improving the scanner's optics. The liquid crystal itself is also somewhat tunable. A bias voltage across the crystal is required to shift its characteristic curve—the relation between reflectance and applied field—to a region in which the nonlinear crystal's optical response accurately mimics the spatial variations in the charge image.

Rowlands envisions the XLV being useful at first for static imaging (in contrast to fluoroscopy) and chest x rays, an application well matched to the system's dynamic range. He's now exploring its clinical practicality at Canada's Thunder Bay Regional Health Sciences Center in northwestern Ontario, where he is setting up a new imaging research institute. Figure 2 compares a standard digital radiograph of a phantom chest using an active-matrix system with some smaller patches using a prototype XLV; "phantom" here refers to a dummy body part that replicates absorption properties of human anatomy.

In developing countries, a crying need exists for simple devices that can ensure bones are set properly and can screen for diseases such as tuberculosis. But Rowlands speculates that reduced cost may affect the technology's use even in the developed world. In the US alone, hundreds of millions of x-ray exams are performed annually. "It's somewhat fanciful, but just as PCs and laser printers are now ubiquitous, one can imagine each hospital bed in the intensive care unit outfitted not just with its own heart monitor, but its own x-ray imager."

Mark Wilson

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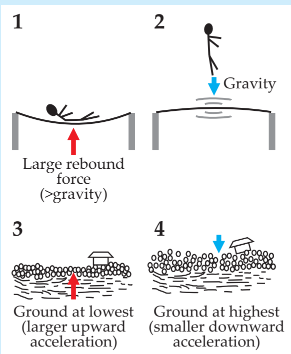
physics update

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

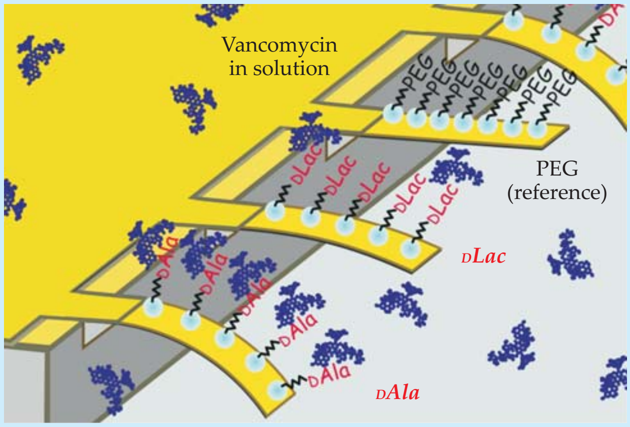
Trampoline model of vertical earthquake ground motion. Seismic sensors at the surface of a borehole near the epicenter of a magnitude-6.9 earthquake this year in Japan revealed unpredicted asymmetry in the vertical wave amplitudes at the soil surface: The largest upward acceleration was more than twice that of the largest downward acceleration. The data also showed that the soil surface layer was tossed upward at nearly four times the gravitational acceleration—more than twice the peak horizontal acceleration. These findings run contrary to current structural engineering models, which presume that seismic waves from earthquakes shake the ground horizontally more than vertically. Shin Aoi and colleagues at Japan's National Research Institute for Earth Science and Disaster Prevention propose what they call a trampoline model to explain the observed nonlinear bouncing behavior. In their model, the soil undergoes compression in the upward direction and behaves as a rigid mass with no intrinsic limit on acceleration, much like an acrobat rebounding from a trampoline (figures 1 and 3). In the downward direction, though, dilatational strains break up the soil and the loose particles fall freely at or below gravitational acceleration (figures 2 and 4). The observed seismographic data was simulated by combining the theoretical waveform from the trampoline model with selected borehole data that resembled elastic deformation of a deformable mass. The researchers say that other events need to be analyzed to learn how material conditions affect vertical ground response during high-magnitude earthquakes. (S. Aoi et al., *Science* **322**, 727, 2008.)

—JNAM



Sensing superbug stress under drug binding. Overuse of antibiotics has spawned strains of bacteria whose cell walls are impervious to the crippling blows once delivered by penicillin and its derivatives. One such so-called superbug, methicillin-resistant staphylococcus aureus, although found primarily in prisons and hospitals, has now spread beyond those confines. Despite the controlled use of the drug vancomycin, a last line of defense against MRSA, the latest threat comes from vancomycin-resistant bacteria, which mutate by deleting a key hydrogen bond that allows the drug to bind and inhibit cell wall growth, thereby mechanically weakening the bacteria. Rachel McKendry at University College London and her collaborators recently demonstrated a nanoscale cantilever system that is sensitive enough to detect the difference between the native drug-sensitive bacteria and the mutated resistant form with the missing hydrogen bond. The researchers coated silicon cantilevers with vancomycin-resistant (DLac in the schematic) and vancomycin-sensitive (DAla) bacterial cell-wall analogues, then immersed them in a solution containing free vancomycin molecules. As expected, the molecules preferentially bound to the cantilevers coated with the drug-sensitive analogue; those cantilevers experienced a marked deflection—as measured by an optical detector—that equated to an 800-fold difference in binding compared with the cantilevers coated with the drug-resistant analogue. The researchers believe their system will lead to sensitive, nondestructive, and rapid nanomechanical biosensors for high-throughput drug–target interaction studies and will aid in the design of more effective drugs. (J. W. Ndieyira et al., *Nat. Nanotechnol.* **3**, 691, 2008.)

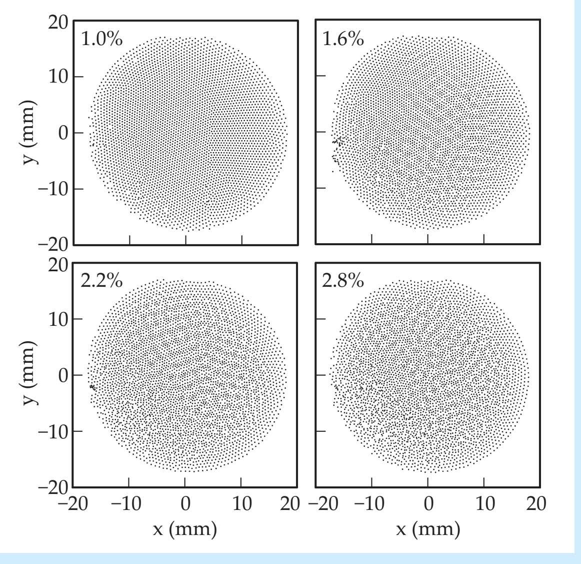
—JNAM



Tracking mercury by its isotopes. Different isotopes of the same element don't always behave identically in chemical reactions. As a result, naturally occurring samples can have measurably different ratios of stable isotopes. In most observed isotope fractionation, deviations in reactivity vary with the mass difference between isotopes, due either to kinetic effects or to differences in the zero-point vibrational energy of chemical bonds. Last year Bridget Bergquist and Joel Blum of the University of

Michigan in Ann Arbor found that photochemical reactions of mercury can result in isotope fractionation that does not fit the mass-dependent pattern: Odd-numbered Hg isotopes behave differently from even-numbered ones. Such mass-independent fractionation, observed in only a few elements so far, may be due to spin–spin interactions between nuclei and the unpaired electrons created in light-initiated reactions. Now, Abir Biswas, working with Blum and other Michigan colleagues, has found that Hg stored in coal deposits shows the effects of both mass-dependent and mass-independent fractionation. Moreover, coal samples from different regions—the US, China, and Russia–Kazakhstan—bear different Hg isotopic signatures. The researchers suggest that those signatures could provide some information about how Hg pollution (produced when the coal is burned) circulates in the environment, a process that is poorly understood. (A. Biswas et al., *Environ. Sci. Technol.*, doi:10.1021/es800956q.) —JLM

Two-dimensional melting in a dusty plasma. The melting transition has long fascinated physicists, both for its ubiquity in nature and industry and for the sophisticated physics of the phase transition in general. Two-dimensional systems can mimic



surfaces, which melt differently from bulk matter. One such system is a 2D dusty plasma: Background gas in a vacuum chamber is ionized when RF power is applied to an electrode. With sufficient care, one can levitate a single layer of charged "dust" microspheres above the electrode; electrostatic repulsion spreads the particles apart, usually in a stable 2D crystalline pattern. At Ohio Northern University, Terrence Sheridan came up with a new way to heat only the layer of dust. He modulated the RF power at a resonance frequency so as to jiggle the dust up and down; some of that motional energy coupled to an in-plane acoustic instability, increasing the dusty plasma's effective temperature. The panels show the dust distributions for different modulation amplitude levels. At 1.0%, the entire system oscillates vertically as a crystalline rigid body. As the hexagonal crystal is "heated," the coupling becomes evident in the central region at 1.6%. The crystal begins to melt at 2.2% and enters a hexatic liquid-crystal phase; it fully melts at 2.8%. For more on dusty plasmas, see Physics Today, July 2004, page 32. (T. E. Sheridan, *Phys. Plasmas* **15**, 103702, 2008.) —SGB

Shocking start for the solar system. In the 1970s, the hypothesis arose that our solar system was formed by a passing shock wave from a supernova, which triggered the collapse of an interstellar cloud into a dense region of gas and dust that further contracted to become the Sun and its orbiting planets. The original evidence came from very old meteorites that contained magnesium-26, a daughter product of the short-lived radioactive isotope (SLRI) aluminum-26—produced in stellar nucleosynthesis. Further evidence came from another SLRI, nickel-60, which can only be produced in a supernova's furnace. In astronomical terms, short-lived means a half-life of about a million years; any SLRIs would have been transported to, and dropped off in, the pre-solar cloud faster than that time scale. Computer modelers from the late 1990s, however, could not produce both the collapse and the injection of supernova material unless they artificially prevented the shock wave from heating the cloud. That situation has now been remedied by a group from the Carnegie Institution of Washington, who used a modern, adaptive-grid computer code with an improved treatment of heating and cooling. Their new models show that a supernova's shock wave moving into an otherwise stable solar-mass cloud can both trigger the collapse and leave behind enriched gas and dust, including the SLRIs whose products are found in meteorites. Furthermore, the researchers found that a protostar began to form in less than 200 000 years, in the blink of an astronomical eye. (A. P. Boss et al., *Astrophys. J. Lett.* **686**, L119, 2008.) —SGB

Ruffling a membrane. Soft biological tissue is often subjected to forces that affect the tissue's geometry, and finite elasticity provides a robust theoretical framework for analyzing the mechanical behavior of those tissues. Although the theory can accommodate anisotropic, nonlinear, and inhomogeneous processes subjected to large stresses and strains, its complexity makes many problems intractable. For growing tissue, though, the slow addition of cells generates shape- or size-changing stresses that are small enough to model successfully (see Physics Today, April 2007, page 20). So, too, are simple geometries for tissues in equilibrium, even after those tissues are subjected to large stresses. Two recent papers have looked at applying the theory to those cases in thin elastic disks. In one recent study, Julien Dervaux and Martine Ben Amar (both of École Normale Supérieure, Paris) looked at anisotropic growth rates: If growth was faster in the radial than in the circumferential direction, the disk became conelike, while a reversal of rates generated saddle shapes. A separate study by Jemal Guven (National Autonomous University of Mexico) along with Martin Müller (ENS) and Ben Amar looked at excessively large circumferences for a given radius. Using the fully nonlinear theory, the researchers found an infinity of quantized equilibrium states for an ever-increasing perimeter at fixed radius. The ripples around the edge grew in size and number—not unlike the flower petals shown here—eventually crowding together enough to touch, like the ruffled collar in a portrait by Rembrandt. For more on the elasticity of thin sheets, see the article in Physics Today, February 2007, page 33. (J. Dervaux, M. Ben Amar, *Phys. Rev. Lett.* **101**, 068101, 2008; M. M. Müller, M. Ben Amar, J. Guven, *Phys. Rev. Lett.* **101**, 156104, 2008.) —SGB