

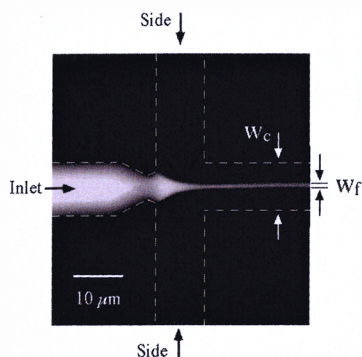
PHYSICS UPDATE

► **SIMPLE, PRECISE COHERENT CONTROL** of a molecular wavepacket has been achieved by Stephen Leone's group at the Joint Institute for Laboratory Astrophysics, University of Colorado and National Institute of Standards and Technology. In the experiment, an excited electronic state of Li_2 was "pumped" by a broadband, phase-modified femtosecond laser pulse into a superposition of two rotational states. The resulting wavepacket was monitored by a second, time-delayed "probe" pulse. Both pulses can have carefully shaped phases (created with the help of simple microscope coverslips and mirror holders) to encode information in the molecule during either the excitation or detection process. For example, the pump pulse contains the spectral components needed to excite the two rotational states. By varying the relative phases of the components, the experimenters were able to directly control the time evolution of the wave packet. On the other hand, by using a carefully defined probe pulse acting as a highly selective filter, they were able to extract detailed information from a wavepacket initially prepared by a poorly defined pump pulse. The ability to coherently control atoms and molecules has a direct impact not only on the field of quantum dynamics, but also on technologies such as optical communications and information storage. (R. Uberna *et al.*, *J. Chem. Phys.* **108**, 9259, 1998.) —SGB

► **MICROFLUIDICS: MIXING NANOLITERS** in microseconds. Princeton University researchers have built a tiny mixing vessel in which a submerged fluid jet (pinched down to a waist as small as tens of nanometers) is used to achieve fluid mixing times of less than $10\ \mu\text{s}$. Mixing, being diffusion driven, is normally a slow process on macroscopic scales but can be sped up by introducing turbulence. Turbulence, however, is difficult to predict and control, so the researchers looked to speed up

mixing by shrinking the size scale. The device consists of two channels intersecting at right angles and open to viewing through a coverslip from above. One fluid to be mixed flows under pressure through one channel. The second fluid enters the second

channel, also under pressure, from both ends and converges at the intersection where it hydrodynamically focuses the first stream down to a size at which diffusion across it (mixing) takes mere microseconds. The mixed sample is delivered in a controlled laminar flow at rates of nanoliters per



second. At this rate a shot of espresso would take a year to deliver. The Princeton mixer, frugal with expensive samples and compact enough to sit on a silicon chip, makes it possible to study fast reaction kinetics at previously unattainable time scales. For example, proteins fold in response to quick changes in concentration of the "denaturant" in the solvent surrounding them. (J. B. Knight *et al.*, *Phys. Rev. Lett.* **80**, 3863, 1998.) —PFS

► **MAPPING THE HELIOPAUSE** from near-Earth space may be possible by monitoring the echo of solar extreme ultraviolet (EUV) radiation. The heliopause is the boundary, believed to be at least 120 astronomical units away, where the outgoing solar wind meets the incoming plasma of the local interstellar medium (LISM). Mike Gruntman (University of Southern California) and Hans Fahr (University of Bonn) have now calculated that the 83.4 nm resonance line from singly ionized oxygen at the heliopause will be brighter than the general EUV background at that wavelength, at least in the "upwind" hemisphere as the Solar System plows through space. Because both the heliopause's shape and the interstellar plasma's flow depend on the interstellar magnetic field, mapping the heliopause in three dimensions can tell us much about the LISM. The measurements can even be calibrated, along one line of sight, when the Voyager I spacecraft (now 67 AU away) eventually reaches the region. (M. Gruntman, H. J. Fahr, *Geophys. Res. Lett.* **25**, 1261, 1998.) —PFS

► **TWO FORMS OF LIQUID WATER** may coexist at very low temperatures, possibly shedding light on why water has such unusual properties compared to other liquids. For example, below 4°C , water shrinks when warmed whereas most other liquids expand when heated (PHYSICS TODAY, April 1996, page 9). Two recent studies of supercooled water have found what looks like a phase transition between two different liquid forms, both lacking long-range order. Mixtures of different liquids are common, but evidence for two liquid phases of a single pure substance has not been seen before. Osamu Mishima and Eugene Stanley studied the melting curve of ice IV and found it consistent with a liquid-liquid phase transition. Meanwhile, Marie-Claire Bellissent-Funel reached a similar conclusion from a two-level model of water and neutron diffraction studies. The two phases have different densities, reflecting perhaps different clusterings of H_2O molecules at short distances. Supercooled water occurs naturally in stratospheric clouds and cells of all plants that survive subzero temperatures, lending a practical aspect to the investigations. (O. Mishima, H. E. Stanley, *Nature* **392**, 164, 1998. M.-C. Bellissent-Funel, *Europhysics Lett.* **42**, 161, 1998.) —BPS ■