Physics Update

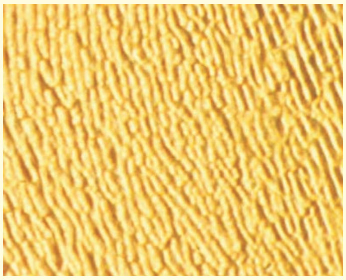
Interatomic coulombic decay (ICD) has been experimentally confirmed. In 1997, this new mode of atomic decay was predicted for weakly bound atoms (as in a cluster or a fluid): One atom of the cluster is excited; but a different, neighboring atom ejects a low-energy electron. A research team in Germany has now unambiguously demonstrated ICD in the smallest possible cluster of neon atoms—a dimer—with the two atoms joined by the weak van der Waals force. The removal of a tightly bound electron from one of the atoms allowed a less tightly bound electron to jump into the vacancy and thereby gain energy. The extra energy was insufficient to liberate any of the remaining electrons in that same atom, but it was sufficient to release a low-energy electron from the neighboring atom. The scientists detected ICD's fingerprint: the two neon ions, emitted back-to-back with equal momenta, and the ejected electron, with all kinetic energies adding up to a constant. In separate work, a group in Sweden experimentally found that ICD was slower on the surface of a large neon cluster than in the bulk. That finding was consistent with the theory and showed the exquisite sensitivity of ICD to the chemical environment—in this case, the number of atomic neighbors. Though generally masked by inelastic scattering, ICD may have a wide-ranging impact in chemistry and biology; it should occur frequently in most hydrogen-bonded systems, including liquid water. (T. Jahnke et al., *Phys. Rev. Lett.* **93**, 163401, 2004; G. Öhrwall et al., *Phys. Rev. Lett.* **93**, 173401, 2004.)

—BPS

The cycle of the natural nuclear reactor in Gabon, West Africa, has been uncovered. In 1972, a site with the necessary conditions for self-sustained fission was found at the Oklo mine in Gabon: A 2-billion-year-old uranium deposit some 5–10 meters thick and 600–900 meters wide was bathed by an ancient river. That natural reactor is estimated to have operated at an average power of 100 kW over its 150 000-year lifetime. By examining in detail the reactor's krypton and xenon isotopes in grains of aluminous hydroxy phosphate, physicists at Washington University in St. Louis have now discovered the reactor's operating cycle: 30 minutes on followed by 2.5 hours off. While on, the reactor's heat boiled the nearby water until there wasn't enough to slow the neutrons adequately, whereupon the reactor turned off until it cooled enough for the steam to condense. The researchers also note that the Al phosphate's ability to capture fission products may be useful in man-made reactors and nuclear waste storage. (A. P. Meshik et al., *Phys. Rev. Lett.* **93**, 182302, 2004.)

—PFS

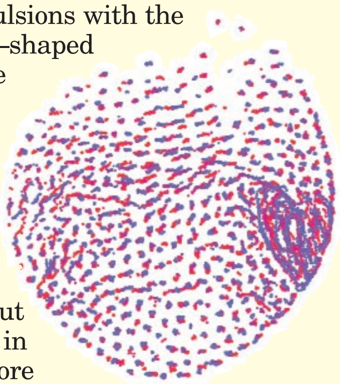
Spontaneous pattern formation with incoherent white light. For many years, smooth, coherent optical beams propagating in nonlinear media have been known to break up into regular periodic patterns of bright and dark spots, resulting from competition between diffraction and nonlinearity. Now, a group of physicists at the Technion—Israel Institute of Technology has demonstrated spontaneous pattern formation using light from an ordinary incandescent bulb, which is both temporally and spatially incoherent.



The photograph shows a characteristic spontaneously formed pattern of 10-micron-thick filaments of white light from the technion experiment. The process is a collective phenomenon wherein all colors interact with each other and lock into a single periodic pattern. Furthermore, all the colors begin the pattern-formation process at a specific common nonlinearity threshold, and the spectrum of the light self-adjusts so the pattern's contrast is higher at shorter wavelengths. The physicists say the phenomenon is universal; it may be found in other wave systems that exhibit interplay between nonlinearity and random statistics or noise. (T. Schwartz et al., *Phys. Rev. Lett.* **93**, in press.)

—SGB

Coulomb dust balls. Physicists at the Universities of Kiel and Greifswald in Germany have been able to produce spherical clouds of plastic 3.4-micron balls—"dust" particles—in the middle of a hot plasma. The particles managed to balance their mutual negatively charged repulsions with the plasma's compressive force—shaped by a glass tube enclosing the particles—and arranged themselves into a void-free spherical cloud. A cloud's internal form depended on its size. Coulomb balls of up to a few thousand particles showed nested, concentric shells near their surfaces. But no such order was apparent in the largest Coulomb ball (more than 6000 particles and 15 mm in diameter). The vertical slice through the center of that one, shown here, reveals a region of rapid liquid-like flow on the right and a frozen, solid-like region at the bottom.



For more on dusty plasmas, see PHYSICS TODAY, July 2004, page 32. (O. Arp et al., *Phys. Rev. Lett.* **93**, 165004, 2004.)

—PFS

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