

PHYSICS UPDATE

▶ **A SUPERFLUID GYROSCOPE**, designed like an AC SQUID, has been demonstrated by Richard Packard and his colleagues at University of California, Berkeley. SQUIDS—superconducting quantum interference devices—exploit a peculiar property of superconductors: The amount of magnetic flux through a circulating supercurrent must be a multiple of a basic flux unit. At the heart of such a device is one or more very thin insulating barriers that interrupt the ring-shaped superconductor. Electron pairs tunneling through the insulation interfere with each other in a way that depends on the amount of flux threading the superconducting circuit; thus the quantization of flux can be exploited to measure tiny magnetic fields. In a superfluid, by contrast, the quantized quantity is fluid circulation, which can be exploited to measure tiny rotations. In the Berkeley experiment, the flow of superfluid helium through a ring-shaped vessel is interrupted by a barrier containing a submicrometer-sized pinhole. When the vessel is rotated, the helium must squirt back through the hole to maintain constant circulation in space, and the squirting can be monitored. With their proof-of-principle demonstration, the metrologists measured the rotation of Earth with a precision of 0.5%. (K. Schwab, N. Bruckner, R. E. Packard, *Nature* **386**, 585, 1997.) —PFS

▶ **A NEW CELESTIAL CLOUD** of positron-annihilation radiation has been found by NASA's Compton Gamma Ray Observatory (CGRO). Positrons result from some radioactive decays and are routinely made on Earth (at many hospitals and accelerators, for example) and in high-energy phenomena in deep space. For instance, the heart of the Milky Way has long been known to emit 511 keV gamma rays from positron annihilation. At a meeting in Williamsburg, Virginia, in late April, a multi-institutional CGRO scientific team, led by William Purcell of Northwestern University, presented maps that show a new and surprising 511 keV emission region projecting north asymmetrically 3000 light-years out of the plane of our galaxy. —PFS

▶ **PROTON TRANSISTOR MEMORY.** Electrons do most of the work in electronic devices; indeed, heavier, mobile, positively charged ions are usually a nuisance. A new experiment, however, has made hydrogen ions into the primary carriers of information in a Si-SiO₂-Si device. The protons, buried in the central layer of the semiconductor sandwich, migrate between the interfaces with the outer silicon layers. Judged as a storage device, this transistor did pretty well: It retained its state (on or off) for up to 25 hours at 200 °C; it successfully underwent 10 000 write-erase cycles, showing that the protons are imprisoned between the silicon walls; and it could be switched in 50 ms. The

chief virtue of this nonvolatile memory device may prove to be its ease of construction. (K. Vanheusden *et al.*, *Nature* **386**, 587, 1997; K. Vanheusden *et al.*, *J. Non-Cryst. Solids*, in press.) —PFS

▶ **SPRINGTIME FOR COMET HALE-BOPP.** Now past its prime and lost in the glow of the setting sun, Hale-Bopp was first spotted two years ago as far away as seven astronomical units. Astronomers could thus observe the thawing process from an earlier stage than is usual for comet watches, and their observations covered the spectrum from ultraviolet to radio wavelengths. So, what are they learning from the comet's approach? First of all, the diameter of Hale-Bopp's nucleus is estimated to be 30–40 km, at least three times bigger than that of comet Halley. Of the cometary products vaporized on the inward trip toward the sun, the chief gases were water vapor, carbon monoxide and carbon dioxide, which are also the main constituents of ices in dense interstellar molecular clouds. The comet's dust seems to contain silicates, particularly magnesium-rich crystalline olivine. Crystalline silicates are also seen in dust around some young stars. Gas and dust production in general were more than 20 and 100 times greater, respectively, for Hale-Bopp than for Halley at comparable distances from the Sun. Chemical composition analysis is consistent with the comet originating in the Oort Cloud rather than the Kuiper Belt. (Several articles in *Science* **275**, 1997.) —PFS

▶ **DETECTING LONG-TERM TRENDS** in ultraviolet radiation can be a problem. A controversial 1988 study concluded that the UV radiation reaching the ground was actually decreasing overall, along with the stratospheric ozone that absorbs it. Now, that claim has been laid to rest. Betsy Weatherhead (with NOAA) and her colleagues have published an exhaustive analysis—statistical, geophysical and instrumental—of data from 14 US sites covering 1974–91. Within the data, they discovered severe limitations for establishing trends. After they eliminated several geophysical causes (ozone, clouds, haze, particulates and temperature) of the apparent UV decrease, they were led to conclude that the trend was in the network of instruments. The UV meters were originally intended to measure relative changes in UV at specific locations, not absolute trends on a continental scale. Thus, over the years, there were changes in network management, calibration techniques, and even instrument locations, all attended by poor record keeping. “For one site,” said Weatherhead, “we found an 11% drop in UV that couldn't be accounted for. Later, we discovered that an antenna had been built there, which immediately explained it.” (E. C. Weatherhead *et al.*, *J. Geophys. Res.* **102** (D7), 8737, 1997.) —SGB ■