(The Pierre Auger Observatory had previously spotted a weaker hotspot in the southern sky.) In a five-year scan that concluded in May 2013, the Telescope Array identified 72 cosmic rays with energies above the GZK limit, via the shower of particles created when the UHECRs interact with Earth's atmosphere. Ground-based scintillators recorded the arrival of shower particles, and fluorescence detectors monitored the energy deposited in atmospheric nitrogen. (See PHYSICS TODAY, May 2007, page 17.) About 25% of the observed UHECRs came from the direction of the hotspot, which fills only 6% of the northern sky. The hotspot is large enough to cover many potential UHECR sources; its extent arises in part because galactic and intergalactic magnetic fields bend UHECRs and thus muddle their source locations. Fortunately, particles with energies near and beyond the GZK cutoff bend little enough that a larger and more sensitive array may yet reveal their origins. (R. U. Abbasi et al., *Astrophys. J.* **790**, L21, 2014.) —SKB

Controlling a tipping point. The concept of a tipping point is familiar: A generally stable system evolves to where the stability disappears and the system suddenly and irreversibly switches to a dramatically different, perhaps catastrophic state. The system may be a power grid that experiences a slow rise in demand, leading to a large-scale power outage, or a climate system, subject to increasing greenhouse gases, that has an abrupt shift in mean temperature. For a system with multiple potential outcomes, Takashi Nishikawa (Northwestern University) and Edward Ott (University of Maryland) report that it may be possible to steer the system to a desirable outcome by giving it a small, carefully chosen push. They theoretically consider the evolution of a noisy one-dimensional system: At each iteration, the current position is mapped to a new position, where the mapping depends on a slowly varying parameter plus some random noise. When the parameter reaches a threshold value—a so-called bifurcation—the system will shift to one of two states, but which it is can depend very sensitively on the noise fluctuations or the particular details of how the parameter varies. The researchers show with simulations and analytically that if the noise amplitude is low, one can get a 90% chance of reaching the desired outcome through a one-time shift in the system's position by an amount just a few times larger than the noise level. Surprisingly, the required nudge is smallest during a window of opportunity that occurs a finite time after the bifurcation. Although the method can be generalized to higher dimensions, the authors caution that it requires having an accurate system model. (T. Nishikawa, E. Ott, *Chaos* **24**, 033107, 2014.) —RJF

The most distant stars in our galaxy. The Milky Way, the Sombrero (shown here), and other spiral galaxies are enveloped by huge spherical halos of dark matter, low-density gas, and sparsely distributed stars. John Bochanski of Haverford College and his collaborators are searching for our galaxy's outermost halo stars, whose properties carry clues about the galaxy's past. The search focuses on red giants. Besides being luminous—and therefore detectable at large distances—red giants have IR spectra that set them apart in photometric surveys from other stars except red dwarfs. But red dwarfs, being less luminous, are found at shorter distances; their apparent motions across the sky tend to be quicker than those of distant red giants. From two photometric surveys and one kinematic survey, Bochanski's team has identified

404 red giant candidates. Fifteen were subjected to the first round of spectroscopic observations. One candidate was unidentifiable, nine were red dwarfs, and three were not-too-distant red giants. But two candidates turned out to be red giants whose distances, 238 kiloparsecs (8.09×10^5 light-years) and 274 kiloparsecs (8.94×10^5 light-years), are roughly seven times larger than the diameter of our galaxy's disk. At those record-breaking distances, the ambient gas is too rare to feed star formation; the two stars were born elsewhere. Two origins are plausible: The stars could be leftovers from a satellite galaxy that the Milky Way consumed, or they could have been flung into the halo from our galaxy's disk by a violent event. (J. J. Bochanski et al., *Astrophys. J. Lett.* **790**, L5, 2014.) —CD

The sound of the slurry. The mining and minerals industry has long used flowing water as a cost-effective and safe way to move its waste tailings from their origin to a storage pond. (See the article in PHYSICS TODAY, March 2009, page 31.) And nuclear sludge such as that held in tanks at Hanford, Washington, in the US and at Sellafield in the UK can also be hydraulically transported for eventual treatment. But a hydraulic conveyor needs continual monitoring to avoid blockages, maintain pressures, and minimize corrosion. Many monitoring methods are in use, but the job quickly gets complicated when solid–liquid suspensions are difficult or dangerous to access as they tumble along a pipeline and when they consist of a range of particle sizes and densities. As part of his PhD work at the University of Leeds in the UK, Hugh Rice took an acoustic method that was previously used to characterize marine sediments and adapted it for optically opaque industrial flows. Using a pair of piezoelectric transducers operating at 2 MHz and 4 MHz, Rice and colleagues have obtained attenuation and backscattering coefficients for each of four particle types, ranging in size (40–700 μm), density (glass and plastic), and shape (spherical and jagged). Until now those coefficients were available only for quartz sand. Using a dual-frequency algorithm borrowed from marine science to invert the signals in flowing suspensions, the researchers tested the flow-measurement method in a pipe as shown here. The results showed particle segregation and different flows for different particles. Ultimately, Rice and company expect to use such measured coefficients to obtain concentration profiles and flow regimes in arbitrary industrial settings. (H. P. Rice et al., *J. Acoust. Soc. Am.* **136**, 156, 2014.) —SGB