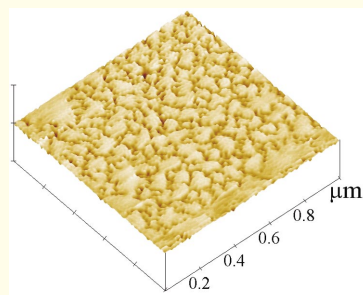


# PHYSICS UPDATE

► **NANOBUBBLES IMAGED** on hydrophobic surfaces. A hydrophobic surface not only sheds water but also attracts other such nearby surfaces when immersed in water. One idea to explain these interactions invokes bubbles—only 20–30 nm high—on the surfaces. As two hydrophobic surfaces approach



each other underwater, the bubbles would eventually coalesce, drawing the surfaces together through capillary adhesion. A complete layer of bubbles also could serve as a kind of lubricant that allows water to slip smoothly over the sur-

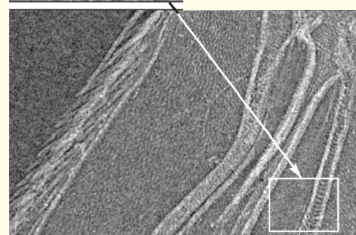
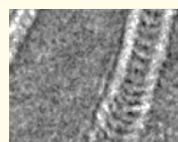
face—such as happens with the hydrophobic fabric of swimming suits worn by Olympic contenders. Such nanobubbles are too small to image with light and too fragile to probe with most contact techniques. Another difficulty is posed by thermodynamics: A 10-nm bubble would have a pressure of 14 MPa (140 atm) and should rapidly dissolve. Now, James Tyrrell and Phil Attard of the University of South Australia have gently examined clean glass surfaces underwater with a tapping-mode atomic force microscope. As shown here, they saw irregularities that formed closely packed networks, which covered the surfaces nearly completely. Because the irregularities were softer than the substrate, could be destroyed by pressing too hard, and reemerged after destruction, the researchers concluded that they imaged nanobubbles. In addition, they found that the nanobubbles are not spherical but are flattened like pancakes, with curvatures—and therefore pressures—much lower than previously expected. (J. W. G. Tyrrell, P. Attard, *Phys. Rev. Lett.* **87**, 176104, 2001.) —JRR

► **INTERGALACTIC MAGNETIC FIELDS** can arise from galactic black holes. Intergalactic voids—the vast regions of the cosmos that are largely empty of galaxies—are permeated by very weak magnetic fields, far less than a microgauss. The “walls” where galaxies and galaxy clusters reside may have fields up to a microgauss. All these fields have most often been thought of as either primordial (arising at the Big Bang) or due to shock waves at massive colliding gas clouds. Now, researchers from the University of Toronto and Los Alamos National Laboratory have found a new source of diffuse cosmic magnetism. They analyzed 100 large radio-loud galaxies: 70 giant ones in isolation and 30 smaller ones in the dense environs of galaxy clusters. They concluded that fully half of the energy content (up to  $10^{60}$  ergs or more) of the extensive radio-emitting lobes is in magnetic energy thrown out of  $10^8$ -solar-mass black holes at the cores of the galaxies. Summed over

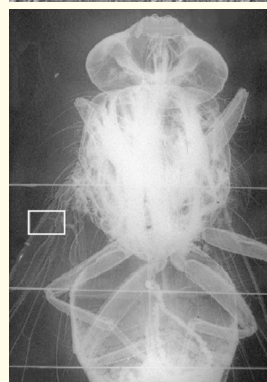
many galaxies, this energy reservoir appears to be the largest available in the mature universe for magnetizing intergalactic space. Furthermore, because the lobes have a higher pressure than the surrounding intergalactic medium, even when the central black hole has “turned off,” the lobes with their force-free fields will expand into the IGM. These expelled magnetic fields should exert a substantial influence on subsequent galaxy and large-structure formation. (P. P. Kronberg et al., *Astrophys. J.* **560**, 178, 2001.) —PFS

► **BEC ON A CHIP.** The latest feat of atom optics, performed by a group at the Max Planck Institute for Quantum Optics in Munich, is the creation of a Bose–Einstein condensate of rubidium atoms in a microscopic magnetic trap built into a lithographically patterned chip. The BEC formed a few tens of microns above the surface in only 700 ms, which allowed a 10-s duty cycle that included loading the trap as well as forming and detecting the BEC. In addition, the researchers moved the condensate a distance of 1.6 mm along the microchip, after which they demonstrated the continued coherence of the BEC. Such a capability opens up possibilities for “atomtronic” applications in interferometry, holography, and quantum information processing. (W. Hänsel et al., *Nature* **413**, 498, 2001.) —PFS

► **X-PINCH FLASH PHOTOGRAPHY.** A metal wire is heated when a current runs through it. A 25- $\mu\text{m}$  thick molybdenum wire carrying  $10^5$  amps is vaporized into a plasma, and the magnetic field generated by the current compresses that plasma. Cross two such wires and at their juncture you get an x-pinch—a 1- to 2-micron region of  $10^7$  °C plasma that emits x rays of energy



greater than 2.5 keV for less than a nanosecond. Now, researchers at Cornell University's Laboratory of Plasma Studies have used such x-ray point sources to generate few-micron-



resolution radiographs of tiny objects such as the housefly (bottom) and its wing shown here, using phase-contrast imaging. For more on the imaging technique, see PHYSICS TODAY, July 2000, page 23. Several x-pinch results were presented in November at the American Physical Society's Division of Plasma Physics meeting. (Papers RP1.101–104 and UI2.001.) —JRR