PHYSICS UPDATE

QUANTUM EVAPORATION from a pool of superfluid helium-4 has demonstrated directly that the evaporated ^{4}He atoms had been part of a Bose–Einstein condensate (BEC) in the liquid—that is, the atoms were in a single macroscopic quantum state with zero momentum. In his experiment, Adrian Wyatt of the University of Exeter, in England, used a well-collimated beam of phonons, aimed at the liquid surface from below, to pop helium atoms up out of the liquid, much like light ejects electrons from a surface in the photoelectric effect. By measuring the momenta and energies of the phonons and the evaporated atoms, Wyatt found that the atoms originally had zero momentum parallel to the surface, and thus came from a BEC. Theories of superfluid ^{4}He had supposed this to be the case, but it had not been experimentally verified until now. (A. F. G. Wyatt, *Nature* **391**, 56, 1998.) —PFS

LOCALIZATION OF NEAR-VISIBLE LIGHT has been achieved by a Florence–Amsterdam collaboration. In a disordered medium such as a cloud or milk, light waves scatter repeatedly, which leads to common diffusion of light. In the new experiment, the medium had such a high index of refraction (gallium arsenide powder, with very low absorption at a wavelength of 1064 nm) that the light's electric field could not oscillate even once before scattering. This led to huge interference effects that, in essence, halted the diffusion and trapped the light within the medium. Diederik Wiersma calls this a new electromagnetic phenomenon—the optical counterpart of the metal–insulator transition of electrons in a disordered system. For more on localizing light, see PHYSICS TODAY, May 1991, page 32. (D. S. Wiersma *et al.*, *Nature* **390**, 671, 1997.) —PFS

WATCHING A CHEMICAL REACTION with a scanning tunneling microscope (STM) can offer a unique way to determine chemical kinetics. A fundamental question of physical chemistry is how to link a reaction's kinetics—the rate equations as functions of macroscopic variables like temperature or pressure—with the underlying microscopic mechanisms responsible for the reaction. With the kinetics in hand, one cannot uniquely determine the elementary reaction steps. The reverse process is unique, but how does one determine the basic steps of a complex reaction in order to derive the kinetics? Now, a group at the Fritz Haber Institute in Berlin has done just that by watching the catalytic oxidation of carbon monoxide on a platinum surface—cooled to slow the reaction rate to match the speed of its STM. The sequence of atomic-scale images was then used to derive a rate equation, which was in excellent agreement with previously determined kinetics for this important reaction (which can remove CO from exhaust fumes). Joost Wintterlin thinks this is the first time that a kinetic description of a chemical reaction was achieved based only on the statistics of the underlying atomic processes. (J. Wintterlin *et al.*, *Science* **278**, 1931, 1997.) —SGB

SINGLE-WALLED CARBON NANOTUBES can be either semiconductors or metals, two independent teams have now conclusively demonstrated. Shortly after nanotubes were discovered in 1991, theorists predicted that these seamless rolled-up sheets of carbon hexagons could be either metals or semiconductors, depending on the tube diameter and the helicity—related to the corkscrew-like angle at which the flat carbon sheets are rolled. Using scanning tunneling microscopes (STMs), a team from Delft University of Technology and Rice University and, separately, a Harvard group have confirmed the relation between tube morphology and conductance, by relating atom-scale images of the nanotubes to tunneling-current measurements of the electron density of states. An unexpected finding from the STM images was that nanotubes exist with a wide range of helicities, not just wrapped at preferential angles, as previously thought. (J. W. G. Wildöer *et al.*, *Nature* **391**, 59, 1998. T. W. Odom *et al.*, *Nature* **391**, 62, 1998.) —BPS

THE DURATION OF SONOLUMINESCENT PULSES has now been determined and is independent of wavelength. Sonoluminescence (SL) is the clock-like emission of light pulses from a bubble that is trapped in a fluid by an acoustic field. (See PHYSICS TODAY, September 1994, page 22.) Until last August, researchers could only establish an upper limit for the width of SL flashes, not their actual duration. But then, researchers at the University of Stuttgart adapted the technique of time-correlated single-photon counting to SL and announced that SL pulses for their bubbles lasted from about 50 ps up to more than 250 ps, and presented evidence that the length of the pulse for a given bubble is identical in the red and the UV parts of the spectrum. Applying the Stuttgart technique, researchers at the University of California, Los Angeles were able to confirm the result, and found that the flash width varies by less than 3 ps from 200 nm to 800 nm. The different pulse widths for different bubbles depend on the composition of the bubble's gas and on the intensity of the emitted light. The color-independence of the pulse duration rules out the "adiabatic heating" hypothesis, because blackbody radiation should last longer at the longer wavelengths. Both groups think that bremsstrahlung remains a viable mechanism for producing the light. (B. Gompf *et al.*, *Phys. Rev. Lett.* **79**, 1405, 1997; Hiller *et al.*, *Phys. Rev. Lett.* **80**, 1090, 1998.) —BPS

CORRECTION: In the January 1998 Physics Update, "Do Earthquakes Have Electrical Precursors?" (page 9), the sixth sentence should have begun, "Varotsos claims to have predicted . . ." ■