Physics Update

A TECHNIQUE FOR GENERATING HIGH-FREQUENCY, single-energy phonons has been devised, making it feasible to perform phonon spectroscopy, used to study how matter absorbs and radiates phonons. Researchers at Utrecht University in the Netherlands produce a directional beam of monochromatic phonons in a molybdate ($PbMoO_4$) crystal by shining a pair of interfering, narrow-frequency-band dye lasers on a gold film deposited on one face of the crystal. With a periodicity in time, the interfering lasers create a deformation, or "strain", in the film. The periodic deformations produce a phonon beam whose frequency is equal to the frequency difference between the two lasers. The beam then travels into the crystal, enabling studies of some of the crystal's properties. The phonon frequency can be tuned by changing the frequency of one of the lasers. The collimation of the beam is limited by Fraunhofer diffraction, in which a series of parallel rays that pass through a small opening (the spaces in the crystal, in this case) spread out by a small amount (on the order of 0.01 radians in the experiments). (E. P. N. Damen *et al.*, to appear in *Phys. Rev. Lett.*)

MACHOs MAKE UP LESS THAN 20% of the presumed dark-matter halo shrouding our Galaxy. The presence of massive compact halo objects, such as nonradiating neutron stars or white dwarfs, and substellar objects such as planets, is invoked to partially explain the rapid rotation of the outer parts of the Milky Way. Several groups search for MACHOs by scanning stars in one of our companion galaxies, the Large Magellanic Cloud. (See PHYSICS TODAY, July 1994, page 17.) The "MACHO collaboration" has now finished a full analysis of its first year's data, with three known lensing events in the LMC. Livermore physicist Kem Cook reported at the April meeting of the American Physical Society in Washington, DC, that he and his colleagues are now convinced that the LMC events are indeed related to the influence of nonluminous objects. They therefore assert that these measurements constitute the first definitive observation of halo dark matter in our Galaxy. Furthermore, they calculate that for a standard halo model, MACHOs add up to about 7.6×10^{10} solar masses and that the MACHO fraction of this dark halo is less than 19%.

THREE NEW MEASUREMENTS OF G, the Newtonian gravitational constant, disagree significantly with the accepted value and with each other. The least well known of all the fundamental constants, the accepted value of G was established in the 1980s to be 6.6726 ± 0.0009 in units of $10^{-11}\ m^3\ kg^{-1}\ s^{-2}$. G is arguably the most difficult constant to measure because, among other reasons, gravity is the weakest of the four known fundamental forces and it is impossible to shield delicate measurements from the gravitational influences of buildings and other nearby objects. Underscoring this difficulty, scientists from three labs (the University of Wuppertal in Germany, the Measurement Standards Laboratory of New Zealand and the German Bureau of Standards—PTB Braunschweig) reported new and differing measurements of G at the April APS meeting. In the same units as above, the Wuppertal value was 6.6685 ± 0.0007; the New Zealand measurements gave 6.6656 ± 0.0006; and the German Bureau of Standards value was a whopping 6.7154 ± 0.0006. Although the techniques differed, the groups all essentially determined G by measuring the gravitational effects of cylindrical masses acting on objects suspended above the ground in static equilibrium. According to Hinrich Meyer (Wuppertal), we are "forced to conclude that G is known with an uncertainty of 6×10^{-4} and not 1.28×10^{-4}" as previously thought. Meyer's group hopes for a more precise determination of G by the end of 1995, while researchers at Los Alamos, the lab that helped set the 1980s standard by measuring oscillations, are also undertaking a new measurement of G.

USING PLASMAS TO TREAT WASTE. In laboratory and pilot research furnaces at MIT, Daniel Cohn and colleagues used a "hot" plasma to melt waste material characteristic of that generated by Department of Energy facilities (consisting of soil, metals, combustible materials and sludges) into a lavalike liquid. To do this, they created a 10 000° C arc plasma by passing an electric current between a graphite electrode and a graphite hearth in a nitrogen-filled gas chamber. The resulting liquid solidified into a stable black glass that could be safely stored or even used as a construction material (for nonradioactive waste). They believe the process would produce no toxic ash, virtually no dioxin and less gas emission than traditional incineration techniques, although these byproduct measurements haven't yet been made. In a separate demonstration at the Hanford Waste Reservation in Richland, Washington, Cohn and colleagues used "cold" (room-temperature) electron-beam-generated plasmas to act selectively on minute concentrations of hazardous carbon tetrachloride molecules that had been vacuum-pumped from waste deposits. The CCl_4 split into less stable compounds that eventually broke down into carbon dioxide, table salt, water and some carbon monoxide. Cohn described the work, done in collaboration with Pacific Northwest Laboratories and T and R Associates, at the April APS meeting.

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