# PHYSICS UPDATE

**PEEKING AT BARE ELECTRONS.** Modern quantum theory holds that the electromagnetic coupling constant, $\alpha_{\mathrm{QED}}$, should increase with increasing momentum transfer $Q^2$, even as the strong coupling constant $\alpha_{\mathrm{strong}}$ decreases. At high enough energies, they should become equal. According to theory, an electron is surrounded by a cloud of virtual photons, which themselves can dissociate into virtual fermion–antifermion pairs within the limits of the uncertainty principle. The "bare" electron is thus screened by attracting the positively charged virtual particles and repelling the negative ones. A collision with high $Q^2$ penetrates closer to the bare electron, resulting in a higher coupling constant, as now shown by physicists studying $e^+e^-$ collisions at the TRISTAN accelerator in Japan. At a center-of-mass energy of 57.77 GeV, well below the mass of a $Z^0$, they found $1/\alpha_{\mathrm{QED}} = 128.6 \pm 1.6$, in excellent agreement with the theoretical value of $129.6 \pm 0.1$, and significantly different from the canonical low-energy value of 137. (I. Levine *et al.*, *Phys. Rev. Lett.* **78**, 424, 1997.) —PFS

**METAL INCLUSIONS CAN HAVE QUANTIZED SIZES.** Whether or not nature dictates the size and shape of chunks of one element embedded in another solid is important at the microscopic level. For example, the melting point of some materials can be raised or lowered considerably by burying extremely small pieces of them inside another material. A Berkeley–Copenhagen–Rio de Janeiro collaboration has now shown that lead inclusions, a few nanometers across, in equilibrium within an aluminum matrix, assume only special ("magic") sizes. These preferred sizes (and the inclusions' faceted shapes) are determined by the material minimizing the residual strain energy imposed by the crystalline mismatch between the two elements. In time, this magic-size phenomenon might be useful for tailoring specific thermodynamic, magnetic, electronic, or optical properties of materials. (U. Dahmen *et al.*, *Phys. Rev. Lett.* **78**, 471, 1997.) —PFS

**A NEW ELECTROLUMINESCENT DEVICE** runs on 15–25 V, an order of magnitude less than the 150–200 V needed by current devices. Head-mounted displays for automobile, aircraft and microsurgery environments need small currents and voltages to be practical. At the heart of today's thin film electroluminescent (TFEL) devices is a host material such as zinc sulfide doped with luminescing centers such as manganese atoms. Electrons are supplied by defects at the interfaces with insulating layers on either side of this material. The high voltage, applied across the whole sandwich, launches electrons into the ZnS where they excite manganese atoms, which then emit light. The new TFEL concept, developed at the Georgia Institute of Technology, employs tailored band offsets between silicon (as the electron source), the very thin insulating layers and the luminescing material. The offsets give the electrons their required kinetic energy using much less voltage. The efficiency of the new device is still low and the cost of growing the crystalline insulating layers is comparatively high, but the lower voltage requirements, and the smaller circuitry this will permit, may make the approach worthwhile. (C. J. Summers *et al.*, *Appl. Phys. Lett.* **70**, 234, 1997.) —PFS

**IS THE UNIVERSE HONEYCOMB-LIKE?** As astronomers measure redshifts, and therefore distances, for an ever-increasing inventory of galaxy superclusters, the three-dimensional architecture of the universe becomes more evident. New redshift surveys benefit from fiber optics and automation to generate an abundance of high quality data quickly. Now, a fresh analysis of current redshift catalogs offers some evidence for a regular three-dimensional arrangement of superclusters, separated by voids, on a scale of about 120 megaparsecs (about 390 million light-years). A cellular distribution of superclusters and voids has been known for more than a decade, but their apparently regular, honeycomb-like pattern is new. The researchers suggest that some new physics might be needed to explain the sort of immense regularity they seem to be finding in the data. (J. Einasto *et al.*, *Nature* **385**, 139, 1997.) —PFS

**OUR LOCAL GROUP OF GALAXIES** is still forming. For decades, astronomers have wondered about the origin of certain fast-moving clouds of atomic hydrogen in the vicinity of the Milky Way. Some clouds appeared to be plunging into the plane of the Galaxy (at speeds up to 500 km/s), while other clouds seemed to be moving away from the Milky Way. In either case, they were not rotating with the Galaxy. A synthesis of new radio telescope measurements, together with numerical simulations and reevaluated data from COBE and the Hubble Space Telescope, indicates that the clouds may be orbiting the center of mass of the Local Group, whose largest shareholders are the Andromeda galaxy (with 65% of the mass of the group) and our own Milky Way (30%). Thus, the clouds could be the raw material of galaxy formation. Reporting at January's American Astronomical Society meeting in Toronto, Leo Blitz of the University of California, Berkeley, and David Spergel of Princeton University said that the high-velocity clouds will continue to feed the Milky Way (providing fuel for future star formation) and might even harbor dark matter, which would account for their continued stability and unexplained large internal velocities. Spergel said that the new interpretation of the nearby high-velocity clouds might also apply to larger, more distant hydrogen clouds in the cosmos. —PFS