An acoustically invisible, rigid wall

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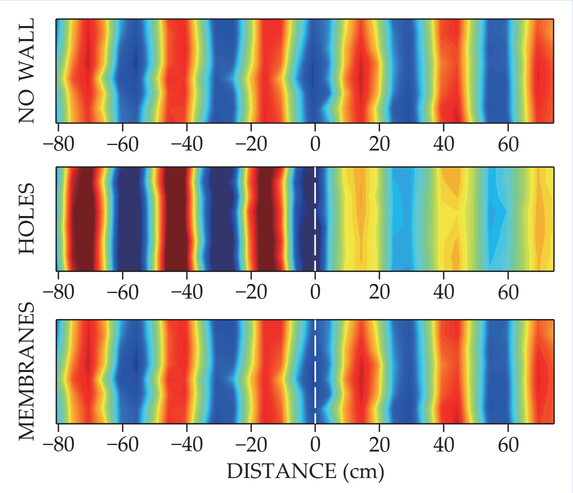
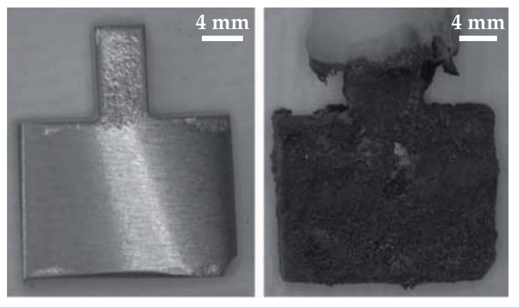
The transfer of angular momentum from some part of the superfluid rotating more slowly than the crust, or the gradual untwisting of twisted magnetic field lines. (R. F. Archibald et al., *Nature* **497**, 591, 2013.) —RMW

An acoustically invisible, rigid wall. You can't have a conversation across a rigid wall—all the sound impinging on it is reflected. Moreover, drilling small holes in the wall won't do much to facilitate communication: Just as heat energy is poorly conducted through a thin wire, acoustic energy is poorly transmitted through small holes. But, reports a collaboration led by Sam Hyeon Lee of Yonsei University in South Korea and Oliver Wright of Hokkaido University in Japan, covering the holes with taut plastic film can make a world of difference. When excited at its resonance frequency, a membrane oscillates like a tiny loudspeaker and creates pressure waves that pass through the wall. The figure shows the results of a plane wave launched from the left and normally incident on a rigid, 5-mm-thick acrylic plate (white dashed line) perforated by four small holes. Red represents compression; blue, rarefaction; and yellow and green, near-zero excess pressure. Not much sound got through the uncovered holes, but the membrane-covered holes transmitted 80% of the acoustic energy. Follow-up experiments with different angles of incidence and cylindrical waves also found excellent film-enhanced transmission. Because the passageways are so tiny, the incident acoustic energy density becomes greatly concentrated in those conduits—by a factor of 5700 in one experiment. Moreover, the individual holes in the experimental trials had radii much smaller than the wavelength of the impinging sound. Those two features, say the study's authors, could lead to sensitive acoustic detectors that achieve subwavelength resolution. (J. J. Park et al., *Phys. Rev. Lett.*, in press.) —SKB



Quantum illumination. Detecting a specific target in a cluttered environment is never easy. In 2008 a quantum detection scheme was proposed in which entanglement provided an advantage over the best possible classical llumination source of the same average power. Start with two entangled light beams created, for example, via parametric down-conversion. One beam, called the signal, is sent into a noisy environment to see if a particular object is located there; the other beam, dubbed the idler, is held close to home. As light returns from the targeted environment, the receiver combines it with the idler. If the signal beam reflects off the object before returning, then an unambiguous signal pops out of the noise—even if the original entanglement is lost. Two groups have now demonstrated the so-called quantum illumination (QI) experimentally. A group from Italy's National Institute of Metrological Research in Turin and the University of Milan demonstrated QI detection that outperformed the best similarly powered classical protocol by orders of magnitude, independent of noise. Meanwhile, in a new twist, a group at MIT used the QI protocol for encrypted communication and showed that messages transmitted through a noisy environment not only survive but remain immune from passive eavesdropping. Both results show that entanglement-related enhancements can survive the loss of that very entanglement, with potential for practical uses in real-world environments. (E. D. Lopaeva et al., *Phys. Rev. Lett.* **110**, 153603, 2013; Z. Zhang et al., *Phys. Rev. Lett.*, in press.) —SGB

Leaner, greener iron and steel. Among the various industrial sectors around the world, iron and steel manufacturing is the second-largest consumer of energy (behind petroleum and chemical processing), according to the International Energy Agency, and the largest emitter of carbon dioxide. The processing of raw iron ore is particularly energy- and CO_2-intensive: Carbon is typically added to chemically reduce iron oxide, producing iron and CO_2, and excess dissolved carbon is removed by reacting it with oxygen gas. An alternative, lower-energy, carbon-free method for removing oxygen from iron oxide and other ores may now be one step closer: molten oxide electrolysis. As common classroom demonstrations with water show, passing electricity through an oxide can strip water of oxygen at the anode. But in molten iron ore, the anode material must face extremely harsh conditions: reaction temperatures above 1500 °C, a highly corrosive environment, and an oxide that spontaneously reacts with most metals on contact. MIT's Donald Sadoway and colleagues have now demonstrated that chromium–iron alloys can, at



least at the laboratory scale, survive in that environment; moreover, the alloys are efficient and inexpensive. Compared with its initial size and shape (at left), the $Cr_{90}Fe_{10}$ anode (at right), though covered with electrolyte, showed little change in dimensions after several hours of electrolysis of magnetite, Fe_3O_4. Key to the alloy's stability is the formation of a conducting outer layer comprising a solid solution of Cr_2O_3 and alumina (which the researchers had in the electrolyte). The results present challenges to current theories of oxidation in extreme environments but nevertheless pave the way for assessing the alloys' performance at larger scales. (A. Allanore, L. Yin, D. R. Sadoway, *Nature* **497**, 353, 2013.) —RJF