Physics Update

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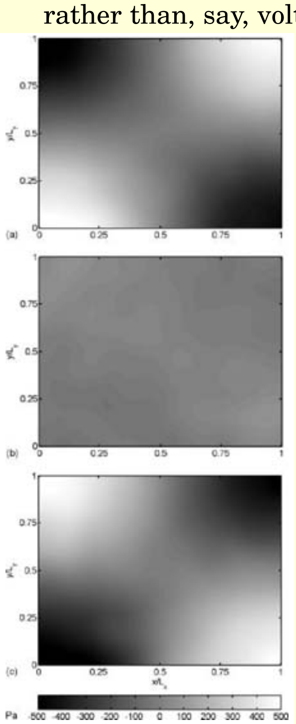
Shock-produced coherent terahertz light. Physicists at MIT and Lawrence Livermore National Laboratory have uncovered a new source of coherent radiation distinct from both traditional and free-electron lasers. Their theoretical work predicts that weak but measurable coherent light in the THz regime is produced when a shock wave passes through virtually any dielectric crystal, including table salt. The light-producing mechanism is a temporally periodic polarization current produced by the concerted motion of row after row of atoms in the target crystal. The physicists were surprised by the light's coherence, which arises not from the source of the mechanical shock but from the periodicity of the lattice. The next step will be to conduct an experimental test of the prediction at two national labs—Livermore and Los Alamos. According to team member Evan Reed, the first likely application of coherent radiation will be as a diagnostic for understanding shock waves. The radiation should also provide information about atomic-scale properties of the shocked crystal. (E. J. Reed et al., *Phys. Rev. Lett.* **96**, 013904, 2006.) —PFS

Pressure-sensitive paint (PSP) as an array of optical microphones. An optical microphone responds to an acoustic signal by modulating light rather than, say, voltage. If that microphone is an oxygen-sensing molecule—a luminophore—embedded in a coat of paint and if the luminophore is in an excited state, then the paint's luminescent intensity is reversibly changed as the oxygen's partial pressure changes. That's PSP, which has been used in one-dimensional and single-spot acoustic experiments. Going to 2D, scientists from Purdue University and the Georgia Institute of Technology prepared a special PSP that is porous enough to allow fast diffusion of air into it, and used it to coat a 365-cm^2 inner wall of a rectangular resonant cavity. With an operating loudspeaker mounted on another wall and a light source to continually excite the luminophores, the researchers demonstrated the system's viability by using a CCD camera to record a particular mode of an acoustic standing wave at the wall. Shown here are images taken at phases of 0, $\pi/2$, and π. The data provided a complete history of the pressure at more than 137 000 pixel locations across the wall. The acousticians say that the technique can measure pressure amplitudes as low as 50 Pa (atmospheric pressure is about 10^5 Pa) and has no theoretical upper limit. (J. W. Gregory et al., *J. Acoust. Soc. Amer.* **119**, 251, 2006.) —SGB



A cosmic peek at spacetime foam. Far from being a passive backdrop, spacetime is generally thought to be dynamic, undergoing quantum fluctuations that make it foamy on the scale of the minuscule Planck length, about 10^{-35} m. There is no consensus on the size or character of the fluctuations: Two current models are the so-called holographic model, which is consistent with black-hole physics, and the uniform random-walk model. For any model, the fluctuations give rise to exceedingly tiny uncertainties in distance measurements. Three physicists from the University of North Carolina at Chapel Hill have found a way to use extragalactic point sources—like very distant active galactic nuclei or quasars—to amplify those infinitesimal effects. The key idea is that a propagating wavefront acquires uncertainties in both phase and direction as it moves through and scatters off the spacetime fluctuations. If the light's wavelength is short enough (radio won't work) and the travel path long enough, those uncertainties will show up in interferometric observations as a decreased fringe visibility. Using *Hubble Space Telescope* observations of an appropriately bright and distant source, the UNC researchers have decisively ruled out the random-walk model. According to them, proposed large optical instruments such as the VLT and Keck interferometers will be on the verge of probing the holographic model. (W. A. Christiansen, Y. J. Ng, H. van Dam, *Phys. Rev. Lett.* **96**, 051301, 2006.) —SGB

Fission fragments weighed. A team of scientists from the University of Jyväskylä in Finland has made high-precision mass measurements of 23 neutron-rich isotopes of strontium, zirconium, and molybdenum. The isotopes were produced as ions in proton-induced fission reactions of uranium. The researchers obtain a precision of about 10 keV by coaxing an isotopically clean ion bunch into a Penning trap—which combines a strong magnetic field with a static electric quadrupole field—where the ions' mass can be deduced from the observed cyclotron motion in the magnetic field. The improved isotope masses provide information about nuclear binding energies and can reveal subtle effects in the complex structures of those nuclei. Astrophysicists, who consider how nuclei are built inside stars or novae, are also interested in the more precise data. (U. Hager et al., *Phys. Rev. Lett.* **96**, 042504, 2006.) —PFS ■