Out into the Cold: Early Experiences with Superconductivity

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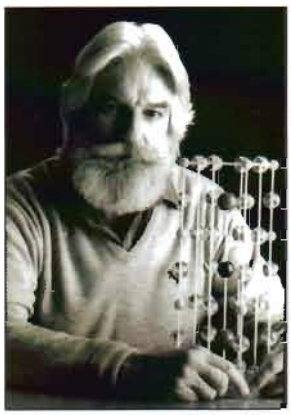
The following article is part of a yearlong series celebrating the 100th anniversary of the discovery of superconductivity. Contact CSA if you have ideas for submissions: theresa@cryogenicsociety.org.



One of my earliest memories was watching my parents ice skate on frozen Wappingers Pond where they had taken me swimming for my first time only a few months before. The mid-Hudson Valley was, and still is, notorious for its temperature extremes, the river itself usually completely freezing over between its banks. In mid-winter the outside temperature could approach -50°F (-46°C, 228K). I was reminded of the rigors and discomfort of my boyhood cold climate experiences this past July at ICEC-ICMC held in Wroclaw, Poland, as one of a group of attendees who underwent a "cryotherapy" session at a nearby spa, where "room temperature" was approximately -100°C. Thomas Wolfe was wrong...You **can** go home again!

Ice was the base cryogenics technology of my childhood years throughout the early 1940s, delivered daily, sawdust covered, in carts drawn by horses due to the wartime rationing of gasoline for automobiles and trucks [1]. Household refrigeration didn't really arrive for working class folks until after WWII. However, while I was in grammar school, although we didn't have formal science classes, we had occasional "science demonstrations," usually conducted by engineers from the nearby IBM plant. I remember two in particular, one on something called "dry ice," really cold to the touch, which just sat there and smoked and didn't melt; the other by a gentleman who brought what looked like a large thermos bottle containing "liquid air" into which was dunked a tomato, which was then withdrawn and struck with a hammer, shattering it as if it were glass. Pretty impressive to a seventh grade male (~1948).

My next encounter with cryogenics didn't occur until I was 18. My high school grades were atrocious, to put it mildly, not good enough to get me into college, and I did not want to go anyway—I wanted a job so I could buy a car. So I did what Wappingers Falls boys usually did: I went to work at IBM, first setting pins in the employee bowling alley and then as a mail boy in the mail room of a new IBM lab in downtown Poughkeepsie. I really wanted to be a bench technician, so between delivery runs I hung out with the engineers. One day one of them called to me, "Hey, kid. Come over here and I'll show you something really cool." (He didn't actually say "cool.") His name was Jim Crowe [2].

Jim splattered some solder on his bench top, scraped it off, cut out a small rectangle with his "dikes," wired it in series with a flashlight battery and a resistor of unknown (to me) size, and also hooked up in parallel with leads to a Hewlett-Packard vacuum tube voltmeter. Next to his bench was a huge stainless steel container which Jim told me held liquid helium, saying it was the coldest substance known to man. He dropped the wired up solder chip through a small opening in the top of the "dewar" and we watched the voltage across it slowly drop...and then suddenly disappear! At the time, I knew enough about electricity and Ohm's Law to complain, "The leads must have come off!" Jim said, "No, that's 'superconductivity'. The resistance of the lead-tin in the solder goes away under liquid helium." I thought to myself, "Yeah, sure!"

That evening I had dinner at home with another IBM engineer, my dad. I told him about my experience, and he replied, "Hmm. I've heard some talk about making a superconducting computer. But I don't know...you would have to fill up a whole building with liquid helium." This was 1953.

That was my first and last experience with superconductivity for some time to come. Shortly after turning 21, IBM decided I was worth educating and sent me (as an employee!) to college and graduate school for nine years, and I wound up with a physics doctorate from Harvard (superconductivity was not taught at Harvard in the early 60s!). IBM assigned me to the San Jose, now Almaden, Research Lab, and in 1972, Rick Greene (now at UMD) and I teamed up to start working on organic metals as possible room temperature superconductors, both of us having become disciples of Bill Little's dream that properly prepared polymeric chains might exhibit really high (> 500K) superconductivity, and in 1975 the group indeed discovered the world's first 300 degree superconductor, the inorganic polymer polysulfur nitride...alas, the units were millikelvin! In 1986, 25 years ago, Bednorz and Mueller taught us we should have been spending our time looking at layered copper oxide perovskites instead.

Paul Grant at 17. This photo shows him about six months before he went to work for IBM.

Nevertheless, I remain an ardent fan of the Little/Ginzburg exciton-mediated BCS-pairing proposal to enable superconductivity well above 300K. In 1998, I wrote a "sci-fi" piece for ***Physics Today*** predicting its fulfillment by 2028 [3]. Maybe then I can finally come in from the cold.

References

1. A fascinating tale of pre-industrial cryogenics technology can be found in Gavin Weightman's book, "The Frozen Water Trade," (ISBN 0-7868-6740-X), the story of two New England brothers who "farmed" almost every northeastern pond and lake each winter to cool the cocktails of Caribbean resorts in the 19th century.

2. Jim Crowe invented one of the very first superconducting memory elements, and arguably the first to employ trapped flux. See J. W. Crowe, "Trapped-Flux Superconducting Memory," IBM Journal, October 1957, p. 295. Jim Crowe became a good friend, mentor and my manager when I returned to work at IBM summers during my college years.

3. P. M. Grant, "Researchers Find Extraordinarily High Temperature Superconductivity in Bio-Inspired Nanopolymer," Physics Today, May 1998. Nineteen more years to go. http://www.w2agz.com/Publications/Popular%20Science/Bio-Inspired%20Superconductivity,%20Physics%20Today%2051,%2017%20(1998)a.pdf