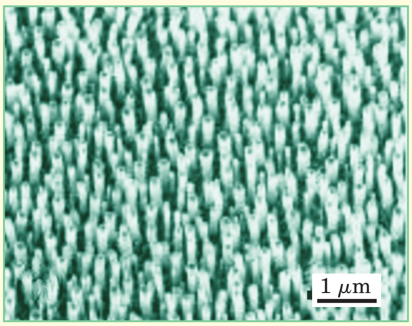
Physics Update

Stellar magnetic fields in a jar. The magnetorotational instability—the creation of an induced magnetic field in a rotating electrically conducting fluid immersed in an external magnetic field—has been known from astrophysical theory and numerical simulations. Now, physicists at the University of Maryland, College Park, report the first experimental observation of this phenomenon. With a baseball-sized copper ball rotating within a spherical vessel that contained liquid sodium, the researchers created conditions similar to those in Earth's core, the outer envelopes of stars, and accretion disks surrounding black holes. In each case, a differentially rotating fluid (inner parts of the fluid rotating faster than outer parts) is destabilized by small magnetic fields, with the result that angular momentum is carried radially outward. Among other findings, the Maryland experiment demonstrates that the instability can arise even in the presence of preexisting turbulence. (D. R. Sisan et al., *Phys. Rev. Lett.* **93**, 114502, 2004.) —PFS

An antenna for visible light, analogous to antennas for radio waves, can be made with carbon nanotubes (CNTs). In a process that provides the backbone of radio and TV broadcasting, a radio wave excites electrons into meaningful currents in an antenna whose length is some multiple of the wave's half-wavelength. Scientists at Boston College used aligned but randomly placed multiwalled CNTs (see figure) as an array of little metallic antennas, each about 50 nm wide and hundreds of nanometers long, that are sensitive to optical wavelengths. The team demonstrated not only the length-matching effect, but also the disappearance of the response when the incoming light was polarized at right angles to the nanotubes' axis. According to the team's Zhifeng Ren, CNT optical antennas might be useful for a new generation of terahertz or infrared detectors, high-efficiency solar energy converters, or optical computers. (Y. Wang et al., *Appl. Phys. Lett.* **85**, 2607, 2004.) —PFS



Laser wakefield acceleration of monoenergetic electron beams has been achieved by three independent groups. When an intense laser pulse enters a gas or plasma, the laser's electric field can accelerate the mobile electrons until the relatively stationary ions pull them back via the Coulomb force. The resulting plasma wave moves along in the wake of the laser pulse. Under the right conditions, electrons can surf the wave, but until now the accelerated electrons have had a wide spread of energies. However, the accelerating electrons can outpace the wave and all can achieve the same energy—provided the acceleration is stopped at the right moment. Groups led by Victor Malka (CNRS, France) and by Stuart Mangles (Imperial College London) exquisitely tuned their laser and plasma parameters to produce collimated electron beams of about 170 MeV and 70 MeV, respectively. Meanwhile, a group led by Wim Leemans (Lawrence Berkeley National Laboratory) used three lasers—two to bore a plasma channel and the third to produce wakefield acceleration—to avoid the quenching effects of diffraction and achieve an 80-MeV beam. The LBNL group says that their method is useful for lengthening the acceleration distance in a plasma. All three groups generated electron beams in a distance of 3 mm or less. (S. P. D. Mangles et al., *Nature* **431**, 535, 2004; C. G. R. Geddes et al., *Nature* **431**, 538, 2004; J. Faure et al., *Nature* **431**, 541, 2004.) —SGB

Nanowires of iron have been fabricated using atom-optics techniques. An atom in a light field of an appropriate wavelength will acquire an electric dipole moment, which in turn can interact with the light field. Only a few atomic species have been amenable to such coupling, and now iron—a ferromagnet—has joined the list. Two independent groups, both in the Netherlands, sent a collimated beam of iron atoms into an optical standing-wave pattern, in which the atoms were preferentially drawn into either the minima or the maxima. Thus positioned, the atoms were deposited onto a substrate. The image here (from the group at Radboud University in Nijmegen) shows 95-nm-wide wires, each about 8 nm high. A full array of 8600 iron lines, about 400 μm long, was grown in a half hour. With a better-collimated atom beam, the Eindhoven University of Technology group grew iron wires that were only 50 nm wide but had a low contrast with the background substrate—they were just 0.6 nm high. Magnetic nanostructures can offer new possibilities for data storage, spintronics, and novel phenomena like magnetic bandgaps. (G. Myszkiewicz et al., *Appl. Phys. Lett.* **85**, in press. E. te Sligte et al., *Appl. Phys. Lett.* **85**, in press.) —SGB