SUPERCONDUCTIVITY

C_{60} Enters the Race For the Top

In the mid-1980s, the discovery of 60-atom carbon spheres (C_{60}) and high-temperature superconductors came as two major surprises. Now an international trio of researchers led by physicist Hendrik Schön of Lucent Technologies' Bell Laboratories in Murray Hill, New Jersey, has combined these two feats. In a paper published online this week by *Science* (www.sciencexpress.org), Schön's team reports that by placing a crystal of C_{60} spiked with other compounds in the heart of a transistor, they can turn it into a high-temperature superconductor capable of conducting electricity without resistance up to 117 kelvin (K).

"This is huge," says Art Ramirez, a condensed matter physicist at Los Alamos National Laboratory in New Mexico. C_{60}-based transistors spiked with new compounds might well superconduct at higher temperatures, perhaps even at room temperature, Ramirez says. Moreover, the crystals that Schön's team created are far easier to craft into electronic components than the standard high-temperature superconductors made from copper oxide–based ceramics, a property that could pave the way to new high-speed computers based on the technology. "This is what people have been trying to do all along" with high-temperature superconductors, Ramirez says.

This week's report follows up a discovery that Ramirez, then at AT&T Bell Labs, and colleagues made in 1991. The researchers found that crystals made of the soccer ball–shaped C_{60} molecules would superconduct at 18 K if they were spiked with alkali metals to make them better conductors of electrons. Superconductors can also work by conducting positively charged "holes," which are essentially electron vacancies in a material. In the late 1990s, Schön and his colleagues began to suspect that they could push the threshold temperature for superconducting (called the critical temperature, or T_c) higher if they could coax the C_{60} to conduct holes instead of electrons. Doing so, they and others determined, would increase a property in the material known as the density of states, the number of charges the material can harbor at key energy levels. That number is closely tied to the superconducting temperature.

Boosting the number of holes in C_{60} was difficult. The traditional strategy of doping the material with other compounds—in this case, ones that added holes—made the C_{60} crystal fall apart. But last year, Schön and Bell Labs colleagues Christian Kloc and Bertram Batlogg hit upon a novel solution: building a transistor around the crystal and using its charge-carrying ability to flood the crystal with holes. The scheme worked. As the trio reported in the 30 November issue of *Nature*, the C_{60} transistor started superconducting and kept it up at temperatures as high as 52 K.

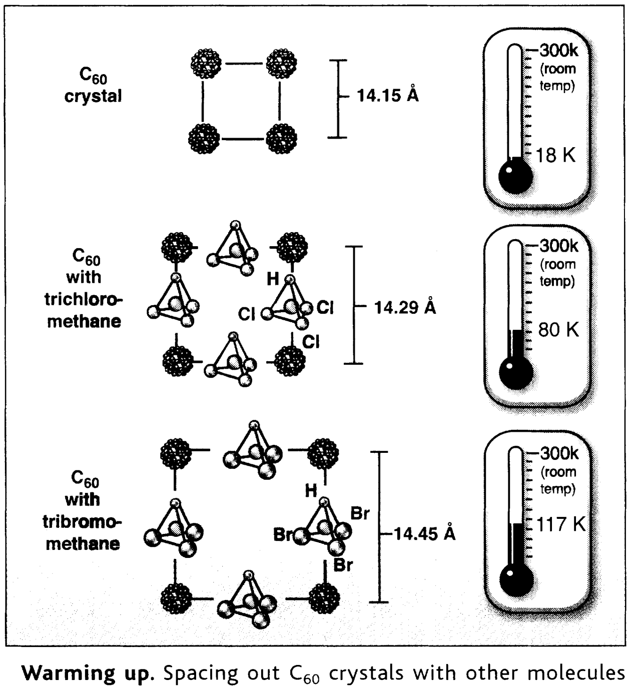
This week's report, which more than doubles that record, shows that Schön and his colleagues had another trick up their sleeves as well. This time they added another way of increasing the material's density of states: expanding the distance between individual C_{60} molecules in the crystal, a property known formally as the material's lattice constant. C_{60} has a lattice constant of 14.15 angstroms. "If you expand the lattice, the density of states becomes larger and the T_c increases," says Schön.

According to Schön, Kloc—the group's crystal grower—tried numerous additives and ultimately hit on two compounds, trichloromethane and tribromomethane, that did the trick. The former expands the lattice constant to 14.29 and the latter to 14.45. The compounds hiked the material's density of states, touching off an exponential increase in T_c.

That huge jump bodes well for researchers, Ramirez says. "They need to expand [the lattice constant] to something like 14.7, and that will be room temperature." So far, nobody knows whether any additive will push C_{60} to that magic number without making the crystal fall apart. But now that the word is out, other groups are sure to try their luck. "This is a footrace now," Ramirez says.

Even if C_{60} proves not to be a room-temperature superconductor, it could still have a big impact on applications. Ceramic superconductors are "extremely difficult" to fashion into transistors and other electronic components, Ramirez says, because the interfaces where they join with other materials typically harbor imperfections that trap electric charges moving through the devices. The problem can be overcome by growing devices one atomic layer at a time. But that's difficult and costly.

Organic materials appear far more forgiving, Ramirez says: "With essentially a shoestring effort, [Schön's team] gets incredible device quality and performance." Because superconducting electronics are extremely fast and are ideal for detecting minute magnetic fields, a new supply of C_{60}-based superconducting devices could revolutionize fields as disparate as high-speed computing and medical imaging. For researchers of all stripes, that would be another welcome surprise.



Warming up. Spacing out C_{60} crystals with other molecules nudged them toward room-temperature superconductivity.

–ROBERT F. SERVICE

LONGEVITY

Hints of a 'Master Gene' For Extreme Old Age

As children, siblings fight over their toys, and even as they age, many are reluctant to share. But for sisters and brothers who have reached age 90 or more, what they share—their DNA—may be key to why they've lived so long. Preliminary evidence, published in the 28 August issue of the *Proceedings of the National Academy of Sciences*, suggests that genetics plays a major role in the ability to survive to extremely old ages.

"If it turns out to be true, it's really important for gerontology," says George Martin, a pathologist at the University of Washington, Seattle. Indeed, if the results hold up, they promise to overturn some ideas about the mechanisms of aging—and they might eventually provide clues about how to slow the process.

For decades, researchers have fiercely debated whether the extreme longevity that clusters in some families stems from purely environmental factors or also has genetic roots. And if the fountain of youth has a genetic component, researchers have won-

ILLUSTRATION: C. SLAYDEN

Thank the genes? These siblings may share a "booster rocket" that lets them blast past age 90.

dered, does it stream from hundreds or thousands of genes or very few?

Several groups have identified human genes and regions of mitochondrial DNA that might make small contributions to longevity. In these studies, scientists have picked candidate genes or sequences and then compared the frequency of different variants in long- and shorter lived people. Using this method, they've found, for example, that forms of some genes such as *ApoE* predispose their bearers to cardiovascular disease and Alzheimer's—and thus increase mortality—whereas other versions protect against these same maladies. In addition, studies of model organisms have identified single genes that can dramatically lengthen life-span (*Science*, 6 April, p. 41). But until now, no one has conducted an open-ended search designed to pick up any genetic region that confers exceptional life-span in humans.

To unearth a genetic basis for longevity, Thomas Perls, a geriatrician at Harvard Medical School in Boston, Louis Kunkel, a molecular geneticist at Children's Hospital in Boston, and their colleagues studied 137 sets of extremely old siblings—308 individuals in all. Each set included one person who was at least 98 years old and any brothers or sisters who were at least 91 and 95, respectively. Siblings share, on average, half of their DNA. So, to identify regions that might confer longevity, the researchers searched for shared stretches of DNA present at a frequency higher than expected by chance. This process led them to a hefty tract on chromosome 4.

That a single region of DNA emerges in a study of only several hundred people suggests it is "a master gene": one that contributes significantly to longevity, says immunogeneticist Claudio Franceschi of the Italian National Research Center on Aging in Ancona. Genes that make only small contributions would require much larger sample sizes to detect, he explains.

Leonid Kruglyak, a geneticist at the Fred Hutchinson Cancer Research Center in Seattle, agrees: "Before this, you could argue that a lot of longevity in families was due to environment, not genes. If [the result] holds up in future studies, it suggests that there is a genetic component—and that a single gene contributes a great deal."

Perls suggests that extreme longevity—living 20 to 25 years longer than average—requires "a substantial genetic advantage." Such an advantage would include freedom from genes that predispose to disease as well as "genetic booster rockets," as Perls describes them: genes that slow the process of aging and decrease susceptibility to all age-related diseases.

Experts caution, however, that the Harvard group's data lie at the edge of statistical significance. Because the results are "right on the borderline," says Kunkel, "you really can't believe the data fully until they are replicated by another study."

Thomas Kirkwood, a gerontologist at The University of Newcastle in the U.K., says he likes the group's approach: "Family studies to look for genes that associate with human longevity are definitely the way to go." But he cautions that "the evidence in this analysis is too flimsy to warrant getting very excited." Not only is the statistical significance low, he says, "but the statistical assumptions used to generate it have not been verified."

Although the work is preliminary, David Burke, a mouse geneticist at the University of Michigan, Ann Arbor, says the Harvard study represents a significant advance, because it points toward an area for further exploration: "There are a lot of papers looking at the process of aging in a variety of experimental organisms, and that's great. But any time we can get information about humans, that's extremely valuable."

Perls, Kunkel, and their colleagues are scouting out more long-lived siblings so they can repeat the study. At the same time, they've started a company, Centagenetix, that is trying to find the gene or genes of interest. Hundreds lie in the suspect region, and all are vying for candidacy, says Kunkel. None of the genes implicated in aging by model organism studies reside in the area, so a winner could represent a new physiological pathway or a different member of a pathway already identified, he says.

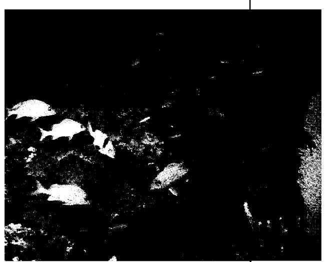
–EVELYN STRAUSS

CREDITS: (TOP TO BOTTOM) RICK KOZAK; NOAA

ScienceScope

West Nile Watch The West Nile virus's rapid invasion into North America (*Science*, 24 August, p. 1413) continues, with authorities in two more U.S. states last week detecting the virus for the first time. The appearance of West Nile in dead birds in Indiana and Michigan means that the virus has been found this year in 15 states and Washington, D.C. Meanwhile, Health Canada confirmed detection of the virus in 10 dead birds found in southern Ontario. The number of confirmed human cases in 2001 has grown to seven—in New York, Georgia, and Florida—including one fatal case in Atlanta.

Whole Earth Catalog An enigmatic new organization with the lofty goal of recording all 7 million to 100 million species on Earth within 25 years is gearing up now that it's hired a CEO. The new All Species Inventory chief, Brian Boom, formerly with The New York Botanical Garden, says the effort will be "organismal biology's equivalent to the human genome project."



Launched last fall in California, the All Species project is backed by an intriguing alliance of science and tech figures, including prominent biologists, former *Whole Earth Catalog* publisher Stewart Brand, and Kevin Kelly, co-founder of *Wired* magazine (www.all-species.org). Organizers explain that it won't try to duplicate ongoing species inventories and database projects. Instead, "we're looking for the bottlenecks and the holes in funding," says Boom. He and others mention everything from genetic sampling to training lay taxonomists in developing countries.

The inventory has over a million dollars in start-up money, but it's now moving into a major fund-raising phase, Boom says. The goal is hundreds of millions of dollars, and he claims tentative commitments from unnamed tech industry donors. Planners expect to flesh out the project at a meeting next month in Mexico and another at Harvard in October chaired by biodiversity champions Peter Raven and E. O. Wilson.

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