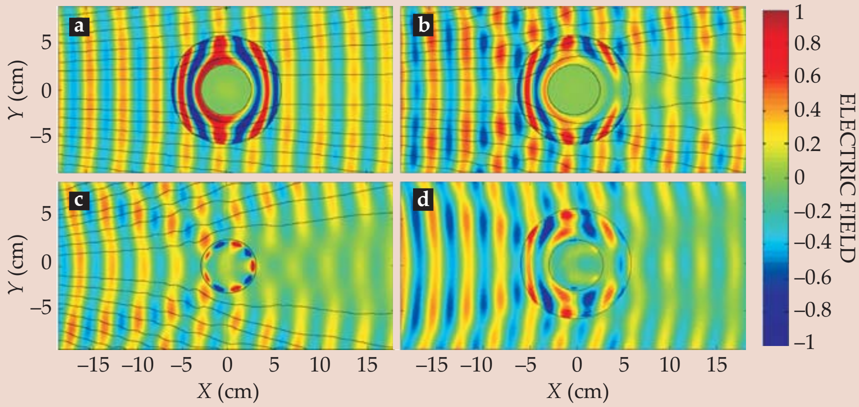

Figure 2. Snapshots of the electric-field patterns and direction of power flow (black lines) reveal the effect of perfect and imperfect cloaking as polarized microwaves approach from the left. The cloak lies in the annular region between black circles and surrounds a copper cylinder. **(a)** Simulation of waves dispersing within an ideal cloak whose material properties ε and μ correspond to an exact coordinate transformation. **(b)** Simulation of a cloak whose simplified values of ε and μ are those of the actual device. **(c)** Experimental measurement of a bare copper cylinder, uncloaked. **(d)** Experimental measurement of field patterns in the actual cloak. In each case the electric field is measured or simulated at various points along a Cartesian grid. (Adapted from ref. 2.)

microwaves were directed toward it. Figure 2 compares theoretical simulations with those experimental results, revealing deviations from the ideal. In each case, as waves propagate through the cloak and approach the inner radius, the wavefronts begin to lag with a concomitant compression in wavelength and a reduction in intensity. The penalty for using the reduced parameter set for ε and μ is nonzero reflectance of the incident radiation, as pictured in figures 2b and 2d. Real materials, of course, also absorb some fraction of incident radiation. Nevertheless, the device dramatically reduces backward and forward scattering of microwaves, compared with the case where the waves are incident to an uncloaked copper cylinder (figure 2c).

Other researchers have recently proposed alternative invisibility schemes.[5] In 2005 the University of Pennsylvania's Andrea Alù and Nader Engheta proposed the use of a plasmonic shell that suppresses scattering by resonating in tune with the incident radiation. The

physics update

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Ball lightning in the lab. Seen infrequently and never scientifically studied in nature, the meandering globes of light known as ball lightning have nevertheless been reported thousands of times over the past few centuries, usually in the warm summer months when thunderstorms abound. Many dozens of theories

have arisen, but few can explain the most puzzling properties of the atmospheric phenomenon—the balls, which can range in size from 1 cm to 1 m, last up to 10 seconds and move unpredictably through the air. They have even entered houses through chimneys and squeezed through small openings. One recent theory says that ball lightning arises from silicon nanoparticles that form in the soil when silicon oxides react with carbon. When a lightning strike vaporizes the oxides into metallic silicon, the vapor subsequently condenses in the air, electrostatically bound and glowing with the heat of oxidation. A team of physicists and chemists in Brazil has now given credence to that so-called Abrahamson–Dinniss theory. They mounted a silicon wafer on a steel plate and completed an electric circuit by touching the wafer with a movable tungsten or graphite electrode. When the electrode was slowly removed, an electrical arc formed with hot tiny silicon fragments flying everywhere. But at a separation of about 1–2 mm, luminous spheres formed and also flew off. The resulting balls were 1–4 cm across, had lifetimes up to 8 seconds, moved at speeds of 5–30 cm/s, and decayed with no trace. The figures show one such ball, at 80-ms intervals, passing through a small gap under an electrical conductor. The experiments were done in conditions not very different from those found in nature: room temperature, normal atmospheric pressure, and 70% relative humidity. (G. S. Paiva et al., *Phys. Rev. Lett.*, in press.) —SGB

Guided atom laser. A trapped cloud of atoms chilled into a Bose–Einstein condensate is a single coherent structure. When extracted from the trap and allowed to propagate, it acts like a laser beam, except that the coherent waves are of matter rather than light. In a typical atom laser, the atoms are released and accelerated by gravity, a process that decreases the atom laser's de Broglie wavelength. Now, physicists from the Institut d'Optique Graduate School in Palaiseau, France, have coupled atoms from an optomagnetic BEC trap to a horizontal optical waveguide, which generated a quasi-continuous atom laser, impervious to gravity and having a constant de Broglie wavelength of 0.5 μm. The RF coupling converts the atoms from a magnetic to a nonmagnetic state, and they emerge with a typical velocity of 9 mm/s and a velocity spread of just a few μm/s, driven along a confining beam of light, as shown in the figure. Changing the RF coupler's frequency can tune the de Broglie wavelength, and changing its power can alter the atom laser's density. In addition, the