SCIENCE AND INNOVATION *at Los Alamos*

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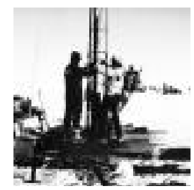
Fred Reines (left) helps lower Wright Langham into a detector similar to the one used by Reines to detect neutrinos for the first time. The active medium of the detector was a liquid scintillator developed by F. Newton Hayes for assays of large biological samples. The availability of liquid scintillators led to the whole-body counter, a device for monitoring the amount of certain radionuclides in the bodies of workers exposed to radioactive materials. Wright Langham was one of the world's experts on the metabolism of plutonium.

Lattice-gas hydrodynamics, a discrete model for fluid flow, was invented by Brosl Hasslacher at Los Alamos with U. Frisch and Y. Pomeau. This novel formulation provides a fast, efficient, reliable method for simulating the Navier-Stokes equations and two-phase flow. A modification by Ken Eggert and coworkers is now being applied to model flow through porous media, a problem of great interest to oil companies.

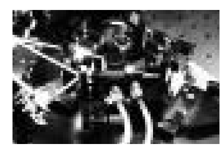
Norman Doggett and Judy Tesmer examine a gel at the Laboratory's Center for Human Genome Studies. The Human Genome Project, a joint DOE-NIH effort, was largely conceived at a DOE meeting in Santa Fe in 1986. Researchers at the Los Alamos Center developed a widely used technique for fingerprinting DNA, discovered the human telomere (the sequence at the ends of every human chromosome), are developing physical maps of several human chromosomes, and are preparing chromosome-specific libraries of clones, which are extremely useful in physical-mapping projects.

The Perhapsatron, the doughnut-shaped discharge tube shown here, was built by Jim Tuck in the early 1950s at Los Alamos. It marked the beginning of the United States effort to achieve controlled thermonuclear fusion by confining a hot, dense plasma with magnetic fields. Now the United States is part of an international effort to reach breakeven conditions in magnetically confined fusion.

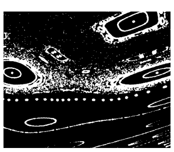


An international team, including Los Alamos scientists, prepares to take measurements in a borehole in Greenland to look for deviations from Newton's law of gravity. The experiments involved both particle physicists and geophysicists, and led to further measurments in the ocean that found no deviation.

Norris Bradbury (left) and Stan Ulam (right) are shown at the Rover test site. Project Rover, a joint effort of the Laboratory and the Air Force begun in 1955, successfully developed technology for nuclear rocket propulsion suitable for sending large manned or unmanned payloads to planets beyond Mars or outside the solar system. The high-specific-impulse exhaust is generated by passing hydrogen through a very high-temperature nuclear reactor. Russian scientists picked up this technology when it was declassfied and have now offered to share their further developments with us.

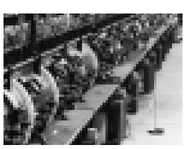


The Bright Source, an intense, short-pulse excimer laser, was developed by Los Alamos scientists to study weapons physics, ultrafast chemical reactions, and atoms under extremely high electric fields. Lasers for fusion, isotope separation, environmental monitoring, and nuclear nonproliferation have also been developed at Los Alamos.



Complex shapes, generated by iterating a simple area-preserving transformation starting from fifty points in the plane, illustrate the groundbreaking work of Mitchell Feigenbaum on the emergence of complex, chaotic behavior in simple deterministic physical and mathematical systems. Feigenbaum's research in the late 1970s was firmly within the tradition that began with the "numerical experiments" of Fermi, Pasta, and Ulam in 1952 and continues today at the Laboratory's Center for Nonlinear Studies.

Los Alamos, under a funds-in agreement with Phillips Petroleum Company, is recording microseismic activity to map rock fractures in the giant Ekofisk oil field 250 miles off the coast of Norway. The formations are subsiding after significant petroleum production. The measurements will assist Phillips in developing production strategies. The techniques for mapping rock fractures were originally developed as part of the Laboratory's geothermal-energy research projects.



Side-coupled cavities at the Los Alamos Meson Physics Facility accelerate highly intense pulses of protons to 800 MeV . Laboratory scientists invented the side-coupled cavity in 1967 specifically for use in LAMPF, but it also revolutionized the design of x-ray-therapy machines and other medical linear accelerators.

In 1947 Enrico Fermi used this trolley, an analog Monte Carlo computer, to simulate the paths of neutrons (solid lines) in a weapon or a reactor. Nick Metropolis, Stan Ulam and John von Neumann developed the first digital Monte Carlo programs for the Manhattan Project. Later Monte Carlo developments at the Laboratory include the Metropolis method and the MCNP code to simulate neutron and particle transport, which is widely used in radiation safety, nuclear safeguards, reactor design, fusion engineering, medical radiation therapy and diagnostics, and even oil-well logging. The lattice simulations of quantum field theory discussed by Rajan Gupta in this issue also employ the Monte Carlo method.

The MANIAC I, the second large-scale electronic computer, was designed and constructed at the Laboratory under the direction of Nick Metropolis and became operational in 1952. It used vacuum tubes for logic and cathode-ray storage tubes for memory (each connected to a neon light to show whether it stored a 1 or a 0). The MANIAC I was used for hydrodynamic and other weapons-design calculations, a variety of scientific problems, and the development of a high-level programming language and operating system.