Computers

Calculating a record prime

As participants in the Great Internet Mersenne Prime Search (GIMPS), more than 4,000 people worldwide are chasing after the record for the largest known prime number. On Jan. 27, Roland H. Clarkson of Norwalk, Calif., hit the jackpot when his personal computer established that the 909,526-digit number $2^{3,021,377} - 1$ is evenly divisible only by itself and 1. A sophomore at California State University Dominguez Hills, Clarkson had tested only eight exponents out of a huge number of possibilities before identifying the record prime.

Clarkson's number is the 37th known Mersenne prime. Expressed in the form $2^p - 1$, where the exponent p is itself a prime, Mersenne numbers have characteristics that make it relatively easy to determine whether a candidate is prime. For example, written out in binary form, a Mersenne number consists of an unbroken string of 1s—3,021,377 of them in the case of the record prime number. That prime is surprisingly close to the previous record holder, which has the exponent 2,976,221 (SN: 9/13/97, p. 164). "I never would have imagined two Mersenne primes would be so close together," Clarkson says.

He discovered the champion prime using software written by George Woltman, a computer programmer in Orlando, Fla., who started the GIMPS project in 1996. Clarkson also relied on networking software developed by Scott Kurowski of San Jose, Calif., to coordinate the efforts of a large number of GIMPS volunteers. Kurowski's PrimeNet computer distributes work to and gathers results from thousands of copies of Woltman's program residing on computers throughout the world. By handling massive amounts of data processing over the Internet, the system represents "the world's foremost example of a new kind of computing service," Kurowski says.

To attract additional prime hunters, he has offered a cash prize of at least $1,000 for the PrimeNet discoverer of the 38th Mersenne prime. The announcement is at http://entropia.com/services. —*I.P.*

Overcoming quantum error

In principle, quantum computers can solve certain types of mathematical problems in dramatically fewer steps than conventional computers (SN: 1/14/95, p. 30). Quantum information is fragile and easily disturbed, however, so handling combinations of quantum states, such as electron spins, presents considerable difficulties. The entire system must be well isolated from the environment, yet the quantum components need to interact strongly to perform a computation.

Although the recent discovery of ways to correct errors in the values of bits in a quantum computer provided an encouraging sign that quantum computation could eventually be made practical (SN: 1/20/96, p. 38), the error-correcting codes worked best when the faults occurred randomly and independently. In the Jan. 16 SCIENCE, Emanuel Knill, Raymond Laflamme, and Wojciech H. Zurek of the Los Alamos (N.M.) National Laboratory show how it is possible in theory to reduce an entire system's error rate to acceptable levels, even when the faults arise from nonrandom interactions between quantum bits.

The strategy developed by Zurek and his coworkers for what they call "resilient quantum computation" combines quantum error correction, which preserves the values of quantum bits in memory, with methods of ensuring that bits are encoded correctly and that logic operations are completed properly. The researchers show that, as long as the error rate per operation remains below a threshold value, an accurate computation can result.

"The threshold results demonstrate that quantum computation is possible in the presence of physically reasonable sources of noise," Zurek and his coworkers conclude. "Whether resilient quantum computation can be implemented in practice remains to be seen." —*I.P.*

Environment

Forests as pollution filters

Forest canopies have a reputation for filtering particles out of the air, along with any pollutants clinging to them. That reputation now appears undeserved, a pair of scientists reports. Their studies indicate that trees primarily collect gases—particularly those with a low volatility, or rate of evaporation

Michael S. McLachlan and Michael Horstmann of the University of Bayreuth in Germany used data they collected in field experiments to develop a computer model that simulates the removal of airborne organic material. The model, which accounts for each compound's volatility and its propensity for hitchhiking through the air aboard dust particles, indicates that rain removes most particle-bound contaminants from the air, polluting forests and bare soil about equally.

The opposite appears true of organic gases, which are picked up by waxy lipids on leaves, McLachlan and Horstmann report in the Feb. 1 ENVIRONMENTAL SCIENCE & TECHNOLOGY. Because it takes a relatively small amount of any highly volatile organic compound to saturate waxes, only a small fraction of such chemicals that contact leaves will stay behind. However, McLachlan notes, "the semivolatile contaminants do not saturate [leaves]," so a greater proportion of those will be absorbed. Indeed, his model indicates, trees may be 10 times more effective at collecting these pollutants than bare soil is.

While such low-volatility pollutants constitute "only a small subset of organic chemicals," he and Horstmann observe, "this subset includes many contaminants of particular concern, such as chlorinated dioxins, furans, biphenyls, and pesticides." —*J.R.*

Bug sprays seem to really like toys

Pesticide foggers used for treating an entire room usually carry labels instructing occupants to vacate the premises for 1 to 3 hours. The intent is to limit inhalation of the potentially toxic vapors or contact with wet residues. A new study now finds that for young children, dry residues can provide a greater source of exposure—and can continue to do so for a week or more.

Scientists in New Jersey hired a licensed professional to spray two Rutgers University apartments with a pesticide, following instructions on the label. The researchers then placed hard plastic toys and stuffed animals in rooms an hour after they had been fogged. Throughout the next 2 weeks, they swabbed the furniture for residues and removed toys for testing. Their findings, reported in the January ENVIRONMENTAL HEALTH PERSPECTIVES, show that the toys—far more than the furniture—accumulated pesticide residues for at least 1 week.

"I didn't expect this. It was a big surprise," notes study leader Paul J. Lioy of Rutgers and the University of Medicine and Dentistry of New Jersey in Piscataway. Indeed, the data suggest that the pesticide leaped "like a grasshopper" from one surface to another for 2 weeks, with certain plastics and foam effectively sopping it up "like a sponge," Lioy says. The fact that the toys acquired far higher residues than the furniture or linoleum floor, he says, traces to their particular chemical affinity for holding onto the pesticide. Though his team had used chlorpyrifos, a popular termite and roach killer, Lioy said any semivolatile pesticide should leap similarly.

The team estimates possible toddler exposures, beginning 1 week after fogging, at more than 200 micrograms per kilogram of body weight daily—20 times the recommended allowable daily intake. Some 39 percent of the exposure would come through the skin, with virtually all of the rest from children putting residue-laden fingers or toys in their mouth.

The findings "should be a big boon to the toy box industry," Lioy told SCIENCE NEWS, because the easiest way to cut exposures would be to put toys away whenever they're not in use—at least for the first 2 weeks after any fogging. —*J.R.*