

An efficient white-light LED (light-emitting diode) has been designed and built with very stable, environmentally friendly nitride compounds. Compared to incandescent or fluorescent lighting, solid-state devices for general illumination hold much promise for reducing costs and energy use, but many technical challenges remain. (See PHYSICS TODAY, December 2001, page 42.) One scheme being explored is the phosphor-conversion approach, in which light from a short-wavelength LED excites luminescent materials that then emit at longer wavelengths; the combined emissions produce white light. A team of scientists led by Wolfgang Schnick (University of Munich) used europium to dope two new phosphors—of a type called nitridosilicates—that are chemically and thermally stable and emit red and green light when excited by a blue-light LED. The resulting white light is of excellent quality and renders the colors of illuminated objects more faithfully than does a fluorescent lamp. In addition, at 25 lumens per watt, the new device's efficiency greatly exceeds that of an incandescent lamp (15 lm/W), and the researchers think the efficiency can be increased by another factor of 2 to 4. The team also reports that the materials used pose no environmental hazards during production, service, and disposal. (R. Mueller-Mach et al., *Phys. Status Solidi A* **202**, 1727, 2005.) —SGB

Building a better raindrop. A new way to mathematically model raindrop formation in clouds may improve our understanding of Earth's climate, cloud formation and movement, and the effect that small airborne particles have on rainfall. The first step in forming raindrops is called autoconversion, a process in which small droplets in a cloud combine to form larger drops. But to date, mathematical treatments of autoconversion have been oversimplified and vague because some of the terms in the equation lacked a physical basis. So Yangang Liu, Peter Daum, and Robert McGraw (all from Brookhaven National Laboratory) developed a new model for raindrop formation that takes into account the limited size range of droplets that can interact to create raindrops, the amount of liquid water present, and the concentration of droplets in a cloud. The atmospheric scientists say that their model not only is fully determined by the physics, with no tunable parameters, but is as easy to use as the previous ad hoc models. (Y. Liu, P. H. Daum, R. L. McGraw, *Geophys. Res. Lett.* **32**, L11811, 2005.) —HL

A soliton transistor. A three-terminal device based on Josephson junctions (sandwiches of two superconducting layers separated by a thin film of insulating material), and involving not the gated flow of electrons or holes but the controllable

flow of tiny magnetic vortices, has been built and tested by Farshid Raissi, a scientist at the Toosi University of Technology in Tehran, Iran. In the 800-micron-long apparatus, trains of vortex solitons—created by applying small magnetic fields to the junction and set in motion by applying a brief current to the junction—are used to control the flow of a separate soliton train consisting of vortices established with a contrary magnetic orientation. Switching between on and off states is accomplished with the controlled annihilation of solitons and antisolitons. Raissi has observed switching speeds of 8 GHz, as fast as or faster than the best existing transistors, and he expects no insurmountable problems in shrinking and mass-producing his soliton device. He also expects to achieve speeds of 200 GHz, which would make this architecture quite attractive for use in supercomputers. (F. Raissi, *Appl. Phys. Lett.* **86**, 263503, 2005.) —PFS

One of the world's fastest computers tackles one of the world's toughest problems: the generation of Earth's magnetic field. The field arises from the planet's fluid outer core. There, according to the prevailing picture, convection and rotation drive a dynamo that generates and sustains the field. Because the underlying equations are nonlinear and complex, modeling any magnetohydrodynamical system is tough. Earth's dynamo poses an additional challenge: Many of the features that geophysicists want to understand, such as the field's sporadic reversals of polarity, occur over tens of millennia, with the fluid's viscosity close to that of water. To work at all, computer models of Earth's dynamo must artificially raise the viscosity. The first comprehensive model, published 10 years ago, relied on a boost factor of a million and yielded one tentative field reversal (see PHYSICS TODAY, January 1996, page 17). Now, using Japan's



powerful Earth Simulator computer (shown in the photo), Futoshi Takahashi of Japan's Institute of Space and Astronautical Science and Masaki Matsushima and Yoshimori Honkura of Tokyo Institute of Technology have reduced the required boost factor to a relatively modest 100. In their simulation, which runs over 400 000 years, reversals begin when strong, high-latitude patches of magnetic flux drift toward the poles and fade away. Patches of reversed polarity then emerge at low and mid latitudes and drift poleward to complete the reversal. (F. Takahashi, M. Matsushima, Y. Honkura, *Science* **309**, 459, 2005.) —CD ■