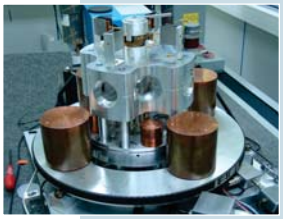
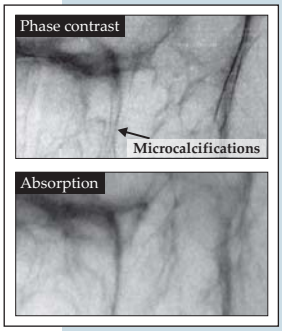
physics update

These items, with supplementary material, first appeared at http://www.physicstoday.org.

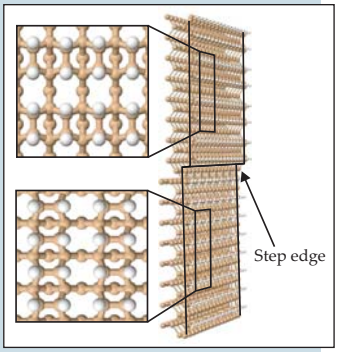
Another close look at "big *G*." In 1798, more than 70 years after Isaac Newton died, Henry Cavendish was the first to measure Newton's gravitational constant *G*. He used a torsion balance in which test masses on a suspended balance beam were slightly deflected by nearby source masses. In 2001 physicists at the International Bureau of Weights and Measures (BIPM) in Sèvres, France, used an updated torsion balance to measure *G* in two substantially independent ways—the standard Cavendish method that relies on measuring the angular deflections and an electrostatic force compensation method that holds the test masses steady against deflections. The two results agreed within their uncertainties but were notably higher than the previously best-determined value. The BIPM team has now rebuilt its torsion balance (seen in the figure) to reduce uncertainties and has redone the measurements. The two methods again generated values that agree with each other; the new combined result is $G = 6.675\,45(18) \times 10^{-11}$ m^3 kg^{-1} s^{-2} with an uncertainty of 27 parts per million. The value statistically agrees with the team's earlier result but is 241 ppm above the 2010 value recommended by the international Committee on Data for Science and Technology (CODATA). Two of the researchers are organizing a 2014 conference that will feature all experimenters with recent big *G* results, trying to pin down this poorly known fundamental quantity. (T. Quinn et al., *Phys. Rev. Lett.* **111**, 101102, 2013.) —SGB



Low-dose phase-contrast mammography. Small, treatable tumors are difficult to spot in mammograms because healthy and cancerous tissues differ little in how they absorb x rays. But absorption isn't the only source of contrast. As x rays pass through an inhomogeneous medium, they can acquire differences in phase—even if the medium is a uniform absorber. Early attempts at phase-contrast imaging required a synchrotron or other bright, coherent source of x rays. Now Alessandro Olivo of University College London and his collaborators have built a prototype machine that performs phase-contrast mammography with a conventional x-ray tube at clinically acceptable doses. The setup works by masking the x-ray source with an array of hundreds of narrow, closely spaced holes. Each beam that emerges points at a single pixel of a flat-panel detector. The detector is also masked—such that half the x rays from each beam are prevented from reaching their designated pixel. When an object is placed between the source and the detector, the beams suffer either absorption or, thanks to a change in phase, refraction. Because of the setup's geometry and the small angles of refraction involved, some refracted photons will still reach their pixel, but others will miss and hit the mask. Enough photons are diverted to the mask that they boost the contrast of what would otherwise be a conventional absorption image. Olivo's team tested its setup on donated samples of cancerous breast tissue. Microcalcifications that presage cancer showed up more clearly in the phase-contrast image than in an absorption image. (A. Olivo et al., *Med. Phys.* **40**, 090701, 2013.) —CD



Anisotropic friction on a silicon surface. The frictional force we experience in our day-to-day activities arises from atomic-scale surface roughness. When two surfaces rub against each other, thousands of atomic projections, or asperities, interact. Those interactions have now been explored at the single-atom scale by Franz Giessibl (University of Regensburg, Germany), his postdoctoral fellow Jay Weymouth, and colleagues. In particular, the team observed anisotropy in the friction force opposing motion over a silicon crystal whose surface is saturated with hydrogen. As the figure shows (beige is Si; white is H), each terrace on the Si surface presents rows of aligned Si dimers, but the rows in neighboring terraces are orthogonal. The researchers measured how the oscillation frequency of a lateral force microscope cantilever tip varied as they dragged it parallel to the dimers on one terrace and perpendicular to the dimers on another. Those frequency changes mirror changes in the spring constant of the cantilever and so allow one to determine the force experienced by the microscope tip. The deduced forces clearly distinguished between motions parallel and perpendicular to dimers. Moreover, collaborating theorists led by Pavel Jelinek (Academy of Sciences of the Czech Republic) ran first-principles simulations whose results agreed well with the measured forces. Interestingly, the simulations reveal that the Si dimers respond to the encroaching cantilever tip by rocking back and forth like a seesaw. (A. J. Weymouth et al., *Phys. Rev. Lett.*, in press.) —SKB



Cell electrospinning goes live. First patented in 1934, electrospinning draws a charged, viscous material out of a hollow conducting needle by means of an electric field. For more than 70 years, electrospun fibers have been used in a multitude of applications from sensors to protective clothing. Scaffolds made from spun fibers for tissue engineering have been used for at least a decade, yet challenges remain. For example, it is difficult to evenly spread enough viable cells onto a scaffold and expose them to the nutrients they need to survive; ultrasonic agitation helps to move nutrients around, but it compromises the integrity of the fibers and has not been demonstrated *in vivo*. A recent development is the large-diameter coaxial needle, which provides an outer sheath of a biopolymer that electrically shields an inner core of functional molecules or cells. Using such a needle, researchers led by Suwan Jayasinghe of University College London have now engineered living tissue scaffolds both *in vitro* and *in vivo*. Their thick (up to 1.5 mm) coaxial fibers have a core of mouse neuroblastoma tumor cells and nutrients. The figure shows part of a scaffold of those fibers, with fluorescently tagged live cells embedded. The electrospun cells grew and proliferated at the same rates as control samples. With the scaffold implanted in live mice, the cells continued to thrive for the full two weeks of the study, with no signs of rejection. That, says Jayasinghe, now makes possible human trials involving tissues generated with such scaffolds. (S. L. Sampson et al., *Small*, in press.) —SGB ■