

WHAT HIGH T_c MEANS TO ME

That's it. The golden age is back. Physicists are about to solve the one problem of Western civilization: energy forever. High T_c , the superman of high tech, is coming. Physicists are acting in the play of their dreams, and big financial people are seeing on stage the new El Dorado of tomorrow. "A Physicist's Woodstock," quoted *The New York Times* on its front page.¹ Physicists all over the world are rushing to the old, almost dead physics of superconductors. Like rock singers of the 1960s, physicists of the 1960s are again at the top of the charts, dancing to the rhythm of phonons. They are playing it again Sam.

Breaking with the tradition of "wait and see," the Nobel committee awarded its prize less than one year after the discovery. [See *PHYSICS TODAY*, December, page 17.] By so doing the committee established a firm ground for the actual collective search for the "Holy Grail." The race is now more frenetic, since for the winners (who will explain the phenomenon), another Nobel Prize is guaranteed within a few months.

Let's stop the show to try to understand what is happening to the physics community. For years now physicists have been rather frustrated.² They have been working hard, well and in quantity for not much. As Woodstock was the collective expression of the individual despair of young Americans toward the Vietnam War, so the experimental discovery of high- T_c superconductors has crystallized the general individual frustration of physicists into tremendous energy with a Bose-Einstein condensation-like phenomenon. Everyone almost is looking at high T_c as the escape to a better world, but out of high T_c there is no redemption.

In these days of chaos on Wall Street, physics turned to a stock market-like system. The high-energy shares are falling down while the condensed matter ones are jumping high in the sky. A first dramatic result of this crash has been the

alleged murder in Japan of a condensed matter professor by a "ruined overnight" high-energy physicist.³

Enormous amounts of money have been injected by governments and industries into university laboratories to develop high- T_c superconductors. It is clear that all these sponsors are expecting short-term outcomes with numerous technological applications from their investments. On the other hand, physicists are using this sudden opportunity to make a "better scientific living" in a period in which science has been strangled for years. Here a dangerous misunderstanding exists. The financial people are pouring money into university laboratories as they do into promising new industries. This means in particular that physicists are expected to behave as engineers. Are they ready to do so?

Simultaneously the discovery of these new materials represents a drastic advance in condensed matter physics. Moreover it proved, against the well-established belief, that a man's creativity does not die at the age of 35.

References

1. New York Times, 19 March 1987.
2. S. Galam, P. Pfeuty, *PHYSICS TODAY*, April 1982, p. 89.
3. D. Swinbanks, *Nature* **329**, 576 (1987).

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Superconductivity has, since its discovery, been a central part of the subfield called low-temperature physics. "What do you do?" "Low-temperature physics." "Ah, superconductivity or liquid helium, I suppose"—that sort of thing.

In the light of events that are currently being copiously reported in the press, radio, television, *Physical Review Letters*, *Physical Review B1* and so on, do we need to take superconductivity out of the subfield

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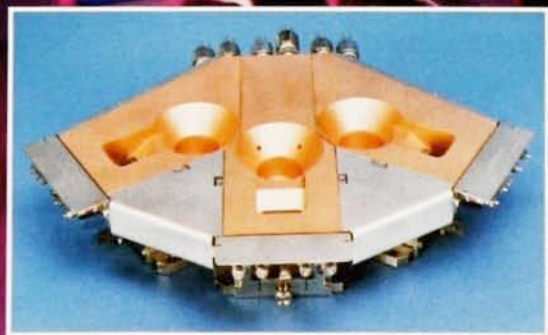
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in which it was born and by which it was nourished?

I suggest that such a wrenching action is unnecessary. The term "low" in "low-temperature physics" has meaning only when referred to a reference temperature; let us call it T_0 . The early cryogenic engineers, not unreasonably, thought of T_0 as being around room temperature. But this temperature holds no special position in physics. Rather, T_0 must be defined as the characteristic temperature (or energy) that is identified with a particular physical phenomenon, often a phase transition. Then the *low-temperature physics* of that phenomenon is its study at $0 < T \lesssim T_0$. Some obvious examples of T_0 : the Fermi temperature for a fermion gas, the Debye temperature for a phonon gas, the Curie temperature for a magnon gas, the energy gap Δ_0/k_B for a superconductor.

Let us not take the beef out of the hamburger.

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6/87

Fusion Community's 'Voice' at DOE

In Raghavan Jayakumar's thoughtful letter "Uniting the Fusion Community" (June 1987, page 11) he mentioned the need for "an elected or appointed group [to] develop an overall research strategy based on [a] review [of research concepts] and on its own collective wisdom," as well as for the "leadership of the fusion plasma community to begin a movement of consolidation and lead the researchers into developing a consensus on research approaches."

I wish to point out that such a group, performing essentially the suggested functions, already exists. It is the Magnetic Fusion Advisory Committee, appointed by and reporting to the Director of Energy Research in the US Department of Energy, which is the main administrative agency for US fusion research. This committee meets quarterly in public session. Over the years since 1982 MFAC has involved the fusion community extensively in such basic issues as DOE program priorities, detailed fusion program planning and the roles of the universities and industry. Various aspects of research in tokamaks (the leading concept) have been examined in detail: upgrade options for the Princeton Tokamak Fusion Test Reactor experiment and, currently, its usefulness for burning plasma

physics using deuterium-tritium plasma, as well as US options for ignition experiments. After assessing the prospects of the Compact Ignition Tokamak, MFAC and its panel endorsed construction of the device (as did the DOE Energy Research Advisory Board). MFAC also examined progress in the open-ended, tandem magnetic mirror system, concluding in the face of declining budgets that it should be discontinued as the major alternative to the tokamak. MFAC and the community also examined the various alternative toroidal fusion concepts, and provided strong support for the stellarator and reversed-field pinch, as well as for compact toroidal systems. In technology, systems studies have been encouraged to define the fusion reactor end product, particularly in respect to necessary power density related to the mass of the fusion core.

These in-depth studies have involved scores of physicists, engineers and managers from the national laboratories, universities, industry, government agencies and the public. The findings are submitted to the Director of Energy Research and usually result in concrete action.

A word about Jayakumar's concerns for cohesion and outside support of major new initiatives. As mentioned, the CIT, a \$300 million ignition experiment, is the major new US magnetic fusion device. It now has Administration funding support and has been favorably reviewed by Congress. Prospects for construction are bright because of unified community support. The fusion program seems to me to have a uniform purpose, not only for tokamak research but for research in alternative concepts, technology and basic fusion physics, even in the face of tight budgets.

We hope, as Jayakumar suggests, to keep the spirit of cooperation in the fusion community alive by continuing the processes I have discussed in this letter.

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7/87

Mirrors in Space: How Costly?

To avoid any misunderstanding regarding our closing statement in the debate on the APS directed-energy weapons study (PHYSICS TODAY, No-

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