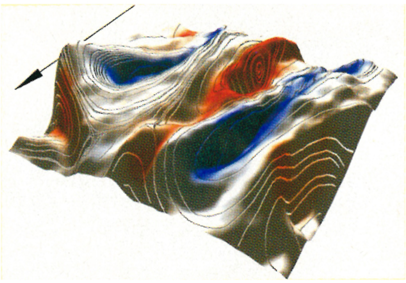
PHYSICS UPDATE

MEASURING GRAVITY GRADIENTS with atom interferometry and laser manipulation. An atom can be coaxed into two wavepackets, which can then recombine to produce an interference pattern that will depend on any forces present, including gravity. Now, Mark Kasevich and his Yale University colleagues have put two such atom interferometers together, and thereby made a highly sensitive gradiometer, which may be able to detect changes in gravity as small as $10^{-10}\ g$ over a distance of 1 meter. That is as good as any other technique now available, and the sensitivity is likely to get even better after more development. Because the test objects are individual atoms and the readout is based on stable laser beams, systematic uncertainties are eliminated or greatly reduced. Also, because two separate ensembles are used, the device is immune to vibrations transmitted by moving platforms. Gradiometer applications include covert navigation, underground structure detection, oil exploration and geodesy, as well as fundamental studies of general relativity. (M. J. Snadden *et al.*, *Phys. Rev. Lett.* **81**, 971, 1998.) —PFS

ELECTRIC NOISE can increase human tactile sensation. Researchers at Boston University and the University of Massachusetts Medical Center applied a normally undetectable mechanical force, along with a low level of randomly fluctuating electrical current, to the finger pads of 11 young, healthy subjects. At some specific value of the electrical "noise," 9 of the subjects reported detecting the mechanical stimulus—a clear signal that stochastic resonance (SR) was at work. (For a review of SR—the phenomenon whereby a subthreshold signal is detectable in the presence of noise—see PHYSICS TODAY, March 1996, page 39.) In most SR experiments, the signal and the noise are of like kind (for example, mechanical). The researchers speculate that the electrical noise helps nerve cells in the finger pads to reach their threshold for firing. The finding could have clinical uses for enhancing the sense of touch in the elderly, in stroke patients and in people with diabetes. There could also be applications in telerobotics and new microdevices. (K. A. Richardson *et al.*, *Chaos* **8** (3), 1, 1998.) —BPS

TURBULENCE IN SOAP FILMS. Researchers at Los Alamos National Laboratory have made quantitative measurements of the velocity and vorticity fields, as well as the fluctuating thickness, throughout an entire soap film. Rather than using the standard single-point probes, they added tiny, highly reflective titanium dioxide particles to the fluid, let the film flow through a comb and snapped pictures of the resulting two-dimensional turbulence every 160–300 μs with a digital camera. The accompanying composite image shows—for a 12 mm square region of soap film located 1 cm downstream from a comb—the film's thickness fluctuation as the surface elevation (greatly exaggerated); the vorticity as color, with red and blue representing high positive and negative values; and the streamline pattern as textured lines. Although the film was clearly compressible, the researchers found the statistics of enstrophy (vorticity squared) to be in rough agreement with the theory for incompressible turbulence. (M. Rivera *et al.*, *Phys. Rev. Lett.* **81**, 1417, 1998.) —BPS



LASER WAKEFIELD ACCELERATION (LWFA) of injected electrons has been announced by a multi-institutional team of scientists in France, as a part of the drive to develop compact methods for accelerating particles to high energies. A short, intense laser pulse fired into a plasma can excite a "wake" of charge oscillations. An injected particle starting with just the right velocity can ride these plasma waves to ever higher energies. The experimenters achieved a maximum longitudinal electric field of 1.5 GV/m, with a corresponding electron energy gain of 1.6 MeV. In earlier LWFA experiments (see, for example, PHYSICS TODAY, August 1995, page 9), the electron plasma wave was "self-modulated," meaning that it grew from an instability and had an unpredictable phase. The French team says that the LWFA they demonstrated is more readily controlled, and thus will eventually make a better accelerator. (F. Amiranoff *et al.*, *Phys. Rev. Lett.* **81**, 995, 1998.) —PFS

THE "SWEET SPOT" OF A BASEBALL BAT has now been analyzed by a physicist. The collision between baseball and bat involves an exchange of energy lasting less than 2 ms. Whether the encounter results in a home run or not (a record-breaking subject of great interest this year) depends on many factors. But generally the batter will want to make contact near the sweet spot—about 17 cm from the fat end of a typical bat—which imparts the least amount of vibration (and pain) to the batter's hands. Rod Cross of the University of Sydney in Australia found, among other things, that a baseball bat has two equally important modes of vibration and that consequently the bat has three sweet spots (the two nodes in the barrel plus the center of percussion) closely spaced over a few centimeters. Additionally, there is no impact spot on the bat where impulse forces on the hands remain zero. (R. Cross, *Amer. Jour. Phys.* **66**, 772, 1998.) —PFS