# physics update

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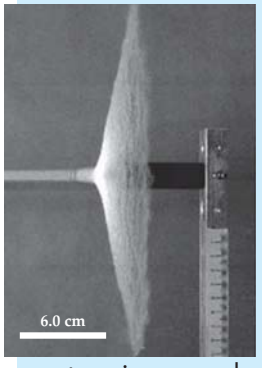
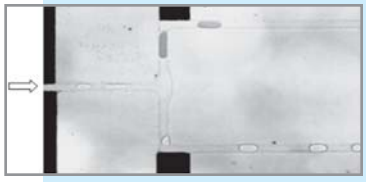
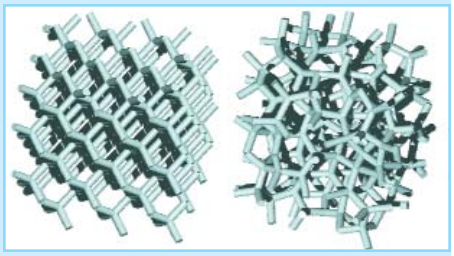
**Granular liquids with zero surface tension.** New experiments with spherical glass beads show that liquid behavior can arise simply from rapid collisions among a sufficiently dense stream of particles. If one or two beads are dropped onto a horizontal target, they will rebound back the way they came. However, physicists at the University of Chicago have now shown that when many beads are propelled at a target all at once in a dense granular stream, the grains deflect out laterally in the form of a very thin, symmetrical sheet or cone as if they constituted a liquid (see the figure). Indeed, the experiments using noncohesive granular particles quantitatively reproduce results obtained with streams of water in the limit of vanishing surface tension. To ensure there was no cohesion between the beads, the researchers baked them in a vacuum oven to evaporate any lurking moisture. The stream's liquidlike conditions are established near the target in a small region where the incoming and rebounding beads rapidly collide with each other. As the density of the stream decreases, the particulate nature of the flow gradually reasserts itself. (X. Cheng et al., *Phys. Rev. Lett.* **99**, 188001, 2007.) —PFS




**Capacitive microdroplet sorting.** Physicists at the Hong Kong University of Science and Technology have used a polydimethylsiloxane-based conducting composite to add one or more pairs of parallel electrodes to a microfluidic device. The paired electrodes sit on either side of the flow channel and form a capacitor with the liquid being the dielectric material between them. When a droplet having a different dielectric constant is carried by the liquid through the capacitor, a signal is detected, the shape and amplitude of which vary with the droplet's size and composition. Using a second capacitor reveals the droplet's velocity. The scientists, led by Weijia Wen, also demonstrated that the droplets can be individually manipulated farther downstream. In the image, oil carries two kinds of droplets in from the left. Once detected and identified, a droplet is given an appropriate charge and subsequently deflected by high-voltage electrodes into its designated path. Here, dark-colored water droplets are directed to the upper branch while lighter-colored droplets of ethylene glycol go to the lower branch. Sorting by size is also possible; the Hong Kong team can look at droplets smaller than a picoliter with a capacitive sensitivity of a picofarad. Wen says not only can the device handle about 10 000 drops per second, which is faster than is possible with optical means, but it is also intrinsically cheaper than the optical equivalent. The goal is to engineer a useful digitally controlled biochemical chip for performing various experiments with nanoliter volumes of reactants or biological samples. (X. Niu et al., *Biomicrofluidics* **1**, 044101, 2007.) —PFS



**A large, three-dimensional photonic bandgap** is predicted to occur in an amorphous structure. Photonic crystals are useful because they block the transmission of light in a narrow waveband. For some applications, the bandgap should be 3D and as isotropic as possible. Achieving that desirable combination has proved difficult. Most crystal structures don't yield 3D photonic bandgaps. Diamond is an exception, but its bandgap isn't isotropic. Now, Keiichi Edagawa and Satoshi Kanoko of Tokyo University and Masaya Notomi of NTT Corp have shown that a structure with no long-range order can have a large, 3D bandgap. And because the structure is amorphous, its bandgap is guaranteed isotropic. The new structure is based on a model for amorphous silicon developed in 1971 by Donald Polk. To create it on a computer, the three researchers started with a random assembly of 1000 particles. They let small groups of particles form tetragonal bonds. Then they removed the particles and turned the bonds into dielectric cylinders. The figure on the left shows a diamond lattice; the figure on the right shows the amorphous structure. Using their computer, the researchers compared the optical properties of the two structures. The diamond structure had the wider bandgap, but not by much. The researchers hope to make a real version of their structure, but their simulation has already proven one important result: Contrary to textbook explanations, Bragg scattering off crystal planes is not necessary to form a 3D bandgap. (K. Edagawa, S. Kanoko, M. Notomi, *Phys. Rev. Lett.*, in press.) —CD



**Martian dunes form in rare bursts**. The surface of Mars is covered with sand dunes of different shapes and sizes (see figure). How did they form? The answers aren't obvious. Compared with the climate that prevails in the Sahara and other terrestrial deserts, Mars has a rather unfavorable climate for building dunes. The density of Mars's atmosphere is 1/1000 that of Earth's. Rarely—about once a decade—does the Martian wind blow strongly enough to loft grains, and then only for 10 seconds or so. The only favorable condition is surface gravity, which, at 3.71 m/s$^2$, makes transporting grains easier than on Earth. Eric Parteli of the Universidade Federal do Ceará in Brazil and his colleague Hans Herrmann of ETH Zürich in Switzerland investigated whether the present Martian climate could form the present Martian dunes. The researchers' principal tool was a model that had been applied successfully to dunes on Earth. Their conclusion: Mars is indeed making its own dunes, and variations in local conditions can account for the different types of dune. Parteli and Herrmann found a surprise when they looked at bimodal sand dunes, those that bear evidence of being shaped by winds that oscillate between two perpendicular directions. They deduced a wind oscillation period on Mars of 50 000 years. That period is roughly the same as the precession period of Mars's rotation axis. (E. J. R. Parteli, H. J. Herrmann, *Phys. Rev. E* **76**, 041307, 2007.) —PFS ■