much of the town, combining with rain to collapse many roofs.

The United Nations' Department of Humanitarian Affairs says that the eruption displaced 45,000 people, but it has received no reports of casualties.

Geoscientists say the work of the researchers and civil defense officials at Rabaul averted untold fatalities. "The town is pretty much nestled inside a caldera — inside a volcano. This time, they managed to get everyone out before the eruption," says James J. Mori of the U.S. Geological Survey in Pasadena, Calif. From 1984 to 1988, Mori worked as a seismologist at the Rabaul observatory.

Rabaul is one of several active calderas — including Long Valley, Calif., and Yellowstone National Park — that have concerned volcanologists during the last decade. Because scientists have never witnessed such a large eruption, they remain unsure of how one starts. They suspect that several spots on the outside of the old caldera might become active, releasing magma around the entire rim of the crater. After such an outflow, the center of the volcano collapses to form a new caldera.

Scientists have worried about Rabaul because it seemed to fit this pattern of widespread unrest. Vulcan and Tavurvur both erupted strongly in 1937. In the 1970s and 1980s, the caldera produced significant quakes and other ominous signs, leading officials to draw up evacuation plans and prepare the populace.

"The eruptions in 1937 and this intense period of unrest starting in 1971 made people worry that the next event could unzipper the ring fracture and lead to a caldera-forming eruption," says volcanologist Daniel Dzurisin of the USGS' Cascades Volcano Observatory in Vancouver, Wash.

Instead, the current events seem a repeat of 1937. The blasts have weakened this week, but a USGS team is en route to set up monitoring devices in case the activity renews.

Satellite measurements indicate that the Rabaul eruption equals the 1980 Mount St. Helens blast in scale but has released far less climate-altering sulfur dioxide than the 1991 explosion of Mt. Pinatubo did. — *R. Monastersky*

# Cesium atoms for optical computers

The task of computing largely involves comparing pieces of information.

A typical personal computer will size up small bits of data, matching one against another. Usually, it does so in series, one bit at a time. Even parallel computers, which run many processors simultaneously, ultimately fall back on step-by-step analysis.

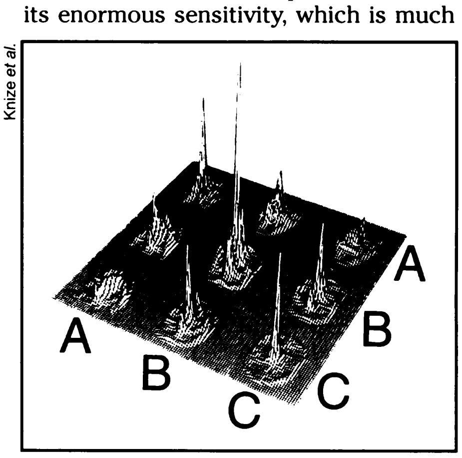
The ability to compare, say, a million pieces of information in one deft stroke would therefore offer tremendous computational advantages. Optical computers, which rely on transmissions of light rather than electricity to perform calculations, might provide such benefits. To date, though, no good material for making the machinery to handle optical comparisons has been found.

Seeking to supply this missing link, Randall J. Knize, a physicist at the University of Southern California in Los Angeles, and his colleagues describe fabricating an optical correlator, a device that uses a vapor of cesium atoms to compare images. They report their work in the Sept. 22 NATURE.

"Optical computing aims to take advantage of the massive parallelism of light," says Knize. "If you expand a laser beam so that it can carry a million pieces of information, then process all of that information at the same time, you could make massively parallel computations in a way that isn't possible with ordinary electronic computers."

"This optical correlator offers a way to process information by comparing two images to see if they are similar," he says. Two laser beams carrying information about two images pass through a glass cell containing a cesium vapor. The cesium cell senses similarities and differences, then emits a third signal that reveals where the two images do and do not overlap.

"We chose cesium vapor because of its enormous sensitivity, which is much




Knize et al.

*A cesium optical correlator compares images of the letters A, B, and C. Same-letter matches yield tall spikes.*

# Cold nuclei, magnetic order, and hot spins

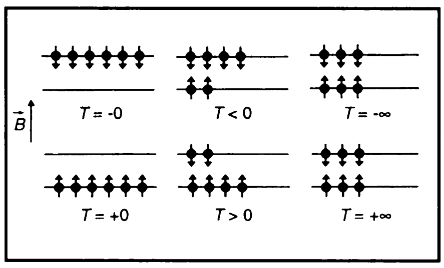
Striving for a new low in solid-state physics, researchers have chilled the nuclei of rhodium atoms to a temperature of 280 picokelvins (pK), just barely above absolute zero. These experiments have also produced negative temperatures as "high" as -750 pK.

The results stem from a long-standing research effort by Pertti J. Hakonen, Olli V. Lounasmaa, and their coworkers at the Helsinki University of Technology in Finland. Their goal is to study interactions between the spinning nuclei of metal atoms to glean insights into the nature of magnetism. Because these spin interactions are extremely weak, the experiments must be done at very low temperatures.

"Nuclear spins in metals provide good models to investigate magnetism," Hakonen and Lounasmaa report in the Sept. 23 SCIENCE.

Ordinarily, temperature (measured in kelvins) describes the average energy associated with either the motion of free particles, such as electrons, in a material or the vibration of particles bound to certain sites in the material. In a metal at ultralow temperatures, however, the spinning nuclei and the free electrons may coexist at different temperatures. Hakonen and his colleagues focus on the spin behavior of atomic nuclei, particularly silver and rhodium.

When placed in a magnetic field at temperatures below 1 microkelvin, these nuclei organize themselves so that their spins tend to line up in the same direction as the magnetic field (see diagram). As the temperature gets closer to absolute zero, the number of misaligned nuclear spins decreases. Spins that are initially oriented in the opposite direction of the magnetic field flip over to a parallel orientation, which has a lower energy.




Hakonen and Lounasmaa/SCIENCE

*Energy-level diagram of silver (or rhodium) nuclei showing spin orientation in a constant magnetic field for positive (lower row) and negative (upper row) temperatures.*

By suddenly reversing the magnetic field, the researchers can create a situation in which nearly all of the nuclear spins are oriented in the opposite direction, or antiparallel to the magnetic field. Because more nuclei are in the high-energy state than in the low-energy state, the nuclei are said to have a negative spin temperature.

In this case, achieving even lower negative temperatures means adding energy to flip more spins into the higher-energy, antiparallel state. Thus, negative temperatures are actually "hotter" than positive ones, the researchers say. Similarly, a temperature of -750 pK is, technically speaking, warmer than one of -800 pK. — *I. Peterson*