Physics Update

Evidence of cosmic-ray acceleration in a supernova remnant has finally been observed. The standard opinion about cosmic rays is that the lower-energy rays (up to about 1000 TeV) probably consist of electrons and ions accelerated to high speeds by repeated scattering in the expanding shock waves of supernova remnants. New pictures of supernova SN1006, recorded by the Japanese ASCA x-ray satellite, reveal both thermal x rays from high-temperature SNR material and nonthermal x rays from the limb of the supernova. The nonthermal emission—synchrotron radiation from electrons having energies of up to 200 TeV or more—is found just where one expects the outward-moving shock front from the supernova to be. The acceleration mechanism treats highly relativistic particles of either charge equally. Thus the evidence for fast electrons implies the acceleration of ions to similar cosmic-ray velocities. (K. Koyama *et al.*, Nature **378**, 255, 1995.) —PFS

Silicon superlattices emit light. Silicon, the backbone of the electronics industry, produces light only grudgingly, a shortcoming that works against the integration of photonics and electronics. Optoelectronic devices can be made from semiconductors in groups III and V, such as gallium and arsenic, but many engineers would like to retain the well-tooled technology that has built up around silicon over the years. Porous silicon, etched by acid into a forest of thin filaments, does emit light, but the physics behind this phenomenon is not yet well understood. Now scientists at the National Research Council in Ottawa, Canada, have gotten superlattices—stacks of alternating Si and SiO_2 films—to emit bright photoluminescence. The SiO_2 layers were 1 nm thick, while the thickness of the Si layer varied from stack to stack; the light correspondingly varied from green to red. When the Si thicknesses exceeded 3 nm, the light was undetectable, probably due to reduced quantum confinement effects. The researchers believe they can tune the light's wavelength by varying the thicknesses of Si within a superlattice. (Z. H. Lu, D. J. Lockwood, J.-M. Baribeau, *Nature* **378,** 258, 1995.) —PFS

Interplanetary dust particles may influence climate. About 10 000 tons of IDPs reach Earth every year, bringing easily detectable amounts of ^3He to the surface of our planet. Scientists at Caltech have found that ancient oceanic sediments have ^3He abundances that imply a 100 000-year periodicity in the flux of cosmic dust, the same periodicity seen in climate indicators. The researchers assert that their data, taken on the flank of the Mid-Atlantic Ridge, support a recently proposed link between Earth's orbital inclination, IDPs and climate. (K. A. Farley, D. B. Patterson, *Nature* **378,** 600, 1995.) —PFS

Do-it-yourself quantum mechanics could regularly take place in classrooms. Researchers at the Autonomous University of Madrid have demonstrated quantized conductance with ordinary wires in a simple microamp–millivolt circuit. As the bare tips of two wires separate—say by bumping the table—the current goes to zero in steps of $2e^2/h$, indicating the ballistic transport of electrons through a nanowire. (See also PHYSICS TODAY, November 1988, page 21.) According to Nicolás García, the connection between the two wires does not break cleanly but is stretched into filaments—much like cheese when one takes a bite out of a slice of pizza. The connection is really many nanowires that break separately. Eventually only one thread remains, and quantized conductance can be seen, at room temperature, with a fast oscilloscope. According to Heinrich Rohrer of IBM in Zurich, "So far, everyone who has tried to duplicate this experiment has succeeded. Even us." (J. L. Costa-Krämer, N. García, P. García-Mochales, P. A. Serena, *Surf. Sci.* **342**, L1144, 1995.) —SGB

Has a glueball finally been unmasked? Quantum chromodynamics, the theory of the strong interactions, regards mesons as bound states of quarks. But QCD also predicts that there should exist some mesons whose principal constituents are not quarks but gluons, the massless bosons that mediate the strong force between quarks just as photons mediate the electromagnetic force. But unlike photons, gluons attract one another. That's why they are expected to form quarkless bound states, called "glueballs." Experimenters have been looking for glueballs since the 1970s, with no obvious success. It's hard to tell a glueball empirically from an ordinary meson. The theory should predict the masses, spins and decay modes of glueballs, but QCD is notoriously stingy with predictions; its coupling constant is much too strong for perturbation approximations. Theorists must resort to number-crunching computer artifices called lattice-gauge calculations. Now James Sexton and colleagues at IBM report the most extensive lattice-gauge calculation ever done in search of glueballs. They believe they have unmasked the f_J(1710 MeV) as the lightest of the glueballs. This meson has long been a suspect, but its decay pattern looked wrong. The enormous number-crunching effort was aimed primarily at showing that the decay rates are indeed what one should expect from a glueball. (J. Sexton, A. Vaccarino, D. Weingarten, *Phys. Rev. Lett.* **75**, 4563, 1995.) —BMS ■