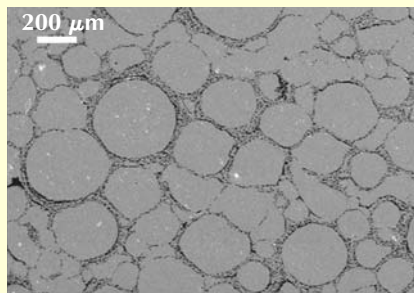


Improved fuel for nuclear energy. Today's nuclear reactors run on pellets of uranium dioxide stacked inside fuel rods. The UO_2 , although extensively shown to be safe and stable, is not used with full efficiency because its low thermal conductivity causes large temperature gradients. The conductivity decreases further as the fuel burns, which limits a pellet's operational lifetime. Pellets that can better shed their heat are therefore desirable, and that's just what nuclear engineers at Purdue University have come up with. Led by Alvin Solomon, the team coated roughly spherical UO_2 granules with a powder of beryllium oxide (BeO), which has



a significantly higher thermal conductivity than UO_2 . As shown in this cross section, when the coated granules were pressed into pellets, the BeO filled all the available space

between the granules. After sintering, the new pellets had a 50% higher thermal conductivity than standard ones. Solomon expects that the new pellets could allow the fuel to produce more power, stay in place longer than the usual three years, and provide the utility companies with greater operational flexibility. The next step is to test the fuel in a reactor. (K. H. Sarma et al., *J. Nucl. Mater.*, in press.) —SGB

Unambiguous evidence for a magnon

A Bose–Einstein condensate has been seen in a crystal of cesium copper chloride. For a collection of atoms that have an intrinsic magnetism, the spin vectors can all be oriented in one direction if the field strength is larger than a certain value. In such a configuration, a small input of energy can tilt some of the spins out of the general formation. The tilting can propagate and act like a wave moving through the sample. If the temperature of the sample is extremely low, then the moving wave can be considered as a quasiparticle—a magnon. Further, a monolithic, static spin tilting is regarded as a BEC of magnons. A group of scientists from Germany, Russia, the UK, and Poland used the antiferromagnetic material Cs_2CuCl_4 , in which the tendency to acquire a static spin tilting competes with both an applied magnetic field and thermal fluctuations. The physicists observed a condensation of magnons when the magnetic field was lower than the critical strength of 8.51 T and the temperature was below a characteristic value in the millikelvin range. Within the crystal, about

10^{23} magnons participated in the BEC. (T. Radu et al., *Phys. Rev. Lett.* **95**, 127202, 2005.) —PFS

Bacterial propeller rotates in steps. Some bacteria swim in liquids with the help of a molecular machine that spins a corkscrew-like filament hundreds of times per second. The roughly 45-nm-diameter machine typically runs on energy from an electrochemical potential that drives either protons or sodium ions into the cell through a channel in the cell membrane. Within the channel are rings of stator molecules surrounding a rotor. Ion flow causes the stators to move or change shape, thereby imparting a torque to the rotor. The filament is attached to the rotor, and the entire assemblage is called a flagellum. (For more on how bacteria move, see *PHYSICS TODAY*, January 2000, page 24.) Researchers have long thought that the flagellar motor rotates in discrete angular steps rather than smoothly, but until now such motion has been indiscernible. A team of scientists from Japan and the UK attached a submicron-sized bead to a filament and monitored its motion as they slowed the bacterial propeller to about 1 Hz by lowering the concentration of sodium ions and reducing the number of stator molecules. They directly observed 26 steps per revolution, which is consistent with the periodic arrangement of the rotor. (Y. Sowa et al., *Nature* **437**, 916, 2005.) —SGB

A new excited nuclear state has been seen in unstable, neutron-rich isotopes of tin. Typically, an unexcited atomic nucleus has its constituent neutrons and protons bobbing around in a roughly spherical configuration. When excited, however, the nucleus can be made to spin, vibrate, or otherwise deform. One excited mode, called a giant dipole resonance, has the protons move in one direction while the neutrons go the other way. In neutron-rich nuclei, a tight core of nucleons can be surrounded by a diffuse halo or skin of more loosely bound neutrons. In the new experiment, the LAND collaboration at the GSI lab in Darmstadt, Germany, generated a beam of uranium-238 nuclei that then dissolved by fission into a swarm of daughter nuclei, from which the desired tin isotopes, ^{130}Sn and ^{132}Sn , were extracted and excited by passing through a lead target. From the debris of the subsequent decays, the researchers reconstructed the excitation energy spectra of the tin nuclei. The expected dipole resonance was seen at about 16 MeV, and a brand new resonance showed up at 10 MeV. The collective nature of the new “pygmy” dipole resonance is not yet fully clear, although calculations show that excess neutrons are oscillating. (P. Adrich et al., *Phys. Rev. Lett.* **95**, 132501, 2005) —PFS ■