PHYSICS UPDATE

Caution: Slippage may occur for tightly confined aqueous Newtonian fluids. Fluid mechanics is one of the most mature and successful branches of physics. Its success for Newtonian liquids—whose viscosity is constant—rests in part on the often-assumed no-slip boundary condition, in which the fluid molecules adjacent to a surface are always stationary with respect to that surface. Now, two teams of researchers—one from the Australian National University and one from the University of Illinois at Urbana-Champaign—have demonstrated that the assumption is sometimes wrong. The Australian researchers measured the motion of a 10-micron silica sphere as they drove it through sugar water toward a wall. The Illinois group studied a system in which one cylinder oscillated toward another, with various fluids between them. In both sets of experiments, the classical no-slip model could not explain the data. Furthermore, the inferred amount of slip depended on the fluid's flow or shear rate. A complete theory will also need to incorporate the fluid's viscosity, its surface wettability, and the wall's roughness. Slippage is already known to occur at times for both non-Newtonian liquids and nonaqueous Newtonian ones. The new studies might have implications for capillary blood flow, lubricants in nanomachines, and filtration. (V. S. J. Craig et al., *Phys. Rev. Lett.* **87**, 054504, 2001. Y Zhu, S. Granick, *Phys. Rev. Lett.* **87**, 096105, 2001.) —JRR

Watching an optical vortex reverse its spin. Vortices occur in whirlpools, tornadoes, Bose–Einstein condensates (BECs), and many other systems. In an optical beam, a vortex is a spiral phase ramp—like the thread of a screw—circulating around a dark spot in the beam where the phase is undefined and the intensity vanishes. It is generally accepted that, once created, a vortex cannot reverse its direction of rotation without first being destroyed. Researchers have built devices to reverse optical vortices, but were unable to watch the reversal itself. Now a Barcelona–Tucson collaboration has observed in detail such a reversal in an optical vortex that freely propagated in vacuum. The key to both reversing and observing the spiral staircase of phase was giving it some intrinsic spatial structure within the beam: The researchers passed the specially prepared laser beam through a cylindrical lens and monitored its interference with a reference beam as it propagated. They clearly observed clockwise rotation of the phase beyond the lens. But just after the focal plane, the screwlike discontinuity collapsed to a line discontinuity then reemerged with a counterclockwise rotation. A spherical lens did not generate such a reversal. The scientists also confirmed that the beam's angular momentum was conserved throughout the experiment. They see some implications of their work for quantum entanglement and teleportation, and for elucidating vortex behavior in BECs. (G. Molina-Terriza et al., *Phys. Rev. Lett.* **87**, 023902, 2001.) —BPS

The nuclear lighthouse effect has been applied to samarium-149. The NLE technique was developed last year by researchers from the University of Rostock in Germany. It allows physicists to get very accurate lifetime measurements of certain short-lived nuclear resonances. In their recent work, the Rostock scientists mounted a thin sheet of $^{149}Sm_2O_3$ on the inside wall of a small cylinder. They then placed the cylinder in an x-ray beam at the Advanced Photon Source at Argonne National Laboratory and spun it at 15 kHz with jets of pressurized air. The nonresonant x rays went straight through the rotor, while those that were absorbed by the nuclei were reemitted after some slight delay. That delay provided enough time for the cylinder to rotate a few milliradians, and the forward-scattered resonant x rays were thus deflected into a detector. The group detected a resonance energy of 22.496 keV with a natural lifetime of 10.3 ns. Samarium is an important material for new permanent magnets but, like some other rare earths, is difficult to study with conventional methods (such as Mössbauer spectroscopy) for a variety of reasons. The physicists say that NLE is capable of resolving subpicosecond lifetimes, which are currently beyond the limits of x-ray detection. (R. Röhlsberger et al., *Phys. Rev. Lett.* **87**, 047601, 2001.) —JRR

A chain of individual gold atoms has about twice the tensile strength of bulk gold. A team of researchers from Madrid, Spain, and Lyngby, Denmark, drew a gold-tipped scanning tunneling microscope away from a gold cantilever to create a string of up to seven atoms. With a second STM placed under the cantilever, the researchers could observe a chain grow as the atoms in the gold electrodes rearranged to release a single atom at one end or the other. Eventually, when the force needed to rearrange the atoms became too great, the chain broke under the strain. That breaking force was about 1.5 nN, independent of chain length. To break a bond in bulk gold, by contrast, requires only 0.7–0.9 nN. The researchers also showed that the atomic chains have close to one quantum unit of electrical conductance and that the chains are elastically stiffer than the electrodes from which they arise. While it's not yet clear that gold atom chains will have any practical use, the study is an example of engineering analysis on the very smallest scale. (G. Rubio-Bollinger et al., *Phys. Rev. Lett.* **87**, 026101, 2001.) —JRR