Computers

Big-league computing

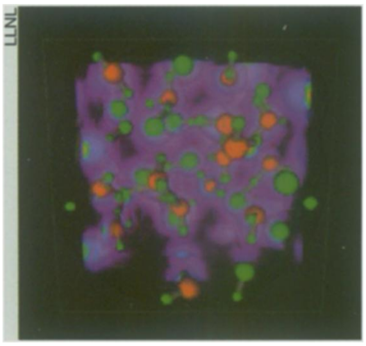
The race to calculate at world-record speeds has two new entries.

Last month saw the unveiling of a new supercomputer, called Blue Mountain, capable of calculating in the range of 3 trillion operations per second. Located at the Los Alamos (N.M.) National Laboratory, the machine consists of 48 commercially available Silicon Graphics Cray Origin2000 computers yoked together. This supercomputer can handle enormous amounts of data, run detailed simulations, and create sophisticated graphics.

At the same time, an advanced computer named Blue Pacific began operating at the Lawrence Livermore (Calif.) National Laboratory (LLNL). Built by IBM, the machine operates at a peak speed of about 3.9 trillion calculations per second. Researchers have already used the computer to model the molecular behavior of explosives, simulate the trajectories of neutrons generated during laser-induced nuclear fusion, perform quantum-chemistry calculations, and study three-dimensional turbulent mixing in a supernova.

Both supercomputers are products of the Department of Energy's Accelerated Strategic Computing Initiative. This effort is a key element in the development of methods to assess the safety and reliability of the nation's aging arsenal of nuclear weapons without underground nuclear testing (SN: 10/19/96, p. 254). The installation of a supercomputer at the Sandia National Laboratories in Albuquerque, N.M., in 1997 represented the first step in that effort (SN: 1/4/97, p. 7; 7/5/97, p. 5).

Earlier this year, the Energy Department announced plans for pushing computer technology by the year 2004 to speeds of 100 trillion calculations per second. In one step toward that goal, IBM has a contract to develop a computer for LLNL capable of operating at 10 trillion operations per second. The machine will use the same technology as did Deep Blue, the chess computer that triumphed over world chess champion Garry Kasparov (SN: 5/17/97, p. 300). —*I.P.*



LLNL

Computer simulations of explosions allow researchers to follow atoms' trajectories as chemical bonds form and break at high pressures and temperatures. Pictured here is an explosion whose products include water and highly corrosive hydrogen fluoride.

Prize-winning calculations

Although the world's fastest computers can now reach speeds of more than 3 trillion calculations per second, achieving even a fraction of that level of performance in practice requires great care in writing programs and matching scientific problems to the computer's capabilities.

Last month, scientists at Oak Ridge (Tenn.) National Laboratory and Lawrence Berkeley (Calif.) National Laboratory and their collaborators managed to get their simulation of magnetic interactions in iron to run at just over 1 trillion calculations per second. This is the highest computer speed yet achieved in a practical application. It was accomplished using the 1,480 processors of a Cray T3E supercomputer.

At the recent SC98 supercomputing conference in Orlando, Fla., an earlier version of the simulation, running at 657 billion operations per second, won the Gordon Bell Prize, awarded annually to the top accomplishment in high-performance computing. —*I.P.*

Materials Science

From Boston at a meeting of the Materials Research Society

Stressfree carbon needs no support

Thin carbon films that are free of internal stresses and nearly as hard as diamond could be used to make sensors and microscopic machines, says Thomas A. Friedmann of Sandia National Laboratories in Albuquerque, N.M. Stresses resulting from misalignments of atoms have until now caused similar diamond films to crack and peel away from their foundation.

Friedmann and his colleagues deposit carbon onto silicon at room temperature, then etch the film off the surface. Heating the material realigns the atoms and removes stresses that had been created by adhesion to the silicon surface. The resulting film is 90 percent as hard as pure diamond and very wear-resistant. Tiny machines made out of this hard carbon would be more durable than ones made of silicon (SN: 7/26/97, p. 62).

Friedmann and his coworkers have made a round membrane just 60 nanometers thick and 2.5 centimeters in diameter that can flex in response to tiny movements. Such membranes could also be used as windows for X rays or electron beams, he says. —*C.W.*

Special steel finds real applications

A steel that's both strong and flexible may owe its unusual combination of properties to quasicrystals in its microscopic structure, says Jan-Olof Nilsson of AB Sandvik Steel in Sandviken, Sweden. Quasicrystals are exotic materials whose atoms are well-ordered but do not take on a repeating atomic arrangement (SN: 10/12/96, p. 232).

The steel—an alloy of iron with 10 other elements—is packed with quasicrystal particles between 1 and 10 nanometers across. Sandvik manufactures about 100 tons of the steel per year, and the company recently has determined that quasicrystals make up about 1 percent of the material's composition. Other steels of this type do not contain quasicrystals. "To the best of my knowledge, this is one of the first examples of the use of quasicrystals in a commercial alloy," Nilsson says.

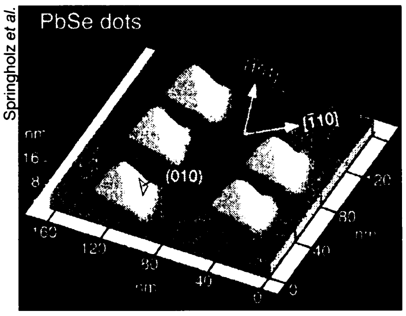
The steel is used to make delicate surgical instruments that require both hardness and flexibility. During eye surgery, for example, it would be unacceptable for a needle to break, Nilsson notes. This year, the steel found its way into less exacting, but more common, devices: electric razors. —*C.W.*

Quantum dots stack into a 3-D array

Tiny islands of a semiconductor material can spontaneously arrange themselves into a three-dimensional lattice, says Gunther Springholz of the Johannes Kepler University of Linz in Austria. The islands, known as quantum dots (SN: 4/11/98, p. 236), adopt a pattern similar to the atomic structure of many materials.

To make the lattice, Springholz and his colleagues lay down alternating layers of lead telluride sheets and arrays of pyramid-shaped dots of lead selenide. By controlling the thickness of the lead telluride spacer layers, they can control the three-dimensional arrangement that the dots will assume, which in turn influences their collective optical and electronic properties.

Spacer layers between 30 and 60 nanometers thick appear to produce the best results, Springholz says. If the spacers are too thin, the dots on individual layers arrange themselves randomly. If the layers are too thick, however, the dots don't align with those above and below. —*C.W.*



Springholz *et al.*

Lead selenide dots on lead telluride assume a pyramidal shape.