PHYSICS UPDATE

FRANCIUM, THE WORLD'S RAREST ELEMENT, has been successfully trapped, setting the stage for high-precision measurements of its atomic structure and of the Standard Model unification of the electromagnetic and weak forces. The heaviest of all alkali atoms, francium's most stable isotope has a half-life of only 22 minutes; less than an ounce of francium exists on the Earth at any one time. Researchers at the State University of New York at Stony Brook prepare francium-210 (with a half-life of 3.2 minutes) at their accelerator and reduce its energy by some 14 orders of magnitude to capture it in a magneto-optical trap. (For more on trapping radioactive atoms, see PHYSICS TODAY, September 1994, page 19.) About 10^6 atoms per second are delivered to the entrance of a glass cell, where approximately 10^4 atoms are captured by the trap at a density of about 10^7 cm^{-3}. The challenges with francium have been to increase the trapping efficiency for these scarce atoms and to find the required laser frequencies for trapping, since there are no known stable isotopes of francium to provide a reference. The researchers are currently trying to locate the 8S and 9S electronic states of the atom, two energy states that are important for the relatively large parity nonconservation predicted by electroweak unification. This effect should be at least 18 times more pronounced in francium than in cesium—for which the smallest combined theoretical and experimental uncertainty thus far has been achieved. (J. E. Simsarian *et al.*, *Phys. Rev. Lett.* **76**, 3522, 1996.) —BPS

DIRECT EVIDENCE FOR FIELD QUANTIZATION now comes from studies of Rydberg atoms in a cavity with very weak microwave fields. Serge Haroche, Jean-Michel Raimond and their colleagues at the Ecole Normale Supérieure in Paris prepared rubidium atoms with a principal quantum number of 51, sent them marching individually into a very high Q superconducting cavity with, on average, less than two photons inside, and monitored their transitions to $n = 50$. They observed the so-called Rabi nutation—an atomic oscillation between the two states—as well as discrete frequency components in the signal, corresponding to the presence of zero, one, two and three photons. (M. Brune *et al.*, *Phys. Rev. Lett.*, **76**, 1800, 1996.) —BPS

A NEW MATERIAL SHRINKS WHEN HEATED over a wide temperature range, from 0.3 K up to 1050 K, at which temperature it breaks down. Unlike most materials, which expand when heated, the zirconium tungstate compound (ZrW_2O_8)—made by an Oregon State University and Brookhaven National Laboratory collaboration—exhibits a negative thermal expansion in all three dimensions. The size of the zirconium tungstate structure is closely monitored as the temperature is raised, using both neutron and x-ray diffraction. Relative to its size at room temperature, the ceramic is 0.25% larger at 0.3 K and is 0.50% smaller at 1050 K. The researchers found that HfW_2O_8 exhibits similar thermal behavior. An important role for such a material would be as a blended component in composite materials in which it is desirable to keep thermal expansion to a minimum. Previously known materials that shrink have done so only over a small temperature range, or have shrunk anisotropically. Individual particles of some bakeware ceramics, for example, shrink in one dimension but actually expand in the other two dimensions; repeated thermal cycling, however, can lead to microcracking and ultimate failure. (T. A. Mary *et al.*, *Science*, **272**, 90, 1996.) —PFS

IDENTIFYING MOLECULES with a scanning tunneling microscope has taken a step forward with work done at IBM's T. J. Watson Research Center. Phaedon Avouris and his colleagues studied the oxidation of silicon using a novel atomic scale STM-induced modification scheme. In this scheme the energy of the STM tip-emitted electrons is tuned to match the energy of strongly antibonding unoccupied orbitals of O_2 molecules. Under these conditions, O–O bonds were broken selectively, allowing the researchers to identify the surface sites to which molecular oxygen was attached. They found that some O_2 was bonded to previously oxidized silicon while other O_2 molecules reached down to previously unaffected silicon in the second atomic layer. (R. Martel, P. Avouris, I.-W. Lyo, *Science*, **272**, 385, 1996.) —SGB

THE EVIDENCE FOR HYPERDEFORMATION of high-spin nuclei reported a year ago by Washington University (in St. Louis) experimenters Dennis LaFosse, Demetrios Sarantites and collaborators seems now to have gone away. Using the then-new Gammasphere gamma detector array at the Lawrence Berkeley National Laboratory's 88-inch cyclotron, the Sarantites group found "picket-fence" gamma spectra strongly suggestive of gadolinium nuclei so distorted by high spin that they took on cigar shapes three times as long as they were wide. (See PHYSICS TODAY, November 1995, page 17.) The existence of such hyperdeformation would present a major challenge to nuclear theory. But in a second paper, submitted in April to *Physical Review C*, the group reports that a 15-fold increase in its data sample has not yielded anything like the 15-fold increase one would expect in the hyperdeformation signal if the effect were real. (D. LaFosse *et al.*, *Phys. Rev. Lett.* **74**, 5186, 1995.) —BMS ■