problem had not been dealt with properly. "As far as statistics are concerned," says Brier, "I think it's clearly significant. I don't think any test would be more appropriate than the one we used."

While the basic claim is being scrutinized, Labitzke and van Loon have been extending their initial correlations. "Everything should hang together if it makes physical sense," says van Loon. "And everything we have touched has turned out right. We have found no contradictions to the original conclusions." The solar cycle correlates with sea level atmospheric pressure and surface air temperature during the Northern Hemisphere summer as well as during winter, but primarily over the oceans. The separation of the record into east- and west-phase years reveals correlations in the Southern Hemisphere too, but the correlations are especially marked in the east phase there rather than the west phase. The strength of the east-phase correlation is particularly evident in the Antarctic stratospheric temperature, which is a crucial factor in the formation of the Antarctic ozone hole (*Science*, 28 October, p. 515).

Much on the minds of those who take these correlations seriously is the question of reliability. The apparent solar effects found in the record since 1952, when the record becomes good enough to identify the QBO, might have been a fluke coincidence, despite the statistically strong correlations. Many researchers would take the whole thing much more seriously if a solar connection could be found in the earlier record too.

There are some promising signs that the sun-weather connection will be traced over more than three and a half solar cycles. In 1979 G. M. Brown and J. I. John found that winter storms in the North Atlantic tracked 2.5° farther south during solar maximum than during solar minimum. In light of the subtlety of the effect, researchers simply ignored Brown and John's paper.

After Labitzke pointed out how sorting according to the QBO phase could help, Brian Tinsley of the University of Texas at Dallas reworked the Brown and John storm track analysis. The deviation between solar maximum and minimum increased from 2.5° in unsorted data to 6° in the west phase during winter. Labitzke and van Loon note that "As Brown and John's signal extends back through three solar cycles before 1952, their work suggests that our results may also be applicable to the period before 1952." Tim P. Barnett of Scripps Institution of Oceanography has also reported that he finds signs of a solar-QBO interaction in long records of tropical sea surface temperature and sea level pressure without stratifying the data according to QBO phase.

Even if the correlations hold up, there would remain the question of mechanism. How could the feeble variations in solar output over a cycle be amplified to give the apparent changes in the weather, a required amplification of over a million? No one has any answers. One encouraging sign, however, is the way geographical patterns of sun-weather correlations resemble the patterns of behavior often taken up by the atmosphere. Thus the sun-weather correlations appear to make some physical sense.

As discussed by Tinsley, solar forcing could conceivably be amplified through multistep processes, several of which he gives for illustrative purposes. Galactic cosmic rays, which are modulated by the solar cycle, might produce chemical reactions in the upper atmosphere that lead to changes in ozone or cirrus cloud particles, both of which affect the amount of atmospheric heating. The resulting changes in heating could lead to temperature changes, changes in winds, perturbation of unstable circulations, and ultimately changes in the weather.

All this is getting much too far ahead of the facts for many meteorologists. "Given the fact that there is no physical basis for expecting these relationships," says John Wallace of the University of Washington, "I would need really strong statistical evidence." That evidence may still be compromised, he says, by the need to group the data by both the QBO and solar cycle. "I have a feeling that this procedure raises deeper statistical issues that haven't been addressed." The more the data are stratified, he notes, the more data are needed to demonstrate significance. The way the patterns of atmospheric behavior make physical sense does not by itself prove a correlation with solar variabilities, he notes.

"I've seen so much time wasted on such things that went away," says Wallace. "I wouldn't say there's nothing there, but I would be very surprised if it does hold up in the long term. This feels like one of the flukes that will go away." Perhaps it will. But by passing its first tests, this sun-weather connection has caught the attention of the scientific community, the essential first step to vindication or outright repudiation.

■ RICHARD A. KERR

ADDITIONAL READING

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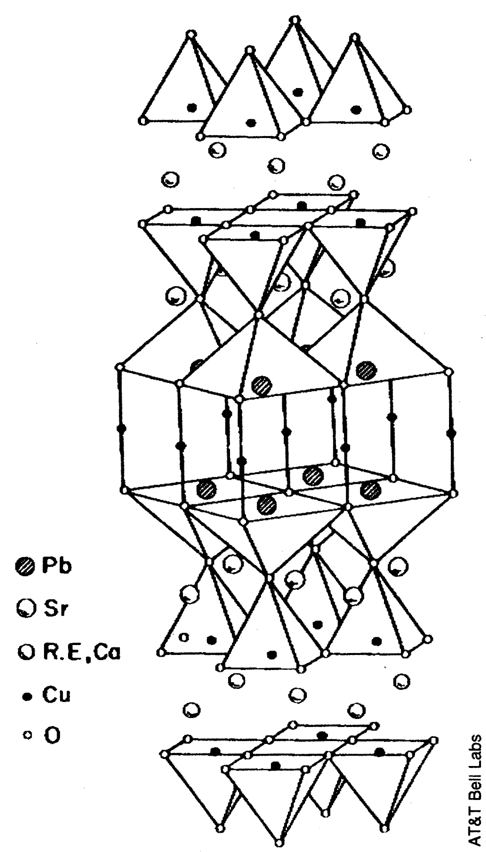
# One More Family of Superconductors

Researchers at AT&T Bell Labs have discovered yet another family of high-temperature superconductors. In the 17 November *Nature*, Robert Cava, Bertram Batlogg, and coworkers describe a group of copper-oxide compounds that become superconducting (lose resistance to electric currents) at temperatures as high as 68 K and whose crystalline structures are similar to previously known high-temperature superconductors. Although the critical temperatures of the materials—the temperatures at which they become superconducting—do not set any records, the Bell Labs researchers say the compounds give new insight into high-temperature superconductivity.

The discovery, Batlogg said, offers more evidence for what superconductivity researchers already believed—that double pyramidal layers of copper and oxygen atoms such as those found in the new materials play a crucial role in high-temperature superconductivity. So far, all of the materials discovered with critical temperatures over 50 K have these same double Cu-O layers, Batlogg noted. "This is apparently the main




**Double pyramidal layers** *of Cu-O sandwich a Pb-O/Cu-O/Pb-O triple layer.*

building block," he said.

The various families of high-temperature superconductors differ in what lies between these layers. In the Y-Ba-Cu-O materials that become superconducting at 93 K, which were the first high-temperature superconductors discovered, it is Cu-O chains that sit between the double pyramidal layers. In the 125 K thallium-based superconductors discovered early this year, it is Tl-O layers sandwiched between the double pyramidal layers. And in the materials fabricated by Bell Labs, the meat of the sandwich is a triple layer—two lead-oxide pyramidal layers on either side of a copper-oxide plane.

The researchers believe the Pb-O/Cu-O/Pb-O layers play the same role in producing superconductivity in the newly discovered superconductors that the Cu-O chains and Tl-O layers play in the earlier materials, Batlogg said. That is, these inner layers accept electrons from the pyramidal Cu-O layers, causing holes (the absence of electrons) in the outer layers. These holes seem necessary to produce superconductivity in the Cu-O layers.

The new family of superconductors has the chemical formula $Pb_2Sr_2ACu_3O_{8+y}$, where A can be either one of the rare earths Y, La, Pr, Nd, Sm, Eu, Gd, Dy, Ho, Tm, Yb, and Lu, or else a mixture of one of these rare earths with Sr or Ca. The Bell Labs scientists say the highest critical temperature they have achieved in this family is 68 K, in $Pb_2Sr_2Y_{0.5}Ca_{0.5}Cu_3O_8$.

Batlogg said the Bell Labs group has seen "clear indications of critical temperatures above 70 K" in some of the new superconductors, but he does not expect the compounds to achieve high enough critical temperatures to be of commercial importance.

In the past 2 years, researchers have found several families of superconductors with critical temperatures above 77 K, the boiling point of nitrogen. These materials are expected to have a number of commercial applications, because they can be cooled with liquid nitrogen instead of the more expensive and difficult to handle liquid helium. The fact that the newly discovered family of superconductors has critical temperatures below 77 K will limit their practical applications.

Preparing the new superconductors is much more complicated than for previously known copper-oxide superconductors, Batlogg said. The Y-Ba-Cu-O materials, for instance, can be prepared simply by grinding together the oxides of yttrium, barium, and copper and baking them, but the best way to make the new materials is to first prepare a copper–oxygen–strontium–rare earth mixture and then react that with PbO at around 900°C. ■ ROBERT POOL

# NeXT Embraces a New Way of Programming

*The object-oriented approach makes programming easier and faster; NeXT hopes to bring it to the masses*

NO DOUBT ABOUT IT: the newly announced NeXT computer is an impressive piece of technology. A product of 3 years' entrepreneurship by Steven Jobs, the dethroned cofounder of Apple Computer, it has explicitly been designed to be an academic's dream machine. It features a built-in network connection, an ultrahigh capacity optical disk for data storage, a blazingly fast central processing unit, the Unix operating system, and more. Best of all, it will sell for only $6500, or about one-half to one-third of what academics are now paying for equally powerful workstations.

For all of that, however, the most intriguing aspect of the NeXT machine is not its hardware, but its software. Even if it stumbles in the marketplace—and most industry analysts agree that the company faces an uphill battle against such entrenched giants as Apple, Sun, and IBM—it still promises to have a lasting influence as the first mass-market computer to embrace "object-oriented" programming: a methodology that is just now emerging from computer laboratories, and that promises to speed software development by factors approaching 10.

Coming at a time when delays, cost overruns, and buggy end products are practically the norm in the software industry, that kind of potential commands attention. "[Object-oriented programming] is one of the few things to come along that could even make a dent in the software bottleneck," says Allen Otis, engineering manager for Servio Logic, Inc., of Beaverton, Oregon, who was chairman of a recent national conference on the subject. "So if it is successful, that is going to make it *the* dominant paradigm for programming."

One way to get a sense of what object-oriented programming is about is to imagine a corporate office. In the standard "procedural" approach to programming, which is embodied in such popular computer languages as Pascal, Fortran, C, and BASIC, one treats the computer like an exceptionally stupid office worker who needs to be told precisely what to do at every step of every task. This does make for a certain efficiency, since the worker can eventually be trained to do the job with no wasted motion whatsoever. But it is also painstaking in the extreme. Make a mistake in describing any one of those steps, which is easy to do, and the machine will obediently start to dun your paid-up customers with bill after bill for $0.00, or some other such idiocy.

In the object-oriented approach, by contrast, the programmer functions more like a high-level executive assembling a team of skilled specialists: "objects" that already know how to handle a variety of tasks. A database object, for example, would be a self-contained piece of code having one preprogrammed method that it can use for sorting a set of records, another method that it can use for extracting the records that meet a given criterion, yet another method for displaying itself in an on-screen window, and so on. The programmer's job is thereby simplified: in principle all he or she has to do is to set up a chain of command among the objects—they operate by passing messages to one another requesting this or that action—and the objects themselves will take care of the rest.

***"Instead of people starting on the ground floor with software, they can start on the 10th floor."***

The job is simplified even more by the fact that an object-oriented programmer is always reusing and building upon what has gone before, as opposed to designing each new program from scratch. When a new object is needed it is usually defined as a specialization of some existing object, in much the same way that a biologist defines *dog* as a specialization of *mammal*. The new object automatically inherits all the attributes and methods of the old one (*hair*, *warm blood*, *live birth*), so that the programmer only has to add in the unique features (*bark*, *tail-wagging*). Among other things, this