

Tomography with fast neutrons. Medical imaging typically makes use of x rays, magnetic fields, ultrasound, or radioactive isotopes. At the July meeting in Pittsburgh of the American Association of Physicists in Medicine, Duke University researchers presented the first three-dimensional transaxial tomographic pictures—of an inorganic test object—from a new technique called neutron stimulated emission computed tomography (NSECT), which employs neutrons having energies between 1 and 10 MeV. Neutrons are highly penetrating and can therefore image deeply buried structures, for example in humans: Neutrons excite the nuclei of atoms, which then emit characteristic gamma rays that can be used to both locate and identify the nuclei. Fast neutron analysis (FNA) has been used for more than 10 years to identify hidden substances, such as explosives or contraband, by their atomic composition. FNA, though, generally does not require 3D reconstructions. As a proof-of-principle that neutron tomography can distinguish between two elements, Carey Floyd presented reconstructed images of a heterogeneous iron-copper sample. The researchers say that, with considerable further development, NSECT could provide early diagnosis of cancer by looking for known differences in the concentrations of trace elements that exist in malignant tissue. Because an individual neutron is more damaging to the body than a single x ray of equal energy, the researchers are working to minimize the number of neutrons needed for a diagnosis. As a next step, the group plans to improve the technique's sensitivity in order to demonstrate the feasibility of imaging molecular species in biological concentrations. (C. Floyd et al., AAPM Meeting Paper WE-D-315-6, 2004.) —BPS

Optical Hall effect. Physicists in Japan have shown theoretically that an optical equivalent of the Hall effect exists and that it should be seen in experiments with polarized light. In the classic Hall effect, an electric current pulled along a conductor by an electric field will be deflected sideways if a magnetic field is applied perpendicular to the electric field. The physicists say that, due to the topological aspects of light, something similar should happen when a polarized light ray moves from one medium into another. The angles of the reflected and refracted rays with respect to the incident ray still obey Snell's law, but the rays no longer all lie exactly in the same plane. The amount of the sideways shift at the deflection will depend on the change in the index of refraction between the two media. Masaru Onoda at the National Institute of Advanced Industrial Science and Technology in Tsukuba, Japan, and his colleagues at the University of Tokyo believe that the effect

can be explored in upcoming experiments using photonic crystals. (M. Onoda et al., *Phys. Rev. Lett.* **93**, in press.) —PFS

Speech science sings a new tune. Two physicists at King's College London have discovered a precise way to model the natural resonance frequencies, called formants, of the human vocal tract. Barbara Forbes (also of the startup Phonologica) and Roy Pike applied the methods of quantum mechanics, in the form of a Klein-Gordon equation, to the classical acoustics of a simple organ pipe, which speech researchers often study to gain basic insights into sound production in humans. A perturbation analysis showed that adding curvatures—dents or bumps—at optimal positions in a straight pipe can shift its natural resonance frequencies up or down, largely independently of each other. The analysis substantially advances Lord Rayleigh's long-standing 1878 result, which looked at a pipe's perturbed cross section but did not account for the resulting wave dispersion. The researchers are now using their theory to program a machine to recognize natural phonetic sounds. They also say the theory has applications in engineering, musical acoustics, and physiological speech production. (B. J. Forbes, E. R. Pike, *Phys. Rev. Lett.* **93**, 054301, 2004.) —BPS

Switchable nanotube diodes. Single-walled carbon nanotubes (SWNTs) can be either metallic conductors or semiconductors and have been used as transistors, sensors, and memory devices. Now, researchers at General Electric's Global Research Center in Niskayuna, New York, have created a room-temperature five-terminal device with a semiconducting SWNT. Most transistors are three-terminal devices: Current comes in at (i) the source and exits at (ii) the drain so long as (iii) the gate carries a certain voltage. That voltage can electrostatically clear a road along which charge carriers flow. In the GE device, the silicon substrate was another terminal, and the gate, located beneath the SWNT, was split into two. That arrangement allowed the physicists to electrostatically dope the two ends of the SWNT separately. They could thus make their device either unipolar—conducting electrons or holes in a single direction only—or ambipolar, in which case they could switch from hole- to electron-conduction by changing voltage. Even more interesting, by biasing the gates with opposite polarities, the researchers turned the device into a switchable p-n junction diode. The researchers expect their device to find uses as both a field-effect transistor and a light-emitting diode. It might also find applications in power electronics, where huge currents and voltages are to be found. (J. U. Lee, P. P. Gipp, C. M. Heller, *Appl. Phys. Lett.* **85**, 145, 2004.) —PFS ■