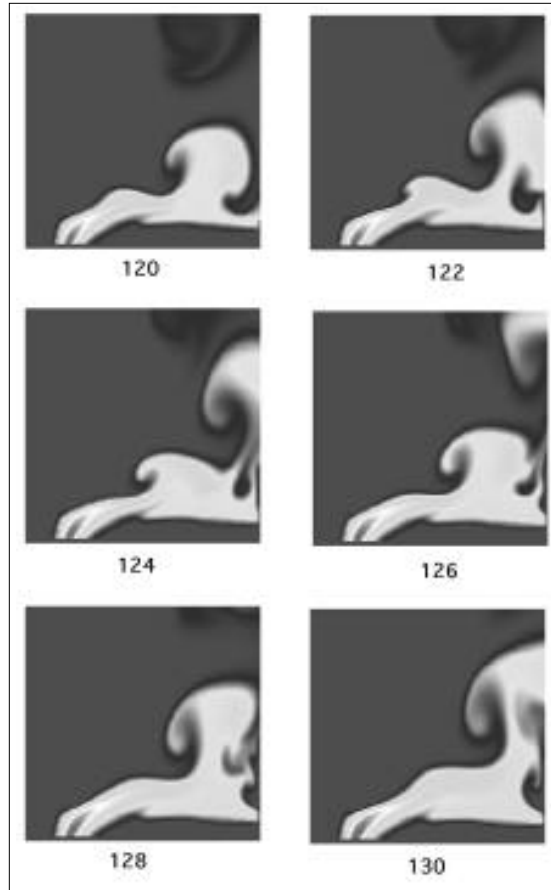


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path of a fire. The model must also predict where spot fires and fire crowning could occur. In addition, the code can be updated as it runs with different weather variables or changes in the fire's configuration so that it can recalculate a series of alternate options for firefighters to consider.

The researchers are attempting to characterize as realistically as possible the detailed behavior of a spreading wildfire driven by wind through a distribution of fuel, including trees, bushes, and grass, that both drags the wind and alters the nature of its turbulence. The model must be simple enough to provide useful information rapidly, yet sophisticated enough to provide a realistic representation of all the complex physical and chemical processes that occur in a wildfire.

In an actual wildfire, fire marshals tap into national databanks to access the terrain and vegetation and the Weather Service for current meteorological data. They also identify fire-fighting resources available in the area. Computer calculations of the wildfire propagation will help fire marshals make decisions on how best to deploy available resources to protect lives and property within the threatened area.



The computer images represent development of a fire's configuration at two-second intervals. The model includes such features as the fire's propagation rate; the rate at which a piece of fuel, like a bush, burns given local wind conditions; and the chemistry of multiple interactions among various fuels, including wood, char, soot, inert gases, and water vapor.

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## TRANSPORTABLE TECHNOLOGY IS A BREAKTHROUGH IN ENVIRONMENTAL RESTORATION

ION-TRAP MASS SPECTROMETER  
DETECTS CONTAMINATION IN REAL TIME  
WITH EXQUISITE SENSITIVITY



This photo illustrates the scale of the miniature ion-trap being developed for the hand-held version. The mini ion-trap will require a small briefcase-sized package of electronics to control it and acquire data.

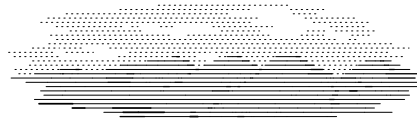
The recent spate of base closures and the military's desire to remediate contaminated sites on its remaining bases prompted the Air Force Center for Environmental Excellence to seek a reliable and economic way of identifying and characterizing contaminated sites.

A transportable instrument developed by Los Alamos researchers to detect and

quantify the amount and type of contamination in soil, water, and gas samples recently passed muster in a field demonstration at Travis Air Force Base, Calif. It reliably detected a variety of contaminants in performance evaluation standards supplied by an ad hoc team assembled by the U.S. Environmental Protection Agency. The team included several participants from the EPA, including the California regional office and the California EPA.

The instrument was found to detect lower levels of certain critical contaminants than an off-site chemical laboratory that analyzed the same set of samples. In exhaustive field studies, the Los Alamos device evaluated 36 different chemical contaminants, including solvents and fuel components, in soil and water samples, and identified these contaminants at levels below one part-per-billion.

In contrast, the off-site lab could not detect these same contaminants in soil until they were 10 to 30 times higher in concentration. Additionally, use of the instrument in the field avoided the costs (approximately \$200 per sample) and time associated with sample shipments, analysis, and reporting of results that can take weeks when using an off-site



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laboratory. Given that most sites require hundreds of samples for a complete characterization, the Los Alamos device is a breakthrough technology in terms of time and money.

The initiative continues Los Alamos' long-time tradition of working closely with the Department of Defense. Additionally, in this case, the Air Force, the EPA and Los Alamos sought a way to qualify an innovative technology for use at several Air Force sites. Subsequent to acceptance by the team, the Air Force can use the instrument at other Air Force sites that are under regulatory administration of different EPA regional offices.

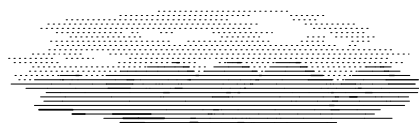
The Dynamac Corp. in Rockville, Md., initiated the collaboration when it recognized the Los Alamos instrument was an innovative and economic solution to the vexing problem of land contaminated with solvents, fuels, and other organic contaminants.

Travis Air Force Base was chosen for the demonstration because of its ongoing environmental sampling activities. It provided a real-world situation where a comparison of the instrument could be made at an active site while working with Travis AFB and contractor personnel.

The instrument not only identifies and characterizes contaminated sites with a sensitivity that meets regulatory standards, it eliminates the need to acquire many samples from a site and ship them off for analysis to a commercial lab — a costly, time-consuming process compared to making the same determinations on-site.



Los Alamos researchers Mary Cisper and Phil Hemberger prepare a soil sample for analysis in the ion-trap mass spectrometer. The two were photographed in a mobile lab during field trials of the spectrometer at Travis Air Force Base in California.



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The heart of the Los Alamos instrument is an ion-trap mass spectrometer. Mass spectrometry is a powerful analytical technique used to identify unknown compounds, measure known materials, and understand the structural and chemical properties of molecules. Ion-trap mass spectrometry is 10 to 100 times more sensitive than traditional forms of mass spectrometry.

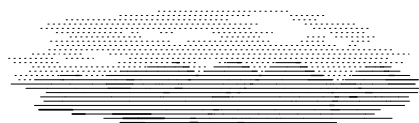
Los Alamos researchers combined a Finnigan Co. ion-trap mass spectrometer with other commercially available components, which they customized to provide an instrument for the Air Force that is easy to maintain, repair, and adapt to different samples and chemical contaminants. The one-of-a-kind device can be powered by a small generator and fits comfortably into the back of a pickup truck. It was used in a small van at Travis AFB.

In use, analysts insert a sample of water or soil into the instrument, which first extracts and separates the various contaminant molecules within the sample. The instrument next ionizes and fragments the molecules by removing an electron and uses electric fields to confine the ions in a trap. By gradually increasing the energy within the trap, first lightweight ions then increasingly heavy ones escape and are detected. The mass of the ionized molecules and fragments is the best indicator of the original chemical compound.

An upgraded instrument that incorporated improvements learned from the Travis AFB demonstration was provided to the Air Force Center for Environmental Excellence.

A hand-held version of an ion-trap mass spectrometer is also being developed at Los Alamos. Although reliable and handy, this smaller version is less sensitive than its larger cousin demonstrated at Travis AFB and, because of its size, is necessarily more limited in application. It could serve to aid researchers in the initial screening of contaminated sites by identifying contaminated areas and could also be used to track the source of contamination in remote areas.

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### LOS ALAMOS USES INNOVATIVE PLASMA TECHNOLOGY TO TREAT CONTAMINATED AIR FORCE SITES

FREE RADICALS OXIDIZE ORGANIC COMPOUNDS

**L**os Alamos scientists recently demonstrated at two Air Force bases another novel environmental technology that efficiently destroys a number of organic contaminants.

The new system destroys volatile organic compounds, or VOCs, with a nonthermal plasma that creates large concentrations of highly reactive molecules called free radicals to break down the contaminants.

Plasma is a partially ionized gas composed of a nearly equal number of positive ions and electrons. The system was successfully demonstrated at McClellan Air Force Base in California and at Tinker Air Force Base in Oklahoma.

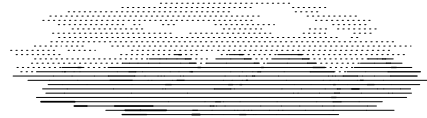
Instead of using heat to break up contaminants, the plasma cells use electrical energy to destroy molecules with highly reactive free radicals — atoms or molecules that have unpaired electrons. These free radicals oxidize organic contaminants in a chemical process similar to conventional thermal destruction, but at ambient temperatures and pressures.

McClellan and Tinker air force base officials were looking for innovative technologies to treat a legacy of waste problems left over from decades of operations.

McClellan was searching for technologies to treat VOCs from a 40-year-old hazardous waste disposal site and recruited two subcontractors to demonstrate new remediation methods under industrial conditions. One was Los Alamos' commercial partner for the silent discharge plasma treatment technology: High Mesa Technologies based in Santa Fe, N.M.



Los Alamos researcher Michael Garcia makes minor adjustments to the Lab's new portable plasma system. The system, housed inside a 20-foot tractor trailer, destroys volatile organic compounds.



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VOCs are common contaminants that come from paints, thinners, cleaning solvents, and industrial fuels. They include benzene, toluene, acetone, freon, xylene, trichloroethylene, trichloroethane, and perchloroethylene, some of which react in the atmosphere and contribute to the depletion of high-altitude ozone, the formation of ground-level ozone, and, to a lesser extent, acid rain.

Conventional waste treatment methods, such as incineration or carbon filtration, create secondary waste streams that can be as difficult to treat as the original contamination.

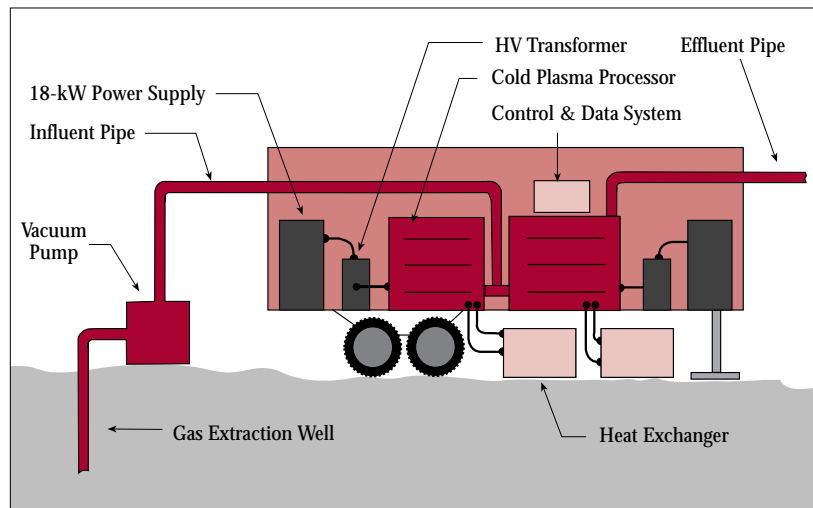
In the demonstration at McClellan, an environmental contractor for the base sucked the volatile organic compounds out of the soil with vacuum pumps from wells drilled in the ground. Next the vapor-laden air stream was directed to the 20-kilowatt plasma system that Los Alamos and High Mesa Technologies delivered to the site.

The Los Alamos technology treated a maximum of 10 cubic feet of air per minute and operated for 300 hours over a two-month period. Researchers monitored gas flows, temperature, pressures, and electrical power and stored the data on a computer.

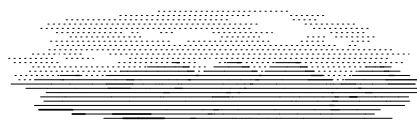
The degree of destruction reached 99.9 percent for the trichloroethylene and nearly 98 percent for the perchloroethylene and averaged nearly 95 percent for all other VOCs. Ninety-five percent removal is a standard target for today's environmental technologies.

Other technologies have achieved this goal, but the Los Alamos researchers believe the plasma technology has other important

→  
A schematic of the portable plasma system.







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advantages. For example, thermal processes use a lot of fuel like natural gas and produce extra greenhouse gas emissions and thermal-generated nitrogen oxides. Lower temperature thermal-catalytic processes also exceed the 95 percent target but use precious-metal, regulated material, or proprietary catalysts.

The successful demonstration at McClellan has prompted High Mesa Technologies to build a larger model of the system for commercialization.

In another demonstration of the same technology at Tinker Air Force Base, the Los Alamos technology treated airborne compounds to demonstrate its effectiveness on low-level contaminants. Ground water was pumped through an air stripper that cascades the water within the stripping tower and causes the highly evaporative contaminants to become airborne.

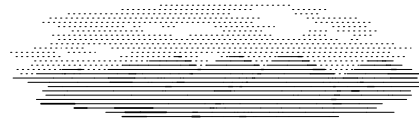
The researchers pumped the air that came off the water stripper through the plasma cells. Clean air exited the system, while leftover, less-hazardous compounds were recovered in small, stainless steel tanks that contained a dry scrubber material. Preliminary results from the demonstration at Tinker AFB show effective elimination of up to 99.9 percent of the contaminants.

The portable plasma system consists of a 20-foot trailer with specialized equipment. The chemical reactions occur in an aluminum tank that houses 20 non-thermal plasma cells. The non-thermal plasma cells use high-voltage electrical energy to create large quantities of highly reactive free radicals. The free radicals subsequently react with and break up hazardous organic chemicals, converting them to nonhazardous substances such as carbon dioxide, water, and acids that can be neutralized.

Most of the free radicals are oxygen atoms and hydroxyl molecules that react with and oxidize the larger molecules, thereby functioning much the same as incineration but without heat and added fuel exhaust.

Los Alamos is developing this nonthermal plasma air pollution control equipment together with the Electric Power Research Institute and High Mesa Technologies. EPRI is the research and development arm of most of the U.S. electric power industry.

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### STUDENTS RECOMMEND CHEAP SUNGLASSES FOR ECONOMY AND UV LIGHT PROTECTION

LOS ALAMOS-SPONSORED COLLEGE COURSE  
TEACHES SCIENCE THROUGH HANDS-ON RESEARCH

**F**or six students who took part in a recent Los Alamos educational program, the future's so bright they'll have to wear shades. And they can tell you which shades they will be wearing thanks to a simple, ingenious research project they designed and carried out using their innate problem-solving ability and a few low-cost gadgets bought at a neighborhood electronics store.



The students' experimental apparatus for measuring the effectiveness of sunglasses in blocking harmful ultraviolet rays was made from inexpensive gadgets.

The undergraduate college students, all of whom had never before taken a formal college-level science or math class, designed an experiment to determine whether cheap, midpriced, or expensive sunglasses offered the best protection against potentially harmful ultraviolet rays.

They did their research, for which they received college credit, at The University of New Mexico-

Los Alamos this spring during a course developed by the Preservice Research Institute for Science and Mathematics, or PRISM, program designed by Los Alamos' Science Education and Outreach Group.

The goal of the '96 PRISM academic year experience was to give students experience in scientific research. After receiving an introduction to the scientific method, they design a project and carry out the research. Students quickly learn that to carry out a good experiment, they must have a well-developed procedure, otherwise nobody else can replicate the experiment.

With summer just around the corner, the students decided to devise a way to investigate whether cheap sunglasses worked as well as pricier name-brand varieties.

After receiving a crash course on the visible and neighboring regions of the electromagnetic light spectrum from a Los Alamos physicist, the students were able to understand how a pair of sunglasses blocks ultra-



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University of  
New Mexico  
student and  
PRISM  
participant  
Nicodemus  
Montoya  
measures the  
ultraviolet  
transmission  
characteristics  
of sunglasses.

violet rays and define their experiment's variables. They surmised that since ultraviolet rays can be harmful to the human eye, the best pair of sunglasses blocks out the most UV rays.

The students devised a process for determining how much ultraviolet radiation was passing through the shades. The aspiring scientists bought a 2 photovoltaic cell, a device that converts sunlight into electricity, and hooked it to a microampere meter — which could tell them how much electricity was being produced and therefore how much sunlight was getting to the cell.

Next, using their newfound knowledge of the electromagnetic spectrum, the students purchased two optical filters: one that blocked out all light except for the portion of the spectrum responsible for so-called ultraviolet A rays, and one that blocked out all but the ultraviolet B rays.

Then came the testing. Using the optical filters to cover the photovoltaic cell so only UV-A or UV-B radiation passed through, students used the microampere meter to measure how much UV radiation passed through with and without the sunglasses. By comparing the meter readings, the students could determine the effectiveness of each pair of shades.

All sunglasses tested were within American National Standards Institute specifications, which recommend that no more than 5 percent of the UV rays pass through. The cheap sunglasses beat out the more expensive brands by actually blocking out a little more UV radiation.

Using state-of-the-art lab equipment and the students' methods, the Los Alamos physicist replicated the experiment on the sunglasses. His results agreed with the PRISM team's findings and showed that the students had designed a research project that could be repeated by other scientists.

The PRISM program is designed to produce university graduates who have a solid foundation in science, mathematics, engineering, or technology. The primary goal of the program is applying and testing strategies that contribute to undergraduate success in those technical disciplines. As a side benefit, the students retain an interest in science regardless of their academic goals. Most of the six students are planning to enroll in another PRISM program this summer and do research in astronomy.

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### LOS ALAMOS TAKES CHEMISTRY TO THE CLEANERS

CARBON DIOXIDE PROCESS REPLACES  
HAZARDOUS DRY-CLEANING CHEMICALS

**W**ith help from Los Alamos, the dry-cleaning industry has found a desperately needed alternative to the hazardous chemicals in use today.

The new system, developed under a collaboration between Los Alamos and Hughes Aircraft, replaces harsh dry-cleaning chemicals with a liquid carbon dioxide cleaning process that could revolutionize the industry worldwide.

Under 800 to 1,000 pounds of pressure, carbon dioxide acts like a liquid and serves as an organic, entirely recyclable solvent that extracts dirt from clothing. When the liquid carbon dioxide is allowed to return to its gaseous state, dirt just falls out. Repressurized, the carbon dioxide can be used again. The only waste generated by the process is the volume of dirt removed from the garments.

The dry-cleaning industry is under severe pressure from regulators to develop an acceptable and economical alternative to the customary chemical treatments.

The primary solvent used for many years by dry cleaners is perchloroethylene, or PERC. This solvent is classified as a hazardous toxic substance and is strictly regulated under the Clean Air Act and the Comprehensive Environmental Response, Compensation and Liability Act.

According to Los Alamos researchers, carbon dioxide does a great job of dissolving sweat, oils, and dirt. It's a better solvent than PERC, it cleans faster, and it's environmentally benign.

Los Alamos researchers investigated how the new process affects fabrics and dyes and how detergents and finishing agents used by dry cleaners





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A liquid carbon dioxide process could revolutionize the dry-cleaning industry by replacing perchloroethylene with a liquid carbon dioxide cleaning process.



might work with pressurized carbon dioxide. The liquid carbon dioxide system will clean any material that is currently dry cleaned and also will clean furs, leathers, and sequins. The system also consumes less energy than the conventional method.

Los Alamos researchers say dry cleaners would need to replace their standard equipment with high-pressure apparatus to safely operate a liquid carbon dioxide cleaning process. However, they add that a distribution network is already in place for restaurants and other businesses that require tanks of carbon dioxide to make soft drinks from a soda fountain.

At present, the dry-cleaning industry has a well-developed chemistry, with effective additives for special problems, so there is work to be done to optimize the carbon dioxide process. Los Alamos researchers plan to conduct further studies that incorporate enzymes to remove food, grass, or blood stains.

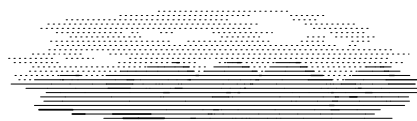
Los Alamos gained its unmatched expertise in the use of carbon dioxide as an alternative to chemical solvents from defense program applications. Carbon dioxide at high pressure can replace solvents used to clean plutonium weapons components.

This project is supported by the Department of Energy's Office of Industrial Technologies and the Environmental Protection Agency's Design for the Environmental Program in the Pollution Prevention and Toxics Branch.

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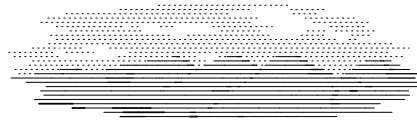


Betty Harris

### IN THE NEWS ...

LOS ALAMOS PHYSICISTS GEORGE ZWEIG AND ZACHARY FISK HAVE BEEN ELECTED TO THE NATIONAL ACADEMY OF SCIENCES. The Academy is a private organization of scientists dedicated to the furtherance of science and its use for the public's general welfare. With 1,760 active members, the Academy acts as an official adviser to the federal government on matters of science and technology. Zweig's research has found applications in a broad range of endeavors in physics, engineering, and auditory physiology. He is credited as one of two independent researchers who discovered quarks, the smallest known bits of matter. More recently, he proposed and proved a sensory model that predicts the ear makes sounds when it listens to sounds (see related article in the February 1996 issue of *Dateline*). Fisk is best known for the discovery and synthesis of new magnetic and superconducting materials and pioneering research on their properties. He was recognized in 1985 for discovering a new class of compounds known as heavy fermion materials. Now a professor at Florida State University, Fisk retains close ties with Los Alamos by serving as a consultant for the Laboratory's Condensed Matter and Thermal Physics Group and participating in the Center for Materials Science's physics study group.

NEW MEXICO FEDERATION OF BUSINESS AND PROFESSIONAL WOMEN ELECTS LOS ALAMOS CHEMIST BETTY HARRIS AS PRESIDENT. Harris says her mission as leader of the NMFBPW is to advance the opportunities of working women through education, advocacy, research, and the dissemination of information. She especially sees the education of women as crucial to elevating the standard of living for all of society. The Federation of Business and Professional Women was started in 1919 and the state organization in 1923. Harris has been a member of the New Mexico chapter for 16 years. She holds a doctorate in chemistry from The University of New Mexico and served last year as the NMFBPW's legislative chair.



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### IN THE NEWS ...

FULBRIGHT SCHOLARSHIP IS AWARDED TO RONNIE MAINIERI OF LOS ALAMOS' COMPLEX SYSTEMS GROUP. Mainieri recently accepted the award from the J. William Fulbright Foreign Scholarship Board to teach and do research in one of Denmark's premier research institutes. The Fulbright Scholar Program is a senior scholar component of the Fulbright Program. Named after the late Sen. J. William Fulbright, who started this program 50 years ago, it is designed to promote academic and professional development and enable people to learn firsthand about each other's countries and cultures. Various professions are represented in the Fulbright Scholar Program, including the arts, the media, literature, and the sciences. Mainieri has chosen to work at Denmark's Niels Bohr Institute. He had studied at this institute once before in 1991 as part of a NATO fellowship.

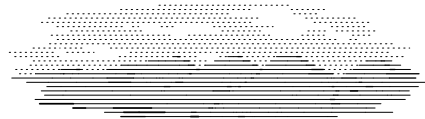
PHYSICIST DHARAM AHLUWALIA RECEIVES A \$2,500 PRIZE FROM THE GRAVITY RESEARCH FOUNDATION FOR AN ESSAY HE CO-AUTHORED ABOUT NEUTRINO OSCILLATIONS. Ahluwalia has worked at the Los Alamos Neutron Science Center since 1992. The paper, titled "Gravitationally Induced Neutrino Oscillation Phases," explores how neutrinos evolve quantum mechanically in a gravitational field assuming neutrinos have mass. Ahluwalia shared the first prize in this year's international award with Christoph Burgard, a physicist now at the European Laboratory for Particle Physics, known as "CERN," in Geneva. Two years ago, Ahluwalia received an honorable mention from the same foundation for another paper, "Quantum Measurement, Gravitation, and Locality." The Gravity Research Foundation encourages work in gravitation and general relativity. Founded in 1949, the foundation has awarded prizes every year since. The neutrino paper is scheduled for publication in the September issue of the Journal of General Relativity and Gravitation.



Ronnie Mainieri



Dharam Ahluwalia



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**BRIEFLY ...**

HIGH SCHOOL TEACHERS FROM AROUND NEW MEXICO GATHERED AT MOUNTAIN ELEMENTARY SCHOOL IN LOS ALAMOS ONE WEEK THIS SUMMER AS PART OF THE CRITICAL ISSUES FORUM SPONSORED BY THE LABORATORY'S SCIENCE EDUCATION AND OUTREACH GROUP. The forum was aimed at introducing critical thinking and problem-solving skills to high school students. The teachers, along with some high school students who attended the workshop, developed an interdisciplinary curriculum on the disposition of nuclear materials. The students recommended the creation of a global organization that would develop regulations governing the safeguarding and handling of nuclear materials around the world. Their recommendation is being forwarded to the Department of Energy and New Mexico's congressional delegation. The students also wrote an official document, developed a presentation, wrote a news release, conducted a poster session, and produced a documentary video on the curriculum. Both teachers and students used GeoNet, an electronic bulletin board service, to learn how to use computers as a research tool.

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