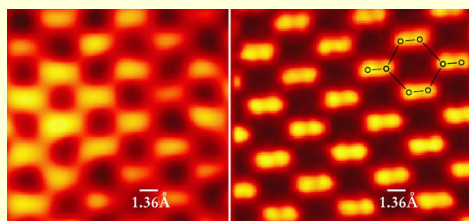


PHYSICS UPDATE

► **LASER-DRIVEN JETS** of carbon and fluorine ions have been produced at the rear of thin foil targets. Using the powerful laser at the Laboratoire pour l'Utilisation des Lasers Intenses (LULI) in Palaiseau, France, a multinational group of physicists aimed 300-fs pulses at 50- μm -thick metal foil targets coated on the rear side with a thin layer of either carbon or calcium fluoride. First, the physicists heated the target to remove contaminants. The laser then generated, at the front of the target, relativistic electrons that penetrated the foil and shot out the back side. Those freed electrons set up a strong space-charge field that ionized atoms near the foil's back surface and then accelerated those ions outward. The researchers succeeded in accelerating fluorine and carbon ions, both having several different charge states, to energies that exceeded 5 MeV per nucleon and within a distance of only about 10 μm . Furthermore, the jets were bright (10^{12} particles per burst) and well collimated, possibly making them useful for future work in particle physics or fusion. According to team member Manuel Hegelich, an outgoing beam of fluorine ions could be used to heat a 100- μm -sized secondary target to a temperature of 200–300 eV (equivalent to 100 000 K) in mere picoseconds. During that tick of time, the crystal of atoms in the target would be heated isochorically (the lattice would not have time to expand), and thus approximate the condition inside stars. Previously, several groups have similarly accelerated protons. (M. Hegelich et al., *Phys. Rev. Lett.* **89**, 085002, 2002.) —PFS

► **SUB-ANGSTROM RESOLUTION** for electron microscopes. A typical scanning transmission electron microscope (STEM) operates at 100–300 keV and has a spatial resolution limited by both spherical and chromatic aberration to about 1.5–2.0 Å, roughly 50 times the electron wavelength. Now, researchers at Nion R&D in Kirkland, Washington, and IBM Corp's T. J. Watson Research Center have demonstrated aberration-corrected STEM operation. The corrector



has four main quadrupoles, three main octupoles, and about 28 other windings; all can be separately excited in

real time to control the electrons. Very stable, computer-controlled power supplies and feedback systems proved essential for successful operation. With the new STEM, Philip Batson (IBM) has obtained 0.75-Å resolution at 120 keV with no extensive after-the-fact computer processing. The figure shows uncorrected (left) and corrected images of the crystal structure of a germanium-silicon alloy. Batson says that the new technology can open the way to smaller, smarter

instruments. (P. E. Batson, N. Dellby, O. L. Krivanek, *Nature* **418**, 617, 2002.) —BGL

► **NEW COSMOLOGICAL UPPER LIMIT** on neutrino mass. Recent neutrino results imply that one or more of the three neutrino flavors (ν_e , ν_μ , ν_τ) have some mass (see PHYSICS TODAY, July 2002, page 13). Considering the number of neutrinos loose in the universe, even a small mass means they will have significantly influenced the development of galaxies. Various physics experiments have established an upper limit of 3 eV for the ν_e and whopping upper limits in the MeV range for the ν_μ and ν_τ . Now, a worldwide collaboration of astronomers has looked at the distribution of 250 000 galaxies in the 2 Degree Field Galaxy Redshift Survey and measured large-scale structure statistics in the form of a power spectrum. They compared the data with calculated power spectra using a model that included baryons, cold dark matter, massive neutrinos (hot dark matter), and a cosmological constant. The model had a few reasonable assumptions—for example, that all three types of neutrinos drop out of thermal equilibrium at the same temperature and that the spectrum of primordial fluctuations from which galaxies evolved is scale-independent—and an appropriate treatment of previously measured cosmological parameters. The group then arrived at two big conclusions: Neutrinos can account for no more than 13% of the matter in the universe, and the sum of all three neutrino masses is no more than 2.2 eV. Group members Øystein Elgarøy and Ofer Lahav say that this is the best upper limit for neutrino mass derived with relatively conservative assumptions on cosmological parameters. (Ø. Elgarøy et al., *Phys. Rev. Lett.* **89**, 061301, 2002.) —PFS

► **A NEW KIND OF OCEAN WAVE** has been detected. The Hawaii-2 Observatory, which sits on the sea floor between Hawaii and California, observes waves of many varieties. Some are acoustic waves that alternately expand and compress water as they propagate through the ocean at the speed of sound in water. Others are Rayleigh waves that are triggered by earthquakes and propagate as horizontal and vertical motions of Earth's crust, including the sea floor. Researchers have now detected a "coupled" acoustic and Rayleigh wave that swaps energy across the interface at the ocean's floor. Propagating at the sound velocity of water, the wave both induces motion of the sea-floor sediments and creates regions of expansion and compression in the water. The new wave requires that the Rayleigh wavelength be shorter than the water's depth and that the shear velocity at the interface not exceed the water's sound velocity. The researchers speculate that similar modes might occur at the air-soil interface. (R. Butler, C. Lomnitz, *Geophys. Res. Lett.* **29**, 57, 2002.) —BPS ■