the electrical properties of the plasma. Sustaining a turbulent dynamo requires the plasma to be nearly perfectly conducting to pin the magnetic field lines to the turbulent flow. Too much electrical resistance and the field lines start to slip. The role of the resistivity is quantified by a dimensionless parameter called the magnetic Reynolds number *Rm*: The higher the *Rm*, the more closely the field lines move with the plasma. Intergalactic plasmas are estimated to have an *Rm* of more than 200. In the Oxford researchers' experiment, *Rm* is about 14.

To conclude that they're seeing turbulent amplification at all, the researchers needed to probe their data a bit deeper. Figure 3 shows the magnetic energy spectrum, the absolute square of the magnetic field's Fourier transform. In the single-jet experiments, the field is strongest in low-frequency components and falls off rapidly at higher frequencies. In the two-jet case, the spectrum's shallower slope—approaching those found in numerical studies of astrophysical plasmas[6]—suggests that the field lines are starting to get tangled up with the turbulence.

The ultimate goal is to access a regime of high enough *Rm* to see a full-fledged turbulent dynamo. Toward that end, Cary Forest and colleagues at the University of Wisconsin–Madison have recently opened a new user facility, the Wisconsin Plasma Astrophysics Laboratory, for mimicking various astrophysical plasma phenomena, including turbulence at the galaxy-cluster scale.[7] "We are also working on parts of the dynamo problem," explains Forest, "but our experiment is quite different in that we create plasmas that are quasi-stationary, not impulsive."

For their part, Gregori, Meinecke, and their collaborators are planning to repeat their experiments next year at the National Ignition Facility in Livermore, California, where they can make hotter, and thus more conductive, plasmas. "We want to know when turbulent dynamo sets in, how it affects the magnetic field, and how it develops over time," says Meinecke. "Those insights could unlock the secrets behind astrophysical events and the origins of magnetic fields in the universe."

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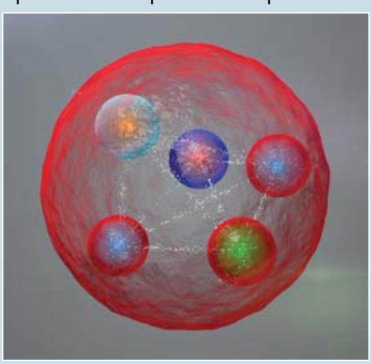
physics update

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

A pentaquark revival. Like wishes, bad news, and backup singers, quarks—the elementary building blocks of hadronic matter—tend to come in threes. The most familiar hadrons, the proton and the neutron, each comprise a trio of up and down quarks. But quantum chromodynamics, the theory that describes the strong forces that bind quarks together, doesn't rule out smaller and larger groupings. Indeed, quark pairs known as mesons frequently show up in the debris of high-energy particle collisions. And experiments at the KEK collider in Japan and at CERN's Large Hadron Collider (LHC) have produced strong evidence of a tetraquark. (See PHYSICS TODAY, September 2014, page 56.) Now CERN's LHCb collaboration has discovered what appear to be two pentaquarks. Both are composed of two up quarks, a down quark, a charmed quark, and a charmed antiquark, but they have opposite parity. The particles, each nearly five times as massive as a proton, were identified among the decay products of so-called bottom lambda baryons produced in proton–proton collisions. Granted, we've heard this story before. In 2003, four independent groups claimed to have observed a less massive pentaquark, but the finding was eventually dismissed as a statistical fluke. The new discovery seems to rest on much firmer ground. The LHCb collaboration analyzed some 26 000 promising decay events—more than 10% of which are thought to have yielded pentaquarks—and report a statistical significance of more than 9σ. Although the particles' existence seems nearly certain, their structure remains a mystery: It's unclear whether the quarks form one tight-knit cluster of five (depicted here), two loosely bound clusters of two and three, or other, more complicated arrangements. (The LHCb collaboration, *Phys. Rev. Lett.* **115**, 072001, 2015; image by Daniel Dominguez/CERN.) —AGS



An insulator with conducting electrons? Samarium hexaboride is a curious material. For starters, it's a Kondo insulator. Jun Kondo proposed in 1963 that the decrease in conductivity observed in some metals at low temperature is due to interactions between fixed, localized spins—magnetic impurities—and delocalized, roaming conduction electrons. In SmB_6, a good conductor at room temperature, it is the localized *f*-shell electrons that interact with the conduction electrons through the Kondo effect, and below 50 K that coupling turns the material into an insulator. At still lower temperatures, below about 4 K, SmB_6 is also increasingly suspected of being a topological insulator: Though insulating in bulk, it appears to support two-dimensional conducting surface states that have zero effective mass, have fixed spin orientation, and are protected by symmetry from scattering. (For more on topological insulators, see the article by Xiao-Liang Qi and Shou-Cheng Zhang, PHYSICS TODAY, January 2010, page 33.) Now Suchitra Sebastian (Cambridge University) and her colleagues report additional unusual behavior in SmB_6: quantized oscillations in the material's magnetization as a function of magnetic field (see figure). The oscillations are a bulk feature—they don't