PHYSICS UPDATE

Superconductivity is reduced as a system becomes more one-dimensional. Moving through very thin passages, Cooper pairs of electrons, which constitute the supercurrent, are sensitive to quantum effects not noticeable in larger wires. For example, quantum phase slips—fluctuations in which the superconducting wavefunction spontaneously tunnels from one state to another—occur well below the critical temperature. The tunneling produces a momentary voltage, and therefore a nonzero electrical resistance, even if the temperature could somehow be reduced to absolute zero. Armed with progressively thinner wires—down to 10 nm across—of molybdenum–germanium deposited onto carbon nanotubes, Michael Tinkham and his colleagues at Harvard University have definitively shown that resistance goes up as the wire diameter goes down. The quantum resistance effect only becomes noticeable for wires less than about 30 nm across. By going to lower temperatures, says Tinkham, one can eliminate resistivity arising from thermal fluctuations, but not from quantum fluctuations. (C. N. Lau et al., *Phys. Rev. Lett.* **87**, 217003, 2001.) —PFS

Sound waves make filters finer. Generally, the performance of filters that remove particulates from fluids is limited by their pore sizes: A filter with large pores isn't likely to catch many tiny particles. By contrast, a filter with tiny pores will trap small particles but inhibit fluid flow. Now, Donald Feke (Case Western Reserve University) has trapped particles up to a hundred times smaller than the nominal pore size by applying a low-power acoustic signal to the filter. The sound field within a porous material creates patterns of standing waves associated with the pores. Rather than wending their way through the filter, particles headed for the focal points either form intricate, stable filaments or gather into groups that orbit in regions of stability for as long as the signal persists. Such an acoustically aided filter offers little resistance to the fluid that flows through it, yet collects particles as efficiently as a much finer filter does. And once the filter has done its job, the trapped particles can be released with the flip of a switch that cuts off the signal. Feke presented his work last October at the 73rd annual Society of Rheology meeting in Bethesda, Maryland. (http://www.rheology.org/sor01a/abstract.asp?PaperID=157) —JRR

Insulator to metal within a picosecond. A group from the University of California, San Diego, and the University of Quebec studied a 200-nm thick film of vanadium oxide (VO_2). They fired a 50-fs laser pulse at the sample, causing what they believe to be two phase transitions: a structural one (the unit cell size increases a bit), monitored with short x-ray pulses; and an electrical one (insulator-to-metal), monitored by short pulses of visible light. The simultaneous, ultrafast measurement of more than 1 degree of freedom showed that both transitions happened essentially all at once. Therefore, the experiment still did not settle an old question in condensed matter physics: Which comes first, the structural change in the sample or the electrical change? Because the crystalline reordering occurs in a few hundred femtoseconds and is reversible, and because x rays scatter differently from the two contrasting crystalline forms, it might be possible to use this whole process as an ultrafast "Bragg switch" to divert subpicosecond portions of a longer x-ray wavetrain. (A. Cavalleri et al., *Phys. Rev. Lett.* **87**, 237401, 2001.) —PFS

A pyroelectric accelerator. A pyroelectric crystal has a permanent electric dipole moment, masked by adsorbed ions on the crystal's faces until there is a change in temperature, which creates strong electric fields at those surfaces. Now, James Brownridge of SUNY Binghamton and Stephen Shafroth of the University of North Carolina, Chapel Hill, have used those electric fields to create stable, self-focused electron beams with energies as high as 170 keV. The beams were apparent in a dilute gas atmosphere, and emanated from the so-called $-z$ face of crystalline $LiNbO_3$ after heating the $+z$ face. The energy conversion was not especially efficient—watts of heating energy produced only microwatts of output electron beam energy—but that might not be important. Brownridge says that such a focused electron beam could be used in a portable, economical x-ray fluorescence device for the elemental analysis of complex materials like tree leaves, rocks, air filters, or blood samples. (J. D. Brownridge, S. M. Shafroth, *Appl. Phys. Lett.* **79**, 3364, 2001.) —PFS

A new neutrino puzzle? Measuring neutrino interactions with nucleons at the Fermilab Tevatron, the NuTeV collaboration has reported a tantalizing three-standard-deviation discrepancy with the Standard Model of particle theory. The group directed intense beams of high-energy muon neutrinos and antineutrinos at the 700-ton NuTeV target–detector and measured the ratios of neutral-current to charged-current interactions. The result translates into a value of 0.2277 ± 0.0016 for $\sin^2\theta_W$, the key mixing parameter of electroweak unification. By contrast, the world average of $\sin^2\theta_W$ from measurements of the masses and decays of the heavy Z^0 and $W^\pm$ bosons that mediate the weak interactions is 0.2227 ± 0.0004. The discrepancy, hinted at in earlier CERN data on Z^0 decay to neutrinos, may be telling us of new particles or interactions that might guide particle theory beyond the confines of the Standard Model. (G. P. Zeller et al., http://xxx.lanl.gov/abs/hep-ex/0110059.) —BMS