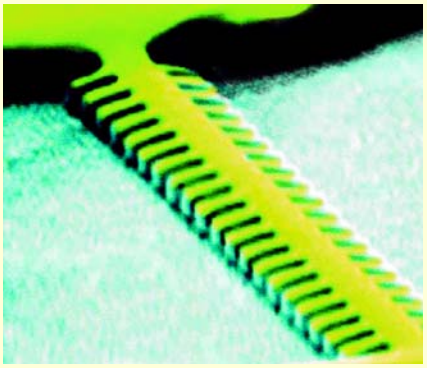
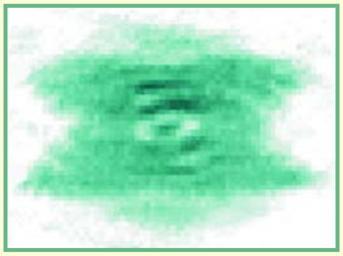
Physics Update

Evidence for quantized displacement in macroscopic oscillators. Physicists at Boston University have performed an experiment in which 500-nm-long silicon paddles sprouting from a 10.7-μm-long central spine of Si (see the figure) oscillate collectively. With the device in an external magnetic field, a current is applied to a gold-film electrode on top of the spine. The resulting Lorentz force causes the structure to vibrate at frequencies up to 1.5 GHz, which makes it the fastest macroscopic oscillator to date. At a temperature of 1 K, the device responds continuously to a changing drive force. However, at 110 mK, precisely where the researchers expect quantum effects to set in, the oscillator responds discretely. Confirmation that this system of about 50 billion Si atoms is quantized will require more work, both theoretical and experimental. (A. Gaidarzhy et al., *Phys. Rev. Lett.* **94**, 030402, 2005.) —PFS



Sticky ice can help planets form quickly. Stars and their planets are typically born in dusty nebulae. However, in just a few million years or less, a newborn star blows away dust from its neighborhood, removing most of the raw material for planet formation. Although gravitationally bound kilometer-sized protoplanets will grow rapidly, getting from dust to protoplanets in a million years has proven elusive using the available van der Waals forces. The outer reaches of our own sun's early nebula were at temperatures below 120 K, and researchers at the Pacific Northwest National Laboratory have now studied cryogenically formed water ice, which is amorphous and fluffy rather than crystalline and solid. They discovered that it has two other unusual properties that can expedite the agglomeration of fragile, micron-sized dust grains. First, cryogenic ice has a persistent, macroscopic electric dipole that is unmasked when an asymmetry is introduced by, for example, a collision with another ice-coated dust grain. Second, the fluffy amorphous ice is mechanically inelastic. In experiments, the scientists found that a free-falling ceramic bead rebounds from a cryogenic ice film to only about 10% of its original height, compared to about 80% for normal kitchen ice. Taken together, the electrostatic and mechanical properties mean that colliding particles are more likely to stick than bounce and the resulting agglomerates can continue to grow rather than shatter on subsequent impacts. (H. Wang et al., *Astrophys. J.* **620**, 1027, 2005.) —SGB

Complex hybrid structures have been observed in a Bose–Einstein condensate (BEC). Researchers in Lene Hau's laboratory at Harvard, using the technique of slowing and then stopping a light pulse in a BEC, sent two such pulses into a specially prepared BEC. They observed solitons, vortex rings, and their interactions, some of which created hybrids that were part vortex ring and part soliton. Never seen before, these bizarre BEC excitations sometimes opened up like an umbrella, then turned inside-out. Two such excitations could collide and form a spherical shell or, in some cases, annihilate each other. The image shows structures that arose after 2.8 ms of evolution in the trap. Hau and colleagues also performed computer simulations that correlate well with the experiments and thus help the researchers to understand the phenomenology. They say that their work will help physicists gain new insights into the superfluid phenomenon and into the breakdown of superconductivity. (N. S. Ginsberg, J. Brand, L. V. Hau, *Phys. Rev. Lett.* **94**, 040403, 2005.) —PFS



Quantum-dot photon detectors. Physicists at Toshiba Research Europe and the University of Cambridge have developed a device that can efficiently detect single photons. The device employs a layer of self-assembled quantum dots—acting as artificial atoms with quantized electron energy states—encased in a resonant tunneling diode that has two conducting gallium arsenide layers separated by an insulating aluminum arsenide layer. If the GaAs layers have the right voltage alignment, a current can tunnel between them; but the physicists purposely misaligned them a bit to prevent such tunneling. A photon striking the diode generates an electron or a hole that can be captured by a nearby quantum dot whose suddenly altered energy state restores the resonance, and the resulting tunneling current is detected. Thus far, the low-noise detection scheme has allowed the researchers to detect single photons with 12.5% quantum efficiency and 150-ns time resolution, but they expect improvements in both quantities. (J. C. Blakesley et al., *Phys. Rev. Lett.* **94**, 067401, 2004.) —PFS ■