PHYSICS UPDATE

A 'MOLECULE' OF LIGHT, a group of photons acting as a single bound object, could effectively be created with a device proposed by Joseph Jacobson and his colleagues at Stanford University. All objects, whether atoms or photons, can be thought of as waves spreading out in space, with a de Broglie wavelength inversely proportional to the object's momentum. For instance, if one binds together two atoms having the same momentum, the de Broglie wavelength of the resulting molecule is half that of the individual atoms. By contrast, two identical photons normally combine so as to retain the original wavelength. The interferometer proposed by the Stanford group would produce true photonic de Broglie waves using a quantum switch consisting of a specially prepared atom in a tiny resonant cavity. When illuminated by a coherent light beam, the switch would either transmit or reflect all of the photons. Jacobson suggests that if an ensemble of 100 photons were sent into the switch and the wave train made to interfere with itself, the group of photons would behave like a composite object with an effective wavelength only 1/100th that of the individual photons. The much smaller wavelength of the photon "molecule" would result in a greater sensitivity than is possible with current interferometers, which are exquisitely sensitive to small rotations or changes in the path lengths over which light waves propagate and are used in such devices as accelerometers and gyroscopes. In addition, this sort of interferometry will allow researchers to study the extent to which the de Broglie wavelength depends on the internal structure of an object. (J. Jacobson *et al.*, *Phys. Rev. Lett.* **74**, 4835, 1995.) —BPS

THE MASS OF THE W BOSON has been newly determined by the Collider Detector Facility collaboration at the Fermilab Tevatron collider. The new value of 80.410 ± 0.180 GeV has only half the uncertainty of the best previous measurement. The data sample consists of almost 9000 events in which the charged Ws were produced in high-energy proton–antiproton collisions and then decayed into a neutrino plus either an electron (about 5700 events) or a muon. The W and Z bosons are the carriers of the weak nuclear force. Now that the top quark has been discovered, the next major quarry in particle physics is the Higgs boson, the particle that supposedly endows other particles with mass. (See PHYSICS TODAY, May, page 17.) Theorists believe that measurements of the top quark mass and the W mass can be used to constrain estimates of the Higgs mass (see page 15). (F. Abe *et al.*, *Phys. Rev. Lett.* **75**, 11, 1995.) —PFS

BLUE-GREEN SURFACE-EMITTING LASER. A collaboration of scientists from the University of California, Santa Barbara, Notre Dame, Matsushita Electric Co (Osaka, Japan) and the University of Tsukuba (Japan) have combined two burgeoning technologies—the direct production of blue-green laser light in layered stacks of zinc selenide and the vertical emission of laser light from the surface of the laser medium—to develop a 488-nm vertical-cavity surface-emitting laser, operating at temperatures up to 30 K. Initially, the laser medium was optically pumped; the atoms were excited by light waves. At a meeting in June at the University of Virginia, however, the researchers announced their operation of a blue-green vertical-cavity surface-emitting laser that uses a much more efficient electrical pumping system. Most of the electrical pumping work was done at Matsushita. (For more on VCSELs, see PHYSICS TODAY, May, page 9.) (P. D. Floyd *et al.*, *Appl. Phys. Lett.*, **66**, 2929, 1995.) —PFS

AN ACCELERATION GRADIENT of 30 GeV/m has been achieved by scientists from a consortium of labs in Japan. The researchers used short (1 psec) and powerful (3 TW) laser pulses to excite a wake field in a plasma. Electrons injected into the plasma with a momentum of 1 MeV/*c* were accelerated up to 18 MeV/*c* in less than 1 mm, for a net gradient of 30 GeV/m. Such ultrahigh acceleration gradients may someday be useful for particle physics applications—allowing the milelong SLAC accelerator, say, to be squeezed into a space of only a few meters—but the whole process would have to be scaled up considerably. (See PHYSICS TODAY, July 1994, page 33 and January 1995, page 36.) Nakajima says that his group has begun development of a high-energy particle accelerator using a table-top terawatt laser, called T^3 in the spirit of keeping things compact. (K. Nakajima *et al.*, *Phys. Rev. Lett.* **74**, 4428, 1995.) —PFS

WATER ON THE SUN. When researchers from the University of Waterloo (Ontario, Canada), Kitt Peak National Observatory and the National Solar Observatory trained a high-resolution infrared spectrometer at the coolest, darkest part of a sunspot, they saw vibration–rotation and pure rotation lines of hot water. These lines are one of the few ways of detecting extraterrestrial water through Earth's own watery atmosphere. At a temperature of 3200 K, the sunspot oasis is cool enough for H_2O molecules to predominate over OH as the main oxygen-containing molecule. According to the researchers, hot water is the most important source of infrared opacity in oxygen-rich late-type stars. (L. Wallace *et al.*, *Science* **268**, 1155, 1995.) —PFS ■