PHYSICS UPDATE

A MOLECULAR VOLCANO, perhaps related to episodic gas releases from comets, has been seen by Bruce Kay and his colleagues at the Pacific Northwest National Laboratory. They deposited an ultrathin (5.4 monolayers) film of carbon tetrachloride (CCl_4) on a cold gold substrate, followed by water vapor. At the frigid temperature involved (85 K), the H_2O was flash frozen into amorphous solid water (ASW), not crystalline ice. With a thick slab (30 monolayers) of ASW blanketing the CCl_4, they then slowly warmed it all up. They found that the CCl_4, which would normally begin to desorb at 130 K and be completely gone at 142 K, was held firmly in place by the ASW until, at a temperature of 156 K, it all burst forth at once, like magma erupting from beneath Earth's crust. They also investigated an overlayer of amorphous solid D_2O and found abrupt desorption at 160 K. The temperature at which ASW begins to crystallize into something more recognizable as ice is 156 K, and 160 K is the analogous temperature for D_2O. Thus, the researchers suggest that the structural changes—such as cracks, fissures and grain boundaries—associated with this phase transition provide the necessary escape channels for the CCl_4. Previous suggestions involved diffusion and pressure as the drivers of desorption. This work was part of a general study of ASW, which is of interest in areas as diverse as glassy materials, cryobiology and cometary and interstellar ices. (R. S. Smith *et al.*, *Phys. Rev. Lett.* **79**, 909, 1997.) —PFS

STORING THE MAXIMUM AMOUNT of classical information in a photon or any other quantum particle is possible even in the presence of noise, researchers have concluded. Various properties, such as polarization or energy, of a photon can be used to store information. Using polarization, for example, horizontal could represent "zero," vertical could be "one," 45° could be "two," and so on. Furthermore, one can store many digits simultaneously in a single photon by putting it into a superposition of many states. However, quantum mechanics prevents a measuring device from perfectly distinguishing between all these different states. Previously, physicists discovered that, no matter how much is "written" on a photon, the maximum amount of information that can be read can be no greater than the amount of entropy in the ensemble of signals that were sent. Whether this limit was realizable was an open question. Now, two investigations have independently shown that this upper limit can be reached, even in a noisy environment involving mixed states. Several strategies, such as employing only those quantum states that are most distinguishable, were found to be useful. These findings provide insights into how one could transmit much information using little energy—that is, few photons. (B. Schumacher, M. D. Westmoreland, *Phys. Rev. A* **56**, 131, 1997; A. S. Holevo, to be published in *IEEE Trans. Inf. Theory*, 1997.) —BPS

HEAVY-ELEMENT CHEMISTRY. Scientists at the Laboratory for Heavy Ion Research (GSI) in Darmstadt, Germany, not only have made a number of the heavy elements (up to element 112) in recent years, but have also performed some nimble chemical tests on the short-lived atoms. Deviations in the expected chemical properties, based on position in the periodic table, are expected for the heaviest elements due to strong relativistic effects. Elements 104 and 105 did indeed show some surprising properties. Now, using both isothermal gas and liquid chromatography on only seven atoms of element 106 (living for mere seconds) GSI researchers have established that 106 behaves chemically much like tungsten and molybdenum, the elements lying directly above it in the periodic table. Thus, for 106 at least, the periodic table is restored. (M. Schädel *et al.*, *Nature* **388**, 55, 1997.) —PFS

HOLLOW-NANOPARTICLE LUBRICANTS have performed well in friction and durability tests, and may be superior to other solid lubricants, which usually come in powdered form. The lubricant consists of balls of tungsten disulfide only 100 nm across (much smaller than conventional 4 μm powder grains) that are flexible, buckyball-like hollow cages. Their elasticity, chemical inertness, small size, low adhesion to substrates and tendency to roll rather than slide when pushed, make for excellent lubricating properties. The Israeli researchers who developed the lubricant foresee a bright industrial future for such nano–ball bearings. (L. Rapoport *et al.*, *Nature* **387**, 791, 1997.) —PFS

A NEW MAGNETOELECTRONIC DEVICE can serve as a nonvolatile memory element or logic gate. Researchers at the Naval Research Laboratory in Washington, DC, use magnetic fringe fields from the edge of a ferromagnetic thin film to generate a Hall voltage in a semiconducting thin film. By reversing the magnetization of the ferromagnet (which is then maintained even without power), the sign of both the fringe field and the output voltage is switched. The prototype is several micrometers across, but the output parameters should improve as the device shrinks—a minimum feature size of 100 nm would correspond to 2 gigabytes/cm^2. For logic gate operation, the next step is to demonstrate that several of the structures can be coupled together. (M. Johnson *et al.*, *Appl. Phys. Lett.* **71**, 974, 1997.) —SGB