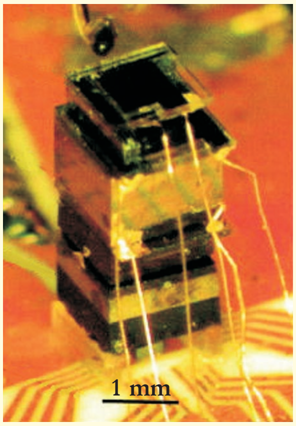
The world's smallest atomic clock has been built at NIST in Boulder, Colorado. About the size of a rice grain (see photo), the clock is built around a semiconductor laser, micro-optics, a heater, and a microcell filled with cesium atoms. Using only 73 mW of electrical power, the clock has a precision of 2.5×10^{-10} over 1 second and 2.5×10^{-11} over 250 seconds. Far more precise clocks are available—some are good to about one part in 10^{15}—but they can require a large tabletop's worth of equipment. This new, tiny, low-power, high-precision clock is also likely to be cheap; it uses standard microfabrication techniques whereby the same process sequence can make thousands of the physics packages on silicon wafers. The timekeeper could be used, for example, in a variety of hand-held, battery-operated devices. (S. Knappe et al., *Appl. Phys. Lett.* **85**, 1460, 2004.) —PFS



The massive Northeast blackout of a year ago shut off not only electricity for 50 million people in the US and Canada, but also the pollution coming from fossil-fueled turbogenerators in the Ohio Valley. In effect, the power outage was an inadvertent experiment for gauging atmospheric repose with the power grid gone. University of Maryland scientists sampled the air with two light-aircraft flights on 15 August 2003, one outside and one inside the blacked-out region; they also looked at samples from a year earlier. The results were striking: About 24 hours into the blackout, sulfur dioxide was down 90%, ozone was down 50%, and light-scattering particles were down 70% over "normal" conditions in the same area. The observed pollutant reductions exceeded expectations, which led the researchers to suggest that the spectacular overnight improvements in air quality "may result from underestimation of emissions from power plants, inaccurate representation of power plant effluent in emission models, or unaccounted-for atmospheric chemical reactions." (L. T. Marufu et al., *Geophys. Res. Lett.* **31**, L13106, 2004.) —PFS

Protein-based nanoactuators can now be controlled rapidly and reversibly by thermoelectric signals. Scientists designing nanoscale devices would like to emulate the efficiency and compactness of the molecules, such as actomyosin, that control muscles in living creatures. A key goal is the simple, controlled, rapid activation of the protein motors. And that's what researchers at Florida State University have done. They set up a flow cell in which motor molecules (which can remain viable for days when refrigerated) were thermally activated in a controllable and reversible way with an electric heater. An important goal of this work, according to FSU's Goran Mihajlović, is to use the protein motors to power linear motion of nanowires; if the wires are themselves magnetic, then the motion could be monitored via a field sensor. The result would be a nanoactuator, controlled electrically but powered with biochemical energy. Possible future applications include a role in bioanalysis chips and gene delivery. (G. Mihajlović et al., *Appl. Phys. Lett.* **85**, 1060, 2004.) —PFS

A four-dimensional universe has been dynamically generated from the seething, quantum-fluctuating spacetime foam of quantum gravity, in which even the notion of "dimension" is slippery. Just as nonrelativistic quantum mechanics can be formulated with Feynman path integrals, quantum gravity can be expressed with sums over geometries; however, attempts to define the sum over geometries have, to date, yielded degenerate spacetimes that do not resemble our universe. But now, a team of researchers from Denmark, Poland, and the Netherlands have found a highly nontrivial prescription for summing geometries that typically yields a stable, macroscopic 4D spacetime. In their formulation, the sum over geometries can be studied with Monte Carlo simulations. A crucial ingredient is the requirement that contributing geometries be causally well behaved. That requirement drastically cuts down the number of summed geometries, and leads to the qualitatively new behavior. (J. Ambjørn, J. Jurkiewicz, R. Loll, *Phys. Rev. Lett.*, in press.) —SKB

The size of the lightest halo nucleus, helium-6, has been precisely measured by performing laser spectroscopy on individually trapped ^{6}He atoms. Although one neutron does not stick to an alpha particle, two neutrons can, and for about a second, they form the loosely bound halo of the ^{6}He nucleus. The size of this exotic nucleus reveals the fundamental forces among the constituent nucleons. Physicists at Argonne National Laboratory produced ^{6}He atoms at the lab's ATLAS accelerator facility and quickly captured and cooled them with a magneto-optical trap. By comparing spectra of ^{6}He with ^{4}He, the scientists determined that the charge radius of the ^{6}He nucleus was just over 2 fm. The result is model independent and is precise enough to test the available theoretical predictions. (L.-B. Wang et al., *Phys. Rev. Lett.*, in press.) —SGB