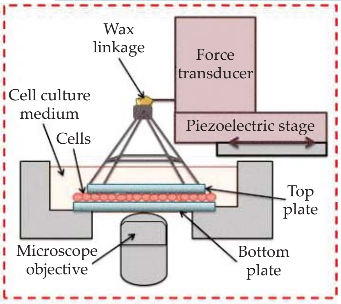
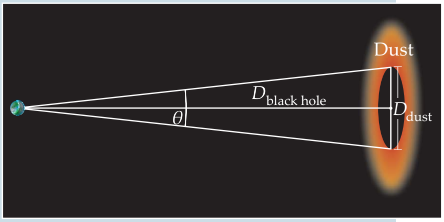
cations secure from would-be eavesdroppers (see the article by Daniel Gottesman and Hoi-Kwong Lo, PHYSICS TODAY, November 2000, page 22). Now Pepijn Pinkse and colleagues at the University of Twente and the Eindhoven University of Technology have shown how to provide fraud-proof physical identification using quantum-secure authentication (QSA). The keys for their experiment were thin layers of white paint sprayed onto the "cards" to be authenticated. When a light pulse comprising only a few photons is focused onto a key, the pattern of reflected light depends sensitively on the spatial shape of the incoming photon pulse, which can be programmed, and on the random, irreproducible positions of more than a million zinc oxide nanoparticles in the paint. After measuring and logging that dependence in an initial "enrollment" of the key, the researchers could interrogate the key with an arbitrary pulse shape and compare the expected response to what was actually observed. The correct key was clearly distinguishable from an incorrect key and even from an optimized forgery attempt based on stolen enrollment information. That the QSA technique does not depend on stored, secret data and can be implemented with current technology should add to its appeal. (S. A. Goorden et al., *Optica* **1**, 421, 2014.) —RJF

Cytoskeleton rheology. A cell's behavior is often closely linked to its mechanical state—for example, how it adheres to a surface or to other cells. And its mechanical state is determined largely by its cytoskeleton—a scaffolding of three distinct stiff polymers that permeates most cells (see PHYSICS TODAY, February 2010, page 60). As part of her PhD work at Stanford University, Claire Elkins (now at Abbott Vascular) developed a linear cell-monolayer rheometer (LCMR, shown here) to both image and quantitatively measure mechanical properties of living cells. She and her Stanford colleagues have now used the device to elucidate the roles of the three cytoskeletal polymers. A monolayer of live cells was placed in the LCMR between two glass plates, about 5 microns apart, and allowed to adhere to the plates. Elkins and company then imparted a shear strain to the adhered cells by sliding the top plate relative to the fixed bottom one for a given distance at a given rate. By closely monitoring the force on the top plate, they could determine a time-dependent quantity called the relaxation modulus G_r. The researchers inhibited the function of each of the three cytoskeletal polymers in turn and systematically studied the resulting cells' relaxation moduli. The results corroborated earlier single-cell studies: Inhibiting tubulin roughly doubled the maximum G_r relative to untreated cells, which means the cells stiffened appreciably; inhibiting either of the other two polymers halved G_r. Thus validated, the LCMR could become a useful biophysical tool, given the ease with which it can obtain average mechanical properties of an entire cell population. (C. M. Elkins et al., *J. Rheol.* **59**, 33, 2015.) —SGB



A geometrically determined distance to a far-off black hole. To find the distance to a nearby star, astronomers consider a triangle whose base is a diameter of Earth's orbit and whose opposite vertex is the star, which apparently shifts position as Earth executes its orbit. Simple trigonometry establishes the distance. Applicable to objects up to a kiloparsec (about 3300 light-years) away, that technique is the basis for the lowest rung of the cosmic distance ladder, the interlocking set of distance determinations that extend to the far reaches of the cosmos. Now Sebastian F. Hönig (then at the University of Copenhagen, now at the University of Southampton) and colleagues have used an analogous geometry to obtain the distance to an object many megaparsecs away: the black hole in the galaxy NGC 4151. As illustrated in the figure, the analogue of the Earth-orbit diameter is the inner diameter of a dust torus that surrounds the black hole. The violent and unstable neighborhood of the black hole sporadically emits at optical and UV wavelengths. Later, when that radiation has reached the dust, the dust reradiates in the IR. From measurements made by the Japanese MAGNUM dust-reverberation project of the time delay between the initial flash and the IR echo, Hönig and company obtained the toroidal inner diameter. They determined the vertex angle from interferometric measurements carried out at the Keck telescopes. Their black hole distance determination of 19 Mpc is precise to about 13%, not yet a new rung on the cosmic distance ladder. Novel interferometer designs, however, promise greatly increased resolution, and some physicists envision a time when geometrically determined distances will directly contribute to our knowledge of the universe's most distant objects. (S. F. Hönig et al., *Nature* **515**, 528, 2014.) —SKB



Methane emission from abandoned wells. Per kilo, atmospheric methane is about 34 times as potent a greenhouse gas as carbon dioxide is. Whether natural or anthropogenic, sources of CH_4 can therefore have a big impact on radiative forcing. Mary Kang of Princeton University and her colleagues have quantified one previously unaccounted source of atmospheric CH_4: abandoned oil and gas wells. Estimates put the number of such wells in the US at 3 million. In her study, Kang focused on 19 wells in the region where oil and gas were first extracted in the US: Western Pennsylvania. She and her colleagues placed enclosing chambers over the wellheads, like the one shown here, and measured the methane flux. They repeated the procedure at control sites near the wells. On average, the methane flux per well was 11 000 mg/h, whereas the mean flux per control site was 0.19 mg/h. Oil and gas extraction in Pennsylvania has taken place—and continues to take place—in more than the two counties included in the Princeton study. Extrapolating across the entire state, the researchers calculate that the CH_4 emission from abandoned wells constitutes 4–7% of the state's total anthropogenic emissions. Extrapolating across the entire US is difficult, given differences in terrain, history of oil and gas development, and other local conditions, but it's clear that CH_4 emissions from abandoned wells may significantly augment those from active systems, which are estimated to contribute 28% of the nation's total. (M. Kang et al., *Proc. Natl. Acad. Sci. USA* **111**, 18173, 2014.) —CD ■