# PHYSICS UPDATE

**X-RAY HOLOGRAMS** with atomic resolution have now been made independently by two teams, and should lead to a valuable new tool for crystallographers. A Hungarian team at the Research Institute for Solid State Physics in Budapest, sent a monoenergetic beam of x rays into a perovskite crystal ($SrTiO_3$). Some of the x rays ejected inner-core electrons from strontium atoms. As these vacancies were subsequently filled, lower-energy fluorescence x rays were emitted. In this process, one component of such an "internal source" x ray goes straight through the crystal, providing a "reference beam." Other components of the fluorescence x ray scatter from other atoms in the crystal lattice, providing "object" waves associated with those atoms. The interference of the reference and object components for each emitting atom is a hologram. The complete hologram is extracted from the fluorescent x-ray intensities, summed over many equivalent emitters and measured over a large solid angle. Meanwhile, a US–German team has created a hologram of hematite ($Fe_2O_3$) in a sort of time reversal of the Hungarians' method. An iron atom in the crystal acts not as a source, but as a detector of interfering reference and object x rays that originated externally, at several energies, as plane waves. The atom's subsequent fluorescence in all directions has information about the local electric field of the incoming, interfering x rays. This method generated holograms with fewer aberrations than the internal source method. Both groups create direct three-dimensional images of the atoms in the crystal from their holograms with the help of mathematical inversion techniques from optics. (M. Tegze, G. Faigel, *Nature* **380**, 49, 1996. T. Gog *et al.*, *Phys. Rev. Lett.* **76**, 3132, 1996.) —PFS

**TWO NEW FORMS OF ICE** have been predicted to form, based on molecular dynamics simulations. Ice already has more solid forms than any other simple substance. According to a German–French–Italian team, "ice XI" should form at room temperature at the extreme pressures of 300–400 GPa. The oxygen atoms arrange themselves into a distorted hexagonal close-packed lattice. The simulations show that ice XI is stable at 400 GPa up to temperatures of 2000 K, and that it is an insulator up to and beyond 700 GPa—pressures at which ice exists within Jupiter. Therefore Jovian ice may not be metallic, as some planetary physicists have suggested. (See page 17 for the latest news on metallic hydrogen in Jupiter.) Meanwhile, at the more modest pressures of 300–500 MPa but in the presence of an electric field, Canadian researchers at Dalhousie University in Halifax have found "ice XII" in their simulations. This version has an open 4-coordinated, quartz-like structure, but whether it is stable or metastable is not yet known. Both groups emphasize that their forms of ice can be experimentally produced. (M. Benoit *et al.*, *Phys. Rev. Lett.* **76**, 2934, 1996. I. M. Svishchev, P. G. Kusalik, *Phys. Rev. B* **53**, 8815, 1996.) —BPS

**AN ULTRASENSITIVE BIOSENSOR** is being developed, using the cantilever from an atomic force microscope. In the Naval Research Laboratory researchers' prototype, the cantilever is coated with antibodies able to bind to the specific antigen (cell, protein, virus or bacteria) being sought. Next, a solution containing the antigen flows over the cantilever, and some of the antigen binds to the antibodies. Then another solution, containing antibody-coated, micron-sized magnetic beads, flows by, and some beads bind to the antigen on the cantilever. Finally, a magnetic field is turned on and the captured beads are counted by the deflection of the cantilever. In this way, antigen concentrations down to attomolar ($10^{-18}$ M) levels can be measured. In a working device, an array of these biosensors would be able to perform such immunoassays in about 10 minutes, much faster than other methods at these small concentrations. According to Richard Colton, these "force amplified biological sensors" will not only be sensitive and fast, but portable, rugged and automated. (D. R. Baselt, G. U. Lee, R. J. Colton, *J. Vac. Sci. Tech. B* **14**, 789, 1996.) —PFS

**THE SURFACE OF PLUTO HAS BEEN IMAGED** for the first time. Using the Hubble Space Telescope, Alan Stern of the Southwest Research Institute, Marc Buie of Lowell Observatory and Laurence Trafton of McDonald Observatory snapped a series of high-resolution pictures throughout Pluto's 6.4-day rotation period, including the ones shown here of opposite hemispheres. The photos, released by NASA on 7 March, reveal that Pluto has more visible-wavelength, large-scale contrast than any planet except Earth. Most of these dark and bright regions are believed to be frost of varying reflectivity that generate Pluto's nitrogen–carbon monoxide–methane atmosphere. Pluto had not been imaged clearly before, even with the largest Earth-based telescopes, because its angular size on the sky is only a tenth of an arcsecond. —PFS