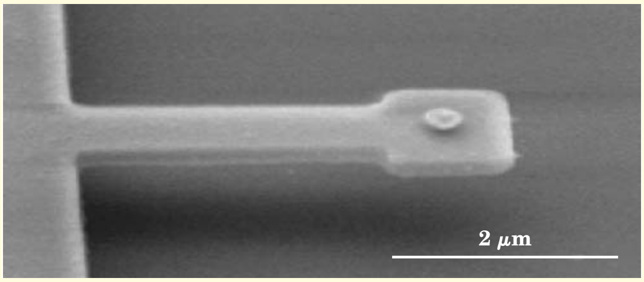
Physics Update

Negative normal stress in sheared complex fluids has been observed in two different systems. Imagine a liquid between a pair of parallel plates. For classical Newtonian liquids like water, glycerin, and oil, sliding one plate with respect to the other creates only a tangential stress, a force parallel to the plates. But some complex fluids, such as polymer melts and solutions, also react with a positive normal stress, a force that pushes the plates apart. About 25 years ago, researchers found that shearing some liquid crystalline polymers made the plates want to pull together. Such negative normal stress has proven rare and somewhat controversial. In one of the new examples, a semidilute suspension of carbon nanotubes, dispersed in a Newtonian polymer melt, was subjected to modest shearing flows. The tubes formed diffuse aggregates that elongated into cylinders and rolled like strings of dough in the hands of a chef. The other new system is an emulsion of water droplets suspended in an oil. When subjected to the same type of modest shearing flows, the droplets came together to form exactly the same type of dough-rolling aggregates and similarly exhibited negative normal stresses. That the same response was seen in both the fairly dilute suspension of nanofibers and the concentrated suspension of soft spheres suggests some underlying universal rheological principle. (S. Lin-Gibson et al., *Phys. Rev. Lett.* **92**, 048302, 2004; A. Montesi et al., *Phys. Rev. Lett.* **92**, 058303, 2004). —BPS

Active black holes in inactive galaxies. Astronomers generally agree that supermassive black holes (BHs) fire the engines at the hearts of so-called active galaxies, but many suspect that dormant supermassive BHs also lurk at the hearts of many normal galaxies. A quiescent BH should flare brightly in x rays from time to time as it tidally disrupts a nearby star and accretes the resulting debris. Now, an international group of astronomers has found evidence for just that scenario. Combining historical data from the German *ROSAT* satellite with new observations from the European Space Agency's *XMM-Newton* and NASA's *Chandra X-ray Observatory* satellites, the researchers identified three galaxies that showed flaring nuclei consistent with the tidal-disruption model. In one case, the astronomers could even obtain an x-ray spectrum that further supported their interpretation of the data. (S. Komossa et al., *Astrophys. J. Lett.* **603**, L17, 2004; J. P. Halpern et al., *Astrophys. J.* **604**, in press.) —SGB

Unmixing gases with sound. Thermoacoustic processes use an oscillating pressure field to create a thermal gradient, or vice versa. (See the article in PHYSICS TODAY, July 1995, page 22.) In a new twist, thermoacoustics is being used to separate the constituents of a binary gas mixture by mass. At Los Alamos National Laboratory, Greg Swift and his colleagues coupled speakers to a long pipe connecting two reservoirs and filled the system with a mixture of two gases. During the pressure maximum of an acoustic cycle, the heavier gas diffused to the viscous boundary layer near the pipe's wall, while the lighter gas was carried along the pipe. In the second half-cycle, during the pressure minimum, the heavier gas was drawn out of the boundary layer and transported in the opposite direction along the pipe. The first separation experiments were done in Swift's lab by Phil Spoor in 1998 with helium–xenon and helium–argon mixtures. Now, Drew Geller and Swift have built off-the-shelf speaker–pipe modules that, when hooked together, use a traveling acoustic wave to achieve arbitrary degrees of purity in the separation process. For example, with five ¼-wavelength modules, they enriched a natural mixture of neon isotopes (9.2% ^{22}Ne, 90.8% ^{20}Ne) to 9.7% ^{22}Ne in one of the reservoirs. A concentration of 90% ^{22}Ne would call for 148 modules; 99% needs 232 modules. (D. A. Geller, G. W. Swift, *J. Acoust. Soc. Am.* **115**, in press.) —SGB

Attogram mass detection with a lithographically fabricated nanoelectromechanical (NEMS) device has been achieved. In recent years, small masses have been measured by monitoring a vibrating cantilever: As molecules are adsorbed onto the cantilever, its resonant frequency changes. Now, researchers at Cornell University have fabricated cantilevers with tiny gold anchors positioned on them, as shown below. Adsorbed molecules—for



example, self-assembled monolayers—are confined to the gold surface, and mass differences have been measured with a sensitivity of 10^{-18} grams. Currently, to get any better measurement of mass, you would have to vaporize the sample and shoot its constituent molecules through a mass spectrometer. The goal of the Cornell group, led by Harold Craighead, is to detect and identify viruses. Their present cantilever can detect 0.39 attogram and will become even more sensitive as the size of the device is reduced. (B. Ilic et al., *J. Appl. Phys.*, in press.) —PFS