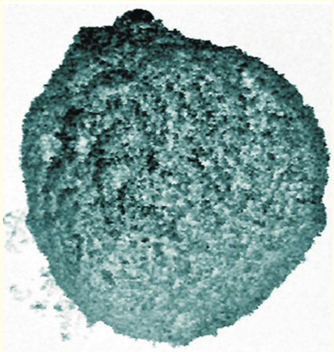
PHYSICS UPDATE

SUPERCONDUCTING BALLS have been observed. Physicists at Southern Illinois University created a "mud" of micrometer-sized high-T_c particles suspended in liquid nitrogen, placed it between two electrodes in a nitrogen bath, and switched on a DC electric field. Normally, particles in this situation would either bounce between the two electrodes or tend to line up in chains; after all, a uniform electric field defines a preferred direction in space. However, the tiny superconducting particles ignored their cue and, to the researchers' great surprise, formed themselves into a ball instead, which *then* bounced rapidly between the electrodes, frantically acquiring and releasing charge. Such balls formed in milliseconds and were very sturdy, surviving many high-impact collisions with the electrodes. One ball, about 0.25 mm across and containing over a million particles of $Bi_2Sr_2CaCu_2O_{8+x}$, is shown here. Using a bath of liquid argon, the researchers showed that the ball dissolved at temperatures above T_c. Apparently, the balls form through a new surface tension phenomenon that arises from a competition between coherence and screening effects. According to Rongjia Tao, the new discovery might provide an important clue for distinguishing high- from low-T_c superconductivity, and could have applications in the area of superconducting thin films and unusual forms of wetting. (R. Tao *et al.*, *Phys. Rev. Lett.* **83**, 5575, 1999.) —PFS



THE MYSTERY OF PRODUCING TANTALUM-180, nature's rarest isotope, may now be understood. The isotope is scarce because its nucleosynthesis is mainly bypassed in the two processes that produced most of the heavy elements we find here on Earth: the s-process (slow neutron capture within stars) and the r-process (rapid neutron capture during supernova explosions). The ^{180}Ta nucleus, with a halflife of more than 10^{15} years, is also the only naturally occurring nuclear isomer—it is essentially in a perpetually excited state. Now, a group of physicists in Germany has found that some ^{180}Ta *can* arise in the s-process. At the Dynamitron accelerator in Stuttgart, they exposed ^{180}Ta to an intense beam of gamma rays, simulating the thermal-photon conditions inside a star, and found that the long-lived isomer can be jarred through an intermediate state into its short-lived ground state (with an effective halflife of only a month, 10^{17} times less than that of the isomer!). Moreover, the temperature of the radiation field corresponded to that of the brief "helium flash" phase in a star's evolution; rapid convection of the stellar material would then quickly remove the ^{180}Ta to cooler regions, where it could then survive in its stable isomeric form. (D. Belic *et al.*, *Phys. Rev. Lett.* **83**, 5242, 1999.) —PFS

COLLISIONALLY IONIZED HYDROGEN, the simplest nontrivial three-body Coulomb scattering problem in quantum mechanics, has now been solved from first principles. When a sufficiently energetic free electron impinges on a neutral hydrogen atom, the bound electron is separated from its proton, and the resulting now-indistinguishable electrons move farther and farther apart from each other (and from the proton) at arbitrary angles and momenta. The wavefunction for that final, asymptotic state is a boundary condition for the problem, and has proven intractable to calculate; thus the dynamical details of the scattering have been impossible to predict. Now, however, a collaboration of California theorists has reformulated the problem. Using massively parallel computational techniques, they first computed the complete wavefunction in a limited region of space, without explicitly referring to an asymptotic state (somewhat analogous to near-field optics), then extracted the dynamical details from the computed solution. By solving the problem for different sized regions, they were able to extrapolate to the asymptotic state. Because the only approximations are numerical rather than physical in nature, the results can be made as accurate as the computational resources allow. Indeed, the researchers are able to fit the best recent experimental cross sections exquisitely well, with no adjustable parameters. (T. N. Rescigno *et al.*, *Science* **286**, 2474, 1999.) —SGB

ULTRASENSITIVE ATOM TRAP TRACE ANALYSIS (ATTA) has been demonstrated. Some well-developed trace analysis techniques, such as accelerator mass spectrometry or low-level counting, lose their effectiveness when the sample being examined is highly contaminated with other isotopes and elements. Now, a group of physicists at Argonne National Laboratory has trapped, detected, and counted single atoms of krypton-85 (with a relative natural abundance of only 10^{-11}) and krypton-81 (abundance of 10^{-13}) in a magneto-optical trap, starting with naturally occurring krypton gas. The ^{85}Kr isotope (halflife 10.8 years) is useful for studies of oceanic, atmospheric, and groundwater transport, while ^{81}Kr (halflife 2.3×10^5 years) is good for dating million-year-old samples of ice and groundwater. ATTA is also sensitive to other useful isotopes, including cesium-135 and cesium-137 for monitoring long-lived nuclear waste, lead-205 for measuring solar neutrinos, and argon-39 for tracing deep ocean currents. (C. Y. Chen *et al.*, *Science* **286**, 1139, 1999.) —PFS