

letters

monopole velocity and monopole catalysis interaction length as two free parameters. The (average) catalysis cross section per nucleon in water is related to the interaction length by $\sigma_c = 1/(n\lambda_c)$, where n is the nucleon number density.

It is true that the monopole catalysis cross section is an experimentally unknown quantity. There are a number of theoretical uncertainties and subtle, but extremely interesting, physics problems associated with the calculation of monopole catalysis cross sections. It is not true, however, that the IMB flux limits are "model dependent."

Reference

1. S. Errede *et al.*, Phys. Rev. Lett. **51**, 245 (1983).

STEVEN ERREDE

The University of Michigan

9/83

Ann Arbor, Michigan

What we meant to say, and perhaps failed to convey clearly, was that the variable IMB flux limit becomes $7 \times 10^{-15} \text{ cm}^2 \text{ sr sec}$ if one assumes a typical hadronic cross section for catalysis and a monopole velocity within broad plausible limits.

—BMS

Education crisis

The September issue on the crisis in high-school physics education was indeed depressing, not so much because of the crisis as because of the poverty of the response to it.

What can be done? From the issue, it appears that very little can be done. Yes, there are some things one can do, and all will help. But after everything suggested has been fully implemented, what then? There will be a few more physics teachers (maybe), and a few more physics students (maybe), and a very big crisis still. Perhaps something completely different is needed.

Let us assume that the how-to-teach courses are useful (a very big assumption indeed). Thinking back on my teachers in high school (who had these courses) and in college (who did not), I remember that those in college were better teachers. But even assuming this, is it better to have a teacher who is trained in teaching, but does not know the subject, or one who knows the subject but has had no formal training in education? Since there are not enough physics teachers, is it better to have a physics course taught by someone who does not know physics, or by a physicist without teaching experience?

If the certification requirements were removed, high-school teaching would be open to a large pool of qualified physicists who might have some interest in doing it, at least part-

time. How many industrial physicists, or college physics professors, might be willing to teach high-school physics for an hour or two a week?

Of course, high-school curricula are not organized to allow a physics class of one hour a week (which is not ideal but better than zero hours a week). That is part of the problem—an insoluble part to those who are more interested in organization than education. To those who want to do something, it is a minor inconvenience.

After all, what is more important, education or red tape?

Yes, something should be done. But what can we do as physicists? What can AAPT, AIP, APS, NSF and so on do? After all, this is a matter of state laws, not of physics. But laws can be changed, and if only one important state were to change its laws, it would have a major effect on the others.

What if the physics community, AAPT, AIP, APS and so forth were to start developing physics courses that could be taught part-time? What if they were to compile lists of physicists who would be interested in doing so in their own communities? What if they were to bring these projects to the attention of the media and the appropriate public figures, governors and legislative leaders of carefully selected states, for example? What if they...

Well, what if? Organizations that can only respond to crises by passing resolutions deploring them will have plenty of crises to deplore.

Yet even if this is done there will not be nearly enough physics teachers. There is a simple solution to that. A lot of high-school students will not take any physics courses, thereby reducing the need for physics teachers. The ideal is for students to be taught by human teachers. But there will not be enough of these. Are these the only two possibilities? Are there things that can be done, that are not ideal, are not perfect solutions, but are indeed possible, and are better than (for many, the only other choice) nothing?

How about movies? Would a series of hour-long movies, shown once or twice a week, teach students something about physics? How about this plus (where possible) a physicist who drops in once every week or two to answer questions?

But what can AAPT, AIP, APS, NSF, and so forth do?

Provide leadership, provide money, organize the production of the movies, compile lists, bring the possibilities to the attention of the media, governors, legislative leaders, university presidents, (other) educators and the physics community.

High-school students can be given an education in physics and other things. But it takes leadership, imagination,

money, work and, above all, an acceptance of reality—that for many the solutions cannot be ideal, cannot be perfect, but can be helpful.

The question is not whether anything can be done, but whether we are willing to do it.

R. MIRMAN

10/83

New York, New York

One aspect of the secondary-school teacher crisis is an inability to retain superior science and math teachers. Your fine recent special issue highlighted this. Readers troubled by such problems may be interested in a special program that was initiated this last summer by five laboratories of the Illinois Research Corridor. The five laboratories united to select and recognize superior science and math teachers in our local area and make summer jobs available to them. The five (Amoco Research Center, Argonne National Laboratory, Bell Laboratories, Fermi National Accelerator Laboratory and Nalco Chemical Company) are a diverse group of private and government-funded laboratories. This was the first time these laboratories have combined resources in this way.

The purpose of the program was to provide summer technical employment for a select group of dedicated high-school science and math teachers. The employment was intended to be interesting and relevant to the science curricula. However, no formal attempt was made to increase specific teaching skills or to teach science material which might be used in the classroom.

Superintendents and principals from local school districts were invited to nominate outstanding teachers for the program. The nominated teachers went through a second phase of selection by representatives of the laboratories. This laboratory group ranked the candidates on the basis of their teaching excellence (as opposed to explicit laboratory-useful skills). Once the 21 top teachers were selected (corresponding to the number of openings), the laboratories divided them by draft.

This first summer's experience with the program has just been reviewed. Responses have been uniformly positive from both teachers and their summer supervisors. Teachers selected on teaching ability proved competent and enthusiastic in their laboratory functions. The jobs ranged from computer programming to environmental testing to electronics and chemistry projects. The teachers were paid for their work and this remuneration is one part of the effort to help keep them in their teaching career.

A growing number of laboratories plan to participate in an expanded program next summer. No outside

funding is required because the teachers provide useful work for the laboratories. The teachers, all now back in school, report increased enthusiasm towards their teaching, increased confidence in their own abilities in their field, better understanding of the research environment and the kinds of careers that their students might anticipate and so on. Community response has also been very favorable. Newspapers have picked up the opportunity to highlight local teachers who are recognized as making a superior contribution in the face of all the less favorable publicity of recent months.

After this summer's experience, the responses recommended that other groups emulate this program. The kind of program described here can be adopted by one or more university, industrial or government laboratory. One interested person willing to spearhead such an effort may be as overwhelmed as we were by the receptiveness to this idea and the ease with which it can be fit into existing normal hiring practices. A small kit of sample materials has been put together and can be made available to individuals interested in harnessing the current interest and doing something positive for the secondary-school science education in their own community.

JEFFREY A. APPEL

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I have followed the recent discussion on math and science education in both this journal and the popular press. I am one of the students of the seventies who, as Beverly Porter and William Kelly noted in their September article (page 32), chose to pursue a career other than physics instruction after studying to do so as an undergraduate.

Nowhere in this discussion of the crisis in math and science instruction, however, have I read anything about programs that use part-time faculty. Experiences from such programs should be of interest to innovative administrators and educators. Part-time instructors with graduate degrees and experience seem well suited to the task of training teachers in new subject areas; the money needed to support such programs should not be excessive, since the financial incentive would be in addition to a full-time salary. The discussion of what contribution those of us in industry might make should not be restricted to company-financed programs that subsidize public schools by providing the services of employees or the use of equipment free of charge.

I encourage those members who have had experience with programs utilizing part-time instructors to contribute

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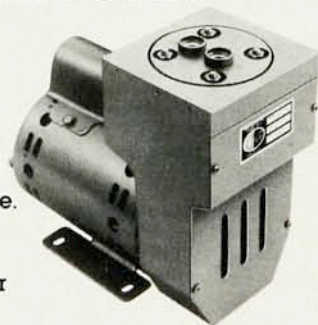


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their opinions and ideas to this discussion.

STEVE GANTHNER
Carolina Power & Light
Raleigh, North Carolina

10/83

The September issue had a good discussion of physics in our public schools. One thing I believe is important to get more students to study physics is to stress the use of physics in everyday life.

In my neighborhood, almost everyone believes that physics is only needed by those going to college. Since this is an agriculture community, our schools stress vocational agriculture. The students never learn how to use physics in agriculture. All boys and most girls are interested in automobiles, but they have no chance to learn how physics is used in automobiles. Most girls take "home ec," but they never learn how physics is used in the modern home.

Some "Future Farmers of America" (vocational agricultural ed students) go on to agriculture college. They may even get a PhD in agriculture and never learn how to brace a fence post.

The interesting work in subatomic particles seems to have caused the authors of physics textbooks to forget that every living person has a need to understand the use of physics in everyday life. Of course, more than one year is needed to teach physics as it should be taught.

Please stress the need to understand physics in everyday life!

JAMES F. JACKSON
Carlisle, Indiana

10/83

Your special issue, "Crisis in High-School Physics Education," dramatizes a long-standing and growing problem. It is little wonder that there is a crisis! A check of the "Positions Open" at the back of the same issue reveals that of the 54 advertisements for college and university positions, only 4 were for people primarily interested in teaching. The others: 27 research appointments and 21 for people to do both research and teaching. In most cases, more importance was placed on research than on teaching, as indicated by comments such as "Ability to attract grants," "Proven research record" or "Extensive publications." Has higher education become more research than education? In the past, college teachers spent their spare time working with students, planning and building new demonstrations and generally finding ways to make physics interesting and exciting to all students, particularly in the general physics classes where the potential high-school teachers are. To-

day, administrators require that professors spend their time planning and writing grant proposals as even small colleges scramble to imitate the prestige schools in their quest for the research dollar. How can professors with, at best, divided interest in teaching generate interest in physics and in teaching physics among their students?

FRED B. OTTO
Orono, Maine

9/83

Breakthrough in phase problem

Your recent article "New method for determining the phases of diffracted x rays" (November 1982, page 83) and the comment "Breakthrough questioned" given by Robert Colella (February, page 112) seem to ignore the fact that the first determination of a difficult crystal structure has been realized. In my paper cited in your article, a concrete method for phase determination was developed, and the success in solving a difficult structure that could not be solved previously with the ordinary direct methods was reported. A series of articles on the application of this method to crystal-structure determination [Acta Cryst. A38, 414 (1982)] and on the discussion [Acta Cryst. A38, 516 (1982)] of the shortcoming of the previously proposed methods by others (those mentioned in your article) have been published. A detailed account, presented in the 1982 March meeting of the American Crystallographic Association, on the technique of solving difficult crystal structures using my method together with the direct methods, appeared recently in *Acta Crystallographica* [A39, 98 (1983)].

The citation of the 1982 Warren award referred mainly to Benjamin Post's 1977 contribution. Post deserves this award for his deep understanding of the mechanism of dynamical n -beam Borrmann (transmission) diffractions in connection with the invariant phases of structure factors, although correct phases cannot be determined using his method because of the influence of the crystal thickness on the transmitted intensity.

The phase determination of germanium and zinc tungstate, mentioned in your article, has nothing to do with the award, since these phases were determined using reflection-type multiple diffraction, which has no connection with Post's 1977 paper. This determination of phases resulted from the consideration of the relative motion of the crystal lattice, which was originally proposed by me during my sabbatical leave at the Max Planck Institute for Solid-State Research in 1981. (My earlier publication, *Appl. Phys.* A26, 221 (1981), concerning this idea was not cited in your article.) Without consid-

ering this lattice rotation, correct phase information cannot be attained. Moreover, reflection-type diffractions differ from the transmission ones in the involved scattering matrix. The matrix of the former is Hermitian, while that of the latter is not. Besides, the degeneracy of the dispersion surface in the reflection case is quite different from that in the transmission case. The sentence, "Chang has developed a variation on Post's procedure and has used it to determine phases in an intermediate compound," contained in your article is therefore incorrect.

In the 1974 paper of Colella, the neglect of the effect of the coupling reflection on the diffracted intensities in n -beam cases affects the correctness of this paper. This neglect usually disconnects the phases and the n -beam diffractions, because the invariant phase is the sum of the phases of the primary, the secondary and the coupling reflections. It is meaningless to deal with the phase problem without considering the coupling reflections. In addition, because no concrete method was proposed in this paper, in no case would it be able to provide phases.

The so-called "virtual Bragg scattering," is, according to Colella, due to the failure of the conservation of energy; this statement is of course mistaken. In fact, the energy is conserved at any crystal setting in n -beam diffractions. Simple proof can be obtained by considering the Poynting vectors of the diffracted beams. Furthermore, the effect of the lattice rotation on the diffracted intensities was not considered. Colella's claim of priority in this field is then not supported by his publications.

Both Post's and Colella's methods lead to no correct phase determination. This is why no crystal-structure determination using their methods has been reported.

SHIH-LIN CHANG

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AN AUTHOR RESPONDS: A careful reading of Shih-Lin Chang's letter and the publications to which he refers raises a number of disturbing questions regarding the validity of the points which he makes in his letter and about some aspects of his research activities.

In the letter, we are informed that his procedure made possible "success in solving a difficult structure that could not be solved with the ordinary direct methods." That phrase is repeated, almost verbatim, in at least four of Chang's recent publications.¹ Three were published in 1982; one in 1983. Nowhere in his letter, nor in any of the three 1982 publications, does Chang mention the very relevant fact that the "difficult structure" was solved and described in a paper submitted to *Angewandte Chemie* on 12 March