

stick together and render the system inoperable. The phenomenon is called stiction, and it's thought that the Casimir–Lifshitz force is responsible. Reducing or eliminating the attractive Casimir–Lifshitz force among MEMS components could alleviate the problem of stiction as MEMS are further miniaturized. And actually reversing the force into a repulsion allows the intriguing possibility of levitating one object above another. If a levitation gap can be achieved that's larger than any surface roughness features (typically

around 15 nm), it could allow the creation of very low-friction force sensors, bearings, or other devices.

Capasso also hopes that Casimir levitation will help him observe a quantum electrodynamical torque between optically anisotropic materials. By levitating one disk of birefringent material above another, he says, it should be possible to rotate the top disk with circularly polarized light and see that the disks' principal optical axes tend to align when the light is removed.⁴

Johanna Miller

References

1. J. N. Munday, F. Capasso, V. A. Parsegian, *Nature* **457**, 170 (2009).
2. H. B. G. Casimir, D. Polder, *Phys. Rev.* **73**, 360 (1948); H. B. G. Casimir, *J. Chim. Phys.* **46**, 407 (1949); H. B. G. Casimir, *Proc. K. Ned. Akad. Wet.* **51**, 793 (1948).
3. E. M. Lifshitz, *J. Exp. Theor. Phys.* **2**, 73 (1956); I. E. Dzyaloshinskii, E. M. Lifshitz, L. P. Pitaevskii, *Adv. Phys.* **10**, 165 (1961).
4. F. Capasso, J. N. Munday, D. Iannuzzi, H. B. Chan, *IEEE J. Select. Top. Quant. Electron.* **13**, 400 (2007).
5. A. A. Feiler, L. Bergstrom, M. W. Rutland, *Langmuir* **24**, 2274 (2008).

physics update

These items, with supplementary material, first appeared at <http://www.physicstoday.org>.

Ice acoustics for detecting neutrinos. Several experiments are operating or being built to detect astrophysical neutrinos. Ranging up to about a cubic kilometer in size, those experiments are embedded in ice or in a liquid such as water, where they watch for telltale flashes of Cherenkov radiation. (See the article by Francis Halzen and Spencer Klein in *PHYSICS TODAY*, May 2008, page 29.) But the highest-energy neutrinos, with energies of an exaelectron volt (1EeV = 10^{18} eV) or higher, are so scarce that

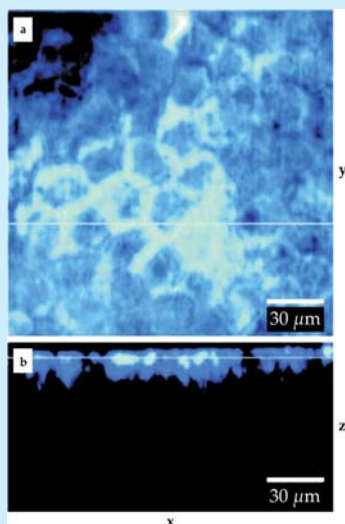


installations spanning 100 km³, along with massive numbers of expensive photomultiplier tubes, would be needed to collect adequate event statistics in a reasonable time. So other detection schemes

are being explored, one of which involves acoustics: When a very-high-energy neutrino interacts with water or ice, a sudden localized thermal expansion occurs and the resulting wave propagates farther than the light flashes. To explore that method, the Aachen Acoustic Laboratory was set up in late 2007 and its first experiment made a precise measurement of the speed of sound in ice that is entirely devoid of bubbles and cracks. The Aachen physicists carefully positioned an array of sensors—six detectors and one emitter—in a 3-m³ water tank (shown here) equipped with a freeze-control unit and a degassing system. The difference in arrival times of an acoustic pulse at adjacent receivers determined the speed of sound. Between 0 °C and –17 °C, where they took measurements, the speed ranged from about 3840 m/s to 3890 m/s, agreeing well with earlier laboratory experiments. The team is also part of SPATS (the South Pole Acoustic Test Setup), which is currently obtaining complementary in situ measurements. (C. Vogt, K. Laihem, C. Wiebusch, *J. Acoust. Soc. Am.* **124**, 3613, 2008.)

—SGB

Tuning vibrations for label-free biological imaging. To map molecules in cells and tissue, researchers prefer biomedical imaging techniques that rely solely on the intrinsic responses of chemical bonds to optical stimulation. Although fluorescence microscopy and other chemical tagging methods yield high-resolution images, they also introduce foreign species or syn-



thetic derivatives that can alter the dynamics of intracellular processes. Spontaneous Raman scattering, which uses a single laser beam to excite the vibrational and rotational modes in chemical bonds, requires no chemical labels but generates a weak signal that gets muddled by Rayleigh scattering. A more sensitive technique known as coherent anti-Stokes Raman scattering uses multiple laser beams to generate coherent optical signals that enhance resonant frequencies in the sample; that method, however, also produces nonresonant background noise. Recently a team led by Harvard University chemist Sunney Xie demonstrated a new technique based on stimulated Raman scattering that tunes the difference between the frequencies of two laser beams to match a desired molecule's resonant frequency, thus amplifying the Raman signal. The measurable intensities of the transmitted beams change only when a match occurs; nonresonant signals are not picked up. The images show the top view (a) and the depth profile (b) of an acne medication (blue) that penetrated a mouse's skin, thus demonstrating the potential of the new technique to monitor drug delivery. (C. W. Freudiger et al., *Science* **322**, 1857, 2008.)

—JNAM

Heating the Sun's corona. It's one of the great natural mysteries: How do the Sun's corona and wind become thousands of times hotter than the Sun's surface? Somehow, energy makes its way up into the corona against a temperature gradient and is converted to heat. A new analysis of data collected by NASA's *Wind* spacecraft doesn't solve the mystery, but it is consistent with a popular explanation. The analysis was done by Justin Kasper of the Harvard-Smithsonian Center for Astrophysics, Alan Lazarus of MIT, and Peter Gary of Los Alamos National Laboratory. They looked at 14 years of in situ observations of particles and fields made as *Wind* flew in and out of the solar wind. The team focused on the two most abundant ion species in the solar wind, H⁺ and He²⁺. Because He²⁺ is four times heavier than H⁺ and carries twice the charge, the two species' kinematics can discriminate among various models for transport and heating. Kasper, Lazarus, and Gary found strong evidence for one picture of coronal heating: Ions are carried upward by magnetohydrodynamic