Physics Update

X-RAY PHASE IMAGING OF A THICK OBJECT has been demonstrated by Keith Nugent of the University of Melbourne in Australia and his colleagues. Conventional imaging with x rays relies on some of them being absorbed by inhomogeneities in the sample—whether a piece of luggage or a human body. It is difficult to see structure in a highly absorbing sample (say a bone) because, to penetrate the object, the x rays' energy must be increased—accompanied by a precipitous drop in absorption. In contrast, phase changes in the x rays, caused by the sample's index of refraction and thickness, are affected much less by increased energy and are very sensitive to the sample's structure. Monitoring such phase changes is analogous to looking through a piece of glass with an uneven surface and deducing the surface shape from the distorted image. The researchers used 16 keV x rays at the Photon Factory synchrotron facility at the National Laboratory for High-Energy Physics (KEK) in Tsukuba, Japan, to penetrate—with negligible absorption—a solid carbon calibration grid that was, on average, 68 μm thick. The resulting data is related to the object being imaged by a transport of intensity equation. The researchers use their data to solve this equation and thereby image the grid's pattern with a resolution of 20 μm. Nugent says they hope to obtain one-micron resolution with the Advanced Photon Source at Argonne National Laboratory. Improvements beyond that will require new detector technology. (K. A. Nugent *et al.*, *Phys. Rev. Lett.*, in press.) —BPS

LASER LIGHT CAN COOL PARTICLE BEAMS in three dimensions. In accelerators, one generally wants all the particles to travel down the beam pipe with the same longitudinal velocity and very little transverse motion. "Cooling" a beam of heavy ions (reducing their random velocities) can be achieved with laser light tuned to a particular Doppler-shifted electronic transition. Although one expects this laser cooling to affect the longitudinal velocity spread, researchers at the Max Planck Institute for Nuclear Physics in Heidelberg, Germany, have shown that the technique also cools transverse motions. In general, the "temperatures" of the excess random motions in a particle beam may be different for each of the three degrees of freedom, but they are in rough equilibrium with each other. Using a beam of 7 MeV beryllium ions in the Heidelberg Test Storage Ring, Rudolph Grimm and his coworkers found that, when the laser is turned on, the greatly cooled longitudinal velocity dispersion is far from equilibrium with those in the two transverse directions. In reaching a new equilibrium, the longitudinal random motions increase again slightly, while the transverse random motions are substantially reduced. The net result is a tighter beam with a higher number density of ions. (H.-J. Miesner *et al.*, *Phys. Rev. Lett.* **77**, 623, 1996.) —PFS

DAYS WERE ONLY 18 HOURS LONG back in the Proterozoic era, some 900 million years (Myr) ago. Using a technique pioneered a decade ago, a multi-institutional collaboration has investigated tidal despinning, a problem first posed by Lord Kelvin. The periodicities of the semimonthly neap and spring tides produce laminated tidal sediments, which can provide an accounting of ancient times much like tree rings carry a record of modern times. The group's analysis of such sediments, collected in Utah, Indiana, Alabama and Australia, shows that the Moon has been receding from the Earth at a constant rate of 3.8 cm per year for the last 900 Myr. That is consistent with today's value, obtained from lunar laser ranging. Not only did the shorter day result from the closer Moon, but the year contained 481 of those days. Previously, the earliest data came from fossilized biota, according to Charles Sonett, and reached back 300–400 Myr. (C. P. Sonett *et al.*, *Science* **273**, 100, 1996.) —PFS

PINPOINTING INDIVIDUAL ADSORBANTS on a surface is now possible with scanning tunneling microscopes (STMs), providing a new tool for addressing one of the central questions in surface science: Do the adsorbants sit directly on top of the substrate atoms or do they settle into the crevices between them? When an STM tip is brought close enough to a surface, it can exert a force sufficient to move a substrate atom laterally on the surface, overcoming the energy barriers that ordinarily keep the native atoms in place. Gerhard Meyer and his colleagues at the Free University of Berlin used an STM first to pluck a copper atom from the edge of a terrace on a copper surface, move it about on the surface and then reattach it to the same location on the terrace. By using these manipulated Cu atoms as markers, they superimposed a grid of Cu unit cells on the surface. Meyer's group was then able to infer that a single adsorbed CO molecule lies directly on top of a substrate atom, instead of between two neighboring atoms. Further, with this grid in place, the CO then became a marker, providing information on how other species—such as C_2H_4 molecules and lead atoms—registered with the surface. This technique can potentially be used to study adsorption on other metallic surfaces, even very complex ones that cannot be studied with conventional crystallographic methods. (G. Meyer *et al.*, *Phys. Rev. Lett.* **77**, 2113, 1996.) —BPS ■