

Revisiting intermetallic superconductors

Since 1986, copper oxide compounds have dominated the superconductivity fast-track, with scientists making headlines last year by reporting transition temperatures near 250 kelvins — about -23°C (SN: 12/18 & 25/93, p.405).

But copper oxides are not the only superconductors worthy of study. In 1953, researchers first saw the zero-resistance phenomenon in a multimetal compound based on niobium, designated A15. In 1974, a group of chemists achieved superconductivity at a temperature of 23.2 kelvins in a niobium-based thin film — a breakthrough that has gone unchallenged for nearly 20 years.

Now, superconductivity researchers are refocusing attention on such “intermetallic” compounds. In the Jan. 13 and Jan. 20 NATURE, researchers at AT&T Bell laboratories in Murray Hill, N.J., led by physicist Robert J. Cava, describe several new families of intermetallic compounds, made from combinations of ordinary and rare earth metals, that achieve superconductivity at elevated temperatures. In the Jan. 10 PHYSICAL REVIEW LETTERS, R. Nagarajan, a physicist at the Tata Institute of Fundamental Research in Bombay, India, and his colleagues describe super-

conductivity in a nickel alloy.

Wondering why other such superconductors hadn't turned up before, Cava realized “people had just stopped looking.”

These superconductors are distinguished by their use of three or four metals in combination. Cava's team describes one quaternary intermetallic compound — based on the elements yttrium, palladium, boron, and carbon — in which they achieved superconductivity at 23 kelvins. In another family of compounds, based on nickel, boron, carbon, and a fourth element from a group of rare earth metals, they saw no electrical resistance at 16.6 kelvins. Indeed, Nagarajan and his colleagues also confirmed superconducting transition temperatures at 12.5 and 13.5 kelvins in a related family of nickel-based alloys.

“We believe that the yttrium-palladium boride carbide superconductor will prove to be the first of a new family of high-temperature [superconducting] intermetallic compounds, and we suggest that boride carbides (and borides) represent one road to high-temperature [superconductors] that is worthy of exploration,” the Cava group writes.

While recognizing that nickel raises the

temperature at which superconductivity occurs, Cava and his co-workers aren't certain why. They note that the layered-crystal structure of the intermetallic compounds “is reminiscent of those of the copper oxide superconductors.” Yet whether they operate by the same electrical mechanism, the physicists say, “remains to be seen.”

Of interest, too, notes Nagarajan's group, is carbon's role in facilitating superconductivity. In one particular compound — containing yttrium, niobium, and boron — the researchers note that adding carbon “leads to a dramatic enhancement of superconducting properties,” seemingly by modifying its “superstructure.” But that mechanism, too, defies a complete explanation.

“The idea of putting four metal elements together to make a superconductor is new,” says Cava. “People have tried two and three, but not four. Sometimes to improve results, you have to let nature stabilize competing factors, and the best way to do that is to put more elements into the pot and see what nature cooks up.”

“The other obstacle to overcome is the prevailing idea that nature always wants to keep things simple. That's not always so. If anything, what copper oxide shows us is that the simplest compound is not necessarily the best.” — R. Lipkin

Radio ears: Probing the universe's fate

Will the universe continue expanding forever, or will it eventually stop expanding and begin to collapse? Powerful radio waves generated when pairs of high-energy jets of matter shoot out of the massive, compact centers of giant galaxies and crash into surrounding gas clouds may carry a remarkably direct answer to this question.

“This is a new tool for doing cosmology,” says astrophysicist Ruth A. Daly of Princeton University, who has worked out a way to use the characteristics of these radio sources to detect changes in the universe's expansion rate.

Daly's method relies on the detection of a distinctive pattern of radio emissions from huge, distant galaxies with powerful, central energy sources thought to be black holes. In each case, the regions of radio emission appear as a pair of enormous, widely separated lobes that bracket and dwarf the galaxy itself.

The most energetic radio waves come from the outer edges of the lobes. There, the twin jets of particles traveling outward in opposite directions from the galactic center slam into the ambient gas and excite electrons, which whirl around in the gas cloud's magnetic field and emit intense radio waves.

Daly has found a way to estimate the distance between the two lobes of an

extended radio source. Calculated on the basis of a link between the spectrum of radio frequencies emitted by a source and how long it took the lobes to form, this estimate doesn't depend on the distance of the radio source from Earth.

Daly can combine this information with observations from Earth of the source's angular width and its redshift — the characteristic shift to longer wavelengths of radiation emitted by a receding source — to determine how much the rate of expansion of the universe has changed. “If the intrinsic sizes of the sources remain roughly constant with redshift, that means the universe is open,” Daly says. In other words, expansion would continue forever.

When Daly applied her method to 10 radio sources several billion light-years from Earth, the results strongly favored an open universe. Now, she and a co-worker are collecting and analyzing data on additional two-lobed radio sources to check these results. “I would like to know how representative those 10 sources are,” she says.

Daly presented her findings at this week's American Astronomical Society meeting, held in Arlington, Va. A report describing the new technique and her preliminary results will appear in the May 1 ASTROPHYSICAL JOURNAL.

— I. Peterson

Sunscreen can't give blanket protection

Sunlovers' security blanket against cancer-causing rays — sunscreen lotion — appears to have some holes in it, researchers now report.

Such lotions help prevent mild skin cancers and sunburn. But exposure to the sun's ultraviolet (UV) rays may have another, less visible effect that sunscreens fail to stop — impairing the ability of immune cells to fight melanoma, report Margaret L. Kripke and her colleagues of the University of Texas M.D. Anderson Cancer Center in Houston. New cases of melanoma, the deadliest of skin cancers, have doubled since 1980. About one in 105 Americans will develop it; 20 percent of them will die from it. U.S. melanoma deaths totaled about 6,800 in 1993.

“Protection against sunburn does not necessarily imply protection against other possible UV radiation effects, such as enhanced melanoma growth,” Kripke and her co-workers report in the Jan. 19 JOURNAL OF THE NATIONAL CANCER INSTITUTE.

In fact, by preventing the pain and redness of sunburn, sunscreen may enable people to stay longer in skin-scorching sun, putting them at higher risk for developing melanoma, Kripke says.

In their study, the researchers applied either a sunscreen or an oil-water mixture to mice's ears and tails. After 20 minutes, the team exposed some mice for 20 to 27

minutes to UV-B, the rays most sunscreens try to block. They repeated the exposure twice a week for three weeks, so the mice received about three times the UV-B needed to give them a sunburn. After the final session, the researchers injected all of the mice's ears with melanoma cells from genetically identical mice to see how well their immune system fought off the cancerous cells.

The group of mice put under the sunlamp had a higher incidence of melanoma tumors than the unexposed mice, Kripke and her co-workers write. The lotion protected them against sunburn; however.

Finding that protection against sunburn does not necessarily imply protection against melanoma is "really kind of surprising," Kripke says.

In other studies using lower light levels, sunscreen reduced the DNA damage that researchers believe leads to melanoma, she notes. She speculates that even a small amount of DNA damage may increase an animal's melanoma risk.

The study "reminds us that the pathophysiology of melanoma appears to

differ markedly from that of non-melanoma skin cancer," note Howard K. Koh and Robert A. Lew of the Boston University Schools of Medicine and Public Health in an editorial accompanying the article.

"This is really a particularly interesting study" because it shows that the radiation stimulates the melanoma cells to grow, says John Epstein of the University of California, San Francisco. However, a stronger sunscreen than the one the researchers used might have offered more protection, he says.

Darrell S. Rigel of New York University Medical School also warns that these results may not apply to humans, since melanoma acts differently in mice.

Other animal studies have found that light not screened out by most sunscreen lotions, such as UV-A, may cause the cell changes that lead to melanoma (SN: 7/24/93, p.53). To ward off skin cancer, use lotions and dress properly, researchers conclude. "With a wide-brim hat you can prevent 70 percent of the rays" from reaching you, Epstein says. — *T. Adler*

Mental disorders strike about half of U.S.

Far more people suffer from mental disorders than previously assumed, according to a national survey published in the January ARCHIVES OF GENERAL PSYCHIATRY. In fact, nearly one in two adults experienced a mental disorder at some time in his or her life, and almost one in three suffered from one during the previous year.

The survey, the most comprehensive look at the mental health of U.S. citizens to date, finds that roughly one-sixth of the population grapples with three or more mental disorders over the course of their lives. These people tend to sink further and further into psychological turmoil. They accounted for a majority of lifetime mental conditions reported by the national sample and an even greater proportion of disorders cited for the prior year.

"Really serious conditions that demanded immediate treatment affected 3 percent to 5 percent of our sample," asserts study director Ronald C. Kessler, a sociologist at the University of Michigan in Ann Arbor. "These people typically had developed several mental disorders over time, not just one disorder that suddenly appeared."

Most individuals who had experienced a mental disorder managed to function adequately at work and home despite their symptoms and to recover on their own, Kessler notes.

The findings come from interviews conducted between 1990 and 1992 with a nationally representative sample of 8,098 people age 15 to 54. Unlike surveys that reported a lower prevalence of mental disorders (SN: 2/27/93, p.134), the new

study employs the latest official psychiatric diagnoses and has obtained a broad array of data on each participant's family and social circumstances.

The most common disorder discerned by the survey was major depression, with 17 percent of the sample citing a history of this condition and 10 percent reporting a bout of depression in the previous year. Next came alcohol dependence, with 14 percent suffering from this problem at some time in their lives and 7 percent experiencing it in the past year.

Social and "simple" phobias reached lifetime prevalences of 13 percent and 11 percent, respectively, with slightly lower rates reported for the previous year. Social phobias range from an inability to speak in public to avoidance of any social activity; typical simple phobias include fear of heights and flying.

Fewer than 40 percent of those who had suffered from a mental disorder had ever received medical or mental-health treatment for their condition; fewer than 20 percent reporting a disorder in the past year had entered such treatment.

Rates of mental disorders fell as participants' education and income rose. Blacks cited a lower prevalence of serious mental conditions than whites. And compared with urban dwellers, people living in rural areas showed a greater tendency to report only one prior mental disorder and to avoid the multiple psychiatric problems that most often necessitated medical treatment.

"Blacks and rural Americans face much adversity, but we need to look at the strengths in these communities, too," Kessler asserts. — *B. Bower*

Fragile bones linked to vitamin D gene

Vitamin D does build strong bones, but perhaps not exactly in the way scientists had envisioned. Australian researchers have linked a single gene—one that codes for vitamin D's receptor, or cellular docking site—to the tendency of people to lose bone mass as they age and to develop osteoporosis.

Despite all the environmental factors, such as dietary calcium, exercise, and smoking, known to influence the thinning of bones (SN: 12/26/91, p.262), genetics still plays a key role in determining who will suffer fractures late in life, says John A. Eisman of the Garvan Institute of Medical Research in Sydney. Scientists had thought that many genes set the stage for osteoporosis.

After examining the results of earlier studies, however, Eisman focused on the gene that codes for the vitamin D receptor. Once activated in the body, vitamin D becomes a key hormone that alters a cell's absorption of calcium.

The Sydney group determined the distribution of the two forms, or alleles, of this gene in 250 fraternal and identical twins. The researchers also measured the density of several bones, including the spine, in each person. A twin with one or two copies of one allele had denser bones than the sibling with one or two copies of the other allele, Eisman, Nigel A. Morrison, and their colleagues report in the Jan. 20 NATURE. When the scientists evaluated 311 middle-aged women, they found they could predict bone density on the basis of the women's genetic makeup.

They suspect that the vitamin D receptor helps control how fast bone builds up and disintegrates. During the first 20 years of life, bone thickens. Decades later, it begins to thin. The twin studies suggest that one form of the receptor leads to less thickening; such bone then has less to lose before becoming fragile.

The researchers calculate that people with two copies of the allele that leads to weaker bones should develop osteoporosis by age 65; those with one copy, by age 69; and those with none, by age 76.

"What is surprising is that [the researchers] made the association with one particular gene," comments Gregory R. Mundy, an endocrinologist at the University of Texas Health Science Center in San Antonio. "I think [the finding] is going to make people sit up and take notice."

However, "it still needs to be confirmed in other groups," Mundy cautions. If the result holds up, then a simple genetic test may help identify people particularly susceptible to developing weak bones, he adds. Moreover, Eisman thinks the finding will speed the development of more effective treatments for osteoporosis.

— *E. Pennisi*