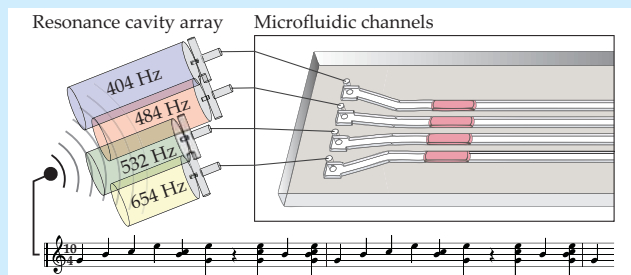


average, the jockey moves slower. That out-of-phase response could help the horse to execute a smoother, more energy-efficient gallop. (T. Pfau et al., *Science* **325**, 289, 2009; photo by Pharaoh Hound.) —SKB

Droplets move to microfluidic chamber music. In principle, setting a droplet in motion inside a microfluidic channel is straightforward: Apply pressure and the liquid flows. In practice, however, precise control of droplet flow along multiple channels simulta-



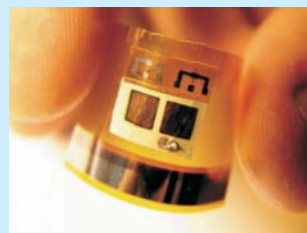
neously is challenging; conventional pressure pumps are not feasible for microfluidic systems. Inspired by the potential of finely tunable acoustic-pressure generators, a group of engineers at the University of Michigan set out to control droplet motion with music. First, they composed a computer-synthesized sequence of single notes and chords. That signal was then sent to four resonance cavities that were tuned according to their lengths to extract and amplify narrow, non-overlapping frequency bands from the input tones. As shown in the figure (and the movie online), unidirectional droplet flow arose from the difference between positive air pressure in the oscillating cavity and relative negative pressure at vent ports near the cavity's outlet. Although the relatively high frequencies of the selected tones produced steady flow, the researchers adjusted the relative amplitudes of the input tones as needed to compensate for variations in average flow velocity. The researchers suggest that someday, conducting complex lab-on-chip microfluidic operations will be as simple as stringing together a few musical notes. (S. M. Langelier et al., *Proc. Natl. Acad. Sci. USA* **106**, 12617, 2009.) —JNAM

Testing gravity's Lorentz invariance. Today's best fundamental theories—whether for gravity, electrodynamics, or elementary particles—say that the laws of physics are identical for all inertial observers, independent of their speed or direction of motion. That so-called local Lorentz invariance has been well tested for quantum field theories (see *PHYSICS TODAY*, July 2004, page 40). To date, however, the LLI of gravitational interactions has received little attention, mostly because the weakness of gravity requires exquisitely sensitive experiments. In general, LLI tests are examined within the “standard model extension,” which incorporates a series of coefficients, nine of which reflect gravitational effects. Any nonzero coefficients demonstrate violations of LLI and could reveal clues about quantum gravity, variants on general relativity, or physics beyond the standard model. Some previously undetermined coefficients have now been pinned down by Holger Müller of the University of California, Berkeley, and his colleagues. Using an atom interferometer with an atomic fountain, they looked for anomalous variations in the gravitational acceleration g as Earth revolves through space. The physicists combined new results with those from previous experimental runs and with lunar-ranging data (see *PHYSICS TODAY*, May 1996, page 26). The bottom line? Of the nine independent gravitational coefficients, five are now known to be zero to within parts per billion, and three to parts per million. One remains undeter-

mined. The team also established that further improvements can come from using horizontal devices—perhaps guided atoms. (K.-Y. Chung et al., *Phys. Rev. D* **80**, 016002, 2009.) —SGB

Large survey of distant galaxy clusters. The types of galaxies that populate our universe have changed over time. The population evolution can be at least partly unraveled by studying the cores of rich clusters of galaxies, then comparing them across cosmic time—at different cosmological redshifts z . But few such clusters are known with $z > 1$. At those higher redshifts, the most prominent spectral feature of the elliptical galaxies at rich clusters' cores—the 4000-Å break in the continuum that occurs when there is a dearth of hot, blue stars—is shifted into the IR. A proven detection method is to scan the sky in two wavelength bands, one on either side of the 4000-Å break, but only recently have near-IR detectors become available that allow ground-based telescopes to see the “blueward” side of the shifted spectral break in distant clusters. A new study, named the *Spitzer* Adaptation of the Red-sequence Cluster Survey, found hundreds of new galaxy cluster candidates using relatively modest observational resources. The astronomers surveyed high- z galaxies by combining wide-field observations from telescopes in Hawaii and Chile with archival IR data from the *Spitzer Space Telescope*. Follow-up observations of the first three candidates confirmed them to be massive clusters at $z \sim 1.2$ – 1.3 , firmly in the realm where evolutionary effects can begin to be studied. The authors expect to confirm many additional distant clusters from the SpARCS survey. (A. Muzzin et al., *Astrophys. J.* **698**, 1934, 2009; G. Wilson et al., *Astrophys. J.* **698**, 1943, 2009.) —SGB

A nanocomposite for electronic skin. Human skin, the largest organ in our body, is a sensitive detector of both pressure and temperature. Efforts to develop similar sensors for electronics are widespread, and many of the tools are already well known: Piezoelectric materials generate electrical signals in response to changes in applied pressure, and pyroelectrics are sensitive to changes in temperature. Unfortunately, most materials that fall into one of those categories also fall into the other, which makes it difficult to discriminate between pressure and temperature changes. But an international team is reporting a nanocomposite that separates the two sensitivities. The bifunctional material features nanoparticles of the piezoelectric ceramic lead titanate embedded in a ferroelectric polymer that can be pressed into a film 30 μm thick. The polarizations of the two constituents can be configured independently. In particular, an alternating voltage



can be used to orient the polymer's polarization with respect to the ceramic's. When the polarizations are parallel, the piezoelectric coefficients of the polymer and composite cancel, whereas the pyroelectric response is enhanced; when antiparallel, the material displays only a piezoelectric response. By controlling the phase of the last cycle of the AC voltage applied to different parts of their composite film, the researchers defined regions that were sensitive to either pressure or temperature. The film thus prepared could be mounted to a flexible foil containing silicon or organic transistors; the figure shows a prototype with two sensor regions. Initial results showed linear responses by the pressure- and temperature-sensitive regions with only limited cross-sensitivities. (I. Graz et al., *J. Appl. Phys.* **106**, 034503, 2009.) —RJF ■