

PHYSICS UPDATE

► **POLARIZATION IN THE COSMIC** microwave background has been measured. The most fundamental properties of the CMB—which can reveal conditions in the universe when it was only about 400 000 years old—are its frequency spectrum and its angular power spectra of both temperature and polarization fluctuations. According to the modern theory of cosmology, the CMB microwaves received an orientation (polarization) just before the seething plasma that pervaded the cosmos in that early era finally became a neutral, transparent gas. Until now, the low level of polarization had allowed that quantity to escape detection. Using the Degree Angular Scale Interferometer detector situated at the South Pole, a group from the University of Chicago and the University of California, Berkeley, has acquired and analyzed enough high-quality data to actually see the CMB polarization. The observed value is consistent with predictions and thus strongly validates the underlying theory. (J. Kovac et al., preprint available at <http://arXiv.org/abs/astro-ph/0209478>.) —PFS

► **HOW JUPITER GOT ITS STRIPES.** A new study of anisotropic two-dimensional turbulence on the surface of a rotating sphere is helping to explain the dramatic stripes on Jupiter and the other giant planets. Researchers at the University of South Florida and Ben-Gurion University of the Negev in Israel incorporated a nonzero ambient vorticity gradient into the classical theory of turbulence. Under certain conditions—including low internal friction, fast rotation, and weak forcing—they discovered that most of the energy was concentrated in alternating zonal jets highlighted by steep energy spectra. The new flow regime has not yet been produced experimentally, but the necessary conditions apply remarkably well to the upper atmospheres of the four giant outer planets of our Solar System. The researchers found that, with their relatively simple formulas, they could quantitatively model the circulation patterns on Jupiter, Saturn, and Neptune; there were insufficient data for Uranus. The new theory does not apply to Earth, which is much closer to the Sun (providing stronger forcing) and has a solid surface that can frictionally dissipate atmospheric energy. (S. Sukoriansky, B. Galperin, N. Dikovskaya, *Phys. Rev. Lett.* **89**, 124501, 2002.) —JRR

► **A SOLID-STATE CATHODE RAY TUBE** has been developed by scientists at the Tokyo University of Agriculture and Technology. The CRT used in most television sets and computer monitors consists of a bulky box with a gun that shoots electrons (cathode rays) from a hot cathode through a vacuum toward

a phosphor screen. The new vacuumless solid-state equivalent makes use of nanocrystalline porous silicon, in which electrons subjected to an electric field are accelerated to several eV by a multiple-tunneling cascade through the interfacial barriers between nanocrystallites. The energetic electrons then ballistically hit a luminescent organic film deposited on the silicon, resulting in uniform planar light emission. Nobuyoshi Koshida argues that the device, unlike other flat-panel luminescent display candidates, has all of the desirable technological features: It consumes little power, is silicon-based, produces a sharp picture, is scalable to large areas, responds quickly, is inexpensive because of its simple design, and can easily incorporate the three primary colors. (Y. Nakajima, A. Kojima, N. Koshida, *Appl. Phys. Lett.* **81**, 2472, 2002.) —PFS

► **ATOMIC-RESOLUTION HOLOGRAPHY** with neutrons. To obtain a holographic image, one must record the interference of two coherent waves emitted by the same source. One wave must reach a detector directly while the other first scatters off of the object to be imaged. Holography using lasers has been familiar for decades, but better resolution has been achieved in recent years with electron and x-ray holography (see *PHYSICS TODAY*, April 2001, page 21). Neutrons, however, because they only interact with nuclei, may offer a more versatile alternative. Last year, a group led by Laszlo Cser of the Central Research Institute for Physics in Budapest, Hungary, proposed two ways to use neutrons for holography. Soon thereafter, a group in Canada realized one of those methods—the inside-source method—using hydrogen, a strong neutron scatterer, to act as a point source of neutron waves within a sample. Now the second, the inside-detector method, has been demonstrated by Cser and his colleagues. The group placed a single crystal of lead, in which they replaced a few Pb atoms with cadmium, into a neutron beam. Because Cd absorbs neutrons 10^6 times more readily than does Pb, the Cd acts as an internal neutron detector. The number of absorptions depends on the total neutron wave field at the Cd, including the interference between the directly arriving and previously scattered neutron waves. After absorbing a neutron, the new Cd isotope emits gamma radiation as it drops to the ground state, and those photons provide the data for the hologram. The physicists not only found the correct lattice parameter (4.93 Å) but also determined the sample's orientation in the neutron beam. Cser believes that holography with polarized neutron beams will be valuable for studying the structure of magnetic materials. (L. Cser et al., *Phys. Rev. Lett.* **89**, 175504, 2002.) —SGB ■