physics update

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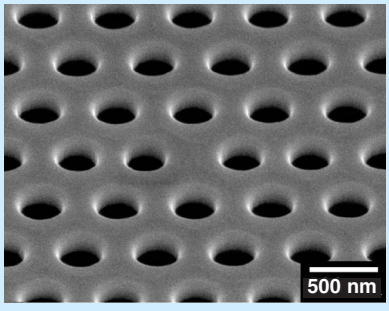
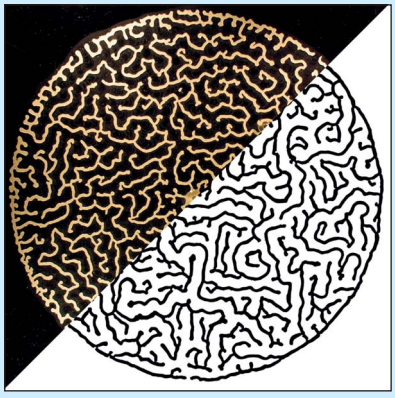
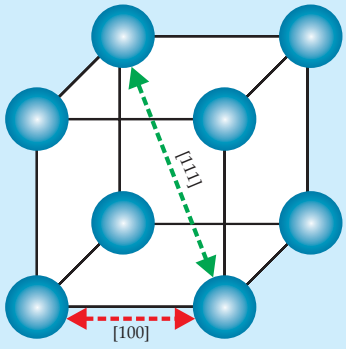
A highly efficient room-temperature nanolaser has been demonstrated by scientists at Yokohama National University in Japan. Made of the semiconductor gallium indium arsenide phosphate, the overall device has a width of several microns, but the active region where laser light actually gets produced has nanometer-scale dimensions in all directions. The device is the first nanolaser to emit continuous coherent near-IR light at room temperature and uses only a microwatt of power, one of the smallest operating powers ever achieved. The laser's small size and high efficiency were made possible by its photonic-crystal design. The researchers etched a repeating pattern of holes through the semiconductor and deliberately introduced a defect into the pattern—for example, by slightly shifting the positions of two holes, as shown here. The imperfect pattern defined a narrow frequency band of light that could exist in the defect region. Curiously, the team found that a high quality factor Q was not necessarily advantageous for optimized device behavior. A high Q may be desirable for low-threshold lasing, but a low Q should be more effective in such applications as a single-photon emitter. (K. Nozaki, S. Kita, T. Baba, *Opt. Express* **15**, 7506, 2007.) —PFS



Turning heat into electricity through sound has been demonstrated by a team of researchers at the University of Utah. The group, led by Orest Symko, has built devices that can create electricity from the heat generated by computer chips, nuclear power plants, or even the Sun. At the June meeting of the Acoustical Society of America in Salt Lake City, five of Symko's students reported the latest advances in their devices, which first convert heat into sound and then sound into electricity. Typically, each device is a palm-sized cylinder containing a stack of material such as plastic, metal, or fiberglass. Applying heat to one end of the stack creates a movement of air that travels down the cylindrical tube. The warm, moving air sets up a sound wave in the tube, similar to the way in which air blown into a flute creates a tone. The sound wave then strikes a piezoelectric crystal, which converts the wave's pressure oscillations into electricity. According to Symko, a ballpark range of 10–25% of the heat typically gets converted into sound energy. The piezoelectric crystals then convert 80–90% of the sound energy into electrical energy. The team expects the devices to be used in real-world applications within two years. (ASA Meeting talks 5aPA2, 5aPA4, 5aPA5, 5aPA7, 5aPA8.) —BPS

A self-generated maze can be explained with simple physics. Remarkable patterns can spontaneously emerge in out-of-equilibrium systems with competing forces. The labyrinthine structures in this illustration were created experimentally (gold and black) and in simulations (black and white) by Bjørnar Sandnes and colleagues at the University of Oslo, Norway. The lines indicate a residue of glass beads that remains after the liquid has been slowly drained from a bead–fluid suspension confined between two glass plates. Shortly after the draining begins, air deforms the air–liquid interface at the perimeter of the suspension and produces fingers in the liquid. The slow draining means that viscous forces are not important determinants of the fingering. Sandnes suggests that the pattern results instead from a combination of capillary pressure that acts at the air–liquid meniscus to advance the finger and a retarding frictional force. As the illustration shows, the simulations run by the Oslo team to test that simple model produce patterns that look much like the experimental results. The group tested further by exploring how the characteristic finger width of the labyrinth varies with the concentration of glass beads in suspension. Again, simulated and experimental results were in good agreement, particularly when the residue of beads was significantly thicker than the plate spacing. (B. Sandnes et al., *Phys. Rev. Lett.*, in press.) —SKB



Polonium's simple cubic structure. Polonium, with atomic number 84, is the only element with a simple cubic crystal structure, and new theoretical work by a team of scientists at the Academy of Sciences of the Czech Republic, Brno University of Technology, and Masaryk University explains why. In a solid piece of Po, the atoms sit at the corners of a cubic unit cell and nowhere else. Most other metallic elements, in contrast, have body-centered cubic, face-centered cubic, or hexagonally close-packed structure. Using state-of-the-art ab initio electronic structure calculations, the researchers have produced a detailed theoretical explanation for Po's unique crystal structure: It is the result of the complicated interplay of relativistic effects that become important in heavy atoms such as Po. In particular, they found that the mass–velocity effect, which describes the relativistic increase in mass of electrons traveling at speeds comparable to that of light, increases faster than the effect of spin–orbit coupling in going down the periodic table from trigonal selenium and tellurium to Po. Another Po oddity: Its elastic anisotropy is greater than for any other solid. It is about 10 times easier to deform a Po crystal along the unit cell's body diagonal (the [111] direction) than along a direction perpendicular to any of the cubic faces (the [100] direction). The team found that this property results directly from the simple cubic structure of Po. (D. Legut, M. Friák, M. Šob, *Phys. Rev. Lett.* **99**, 016402, 2007.) —PFS ■