

PHYSICS UPDATE

▶ **A SUPERCONDUCTING SINGLE-PHOTON** optical detector has been demonstrated by a Russian-US collaboration. The researchers deposited ultrathin (5 nm), 0.2-micron-wide strips of superconducting niobium nitride on a sapphire substrate. When a photon struck the film, a hotspot of excited electrons was created that disrupted the superconducting current and generated a detectable voltage spike. Rapid diffusion of hot electrons and cooling by liquid helium healed the hotspot within about 30 ps, restoring the superconductivity and allowing for a gigahertz repetition rate. The detector is already finding uses in checking integrated circuits, where it can record individual infrared photons that are released when a transistor switches on or off. The researchers say that it might also be used in practical quantum cryptography and as an efficient detector of optical signals for wireless communications in space. (G. N. Goltsman et al., *Appl. Phys. Lett.* **79**, 705, 2001.) —JRR

▶ **INSECT SENSES SUGGEST NOVEL NEURAL** networks. Animals gather information about their environments as sensory neurons generate minute electrical signals in response to chemicals, light, sounds, and other stimuli. A new model of neural networks, based on recent studies of insect olfactory systems, suggests that neurons can be linked in a way that allows them to identify many more stimuli than was previously possible. Researchers from the Institute for Nonlinear Science at the University of California, San Diego, propose that one neuron is able to delay the firing of another neuron. This inhibitory capability means that a given stimulus leads to a specific, robust, and reproducible time sequence of neural activity. The researchers used observed features of a locust's antenna lobe, exposed to fragrances such as cherry and mint, to guide development of the model, which they call competitive networks, or winnerless competition (WLC). They found that, with a network built of N neurons, their model could identify roughly $(N - 1)!$ different stimuli. That is, an 11-neuron WLC network should be able to identify more than 3 million items. The WLC model helps explain why a rose, by any other name, would smell as sweet—but wouldn't smell like an onion. Ultimately, the WLC model may lead to high-capacity, potent computing networks that resemble an insect antenna or a human nose more than a desktop PC. (M. Rabinovich et al., *Phys. Rev. Lett.* **87**, 068102, 2001.) —JRR

▶ **EVIDENCE FOR THE ONSET OF QUARK EFFECTS** in a nuclear reaction has been observed. In low-energy processes, a nucleus is well described by its constituent nucleons—neutrons and protons—and the mesons that hold them together. When a very-high-energy particle strikes a nucleus, however, it

penetrates the nucleus so deeply that the reaction can be described only in terms of quarks and gluons. Now, the several-GeV middle ground is being explored. In experiments at Jefferson Lab in Virginia, a multi-institutional collaboration used photons with energies up to 5.5 GeV to break up deuterium nuclei, and studied the angular distribution of the resulting protons. When the emitted proton had a transverse momentum of at least 1 GeV/c, the data were best described by quark-counting rules. Protons with less transverse momentum were well described by the nucleon-meson picture. The deduced distance scale for the interaction at the crossover energy is about 0.1 fm, larger than many current theoretical expectations for the onset of quark-counting-rule behavior. (E. C. Schulte et al., *Phys. Rev. Lett.* **87**, 102302, 2001.) —BPS

▶ **A BRONZE-AGE BELT** from Syria has been studied with scanning Auger microscopy. Researchers use the SAM technique to identify elements near the surface of a sample by monitoring the kinetics of electrons that were knocked out of the atoms by an incoming electron beam. In this way, a collaboration of researchers from Italy, the US, and the UK has characterized the ancient artifact's microchemistry with a precedent-setting spatial resolution as good as 15 nm. Although bronze is an alloy of copper and tin, the group found that the belt's original patina contained neither of those elements at the surface; rather, the patina arose from silicates and other compounds at the burial site. The researchers even spotted alloy inhomogeneities introduced by the smith during the belt's manufacture. Turn to page 32 for more on physics and archaeology. (E. Paparazzo et al., *J. Vac. Sci. Technol. A* **19**, 1126, 2001.) —PFS

▶ **HOW CONSTANT IS THE FINE-STRUCTURE** constant? The most prominent dimensionless parameter in nature, $\alpha = e^2/4\pi\epsilon_0\hbar c \approx 1/137$, is fundamental to understanding atomic structure. Modern attempts at unified theories allow α and the other fundamental coupling constants to change with time. Since 1999, John Webb and his colleagues at the University of New South Wales in Australia have been reporting astronomical evidence purporting to show that α has changed slightly over cosmological time. They measure α at different redshifts z by looking for deviant spacings between absorption lines of quasar spectra due to intervening gas clouds along the line of sight. Now, using data from the high-resolution spectrometer at the 10-m Keck I telescope, they report that, during the cosmological epoch from $z = 0.5$ to 3.5, the average value of α was almost a part in 10^5 less than it is now. It was a four-standard-deviation effect. A result so potentially important cries out for confirmation—or refutation. (J. K. Webb et al., *Phys. Rev. Lett.* **87**, 091301, 2001.) —BMS ■