A physicist remembers 30 years after the "Woodstock of Physics"

By Tim Palucka

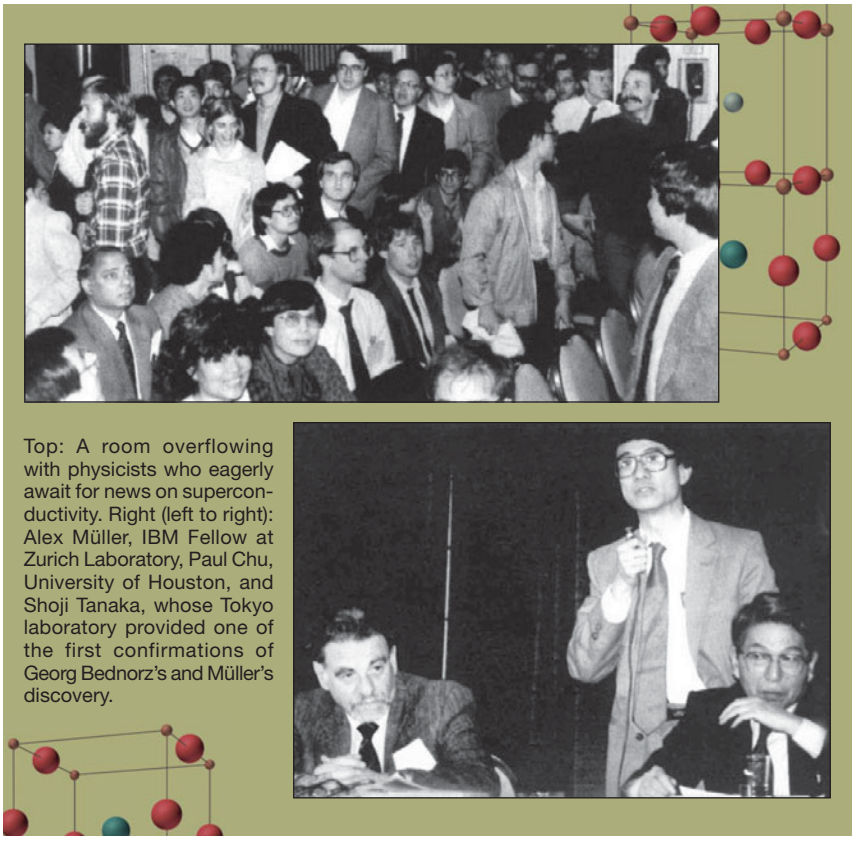
March 1987 was a heady time to be a physicist. At the annual meeting of the American Physical Society (APS), held that year at the Hilton Hotel in New York City, reporters followed physicists around town, trying to get interviews about the new high-temperature superconductors that were supposed to make electricity super-efficient. An APS meeting badge was sufficient to get you to the front of the line in at least one trendy New York night club, *and* free admission. Paul Michael Grant, then a physicist at the IBM Almaden Research Center in California (later with the Electric Power Research Institute and now the founder and principal of W2AGZ Technologies), was surprised to see a photograph of himself, blown up two stories tall on the side of the downtown Sony office building, performing a "dipper-stick" measurement of the transport properties in a liquid helium dewar of a sample of YBCO-123($YBa_2Cu_3O_{7-y}$), whose single-phase structure Grant and his group had identified only two weeks before the APS meeting, exhibiting a critical temperature (T_c) of 93 K. "Seeing that photo displayed in mid-Manhattan knocked my socks off," said Grant.

The highlight of the March meeting week was a special session of five-minute talks on the copper oxide perovskite high-temperature (high-T_c) superconductors. Starting at 7:30 Wednesday night, March 18, and continuing into Thursday morning, the session, dubbed the "Woodstock of Physics," due to its New York city location about 70 miles south of 1969's Woodstock rock music festival, drew 51 speakers and thousands of eager listeners who overflowed the meeting hall.

The path to this level of physics popularity in the United States was an unlikely one: High-T_c superconductivity (T_c > 20 K) seemed to be a research dead end only a few years earlier. In 1984, Grant had reviewed his team's work on organic superconductors that delivered a maximum T_c of only about 10 K and then shut the program down. Other researchers who had been trying to develop room-temperature superconductors had also stopped their efforts.

But K. Alex Müller, one of the early IBM Fellows, located in the company's Zurich lab, decided to leave his management position and return to the lab, and used his USD$50K discretionary funding which was available to all IBM Fellows at the time to explore their "wild notions." Müller had long harbored an idea that materials exhibiting the Jahn–Teller effect—a strong distortion of the lattice periodicity in metals arising from highly degenerate bonding states—might prove promising candidates for high-T_c superconductors. He persuaded J. Georg Bednorz, one of his former postdocs at ETH Zürich, later hired by IBM to work on semiconductor laser structures, to work after hours to investigate doped transition-metal nickel oxide materials that had demonstrated Jahn–Teller properties.

After a number of months of unsuccessfully exploring nickel oxides, Bednorz came across a paper published in 1984 by the French researchers Michel and Raveau titled, "Oxygen intercalation in mixed valence copper oxides related to the perovskites." Immediately, Bednorz



Top: A room overflowing with physicists who eagerly await for news on superconductivity. Right (left to right): Alex Müller, IBM Fellow at Zurich Laboratory, Paul Chu, University of Houston, and Shoji Tanaka, whose Tokyo laboratory provided one of the first confirmations of Georg Bednorz's and Müller's discovery.

and Müller began investigating the French team's La-Ba-Cu-O system, and Grant heard that they had found trace evidence of superconductivity between 20 and 30 K. After keeping the discovery quiet for a while, Müller sought out Alex Buchel, the editor of *Zeitschrift für Physik*, who was an expert in the field of superconductivity, and asked him to personally review the paper and publish it without further refereeing. After all this secrecy, their announcement of 30 K superconductivity finally appeared in late summer 1986 under the title "Possible high-T_c superconductivity in the Ba-La-Cu-O system."

Shoji Tanaka's group at The University of Tokyo in Japan noticed the paper and quickly reproduced the results, and then the word began spreading. Because LaBaCuO powder was easy to make, others around the world soon jumped into the field. Paul Chu's group at the University of Houston and Maw-Kuen Wu's team at The University of Alabama in Huntsville subsequently separately reported the discovery of 90 K superconductivity in a very mixed phase of the lanthanide cuprates.

The YBCO superconductor was the focus of the Woodstock of Physics session. Müller, Chu, Tanaka, and other luminaries spoke for 15 minutes, while the remaining speakers were limited to five minutes. Grant spoke about the unit-cell structure for the 123 phase of YBCO. As he recalls, no major discoveries were announced that night, but the excitement ran high as speakers confirmed reproduction of results and incremental advances.

Sadly, the excitement would not last long. All the hype in the press about how superconductivity would soon ease humanity's energy burden proved quite premature. In the April 1988 issue of *MIT Technology Review*, authors Simon Foner and Terry P. Orlando wrote, "High temperature superconductors are a scientific breakthrough, but technical and *economic* obstacles to useful applications remain." So "stay tuned."

Even today, the mechanism of high-temperature superconductors is not well understood, and the economics regarding its application remains an issue. Grant is now advocating the dual transport of chemical and electrical energy—natural gas and superconducting cables in the same right of way. Still, despite the disappointment of as-yet unfulfilled expectations, he fondly remembers the days 30 years ago when physicists were treated like rock stars, if only briefly. He also regrets that some scientists fed the media frenzy that led to an unrealistic promise of its impact on the energy enterprise. Nonetheless, the discovery of high-temperature superconductivity remains one of the great science stories of the latter half of the 20th century, and the struggle, competition, and secrecy surrounding the participants at our "Woodstock" recall the period around the formulation of the structure of DNA … the "double helix" story all over again.