

PHYSICS UPDATE

▶ **THE CASIMIR FORCE** has now been precisely measured. According to quantum electrodynamics, fleeting electromagnetic waves and particles continually pop in and out of a vacuum. However, when a pair of conducting surfaces bound the vacuum, only electromagnetic modes with wavelengths shorter than the distance between the surfaces can appear. According to Casimir's 1948 prediction, the exclusion of the longer wavelengths results in a tiny geometry-dependent force between the conductors. Using a torsion pendulum (a twisting horizontal bar suspended by a tungsten wire), Steve Lamoreaux of Los Alamos National Laboratory measured the attraction between a gold-plated sphere and a gold plate. He found the expected nonlinear increase in the force as the plates' separation decreased, rising to more than 100 microdynes at 0.6 μm , and agreeing with theory to within 5%. (S. K. Lamoreaux, *Phys. Rev. Lett.* **78**, 5, 1997.) —BPS

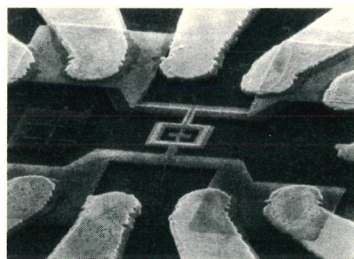
▶ **CAN HYDROGEN BE A HIGH- T_c SUPERCONDUCTOR?**

That hydrogen can be metallic was demonstrated last year (PHYSICS TODAY, May 1996, page 17), when it was also established that the H nuclei (protons) remained largely paired. Now, although theoretical predictions of superconducting transition temperatures have been notoriously difficult to make, two Cornell University physicists, Neil Ashcroft and Clifton Richardson, have used an approach that works well when applied to conventional metals to predict that both atomic and diatomic hydrogen should have superconducting phases near or above room temperature—but only at megabar pressures. Their calculations for monatomic metallic hydrogen agree with earlier work. For proton-paired metallic hydrogen, however, an interesting difference arises in the direct electron-electron term that normally works against superconductivity. The theorists found correlated fluctuations between electrons and holes in overlapping bands at very high pressure, which reduce that term. To date, the trademark zero resistance cannot be seen directly in a tiny sample within a diamond-anvil cell, because the probes are easily pinched off, but indirect, inductive methods might succeed. (C. F. Richardson, N. W. Ashcroft, *Phys. Rev. Lett.* **78**, 118, 1997.) —PFS

▶ **OXYGEN DATING THE MILKY WAY.** A new technique uses stardust to determine the age of our Galaxy. By looking at the isotopic composition of "primitive" meteorites—those that formed along with the Solar System some 4.5 billion years ago—scientists can tell whether certain grains in them came from outside the Solar System. Such specks of stardust would also necessarily predate the Solar System. Larry Nittler of the Carnegie Institution of Washington has sorted 30 000 oxide grains according to the composition ratio $^{16}\text{O}/^{18}\text{O}$. From

this huge sample, he isolated 87 grains for which that ratio was highly unusual. Of those, he thinks that 13 came from low-mass red giant stars whose lives ended before our Sun's began. Using theories of stellar nucleosynthesis and galactic chemical evolution, Nittler and Ramanath Cowsik of the Indian Institute of Astrophysics estimate that the Milky Way is 14.4 billion years old. They admit that the systematic uncertainties could be large. (L. R. Nittler, R. Cowsik, *Phys. Rev. Lett.* **78**, 175, 1997.) —PFS

▶ **TINY SILICON BRIDGES** that can form the basis of a new class of charge, particle and energy sensors have been fabricated by two Caltech physicists. Andrew Cleland and Michael Roukes used a combination of photolithography, electron beam lithography and etching techniques to create minuscule, freestanding single-crystal silicon bridges, each about 0.2 μm thick and suspended about 0.5 μm above a silicon substrate. As shown in the photo, the double torsional oscillator structure (paddle within a square "washer") is suspended, supported by the fingers around the periphery. A current in



a gold wire (bright line) around the circumference of the washer, combined with a magnetic field in the plane of the structure, generate a Lorentz force that causes the struc-

ture to oscillate about its symmetry axis. The particular resonance frequency depends on the structure's size; thus far, resonances ranging from 400 kHz to 120 MHz have been achieved. The nano-engineers are trying to push the technology to a few GHz, at which point macroscopic quantum effects and interactions with phonons might be observable. (Resonant bridges are described in A. N. Cleland, M. L. Roukes, *App. Phys. Lett.* **69**, 2653, 1996.) —SGB

▶ **QUARKS HAVE NO APPARENT STRUCTURE.** Last year, from an analysis of proton-antiproton collisions, the Collider Detector at Fermilab collaboration reported an excess of events with high-energy jets shooting away from the interaction at large angles. The measurement was interpreted by some (although not by the experimentalists themselves) as possible evidence for subquarks. (See PHYSICS TODAY, March 1996, page 9.) To test the subquark idea, the same group has now reported a study of the angle of emission of high-energy jets. They find that quarks are pointlike at the 10^{-19} m level, that there is no additional evidence for subquarks, and that the extra high-energy jets may be more simply explained by extra gluons inside the proton. (F. Abe *et al.*, *Phys. Rev. Lett.* **77**, 5336, 1996.) —PFS ■