zinc oxide, a wide-bandgap semiconductor. Removing the scaffold was unnecessary: Because it's electrically insulating, it has no effect on the metamaterial's electrical properties. The interlocked rings were essentially hollow tubes rather than solid tori—but according to simulations, that geometry doesn't change the qualitative behavior.

Theory was borne out by experiment: The n-type ZnO metamaterial produced the Hall voltage of a p-type semiconductor. For a qualitative picture of what's going on, consider the sketch in figure 2. With the current in the $+x$ direction and the magnetic field in the $+z$ direction, the Hall effect in an n-type material normally produces a positive potential on the $+y$ side (toward the left in the figure) and a negative potential on the $-y$ side. Indeed, that's still the case locally for small regions of material, such as the vicinities of the small black arrows. However, because the currents and voltages are passed from ring to ring via the rings' inner edges, the ring on the left picks up a negative potential and the ring on the right picks up a positive potential. Compounded across the 5-unit-cell width of the metamaterial, the effect gives a measurable inverted Hall voltage on the order of 50 μV from a current of 0.5 mA and a magnetic field of 0.83 T.

It's not yet clear what applications, if any, the Hall-effect inversion might have. Just because the metamaterial behaves like a p-type semiconductor doesn't mean it is one. "The charge carriers still carry negative charge," says Kern, so the metamaterial can't replace the p-type material in a semiconductor diode, for example. And even if it could, p-type semiconductors are readily available, so there'd be no obvious advantage to the replacement.

Still, Wegener and his group are pressing onward. They're working on the technical challenges of interfacing their metamaterial with a silicon chip, to study the effect in more detail and possibly exploit it in a magnetic field sensor. And they're looking into anisotropic metamaterials, which can produce a Hall-voltage gradient with a component parallel to the magnetic field—another effect not found in nature.

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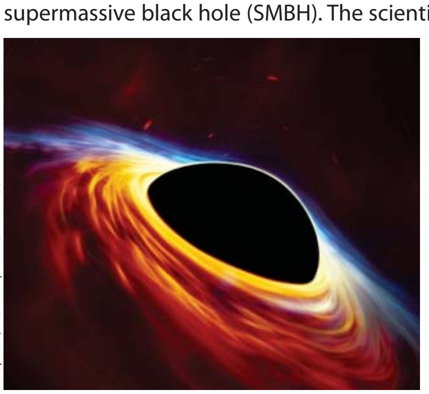
PHYSICS UPDATE

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

SUPERLUMINOUS EVENT MAY LOSE SUPERNOVA STATUS

In June 2015 the All-Sky Automated Survey for Supernovae snagged a huge fish: an extremely luminous object, dubbed ASASSN-15lh, whose spectrum appeared consistent with that of a supernova. The object's luminosity peaked at about 2.2×10^{45} erg/s (2.2×10^{38} J/s), a factor of two higher than that of any other measured stellar explosion (see PHYSICS TODAY, March 2016, page 14). Yet the ramifications of the supernova interpretation, including the sheer scale of nucleosynthesis necessary to generate so much energy, led scientists to consider alternative mechanisms.

Following a 10-month examination at multiple wavebands, one research team now argues that ASASSN-15lh is actually a star that got torn apart by the extreme tidal forces of its galaxy's supermassive black hole (SMBH). The scientists, led by Giorgos Leloudas from the Weizmann Institute of Science in Israel and the University of Copenhagen in Denmark, found that ASASSN-15lh went through three distinct spectroscopic phases, including one with helium emission lines that have never been detected in the brightest supernovae. Further support for the researchers' proposal comes from the location of ASASSN-15lh.



ESO, ESA/HUBBLE, M. KORNMESSER

The event took place at the center of a massive red galaxy whose star formation rate has all but petered out. Such galaxies harbor SMBHs but not the young blue stars whose lives end in supernovae. The researchers also observed a second peak in UV emissions about two months after ASASSN-15lh, which is consistent with the behavior of a previous transient that is thought to be a tidal disruption event.

In making their case, Leloudas and colleagues faced one major objection: The SMBH in question is so massive that it should swallow stars whole rather than shredding them first. The researchers circumvented that problem by proposing that the black hole is rapidly spinning (see artist's conception here), which can extend the range of strong tidal forces by nearly an order of magnitude. (G. Leloudas et al., *Nat. Astron.* **1**, 2, 2016.) —AG

CONSTRAINING INTERPRETATIONS OF QUANTUM MECHANICS

John Stewart Bell's famous theorem is a statement about the nature of any theory whose predictions are compatible with those of quantum mechanics: If the theory is governed by hidden variables, unknown parameters that determine the results of measurements, it must also admit action at a distance. Now an international collaboration led by Adán Cabello has invoked a fundamental thermodynamics result, the Landauer erasure principle, to show that systems in hidden-variable theories must have an infinite memory to be compatible with quantum mechanics.

In quantum mechanics, measurements made at an experimenter's whim cause a system to change its state; for a two-state electron system, for example, that change can be from spin up in the *z*-direction to spin down in the *x*-direction. Because of those changes, a system with hidden variables has to have a memory so that it knows how to respond to a series of measurements; if that memory is finite, it can serve only for a limited time. As an experimenter keeps making observations, the system must eventually update its memory, and according to the Landauer principle, the erasure of information associated with that update generates heat. (See the article by Eric Lutz and Sergio