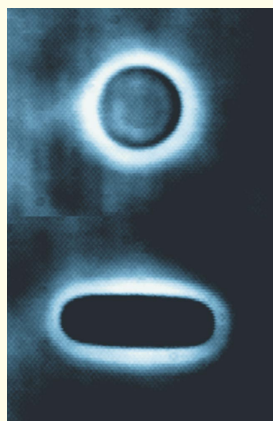


PHYSICS UPDATE

▶ **AN OPTICAL STRETCHER**, a laser tool for studying the elastic properties of cells, has been developed. When light enters a transparent object with an index of refraction higher than that of the surrounding medium, it gains momentum and therefore exerts a force on the object. A group at the University of Texas at Austin, led by Josef Käs, showed that if a



laser beam is defocused so as to encompass an entire biological cell, the force acts backward where the light enters the cell and forward where it exits the cell. The result is that the cell gets stretched by an amount that depends on the power in the beam. The difference between the front and back forces is the much smaller total scattering force that acts at the cell's center of gravity and tends to push the cell in the direction of the light propagation.

A second divergent laser beam in the opposite direction keeps the cell stationary—and doubles the stretching. The researchers used the technique to study very soft human red blood cells (shown here) and much stiffer mammalian cells that contain a cytoskeleton. The tool might be used to screen cell populations for changes in elasticity due to diseases such as cancer. (An early discussion is J. Guck et al., *Phys. Rev. Lett.* **84**, 5451, 2000. J. Guck et al., *Biophys. J.* **81**, 767, 2001.) —SGB

▶ **A MULTIMODE WAVEGUIDE INTERFEROMETER**

(MWI) has been developed that can produce fringe spacings as small as $\lambda/9$, where λ is the wavelength of the incident light. Interferometers are used to detect tiny changes in length. Typically, a beam of light travels over the distance to be measured and then combines with a reference beam that always travels a fixed distance. The two beams create an interference pattern of bright and dark bands, or fringes, that shift as the distance traveled by the measurement beam changes. Usually, the separation of the fringes (which determines the resolution of the interferometer) is no less than $\lambda/2$. Now, two researchers at the University of Stuttgart in Germany have done away with the reference beam. Instead, they have directed a single beam of light obliquely into a waveguide formed by two parallel, movable mirrors. The beam experienced multiple reflections from the mirrors and propagated as a combination of many modes. Each mode interfered with every other mode, which led to a modulation in the light transmitted through the waveguide. The number of reflections within the MWI determines the device's sensitivity. For their 633-nm light and a mirror separation of about 30 microns, the fringe

spacing was only 70 nm. The physicists' calculations suggest that a more refined MWI could show fringe separations as small as 10 picometers. The duo says that, in addition to opening the door to new, high-precision measurements, MWIs might be useful in optical switches and other communication-related devices. (Y. B. Ovchinnikov, T. Pfau, *Phys. Rev. Lett.* **87**, 123901, 2001.) —JRR

▶ **ENTANGLEMENT OF MACROSCOPIC OBJECTS.** A

pair of cesium gas clouds containing 10^{12} atoms each, has been entangled by a quantum optics team at the University of Aarhus in Denmark. No previous entanglement with atoms has involved more than four particles. In the present experiment, the physicists sent a single, off-resonant, linearly polarized laser beam through two separated Cs gas samples whose oppositely directed mean spins were transverse to the beam. First, the researchers measured the sum of the two collective spins without knowing the individual collective spin of each sample. A subsequent measurement 0.5 ms later showed that the sum remained the same, which demonstrated that the two gas samples maintained their collective entanglement—as though they were two macroscopic “atoms.” Such a collectively entangled state is unaffected by the decoherence of a few of its constituent atoms. Although the two samples were just millimeters apart, they could, in principle, be much more distant. The researchers think the method might extend to creating entanglement in solid-state samples with long-lived spin states. (B. Julsgaard, A. Kozhekin, E. S. Polzik, *Nature* **413**, 400, 2001.) —BPS

▶ **AN ANOMALOUS ACOUSTOELECTRIC EFFECT** has been discovered in a manganite thin film by a collaboration of physicists in Russia, Poland, and Ukraine. When an acoustic wave propagates along an electrically conducting surface, it can drag electric charge along with it if there is strong coupling between phonons and electrons. This is known as the acoustoelectric (AE) effect. Manganites are known to show a rich variety of strongly interrelated magnetic, structural, and electrical properties. The researchers grew a manganite thin film atop a piezoelectric lithium-niobium-oxygen substrate, on which they then launched a surface acoustic wave (SAW). They unexpectedly found that a component of the AE current did not reverse when the SAW traveled in the opposite direction. The physicists discovered that the anomalous AE current was related to the strong pressure dependence of the manganite film's conductivity. The total AE current peaked at a temperature near the metal-insulator transition, at which the anomalous effect dominated. At higher and lower temperatures, the ordinary AE effect prevailed. (Y. Ilisavskii et al., *Phys. Rev. Lett.* **87**, 146602, 2001.) —BPS ■