Physics Update

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Hydrogen pellets. As a potential energy carrier, molecular hydrogen can power fuel cells and heat engines, and has only water as its byproduct. But before hydrogen can replace fossil fuels, several technical challenges need to be met. (See the article in PHYSICS TODAY, December 2004, page 39.) The challenge of storing hydrogen in a safe, high-density form is being approached in different ways; now, another possible solution has been found. Researchers at the Technical University of Denmark in Lyngby have infused ammonia, NH_3, into a metallic salt that can then be compacted into pellets, as shown here. This solid form of hydrogen storage is completely reversible: The ammonia is released and decomposed with the help of a catalyst, and the porous salt can then easily absorb a fresh supply of ammonia—more than 50% of its weight, or 9% hydrogen by weight. Although the pellets desorb ammonia so slowly that you can carry them in your pocket, free ammonia is a strong irritant and its release from the solid must be safely contained. The scientists point out, however, that the only byproduct of their process is molecular nitrogen. In addition, ammonia is easier to decompose into CO_x-free hydrogen than either hydrocarbons like gasoline and diesel, or alcohols like methanol. (C. H. Christensen et al., *J. Mat. Chem.*, in press.) —SGB

Room-temperature ice films can be made if water is confined and subjected to a modest electric field. Simulations have shown that strong fields of around 10^9 V/m can align water dipoles and crystallize them into polar cubic ice. In the new work, done in the lab of Heon Kang at Seoul National University in Korea, scientists examined the properties of room-temperature water in the gap between a gold substrate and the gold tip of a scanning tunneling microscope. They saw a sudden phase transition from liquid to solid when two conditions were met: when the gap shrank to a critical value of 7 Å and when the imposed electric field was at least a few times 10^6 V/m. Noting that the field is far too weak to polarize water, the researchers think they have found a new type of freezing transition. They also note that comparable field strengths are found, for example, within ion channels in biological cells, at the charged interfaces of proteins and nanodevices, and in thunderclouds. (E.-M. Choi et al., *Phys. Rev. Lett.* **95**, 085701, 2005.) —PFS

A new nanophotonic waveguide has been proposed. If photonics is to keep up with electronics in the race to produce smaller, faster circuitry that is less power-hungry, then photon manipulation will have to be carried out on scales of space, time, and energy that are hundreds or thousands of times smaller than currently possible. Physicists at MIT have now figured out how to reduce all three parameters (space, time, and energy consumption) simultaneously in a new waveguide design. To process a photonic signal, the researchers would convert it into surface plasmons that are supported on the interface between a metal substrate and a corrugated layer of dielectric material. The plasmons can have a propagation wavelength much smaller than the free-space optical wavelength, thereby shrinking the spatial dimension. Such plasmons are also very slow electromagnetic waves, typified by a low operational energy. Finally, when several dielectric layers are stacked, slow plasmon waves can coexist over a surprisingly large frequency bandwidth. Since the superposition of waves at a variety of frequencies can create a very short pulse, reduction of the time scale is thus achieved. As a bonus, cooling should help control any propagation losses in the proposed device. (A. Karalis et al., *Phys. Rev. Lett.* **95**, 063901, 2005.) —PFS

Seismic noise in the Moon. For many years, scientists have used microseismic noise—mild seismic waves generated by ocean waves and atmospheric processes—to image Earth's internal geological makeup. Researchers from France, Denmark, and the US are now using the technique to explore the Moon and, perhaps some day, other planets. In 1972, astronauts on the *Apollo 17* mission planted an array of four geophones on the Moon that passively recorded its seismicity, and the record was radioed to Earth. The geophones were again activated for more than eight months in 1976–77, and that data set is what has now been analyzed. The researchers looked at noise correlations between pairs of geophones, from which they extracted faint activity signals. The signals grew as the array entered sunlight and declined as it entered shadow—with a precise 29.5-day period. They concluded that the low-level seismic activity arose as surface material cracked when heated by the Sun from −170 °C to +110 °C. The analysis also corroborated the determination of subsurface geology by other, more established experimental methods during the Apollo program. The scientists say that microseismic noise can be used to explore other planets, notably Mars, that have different sources of seismic noise. (E. Larose et al., *Geophys. Res. Lett.* **32**, L16201, 2005.)—HL