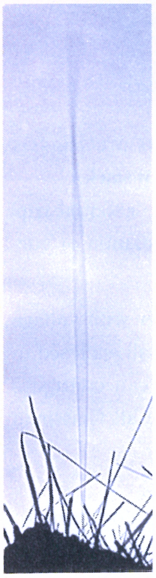
Physics Update

NANOMETER-SCALE IMAGES OF SOUND WAVES on surfaces have been produced by several groups, who announced their results at the recent international joint meeting in Berlin of the Acoustical Society of America, the European Acoustics Association, and the German Acoustical Society. Their techniques all involve combining acoustic microscopy with atomic force microscopy (AFM) to detect ultrasound. Ultrasonic vibrations in the contact between the sample and the tip are the key, as described by Ute Rabe of the Fraunhofer Institute for Nondestructive Testing in Saarbrücken, Germany. Eduard Chilla of the Paul Drude Institute for Solid State Electronics in Berlin showed images of oscillations of single atoms responding to a sound wave. Andrew Kulik of the Federal Polytechnic Institute of Lausanne in Switzerland showed AFM images of sound waves coursing through a tin sample, with different features in the images corresponding to regions of different stiffness. In general, these techniques can potentially provide nanoscopic details on the elastic properties of a material and other subsurface information, such as the stress between different layers of a material. —BPS

THE BENDING PROPERTIES OF CARBON NANOTUBES have been used to create a nanobalance. Researchers at the Georgia Institute of Technology applied an electrical potential to nanotubes protruding from a carbon fiber that, in turn, was attached to a fine gold wire. They then brought the tubes to within a few micrometers of an oppositely charged electrode, and put the assembly in an electron microscope. When an oscillating voltage was applied, a given nanotube could be made to vibrate resonantly, even at the second harmonic as shown here at 3 MHz for a multiwalled tube 6.25 μm long and 14.5 nm in diameter. A particle attached to the tip of such a nanotube would change the resonant frequency, enabling researchers to deduce the mass of the particle. Indeed, the researchers weighed a 22-femtogram graphite particle in this manner. For more on nanotubes, see the article on page 22. (P. Poncharal *et al.*, *Science* **283**, 1513, 1999.) —BPS



WHERE DOES FRICTIONAL HEAT GO? Miquel Salmeron and his colleagues at Lawrence Berkeley National Laboratory addressed this problem by running a nanoscopic hoe (an atomic force microscope probe) through a field of pliant stalks (a monolayer of closely packed, upright, strandlike alkylsilane molecules used in lubrication) planted on a mica prairie. As the loading force of the probe increased, so did the frictional force, while the height of the field decreased. Further, the changes in friction and height were discrete, not continuous. The researchers propose that the zigzag molecular chains are interlocked when upright. When the tip of the probe bends (and images) the chains, each chain is displaced from its neighbors one notch at a time. Such a process consumes energy, which is the energy of friction for this system. (E. Barrena *et al.*, *Phys. Rev. Lett.* **82**, 2880, 1999.) —PFS

AN IMPROVED TEST OF THE STANDARD MODEL, the exquisitely successful merging of electromagnetism with the weak nuclear force, has been carried out in cesium atoms. Atoms are chiefly governed by the electromagnetic force, which conserves parity. But, according to current theory, they also feel a twinge from the weak force, a notorious abuser of parity. Carl Wieman has monitored that nuclear twinge in cesium at the University of Colorado (see PHYSICS TODAY, April 1997, page 17). Now, with Stephen Bennett, he has measured the 6S → 7S transition polarizability, which better calibrates the earlier experiment. Combining their measurement with recently improved theory, they found a value for the weak charge that deviated from the standard-model prediction by 2.5σ, perhaps indicating some new physics to be explored. (S. C. Bennett, C. E. Wieman, *Phys. Rev. Lett.* **82**, 2484, 1999.) —PFS

PINPOINT POLYMERIZATION has been put to use in a new resin with enhanced two-photon sensitivity. Certain chemical reactions can be initiated by two simultaneous photons, which therefore requires a high intensity of light such as is available under tight focusing conditions. With this method, tiny volumes can be targeted within a three-dimensional region, to turn chemical reactions on and off. By scanning the laser, a pattern of chemical changes is imposed on the sample. A Caltech–University of Arizona collaboration, led by Joseph Perry and Seth Marder, developed the new highly sensitive material. There are many possible applications. For example, a three-dimensional pattern of different refractive indices can be produced, or rows of fluorescent binary bits can be encoded. Three-dimensional photolithography is also possible. The team already has built waveguides, photonic crystals, and arrays of cantilevers (as shown here). (B. H. Cumpston *et al.*, *Nature* **398**, 51, 1999.) —PFS