Thallium, bismuth superconductivity

By giving the highest temperatures yet recorded for reproducible bulk superconductivity, thallium and bismuth are generating intense interest among physicists and chemists. Early this year, full superconductivity appeared at a temperature of 106 kelvins in a bismuth compound studied at the University of Arkansas in Fayetteville (SN: 3/5/88, p.148). Now, in a thallium compound, the same researchers have found the onset of superconductivity at 140 K and complete superconductivity at 119 K.

The leader of the Arkansas group, Allen M. Hermann, reported the March 19 findings in New Orleans last week at a meeting of the American Physical Society. At the same meeting Stuart Parkin of the IBM Almaden Research Center in San Jose, Calif., reported that his group had found reproducible bulk superconductivity in a thallium compound at 125 K, according to them the highest temperature yet.

The rush to find compounds in which superconductivity sets in at relatively high temperatures, rather than within a few degrees of absolute zero, began a couple of years ago when J. Georg Bednorz and K. Alex Müller of the IBM Zurich (Switzerland) Research Center found superconductivity at 30 K in a compound involving the rare-earth element yttrium and copper oxide. Further work with copper oxides of other rare-earth elements quickly raised the superconducting transition temperature to a little more than 90 K. There it stuck for more than a year.

Then came the report from Arkansas. According to Associated Press (AP) Science Editor Paul Raeburn, the news service at first refused to put the story on its national wire, believing that nothing like that could come from such a place. AP soon found out different, as various physics and chemistry departments began exchanging samples of the new materials to try to elucidate their structures and possibly raise the superconducting temperature. So far, a group led by Mas Subramanian of E.I. du Pont de Nemours and Co. in Wilmington, Del., seems to be the only one to claim to have made and solved the structure of single crystals, but a number of others claim to have the structure of unit cells of the crystal.

As Robert Hazen of the Carnegie Institution of Washington, D.C., notes, these are layered structures, sandwiches in which planes of copper and oxygen lie between outer layers composed of bismuth and oxygen. The more copper-oxygen planes there are in the "meat" of the sandwich, the higher the superconducting transition temperature. At the meeting he presented a chart in which one copper-oxygen slice produced a transition temperature of less than 80 K, two gave 105 K and three gave 125 K. A four-plane compound has not been investigated, but Hazen predicted it might go to 200 K. Paul Martin of IBM Almaden points out that the space the sandwich can occupy limits the number of planes, probably to about 10. He suggests the four-plane compound will give 150 K to 160 K, and the 10-plane 200 K.

Work with thallium has not spread as widely as that with the rare-earth compounds. Thallium is extremely toxic; Hermann says ingesting 1.7 grams of it would be fatal. The physicists are generally wary of thallium. Bednorz says he refuses to work with it: "I do not wish to be poisoned." He believes thallium is just a step to something better and safer, although he will not speculate on what element that might be. Most of the physicists prefer to leave the handling of thallium to chemists who are experienced with toxic substances and who use isolating hoods, gloves and other protective clothing. Several participants in the bismuth-thallium session at the meeting stressed that the amateur scientists, teachers and schoolchildren who have experimented with the rare-earth compounds should not meddle with thallium. "I would hate to see anyone get hurt over this," Hermann said. — *D.E. Thomsen*

Math society says no to SDI funding

Members of the American Mathematical Society (AMS) have voted to keep the organization from participating in activities that could be interpreted as support for the Strategic Defense Initiative (SDI). They also passed a resolution expressing a strong concern about the "large proportion" of mathematics research funded by military sources.

The referendum results, tabulated and released last week, mark the first time a major professional organization has taken an official stand against SDI and military funding of basic research, says Lee D. Mosher of the City University of New York. Mosher was one of the leaders in the lengthy effort to bring these issues before the AMS membership (SN: 1/31/87, p.71). About 7,000 of the society's 21,000 members voted.

The SDI resolution, says George D. Mostow, AMS president and a mathematician at Yale University in New Haven, Conn., "reflects widespread skepticism in the mathematical community about the ability of the SDI program to achieve its stated objectives." The resolution, supported by 57 percent of those voting, specifically directs that "persons representing AMS shall make no efforts ... to mediate between agencies granting [SDI] funds and people seeking those funds."

A second resolution, approved by 74 percent of the voters, calls for a greater effort to decrease the proportion of funding for mathematics research coming from the Department of Defense (DOD). Presently, DOD funding represents about 40 percent of the support available to mathematicians.

Neither resolution precludes individuals from pursuing their own interests. "The restrictions apply to the actions of the AMS as a society," says Mosher, "not to any individual actions."

What effect passage of the resolutions will have on the AMS and its members is not yet clear. Some, including Everett Pitcher, AMS secretary and a professor at Lehigh University in Bethlehem, Pa., say that, for the most part, AMS already has very little to do with SDI and that the society's representatives in Washington, D.C., are working hard to increase funding for mathematics from all sources. "I think it will have almost no effect on the day-to-day activities of the AMS," says Pitcher.

The society, however, may lose a few members. During the lengthy debate — mainly in the form of letters to the AMS publication NOTICES — that preceded the referendum, several mathematicians threatened to resign from the society if the two resolutions passed. They objected to the injection of complex political issues into what they see as an inappropriate forum for discussing and resolving such questions.

The AMS is only one of three major organizations representing mathematicians. The Society for Industrial and Applied Mathematics, which has a much larger proportion of applied mathematicians in its membership, has gone in a somewhat different direction and is on record as being in favor of "continued balanced funding from multiple sources" for mathematics research. The Mathematical Association of America has not taken a position.

Kenneth M. Hoffman of the Massachusetts Institute of Technology, a member of all three societies who has played an important role in pushing for increased funding for mathematics research, says the issue of military funding has been around for a long time in the mathematics community. The fact that the resolutions didn't pass by even larger margins, he says, shows some change in the direction of acknowledging that "things aren't as simple as they sometimes appear." He contends that most AMS members had too little information about how funding decisions are actually made to vote knowledgeably.

— *I. Peterson*