

An optical probe of quantum gravity? In conventional quantum mechanics you can measure position with arbitrary precision, provided you are willing to pay the cost of growing uncertainty in momentum. In some theories of quantum gravity, though, spacetime has a certain coarseness—a fundamental limit to how precisely you can measure position—enforced with a modified uncertainty relation. But if the uncertainty relation is modified, so too must be the position–momentum commutator that gives rise to it; the equation shown here gives a typical alteration, characterized

$$[x, p] = i\hbar \left(1 + \beta \left[\frac{p}{M_p c} \right]^2 \right)$$

by a deformation parameter β . For a system of mass m , the modifications to the conventional relation are suppressed by powers of m/M_p , where the Planck mass, $M_p = 22 \mu\text{g}$, is the natural mass scale for quantum gravity. Despite that suppression, reports an international collaboration of physicists from the University of Vienna and Imperial College London, quantum-gravity effects on commutators could be experimentally accessible. The trick is to couple a macroscopic oscillator to the radiation field in a highly reflective cavity. The Vienna–London team engineer the matter–light coupling so that, during the course of a mechanical oscillation, the cavity Hamiltonian alternately couples to the oscillator’s position and momentum. As a result, the position–momentum commutator becomes imprinted onto the phase of the radiation field. An oscillator mass of $0.01 \mu\text{g}$ is heavy enough for subsequent interferometric measurements to set bounds on the value of β or analogous deformation parameters that arise in other models. (I. Pikovski et al., *Nat. Phys.*, in press, doi:10.1038/nphys2262.) —SKB

Ultrashort pulses of optical superradiance. A group of excited atoms normally emits light randomly. But when the atoms interact with an appropriate light field, they can act collectively to spontaneously emit coherent, polarized, and intense radiation. Distinct from stimulated laser emission, that so-called superradiance has been explored in systems such as a Bose–Einstein condensate (see *PHYSICS TODAY*, July 2010, page 16) and a semiconductor at near-IR wavelengths. In a new twist, researchers at the University of



Cambridge’s Centre for Photonic Systems generated superradiance in a commercial 405-nm diode laser like the one shown here. The team etched a gap into the diode, producing a gain section and an absorber section. As the gain section is driven by 9-ns current pulses and the absorber is reverse-biased, a dense array of electron–hole pairs is created in the gain section. Those pairs eventually act in concert to spontaneously produce coherent pulses of superradiance as short as 1.4 ps, much shorter than the 22-ps pulses they could obtain from the unmodified diode laser. By adjusting the bias voltage of their room-temperature device, the researchers can get a single pulse per 9-ns interval, although the timing jitter is significant. Assuming the jitter is corrected, the new method of generating ultrashort pulses at visible wavelengths may find

applications in high-density optical storage and in biological imaging. (V. F. Olle et al., *Opt. Express* **20**, 7035, 2012.) —SGB

Diagnosing thyroid cancer with ultrasound. Like other organs, the thyroid gland can develop growths, or nodules, that can turn malignant. Thanks to the gland’s accessibility, thyroid nodules are readily detected using ultrasound. Unfortunately, to determine whether a nodule is malignant, a doctor must insert a needle into the patient’s neck and draw out a sample of cells. Not only is the procedure costly (about \$1500 in the US), it’s more likely than not to confirm the general finding that most nodules—around 70%—are benign. Malignant nodules are stiffer than either benign nodules or thyroid tissue. Being a mechanical stimulus, ultrasound can sense differences in elasticity. But can it diagnose the malignancy of nodules as well as detect them? According to Yongmin Kim (University of Washington in Seattle and POSTECH in South Korea) and his collaborators, the answer is yes. Kim’s team has devised an algorithm that optimizes the use of routinely gathered ultrasound data. The algorithm calculates two metrics: the pixel-by-pixel absolute strain rate and a pixel-to-pixel measure of local contrast. From the metrics, the algorithm creates an elasticity contrast map. The incorporation of local contrast is especially helpful in revealing small malignant nodules whose telltale stiffness can otherwise be masked by the greater elasticity of surrounding tissue. In tests on patients whose thyroid nodules had been independently assessed for malignancy, the algorithm performed well: 19 out of 20 malignant nodules and 76 out of 103 benign nodules were correctly identified. (S. Luo, D.-J. Lim, Y. Kim, *Med. Phys.* **39**, 1182, 2012.) —CD

Heating and cooling with electron spins. In thermoelectricity, a thermal gradient between electrical conductors generates an electrical current (the Seebeck effect) and vice versa (the Peltier effect). Conventionally, those effects arise from the coupling of charge and heat flows. But because an electrical current can be parsed into charge and spin components, researchers hope to exploit the spin degrees of freedom in order to ameliorate or take advantage of the buildup of heat in ever shrinking electronic devices. Bart van Wees and colleagues at the University of Groningen report the latest advance in that effort: a demonstration of the spin-dependent Peltier effect in a heterostructure composed of a 15-nm-thick strip of copper sandwiched between two layers of nickel–iron permalloy. The researchers drove a constant electrical current through the heterostructure and measured the temperature of the lower alloy layer using a thermocouple. To distinguish the spin-dependent effect from the (constant) charge-dependent one, they switched the relative magnetization of the alloys from parallel to antiparallel and remeasured the temperature. When the magnetizations were antiparallel, polarized spins accumulated at the copper interfaces, which cooled the device by 3 mK (at 1 mA) and allowed the researchers to determine the different amounts of heat carried by spin-up and spin-down electrons. The admittedly small effect can be switched on and off magnetically and, more significantly, may be dramatically enhanced to a few kelvin by using nonmetallic materials or those with much larger spin-dependent Peltier coefficients. (J. Flipse et al., *Nat. Nanotech.* **7**, 166, 2012.) —RMW ■