

The Breakthrough

Robert M. Hazen

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The history of science, like the history of political events and war, has become steadily more variegated; the newest format is instant history. The book under review is a distinguished addition to this subcategory.

Roger H. Stuewer's book, *The Compton Effect* (1975), is a classical book about the origins of a modern scientific phenomenon—an eminently respectable text with an extensive bibliography of books, papers, and letters. Perhaps more suspect to traditionalists is Daniel J. Kevles' *The Physicists* (1971), a study of the growth of a scientific profession in one country. The source of possible suspicion is Kevles' extensive use of newspaper and magazine sources. Kevles did not go for interviews, however, like T.R. Reid, author of *The Chip* (1984). A journalist, Reid wrote his fine study of the invention and apotheosis of the integrated circuit on the basis of interviews, as well as books and published papers, all of which he cites.

The extreme, till now, of this less conventional approach to sources was James D. Watson's *The Double Helix*. In 1968 this "instant" history, based on memory and notebooks...with no bibliography...and with its candid delight in the fact that scientists share the foibles and frailties of humanity, proved a shock. The editor of *Nature* couldn't persuade any biologist to review it and the task fell to a professor of comparative literature. Perhaps this is why the MRS BULLETIN's editor thought it politic to approach someone who has never worked on superconductors to review Robert Hazen's gripping book, in some respects closely akin to Watson's book.

MRS BULLETIN readers will scarcely need to be reminded of the scientific stampede unleashed when Bednorz and Müller's cautious, low-profile paper of September 1986 became widely known on the occasion of the MRS superconductivity symposium of December 1986. During the intervening weeks, only a few scientists took in the full significance of what Bednorz and Müller had shown—that a ceramic (usually an insulator) had driven up the superconducting transition from ≈ 23 K (for the best alloy) to over 30 K. Paul Chu of Houston and his team quickly improved this figure and their breakneck labors led to the Y-Ba-Cu-O superconductor, with $T_c \approx 90$ K.

It then became extremely urgent, first to identify the composition of the superconducting phase in the polyphase ceramic, and second to determine its crystal structure. Chu was convinced the crystal structure would be the key to improving and, eventually, understanding high temperature superconductivity. Chu experienced a personality clash with his local x-ray diffraction expert and so turned to David Mao, a member of the informal "mafia" of Chinese-American scientists (the thumbnail sketch of which is one of the book's many minor felicities). Mao, at the Geophysical Laboratory in Washington, at once gave the task of structure determination to his colleague Robert Hazen, who in turn brought in further co-workers.

Formally, the book covers the period from February 20, when Hazen accepted the task, to March 18, the date of the American Physical Society meeting which homed in on the $YBa_2Cu_3O_{x-\delta}$ (1-2-3) superconducting phase. *De facto*, the book looks at the antecedents of the fevered month and glances sideways at simultaneous happenings elsewhere in the world. The main emphasis, however, is on Hazen's frenetic, nightmarish, but wildly exciting period of unremitting labor.

Aristotle said that successful drama requires the writer to observe three unities—action, time, and place. Hazen splendidly achieves the first two, but he could not achieve the third—unity of place. Most of the participants, especially Chu, traveled extensively during that anxious month, speeding from laboratory to laboratory, laboratory to meeting, and occasionally even home.

Hazen's book is splendidly constructed. It helps, no doubt, that he is a multiple professional: an x-ray crystallographer, a professional trumpeter (an apt instrument), and a semi-professional writer. He sets the scene, explains the essentials of superconductivity and its associated measurements, and offers thumbnail sketches of numerous protagonists of the 1-2-3 hunt. He describes how the 1-2-3 phase was identified and isolated, and the process of structure determination, with a canny use of metaphor (the difficulty of interpreting an x-ray powder pattern of two mixed phases is likened to the problem of exploiting two superposed fingerprints).

All this leads to the dramatic climax of the New York APS meeting, with its four rival structure accounts (and the steps that led to reconciling their apparent disagree-

ments). The meeting is described in a splendid piece of atmospheric writing, as cliff-hanging as a good whodunit. The science is readily accessible, at a superficial level at any rate, to any intelligent reader, scientist or not.

The book contains not a single citation, but differs crucially from *The Double Helix* in that Hazen took pains to check the accuracy of his version of the involved sequence of events with many of the principal protagonists—quite an achievement in a book published only 15 months and 18 days after the New York meeting.

Since published papers, as they always do, tidy up the chaotic sequence of actual research, Hazen's is presumably the only approach that can hope to present what actually happens, step-by-step, in the heat of the moment. Incidentally, while the book recounts some apparently disreputable episodes of scientific espionage (which proved false alarms), it has nothing to bring a blush to the most modest cheek.

The main feature of that central month was a race to be first to identify what proved to be 1-2-3, and first with its crystal structure. The unspoken assumption is that fame, fortune, and a Nobel Prize all depend on submitting a paper to *Physical Review Letters* a day or two before any rival. It is quite an assumption!

Recent history might have reminded the protagonists that in the 1984 fever-pitch excitement over the new permanent magnet superphase, Nd₂Fe₁₄B, four teams independently determined its crystal structure and published it almost simultaneously. Now, when this compound is discussed in the literature, all four papers are co-cited; no one inquires which was submitted the earliest.

The frenzy of the race for 1-2-3 was perhaps out of proportion, but perhaps essential to provide the free energy for the achievements of early 1987. Some did manage to keep a sense of proportion. Despite hordes of physicists clamoring for admission, the hotel management refused to release the largest ballroom to the APS meeting because it had been booked for a wedding reception!

MRS members, almost by definition, are devoted to research. Regardless of their immediate scientific concerns, this book is confidently recommended to all of them.

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