PHYSICS UPDATE

RELATIVISTIC NONLINEAR THOMSON scattering has been observed. Normally, when light—having both electric and magnetic fields—is scattered off an electron, the electric field gives the orders and the electron obediently oscillates back and forth. However, if the intensity of the laser light is high enough, the electrons should move at relativistic speeds, whereupon the light's magnetic component could exert a tangible force: The electrons would no longer simply oscillate but would "quiver" nonlinearly in figure-eight patterns. Such nonlinear Thomson scattering should also cause the electrons to emit higher-frequency versions (harmonics) of the original laser light in a characteristic angular pattern that is different for each harmonic. And that is precisely what Donald Umstadter and his University of Michigan colleagues saw, using a terawatt laser. The researchers hope someday to generate the harmonics coherently, which would pave the way for tabletop x-ray lasers. (S.-Y. Chen *et al.*, *Nature* **396**, 653, 1998.) —PFS

A PERFECT DIELECTRIC MIRROR, one that completely reflects a specified wavelength range of light coming in from any direction, has been built by researchers at MIT. Traditional metallic mirrors can reflect a wide range of wavelengths impinging from all directions, but they typically absorb a few percent of the incident power. By comparison, dielectric mirrors (which consist of alternating thin films of two insulating materials) are virtually lossless reflectors in certain wavelength ranges, but they work only for light hitting them at close to normal incidence. Combining the best properties of both mirror types, the MIT group designed a dielectric mirror with nine layers, alternating between the polymer polystyrene (with an index of refraction $n = 1.6$) and the element tellurium ($n = 4.6$). The highly contrasting optical properties in these layers enabled infrared light (in the 10–15 μm range) to be completely and omnidirectionally reflected. The researchers say that, by altering the materials and layer thicknesses, they can build mirrors useful for many other wavelength ranges. Potential applications include low-cost energy-saving window coatings and more efficient optical fibers. (Y. Fink *et al.*, *Science* **282**, 1679, 1998.) —BPS

A QUASI-TWO-DIMENSIONAL ATOM GAS (2DAG) has been produced. Harald Gauck and his colleagues at the University of Konstanz, in Germany, used a battery of lasers to first cool and then confine argon atoms in what was essentially a planar resonant cavity for atom waves. The pancake-shaped argon cloud was about 200 nm thick and floated about 800 nm above a gold substrate. Not only does a 2DAG provide a high-density sample of optically cooled atoms, but by shaping the local light fields, the researchers hope to fashion integrated atom optical elements, such as miniaturized atom interferometers and even one-dimensional atom waveguides. (H. Gauck *et al.*, *Phys. Rev. Lett.* **81**, 5298, 1998.) —PFS

SOLAR SURGERY may be on the horizon, as a low-cost alternative to lasers for certain medical procedures. Daniel Feuermann and Jeffrey Gordon (Ben-Gurion University of the Negev, Israel) have come up with a scheme whereby sunlight is concentrated in two stages—with a paraboloidal dish primary mirror and a secondary dielectric concentrator—then fed through a low-attenuation silica fiber to the operating room. Laser light has high power density, is monochromatic and is highly collimated. Concentrated sunlight can match the power density but not the other two properties of lasers; thus, cutting tissue with sunlight, for example, would not be feasible. For a great many other medical treatments, however, only high power absorption in the tissue matters. Such treatments include tissue coagulation and welding, hyperthermia treatment of tumors, angioplasty and knee and shoulder surgery. The researchers point out that, because the equipment works only in clear, sunny weather, solar surgery would be limited to nonemergency treatments; but that is also the case for most laser medical procedures. They also note that a solar surgical unit would cost less than 10% of a current surgical laser with fiberoptic coupling. (D. Feuermann, J. M. Gordon, *Opt. Engin.* **37**, 2760, 1998.) —SGB

JOSEPHSON EFFECT IN A BOSE–EINSTEIN condensate (BEC). In the Josephson effect, an alternating current is observed between two separated macroscopic quantum states (superconductors) that are held at different chemical potentials. Now, Mark Kasevich and Brian Anderson (Yale University) have seen the same phenomenon in a BEC of rubidium atoms loaded into the traps of a vertically oriented optical lattice—a series of energy wells established by the electric field of a laser beam. With gravity providing the difference in chemical potential between adjacent traps, atoms from each trap tunneled coherently downward, with atoms from all traps in the lattice participating simultaneously. Blobs of condensed atoms then dropped out of the bottom of the lattice with a predictable frequency. Just as the Josephson effect plays a key role in determining $2e/h$ and the volt, the researchers say that the "atom current" in their experiment could be useful for precisely measuring very weak forces. Such forces include not only gravity but also van der Waals–Casimir forces. The spaced-out drops of atoms also constitute a pulsed atom laser beam. (B. P. Anderson, M. A. Kasevich, *Science* **282**, 1686, 1998.) —PFS