of PHYSICS TODAY, which is devoted to grade-school education of children in science, Robert Karplus has pointed out that when a student has reached the age of 15 it is too late to try to interest him or her in science. 2) The information of the public, too long neglected, can be brought about through many channels: adult education, the news media, science museums, and so on. (It is worth noting that New York has not had a true museum for the physical sciences for more than thirty years. On the other hand, there are two excellent new science museums at the West Coast: The Lawrence Hall of Science in Berkeley, and the Exploratorium, under the imaginative directorship of Frank Oppenheimer in San Francisco.) In particular the daily press could contribute a great deal in this respect by dispensing not only science news, but by presenting results that are well established, in attractive, easily digested articles, for instance, in daily columns, possibly in serial form. Such a column could report on the discovery and the properties of x rays (possibly starting out from a novel use of x rays), or on some phase of astronomy, on conversion of energy, and so on. The use of a moderate amount of mathematics in such articles could be made possible by exposing the readers occasionally to mathematical and scientific puzzles, in addition to verbal puzzles such as the ubiquitous crossword puzzle. This might prevent the receivers of high-school certificates to allow their generally quite appreciable knowledge of mathematics to atrophy within a short time, instead of making constructive use of it. Thus, slowly, the general public could learn to understand the beauty and power of science.

Some excellent recent examples of how to present past scientific developments in a dramatic and entertaining form are: *Worlds Within Worlds: The Story of Nuclear Energy* by Isaac Asimov, Volumes 1-3, published by the AEC (1972) and *Einstein—Creator and Rebel* by Banesh Hoffman, Viking, New York (1972).

GERTRUDE SCHARFF-GOLDHABER
Brookhaven National Laboratory
Upton, New York

Superconductors again

I disagree with William Little's argument about not developing high-T_c superconductors (November, 1972, page 13). The real economical limit of refrigeration is not from the consumption of hydrogen or helium but from the second law of thermodynamics. The limit of T_c to high-temperature superconductors is not that well established. Empirically we have the limit set by B. T. Matthias and coworkers, who have searched thousands of superconducting alloys. Theoretically we have the rule of W. L. McMillan, who set the phonon limit of T_c for all superconductors. It appears that breaking the limits set by McMillan and Matthias is still easier than building a perpetual-motion machine.

L. Y. L. SHEN
Bell Laboratories
Murray Hill, New Jersey

THE AUTHOR COMMENTS: The most efficient cryogenic refrigerators available today for superconductor cooling have an efficiency between 10% and 20% of Carnot efficiency. Machines under development may raise this figure 30% for large-capacity systems. An improvement by a factor of at least three in this efficiency is possible, in principle, before one runs into the limit set by the second law. On the other hand, to obtain a similar improvement in system efficiency by the development of high-temperature superconductors would require values of T_c about a factor of three higher than those available today. I contend that the probability that a conventional phonon superconductor will be found with anything like this value of T_c is identically zero and, hence, refrigerator research is much more likely to yield an improvement in overall system efficiency than such superconductor research. Shen's letter appears to miss the point that existing refrigerators are so inefficient relative to the Carnot limit.

WILLIAM A. LITTLE
Stanford University
Stanford, California

Remedy for fear of physics

I am very disheartened when I hear of decreasing enrollments of liberal-arts students in the physics and astronomy courses. Four years ago, I began to investigate the problem and have come to interesting conclusions. I have implemented these thoughts, and, I believe, not in vain, since my modern-physics/astronomy course has increased in enrollment from 45 to 200.

What I essentially discovered was that liberal-arts students are intrinsically interested in physics and astronomy, but they are terribly afraid of not understanding it, especially when it comes to dealing with mathematics. Thus the main task is to make students comfortable and feel that some of the physics and astronomy phenomena are indeed very much in line with their own way of thinking and philosophy. Introducing mathematics as a mere tool and letting the students

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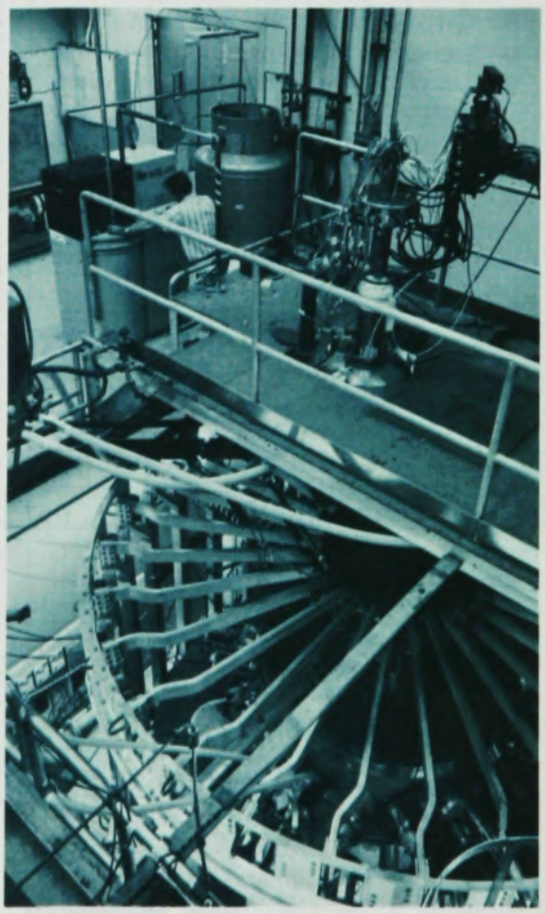
*Operated by the University of California for the U.S. Atomic Energy Commission



Water-cooled toroidal field coils surround the Levitron vacuum vessel. Experimental results from the Levitron are encouraging. It has demonstrated great versatility in providing a variety of toroidal magnetic configurations for plasma confinement. Plasmas with densities of 10^{11}/cc have been confined for up to one second. Very hot electron plasmas (electron temperatures up to 0.5 MeV) have been confined for considerably longer times.

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search for the necessity of the tool themselves makes students unafraid of the mathematics used and develop confidence with it. They also begin to feel that they are the ones who have the real control over the mathematical manipulations, because it is just a tool they use. It is usually a good idea in the introductory lecture to whet the appetite of the student by relating to him some of the striking phenomena in physics and astronomy. Then one can casually bring up the need for mathematics.

GARY R. GRUBER
Hofstra University
Hempstead, New York

New Field?

I fear that, since leaving the mainstream of physics, I have fallen out of touch with some of the more esoteric new fields in our fast-changing science. My present work does, however, require me to be familiar at least with the terminology, if not the substance, of science. Thus, I was particularly intrigued by an ad in the "positions wanted" column in the April 1972 issue (page 86) for a speciality I have never seen mentioned in the help-wanted ads nor in the lists of occupations published by the various professional organizations.

Perhaps you could publish a brief article explaining what it is that a "black theoretical physicist" does and how his activities are related to those of solid-state or nuclear theoretical physicists.

HARRY M. KRIZ
Morgantown
West Virginia

CHAIRMAN OF THE APS COMMITTEE ON MINORITIES IN PHYSICS COMMENTS: We disagree with the implied criticism offered above by Harry Kriz. We feel that PHYSICS TODAY deserves congratulations for a policy that indicates it is serious about including minorities in the mainstream of physics. Under this kind of policy, an employer who really wants to be an equal-opportunity employer has a chance to validate the equal-opportunity claims. In general, when there is an ad for a position, it has been understood by all—black, white and brown alike—that the advertisement is for white prospective employees. This understanding comes from the observed practices of employers and copious disappointing experiences of blacks and other minorities. Too often when a black shows up, an excuse is made and the minority job-seeker finds he has wasted his time. This trouble can be avoided when ads like the April one give facts used by the employer. Also, it discourages the "I would hire them if I could find them" syndrome. The disgraceful situation with respect to minorities in physics can be partially envisioned (by the general physics public) when we realize that of the 17 000 physicists with a PhD, only about 60 blacks, 8 Chicanos and one Native American (American Indian) are included.

It is hoped that PHYSICS TODAY will increase and intensify the "in-course guidance corrections" begun with the ad in the April issue to aim at the moral and practical goal of justice, equality and brotherhood—the realization of the great American dream.

WARREN E. HENRY
Howard University
Washington, D. C.

More tests of QED

The article in "Search and Discovery" (October, 1972, page 17) on the current debate between supporters and doubters of quantum electrodynamics calls to mind the original arguments over Schrödinger's theory of continuous light emission as opposed to the quantum jumps of Werner Heisenberg and Niels Bohr. This letter offers a historical review of the situation.

For practical purposes the Schrödinger theory was superseded because it was inadequate to explain collision processes, and it was shown during the famous encounter between Schrödinger and Bohr in Copenhagen that the theory, as it then stood, could not produce the Planck radiation law.[1] The published form simply stated that radiation was due to oscillations of the atomic dipole moment calculated from the hydrodynamical model of the atom.[2] This is a heuristic precursor to the present theory of Edwin Jaynes.

However, even then it was clear that radiation rates would have to show a final-state amplitude dependence,[3] and an experiment was performed by E. Gaviola to test this dependence.[4] He looked at the relative intensities of 4046Å and 4358Å secondary resonance lines in mercury as he varied the relative populations of their final states by a factor of 100. As best we can tell this experiment has gone unnoticed because it appeared after the issue of Schrödinger's interpretation was dead. Gaviola himself doesn't mention it in a critical review of quantum mechanics written in 1929.[5]

Recently R. K. Nesbet has shown that the Planck radiation law can be obtained semiclassically,[6] and further experimental tests of semiclassical theory (SCT) have been performed by