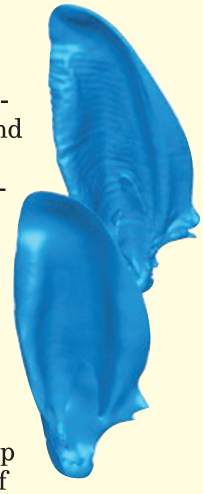
Physics Update

Sorting biomolecules without diffusion. Given a complex biological mixture, scientists frequently need to sort its contents by size or density. Typical methods rely on particle diffusion into different regions of an apparatus. Researchers from Princeton University have come up with a new, deterministic sorting technique that exploits microfluidics. In their device, a laminar fluid carries the biomolecules of interest in a stream through an array of artfully staggered rows of obstacles. Depending on the uniform size and spacing of obstacles in a row, and the staggering from one row to the next, molecules of a certain size will zigzag through the obstacles but, on average, proceed straight with the flow through the array. Larger biomolecules, however, are preferentially carried off at an angle as they traverse the array and separate from the smaller molecules. In initial demonstrations, the researchers have sorted fragments of artificial bacteria chromosomes to within 12% of their molecular weight in 10 minutes, an order of magnitude faster than is possible with conventional methods. (L. R. Huang et al., *Science* **304**, 987, 2004.) —BPS

Magnetic striction revealed. The basic Heisenberg model of magnetic materials invokes spin exchange, an interaction in which a pair of ions (a dimer) share electrons. Many materials, however, manifest higher-order interactions whose physical origins are subject to some debate. Now, scientists in Switzerland have studied a model magnetic system and found strong evidence that coupled ions reduce their separation to gain magnetic energy at the expense of elastic energy in the material. To see the effect, called magnetic exchange striction, the team exposed a manganese compound to neutrons—first, to simultaneously observe several different dimer excitations and thereby obtain magnetic energies as a function of temperature and pressure; and second, to directly probe the ions' separations in the relatively soft lattice. The results were consistent with striction being the dominant higher-order interaction. Mechanical deformations caused by magnetic fields are fairly common: Submarine telephony uses the effect; striction also explains the 120-Hz hum of a transformer's iron core. (Th. Strässle et al., *Phys. Rev. Lett.* **92**, 257202, 2004.) —PFS

Visualizing a bat's biosonar. Bats have evolved highly optimized biosonar systems through which they broadcast ultrasound at various frequencies and then detect the echoes to sense their surroundings, all while darting through the air at high speed. At the Acoustical Society of America's May meeting in New York, Rolf Müller (University of Southern Denmark) presented a multinational team's high-resolution, three-dimensional views of how a bat's ear probes space as the animal whistles on its way. The team first digitally reproduced ears from CT scans and then modeled the diffraction of ultrasound in the ears' structures. To understand how the anatomical details of an ear bring about the spatial sensitivity patterns, the digital ears' features were altered, for example, as shown here. The results of the computational experiments vary considerably with bat species and with anatomical changes. Müller said that tapping into this biological knowledge base may help the development of a new generation of compact antennas. —BPS



Amorphous steel for structural applications has been fabricated by scientists at Oak Ridge National Laboratory. Some amorphous iron-based alloys were made previously, but their cross sections were limited to about 4 mm. Adding a small amount of yttrium, which frustrates the onset of crystallization as the liquid metal solidifies, allows the new alloys to be cast, using commercial techniques, in 12-mm-diameter rods. The new glassy steel is more than twice as hard as the best ultrahigh-strength conventional steel, and yet is less dense. In addition, the steel is ferromagnetic at cryogenic temperatures but paramagnetic at room temperature, a property the researchers say could open up new industrial applications. (Z. P. Lu et al., *Phys. Rev. Lett.* **92**, 245503, 2004.) —PFS

Nanotube water, a quasi-one-dimensional form of water consisting of a string of water molecules threading an ice sheath within a single-walled carbon nanotube (SWNT), has been studied by physicists at Argonne National Laboratory. Neutron scattering measurements, along with computer simulations of the molecular interactions between the water and the surrounding SWNT, confirmed that water molecules first formed an ice lining inside the tube. A chain of water molecules then filled the remaining volume and exhibited fluidlike behavior at temperatures far below the normal freezing point. The hydrogen bonds along the water chain seem to be softened, allowing, for example, a freer movement of protons through the tube. The Argonne researchers say that this anomalous behavior might help to explain other phenomena that feature nanometer-scale confined water. Such phenomena include water migration from soil to plants via xylem and proton translocation in transmembrane proteins. (A. I. Kolesnikov et al., *Phys. Rev. Lett.* **93**, 035503, 2004.) —PFS ■

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