

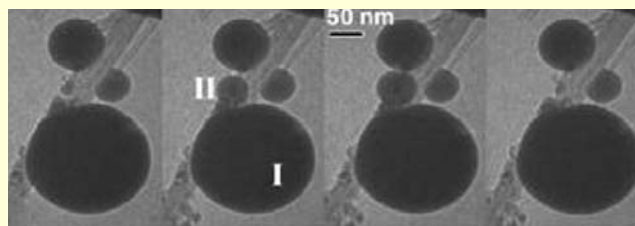
Pyrofusion. A room-temperature, palm-sized neutron generator that uses nuclear fusion has been reported by UCLA scientists. The key component is a pyroelectric crystal that, when heated, becomes charged on a surface. The researchers attached a tungsten probe to a copper disc mounted on the crystal and put the whole arrangement in a vacuum chamber containing deuterium gas. When the crystal is heated, a strong 25-V/nm electric field is generated at the end of the tungsten tip; any nearby deuterium atoms have their electrons stripped away. Repelled by the positively charged tip in the electric field, the resulting deuterium ions then accelerate toward a solid target of erbium deuteride and slam into it so hard that some of the deuterium ions fuse with deuterium in the target. Each D–D fusion reaction creates a helium-3 nucleus and a 2.45-MeV neutron. In a typical heating cycle lasting several minutes, the researchers measured a peak of about 800 neutrons per second—400 times the background of naturally occurring neutrons. The researchers think they can scale up the observed production to more than 10^6 neutrons per second by using a larger tungsten tip, operating at cryogenic temperatures, and constructing a target containing tritium. (B. Naranjo, J. K. Gimzewski, S. Putterman, *Nature* **434**, 1115, 2005).

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The most neutron-rich doubly-magic nucleus, nickel-78, has had its lifetime measured. In a classical chart of the standard nuclides, only 10 nuclei have both their neutron and proton shells filled. Of those, ^{78}Ni and ^{48}Ni are the most exotic, the least stable, and the most difficult to observe. Scientists at the National Superconducting Cyclotron Laboratory at Michigan State University have now culled 11 specimens of ^{78}Ni from the debris of trillions of medium-energy nuclear collisions. From those events they deduced a lifetime of 110 milliseconds—some 2–4 times shorter than previous theoretical estimates. Lifetimes were also determined for the neighboring isotopes of ^{77}Ni , ^{76}Ni , and ^{75}Ni . The new result has implications for the astrophysical rapid neutron-capture process, known as the r-process, whereby elements heavier than iron are produced. (For more on the r-process, see the article in *PHYSICS TODAY*, October 2004, page 47.) Indeed, the shorter-than-expected lifetime of ^{78}Ni means that the rapid nucleosynthesis is further accelerated. (P. T. Hosmer et al., *Phys. Rev. Lett.* **94**, 112501, 2005.)

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Nanoscale electric motor based on surface tension has been devised. Physicists at the University of California, Berkeley put two molten metal droplets—one of 30- and one of 90-nm radius—on the spine of a carbon nanotube. With a



small DC voltage applied, atoms diffused along the CNT from the large drop to the small one, whose radius grew much faster than the large one's shrank. In effect, potential energy was stored as surface tension in the smaller droplet. Eventually, the drops touched, and the higher internal pressure of the smaller one very rapidly drove the fluid back into the bigger one through the newly opened hydrodynamic channel. The cycle (shown in the photos) then repeated. The device is a "relaxation oscillator," with a slow buildup and a rapid release of energy. Varying the voltage easily changes the operating frequency—a complete cycle took about 30 s at 1.3 V, about 6 s at 1.4 V, and about 1.2 s at 1.5 V. Attached to a mechanical linkage, the device could be used as a nanoelectromechanical actuator. (B. C. Regan et al., *Appl. Phys. Lett.* **86**, 123119, 2005.)

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The experimental evidence for pentaquarks is fading, but not extinguished. The proton, the neutron, and all the other well-established baryons can be described as bound states of three quarks. But pentaquarks—if they exist—have combinations of quantum numbers that require five quarks. The oldest candidate is the $\Theta^+(1540)$, a putative positive-strangeness baryon with a mass of 1.54 GeV (see *PHYSICS TODAY*, September 2003, page 19). Since 2003, 10 low-statistics experiments have claimed to see it. At the April 2005 meeting of the American Physical Society in Tampa, Florida, however, Raffaella De Vita of the CLAS collaboration at the Thomas Jefferson National Accelerator Facility reported that the group found no sign of the $\Theta^+(1540)$ in a new photoproduction experiment with at least 100 times as many gamma-proton scattering events as any of the previous experiments. A heavier pentaquark candidate, the anti-charmed $\Theta_c^0(3100)$, although embattled, is still in the running. On 27 April, at the International Workshop on Deep Inelastic Scattering in Madison, Wisconsin, Karin Daum of the H1-detector collaboration at the HERA electron-proton collider ring in Hamburg, Germany, reported that the group's evidence for the anticharmed pentaquark, first reported in 2004, is getting stronger. But the rival ZEUS collaboration, also at HERA, has found no evidence for it. The two groups have put their heads together, but have not as yet reconciled their difference.

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