Physics Update

A strongly interacting degenerate Fermi gas of lithium-6 atoms has been produced. Duke University physicists confined the gas in an optical trap and cooled it to 800 nK. That made the fermions degenerate—their de Broglie wavelengths exceeded the interatomic spacings. The cooling took place in the presence of a 91-mT magnetic field, which induced an extremely large and negative scattering length and caused the atoms to interact strongly. When subsequently released from the trap, the cigar-shaped gas expanded in a decidedly lopsided fashion: The cigar of lithium rapidly got fatter without ever growing longer, and became a thick ellipsoid within 2 ms. When the researchers used a field of 53 mT, the atomic interactions vanished in accordance with theory, and the gas expanded spherically as would any normal gas. The researchers suggest two possible explanations for the anisotropic expansion: Either they were observing a new kind of long-range collision between atoms, or they witnessed so-called "resonance superfluidity" triggered by tuning the interactions between fermions. Either way, the new experimental system can provide a test bed for calculations relevant to all strongly interacting fermions, including the neutrons in neutron stars, the quarks in atomic nuclei, and the electrons in superconductors. (K. M. O'Hara et al., *Science* **298**, 2179, 2002.) —BPS

X-ray interferometry has been achieved in a cavity. Due to their high energies, x rays are notoriously difficult to reflect at high angles to a surface. Indeed, x-ray telescopes in orbit use grazing-incidence mirrors to gradually focus x rays onto a detector. Recently, however, physicists at the University of Hamburg, Germany, succeeded in reflecting x rays directly back from special sapphire crystal mirrors. The price for achieving normal-incidence reflectivity is that it operates only over a few-meV spectral range near a fixed energy determined by Bragg's law. The group used the mirrors to build a prototype Fabry–Pérot interferometer (resonator) for hard x rays. In their instrument's 50-mm cavity, the physicists observed as many as 60 reflections, and measured 0.76-μeV-wide resonances for 14.3 keV x rays. The interference shows up as a modulation, in both time and wavelength, of the radiation that exits the cavity. The work could lead to high-resolution x-ray spectral filters, phase imaging with enhanced sensitivity, x-ray clocks, and a new way of calibrating length measurements at the atomic scale. The addition of a metallic film to the sapphire mirrors could also lead to new combined optical–x-ray devices. (Yu. V. Shvyd'ko et al., *Phys. Rev. Lett.* **90**, 013904, 2003.) —PFS

Neural synchronization tomography. A new brain-imaging method, pioneered by a research group from several institutions in Germany, can not only localize active areas in the brain but also show their correlations when test subjects perform physical tasks. The technique begins with standard magnetoencephalography: The researchers used a helmet with 148 SQUID sensors to map the fluctuating magnetic fields produced by tiny electrical currents in the brain. But then, those magnetic fields are inverted to produce a three-dimensional reconstruction of the current source density within the brain. Phase synchronization of the current source densities in different areas of the brain indicates interactions. The researchers demonstrated the technique, dubbed synchronization tomography, by asking test subjects to tap their finger in time to a rhythmic tone, and to continue tapping at the same rate after the tone was switched off. The resulting images showed that the same regions of the brain were active whether people tapped to an external beat or paced the tapping themselves, but that the synchronization between the different brain areas was dramatically different without external pacing. Other brain imaging methods, including functional magnetic resonance imaging and positron emission tomography, can also provide insight into brain activity, but their time resolution is too low to disclose how the brain regions interact with each other. (P. A. Tass et al., *Phys. Rev. Lett.*, in press.) —JRR

Can the speed of gravity be measured directly through the observation of gravitational lensing effects? Sergei Kopeikin (University of Missouri) and Ed Fomalont (National Radio Astronomy Observatory) used the exquisitely sensitive Very Long Baseline Array of radio telescopes to monitor Jupiter's gravitational deflection of light from a distant quasar that was nearly aligned with the massive planet on 8 September 2002. At the January meeting of the American Astronomical Society in Seattle, the researchers reported that the apparent position of the quasar traced a small loop over the course of several days. Moreover, they argued, the precise measurement of the loop's shape allows one to determine the speed of gravity. Their result, that the speed of gravity equals 1.06±0.21 times the speed of light, is consistent with Einstein's theory of relativity. The experiment is widely regarded as a tour de force. But Washington University's Clifford Will, and other scientists, argue that the reported data are in no way related to the speed of gravity. (E. B. Fomalont, S. M. Kopeikin, http://arxiv.org/abs/astro-ph/0302294; C. M. Will, http://arxiv.org/abs/astro-ph/0301145.) —PFS