PHYSICS UPDATE

Three magnetic devices for atom optics have been demonstrated: a beam splitter, a conveyor belt, and a switch. Just as electrons drive electronics and photons drive photonics, many researchers hope that cold, neutral atoms will drive a future "atomtronics." To process information, atoms will need to be manipulated on or near an "atom chip" using atom-based analogs of mirrors, lenses, waveguides, gratings, and other devices. The new devices reported here all exploit the interaction between a neutral atom's magnetic moment and an external magnetic field with a gradient strong enough to create microscopic potentials. Jörg Schmiedmayer of the University of Heidelberg and his colleagues have designed a beam splitter for guided atoms, using a Y-shaped current-carrying wire nanofabricated on a surface. Depending on how current is sent through the Y, atoms can be directed to the output arms with any desired ratio. A group at the Max Planck Institute for Quantum Optics in Munich has been able to confine atom clouds in separate potential wells and transport them with 800-nm precision near a surface having time-dependent currents in a lithographically patterned conductor. The researchers have used their "magnetic conveyor belt" to merge separate clouds; their evidence shows that the process is adiabatic and can be reversed to coherently split wavepackets. Also using lithography, and following their own beam splitter, a group at the University of Colorado and NIST in Boulder has devised a switch that can direct a guided beam of neutral atoms to either of two output ports separated by 8 mm. Both the incoming and outgoing atoms are guided between two parallel wires having current flowing in the same direction. In the switch region, the atoms are guided alongside two wires with oppositely flowing current. (D. Cassettari et al., *Phys. Rev. Lett.* **85**, 5483, 2000. W. Hänsel et al., *Phys. Rev. Lett.* **86**, 608, 2001. D. Müller et al., *Opt. Lett.* **25**, 1382, 2000; D. Müller et al., *Phys. Rev. A*, in press.) —PFS

Dripping from faucets and ceilings. A better understanding of dripping can improve inkjet printing and deposition of DNA onto gene chips, among other things. Purdue researchers solved the fundamental Navier–Stokes equations for a single drop from a faucet, then observed dripping with a fast camera to develop a model for simulating sequences of hundreds of drops. Among the team's observations was period doubling, in which drops can fall at two characteristic intervals (such as 2 s followed by 4 s). Meanwhile, University of Texas researchers have shown how to prevent drips from a ceiling for up to weeks at a time. They found that a vertical heat gradient in the gas beneath the suspended layer of liquid did the trick. Normally, a liquid is gravitationally unstable to variations in thickness along the layer, but because heat reduces a liquid's surface tension, the warmer, thicker regions are pulled back to the colder regions of higher surface tension. (B. Ambravaneswaran et al., *Phys. Rev. Lett.* **85**, 5332, 2000. J. M. Burgess et al., *Phys. Rev. Lett.*, in press.) —BPS

Ion-beam "photography." Many of the beautiful colors in stained glass windows are the result of light scattering off metal or oxide nanoclusters dispersed in the material. However, the mechanism of nanocluster formation is usually obscured in the complexities of glass chemistry. Now, researchers at the Universities of Orsay and Paris, collaborating with glass experts, have found that by shooting MeV ions into a room-temperature glass containing a metal oxide, they can nucleate and control the density of pure metal nanoclusters. The nucleation requires exceeding a threshold of energy going into electron motion in the glass. Moreover, the nanoclusters grow only upon subsequent heating of the sample, allowing control over their size, and all the clusters grow simultaneously. This is analogous to the photographic process, with ions replacing photons, metal oxide in the glass replacing metal-containing salts in the emulsion, and heat replacing the developer. The ion-beam method allows the density of nucleation sites to be predicted precisely, and standard lithographic techniques could be used to design spatial patterns of clusters, leading to applications in optoelectronics. (E. Valentin et al., *Phys. Rev. Lett.* **86**, 99, 2001.) —BPS

An acoustic nose, used to precisely determine the chemical makeup of a vapor, was demonstrated at the Acoustical Society of America meeting last December in Newport Beach, California. In the device, a flowing stream of helium gas carries the vapor of interest through a heated, specially coated meter-long gas chromatography column, in which the vapor's constituent atoms and molecules are segregated by mass, and all similar atoms or molecules travel together. The various species then fall sequentially on a 500-MHz surface acoustic wave resonator, where they rapidly condense—a hallmark of a vapor—and are then evaporated, making room for the next arrival. The arrival time at the sensor identifies the species by mass, and the total mass of that species alters the resonator's frequency, thereby yielding the concentration. Concentrations as low as parts per billion (or trillion in some cases) were detected. Created by Edward Staples (Electronic Sensor Technology, Newbury Park, California), the zNose™ can analyze a vapor with hundreds of different species in 10 s. Staples anticipates many uses, including in the food and beverage industry, forensics, and environmental science. —BPS ■