why more of them do not end up in our ranks.

While we feel that programs such as ours and the one at Fermilab are important in establishing some contact with the schools, there are other, perhaps more far-reaching efforts that should also be made. One of these is to counteract the "science-phobia" that grips the *majority* of the college students in this country. The idea that science is hard and only for scientists pervades school boards, legislatures and even some science faculties in our universities. Carefully designed college courses for non-science majors can be very effective in alleviating this problem, and we have been very successful with a number of such courses at Yale. Copious demonstrations and illustrations are again the key, as is a recognition of the fact that these students want to *understand* science and technology but not to *do* it themselves. It will take some time, but if more of the general population of this country had a better appreciation of science, the disastrous trend in our schools would begin to receive the attention it needs.

In the meanwhile, all efforts to reach this goal should be pursued, and we would like to join Fermilab in offering to exchange ideas with anyone working on this important problem.

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We read with great interest and pleasure the recent letter by Leon Lederman about the Saturday physics program at Fermilab for high-school science students. At the Westinghouse R&D Center in Pittsburgh, we are in our twenty-sixth year of sponsoring the Westinghouse Science Honors Institute, nicknamed Saturday Science, which has been operating in a manner almost identical to the Fermilab program. The institute is staffed and operated by scientists who volunteer their time and effort out of the conviction that it is our professional responsibility to promote the cause of science in this fashion, and sponsored by Westinghouse out of respect for that conviction. Our annual series consists of 12 lectures (profusely embellished with working demonstrations) but is not limited to physics. Because of popular demand in recent years, we broadened the scope to encompass the life sciences. While most of the lectures are given by scientists from Westinghouse, we have found it desirable from time to time to include guest lecturers from local universities. In any case, we have not attempted so much to balance the program as to have outstanding speakers who may inspire students to consider careers in science. Each of our sessions is offered to 250 seniors (the capacity of the R&D Center auditorium) from about 55 high schools in the Pittsburgh area, chosen for their ability and interest. A recent very successful addition to our program is the granting of two summer internships each year to the top scorers on an optional examination based upon the 12 lectures. These students, working largely independently but under the supervision of scientists at the R&D Center who enjoy the challenge and stimulation of very bright young people, have consistently turned out excellent, professionally done projects that have been a credit to themselves and the laboratories.

Our experience with the Westinghouse Science Honors Institute over the years is that it is greatly respected and appreciated by the local community and considered by a number of schools to be a part of their academic year. We have been a strong positive influence for promoting scientific literacy among many who do not follow science careers, as well as giving some direction to the most scientifically talented among our students. We applaud Fermilab for devoting a small part of their resources to reach out to our best high-school students and expect they will find as much satisfaction in doing so as we have.

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Ice age in physics

The simulated-annealing statistical mechanical approach to complex optimization problems (May, page 17) is highly intriguing. With a bit of forgiveness for loose thinking, it might be adapted to modeling of the scientific process itself. The traveling-salesman problem ("optimally" to link up a given set of nodes), for instance, is suggestive of thematic links or idea-sharings that connect nodal subsets of minds engaged in the attempt to describe nature. All too often, a social phenomenon analogous to too-rapid cooling occurs, by which very strange ideas indeed (for example, quarks, black holes) freeze out of the "melt" and are perpetuated. Associating a "temperature" with the intellectual climate, one observes that in fundamental physics a sort of "ice age" seems to have set in, beginning during the second quarter of the twentieth century. Given a strong application of "heat" to agitate the neurons,

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would such ideas as second quantization, mass and charge renormalization, or QCD again precipitate upon slow cooling?

The trouble is that physics is not a computer simulation. It is a real social process. The perpetuation of bad ideas and ignoring of good ones that goes on routinely in the current ice age is a real tragedy not only for abstract "science" but for our species. So gelid had the mental climate become that one hardly distinguishes individual minds any more. These seem to clump together into ever-growing teams and schools of thought—a sort of opalescence, as near a critical point.

One would like to be able to control the temperature parameter—to heat things up and anneal more slowly in order to precipitate something nearer to an "optimum science." The difficulty of this problem should not be underestimated. Every attempt by external forces (for example, government) to "strengthen science" turns out to mean strengthening the status quo in science and thus acts as a cooling agent. To the present, it would appear that no effective heating mechanism of an institutional nature has been devised (if we leave aside such breakthroughs as the posting of "THINK" signs). Perhaps some of the more inventive of your readers would like to cogitate on the matter.

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Can glass flow?

When I was looking for a picture that showed the flow of glass to illustrate my text, *Invitation to Physics*, I finally turned up an authoritative opinion that glass does not flow. These comments of John P. Hoxie, a consultant to the Corning Glass Works Archives, will be of interest to those readers who have followed the correspondence on this subject in PHYSICS TODAY (June, page 90). Hoxie wrote:

> Glass has a low viscosity at the elevated temperatures involved with its melting and forming. Then it cools below red heat and the viscosity approaches infinite values. The glass technologist frequently uses viscosity language because it is useful in describing the annealing process and elimination of internal strains.

The data he supplied show that there is no possibility of internal movement in glass once it has dropped below 400 °C.

> The other physical observation one may make regarding old windows relates to optical performance and the glazier's compensation for uneven quality. Before 1890, most window glass was produced by hand blowing of cylinders, slitting and flattening them. Such cylinder blowing invariably yielded glass which tapered in thickness, and window panes were wedge-shaped with some prism effect. Where several small panes were mounted in a window sash, the thick edges should all be mounted in the same direction, such as toward the bottom. If the panes in a window were randomly oriented, a viewer would sometimes see a distant horizon as a jumpy line rather than a straight horizontal line.

The marvel that might be pointed out in a physics book is that early civilized man was able to produce a new material intelligently synthesized from natural ingredients, the specimens of which have maintained shape perfectly some 3500 years due to their rigid internal physical properties. The idea of glass somehow slumping at ordinary temperatures is a myth distinctly at odds with both the experience of archaeology and modern research into the nature of materials.

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THE AUTHOR COMMENTS: I am grateful to Jay Pasachoff for continuing the discussion on glass creep. Window panes do not flow under the influence of gravity (a weak force) partly because room temperature (300 K) is too low compared to their glass transition temperature T_g (about 1000 K). However, as pointed out to me by R. E. Dietz of Bell Laboratories and R. G. Wheeler of the Applied Physics Department of Yale University, glass flow can be and is used to date and authenticate Chinese vases.[1] The porcelain ceramic glaze melts around 1200 K and it is flattened (or smoothed) over periods on the order of 500 years by the relatively strong force of surface tension.

Reference

1. C. and M. Beurdeley, *A Connoisseur's Guide to Chinese Ceramics* (Harper and Row, New York, 1974), page 180.

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Meaningless embargo

Recently I participated in a six-week US–USSR scientific exchange at the I. V. Kurchatov Institute in Moscow, sponsored by the Department of Energy. During this time I collaborated with Dutch and Soviet scientists making measurements on a large tokamak as part of their controlled thermonuclear research program.

In the course of our work, I found that we could obtain a large and crucial increase in the sensitivity of our instrument by using an inexpensive ($20.00) low-noise amplifier chip readily available commercially in the US and Europe. Then to my dismay I discovered that my home institute, the Princeton Plasma Physics Laboratory, could not send this to me as it had been placed under embargo as of January 1982. Moreover, their inquiries revealed that amplifiers that are nearly obsolete and cost only a few dollars each have now also been included in the embargo.

We purchased the amplifier chip we needed in Europe and had it shipped to Moscow. The official US position appeared even more ludicrous since the Dutch scientists with whom I worked had brought with them to Moscow a sophisticated and expensive data-gathering system, including advanced computer-controlled amplifiers.

This attempt to embargo such cheap and easily obtainable material is utterly meaningless in terms of interfering with technological progress in the USSR. The only possible aim is to foster among the American people a spirit of distrust and paranoia with respect to the USSR, a spirit completely contrary to that of the scientific exchange. This is one more piece of evidence that the Reagan administration, despite its public statements, is only interested in confrontation, not in cooperation and understanding.

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Soliton revolution

C.-H. Tze's introduction to the review of three books (June, page 55) that are a result of the "soliton revolution" in nonlinear physics omits important historical connections and a vital insight. I would like to set the record straight and illustrate the analytical-computational road—a new mode of working.

In 1834, John Scott Russell first observed solitary wave entities propagate from a suddenly stopped canal barge. They separated over long distances ". . . more and more apart the further they travel."[1] But although he recognized the importance of these "great waves of translation," the scientific and mathematical community ignored them! Even as recently as fifteen years ago, careful experiments by engineers produced similar transformations of periodically excited smooth waves into many solitary-like entities.