PHYSICS UPDATE

NULLED STARLIGHT. Using interferometry, light from two separated telescopes can be combined to create a signal having better spatial resolution than that of either of the individual telescopes. Now this technique has been used in reverse. A group of astronomers at the Multiple Mirror Telescope (since closed) in Arizona, imaging the star Betelgeuse at 10 μm, superposed the light paths from two telescopes in such a way that the stellar wavefronts interfered destructively. The star's light disappeared, leaving behind the faint glow of a surrounding dust nebula. The researchers expect that, using adaptive optics with the two 8.4 m mirrors of the planned Large Binocular Telescope, such a nulling system could be used to image Jupiter-like planets around stars out to 10 parsecs and analyze their spectra. (P. M. Hinz *et al.*, *Nature* **395**, 251, 1998.) —PFS

LOW-FIELD MRI HAS BEEN DEMONSTRATED. In typical magnetic resonance imaging (MRI), a large magnetic field of about 1 tesla (10^4 gauss) spin polarizes hydrogen nuclei inside water molecules (in a human body, for example), and the radio signals from spin-flipping protons are detected. The spin polarization is extremely weak (about 10^{-6}) but is compensated for by the abundance of liquid water (and hence protons) in the body. In the last few years, however, practical MRI has also been achieved with spin-½ noble gases (helium-3 and xenon-129), using optical pumping techniques to achieve very high polarizations of 10–20%. (See PHYSICS TODAY, June 1995, page 17.) Such gas-phase MRI has always been amenable to application at low magnetic fields, and now that has finally been accomplished. A multi-institutional team of scientists led by Ron Walsworth of the Harvard–Smithsonian Center for Astrophysics, successfully used laser-polarized ^{3}He for MRI with magnetic fields of only 20 gauss. The simple, low-field equipment offers many advantages in a medical setting, such as low-cost, portability and compatibility with nearby electronic equipment— helpful for people with pacemakers. Furthermore, using gases and low magnetic fields will aid in imaging porous materials and the interiors of metals, including spaces within conductively shielded objects. (C. H. Tseng *et al.*, Phys. Rev Lett **81**, 3785, 1998.) —PFS

NONLOCALITY GETS MORE REAL. "Bell's inequalities" refers to a set of mathematical relations that prohibit distant quantum particles from influencing each other at seemingly instantaneous rates. In three recent experiments, the inequalities have now been violated over record large distances, with record high certainty and with the elimination of an important loophole. Last year, researchers from the University of Geneva led by Nicolas Gisin showed that pairs of entangled photons, sent through a fiber-optic network to detectors in villages 10 km apart, remained correlated. Now, they've shown that such distant photons violate Bell's inequalities by at least 9 standard deviations (9 σ). At the Optical Society of America meeting in Baltimore in October, Paul Kwiat of Los Alamos and his colleagues announced that they had built an ultrabright source of entangled photon pairs; using it, they obtained a 242 σ violation of Bell's inequalities in less than three minutes. Meanwhile, a University of Innsbruck group led by Anton Zeilinger performed Bell measurements with detectors 400 m apart that randomly switched between settings rapidly enough that light-speed communication between the detectors was impossible (closing the "locality loophole"); the group obtained a 30 σ violation. (W. Tittel *et al.*, *Phys. Rev. Lett.* **81**, 3563, 1998. P. G. Kwiat *et al.*, preprint at http://xxx.lanl.gov/abs/quant-ph/9810003. G. Weihs et al., *Phys. Rev. Lett.*, in press.) —BPS

THIRD SOUND IN SUPERFLUID HELIUM-3 has now been seen. At finite temperatures, some fraction of a superfluid is normal—that is, subject to viscous forces. In such a two-component fluid, at least four acoustic modes are possible. First sound occurs when the components move in phase with each other, second sound when they are out of phase and fourth sound when only the superfluid fraction can move because the normal fraction is stuck in a porous medium. Third sound, which is a surface wave, takes place in a thin film when the normal component is stationary—clamped to the substrate. A group of physicists led by Seamus Davis and Richard Packard at the University of California, Berkeley coated a copper disk with a thin film of ^{3}He—a Fermi liquid that becomes superfluid through a superconductor-like pairing mechanism. The researchers then applied a voltage between the disk and a nearby electrode, setting up standing waves on the surface of the film, analogous to those on a drumhead. The waves were detected by measuring the time-dependent capacitance between another electrode and the substrate. Shown here is the (0,3) mode. For films that ranged in thickness from 92 to 281 nm, the researchers found the expected wave amplitude range of 0.1–10 nm, and that the wave speed was much slower than that of third-sound waves in ^{4}He (first seen in 1962). However, they also found evidence for new ^{3}He physics, including mode mixing and splitting. Because superfluid ^{3}He is anisotropic, new phenomena may exist in these films, including a possible Hall effect. (A. M. R. Schechter *et al.*, *Nature*, in press.) —BGL