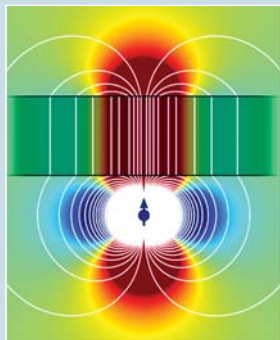


linearly polarized light in a manner inconsistent with their data. Models of GRBs generally assume that the electrons in the shocked ambient material responsible for the afterglow have velocities that are isotropic with respect to local magnetic field lines. Theorists recognize that one way to get circularly polarized light in a GRB is to relax that assumption. But they have yet to craft a convincing model that incorporates anisotropy. (K. Wiersema et al., *Nature* **509**, 201, 2014.) —SKB

The magnetic hose. A guide that routes static magnetic fields as easily as fiber optics carry light could one day see applications as diverse as stepping up voltage in a transformer or manipulating a tiny quantum system. Now re-



searchers led by Alvar Sanchez of the Autonomous University of Barcelona have taken the first step toward developing that routing technology, with a device they call the magnetic hose. The hose works because it is made from a material that has an anisotropic magnetic permeability and thus responds differently to magnetic fields entering it from different directions. The figure illustrates the theory

for the extreme case of an infinite slab with infinite permeability in the vertical (z) direction and zero permeability in the orthogonal directions. Within the material, the field (white lines) is totally vertical. As a result, the dipole field (whose z component is illustrated by the colors) is faithfully transmitted across the slab. Sanchez and company fabricated their finite-sized, finite-permeability hose by surrounding a cylindrical ferromagnet with a coaxial superconducting shell. The ferromagnetic core gives the hose a large permeability in the axial direction, analogous to the z direction in the figure, whereas the field-expelling superconductor enforces nearly zero permeability in the radial directions. To assess their device's performance, the researchers placed a current loop slightly below the hose and measured the dipole field slightly above it. For each of two different hose lengths (6 cm and 14 cm), they found the measured field was at least twice as great as for the ferromagnetic core alone. In theory, additional alternating shells of ferromagnet and superconductor could improve the hose's ability to transmit magnetic fields. (C. Navau et al., *Phys. Rev. Lett.*, in press.) —SKB

Why do active galactic nuclei differ? In some galaxies, including our own, the black hole sits inconspicuously in the middle. But in others, the black hole is orbited by a thick toroidal disk of hot gas. As material in the disk spirals toward the black hole's event horizon, the disk's inner region becomes so agitated and hot that it radiates copiously (see the accompanying artist's impression). Such systems are known as active galactic nuclei, of which there are two broad classes. Type 1 AGNs have broad emission lines characteristic of hot, fast-moving



NASA/JPL

matter. Type 2 AGNs have narrow lines characteristic of cool, slow-moving matter. Given that a thick torus shrouds the AGN engine, the two AGN types could conceivably differ only by viewing angle: Type 1s afford a face-on view of the hot, swirling inner disk; type 2s, an obscured view. Known as AGN unification, that appealing explanation can account for some of the differences between the two AGN types, but not all of them. Now Beatriz Villarroel and her thesis adviser Andreas Korn of Uppsala University in Sweden have shown that another factor is at play. Using data from the Sloan Digital Sky Survey, Villarroel and Korn looked at the neighboring galaxies of a sample of 11 334 type 1 and 53 416 type 2 AGNs. If viewing angle were the sole discriminant, the properties of galaxies in an AGN's vicinity would have no bearing on its type. But that's not the case. Compared with the neighbors of type 1s, the neighbors of type 2s are significantly bluer and seem to be making more stars. Although viewing angle does influence an AGN's outward appearance, Villarroel and Korn's findings indicate that type 1s and type 2s are intrinsically different, perhaps because of their collision histories. (B. Villarroel, A. J. Korn, *Nat. Phys.* **10**, 417, 2014.) —CD

One mystery of magnetic plasma confinement solved.

The fusion of nuclei generates prodigious amounts of energy, as in the Sun's core. Harnessing that energy is the primary goal of researchers who work on tokamaks—large toroidal machines in which a plasma can be confined by magnetic fields and held at high enough temperatures and densities to engender fusion. (See the article by Donald Batchelor in *PHYSICS TODAY*, February 2005, page 35.) Yet the goal remains elusive, in no small part due to myriad instabilities that arise on a multitude of length and time scales, degrading the magnetic confinement of the hot plasmas. In the 1990s researchers discovered that sheared rotation of the plasma and a specific plasma current profile could generate so-called internal transport barriers (ITBs) that inhibit plasma transport across a magnetic surface within a tokamak. The nonlinear, multiscale physics at the heart of ITBs, however, proved to be difficult to unravel. In particular, still unsolved was the mystery of precisely why the ion energy transport was suppressed with ITBs but the particle and momentum transport of the ions was not. Now Gary Staebler and the tokamak team at the DIII-D National Fusion Facility (shown here) operated by General Atomics in San Diego, California, have demonstrated that instabilities at intermediate length scales near the ion gyro-radius (about a millimeter) survive the strong rotation shear and provide the electron energy and momentum transport across the ITB. Using a multiscale quasi-linear transport model, the researchers were able to accurately predict the ion and electron densities and temperatures as well as the rotation of a real ITB experiment at the DIII-D. The upshot is that gyrokinetic turbulence theory works, even in ITBs. (G. M. Staebler et al., *Phys. Plasmas* **21**, 055902, 2014.) —SGB ■

