reputation of the prominent scientists who take part in the Forum will be given to this cause.

Human rights are not mentioned in the agenda of the Scientific Forum. But the agenda does provide a possibility to discuss obstacles to East–West cooperation. Suppose for a moment that some of the participants use it to raise the issue of human rights and, specifically, the imprisonment of Orlov and others. Unfortunately, there is no reason to be optimistic about the results. One can predict what will happen from the experience of other international scientific conferences. Those scientists who are prepared to take a strong action in protest over the imprisonment of a scientist, or official refusal to permit the journey of an invited scientist, and, so on, invariably find themselves in the minority, so that only a very mild resolution can be passed, if any. Of course, even a mild resolution is welcome and makes the overall human rights balance positive when it is an addition to a quintessentially non-political event: a scientific conference. But the Scientific Forum is essentially a political event. The more than probable failure of potential human-rights activists to secure an adequate response to the repressions in the USSR will only stress the overall victory of the Soviets. "Although a miserable handful of spiteful enemies of detente," Soviet papers will say, "tried to hamper the work of the Scientific Forum, the scientific community showed that it wholeheartedly supports the growth of East–West coöperation and the principle of non-intervention into the internal affairs proclaimed by the Final Act of the Helsinki Accord."

Yuri Orlov's health is rapidly deteriorating in the awful conditions of a Soviet prison camp (see PHYSICS TODAY, December, page 88). No better is the condition of Shcharansky, biologist S. Kovalev (arrested in 1974) and others. I urge that there should be no Scientific Forum so long as Orlov and the other Helsinki monitors are imprisoned. By taking part in the Forum, scientists would signal their acceptance, if not approval, of the way the Soviets comply with the Helsinki Final Act.

VALENTIN F. TURCHIN
Forest Hills, N.Y.

* * *

Valentin F. Turchin is a former Soviet dissident, chairman of the Amnesty International group in Moscow. He emigrated to the USA in 1978 and is now a professor of computer science at the City College, the City University of New York.

COMMENT BY LEADER OF US DELEGATION: No one could sympathize more deeply than I do with the motives and concerns that Valentin Turchin so clearly expresses. Indeed, the Academy has not been remiss in communicating those very concerns to appropriate officials of the Soviet Union. But he and I are led to opposite conclusions concerning the Scientific Forum.

To be sure, there is the risk that, regardless of what actually transpires at Hamburg, internal Soviet news media may hail the very fact of the Forum as vindication, indeed as approbation of Soviet policy. But those Soviet scientists present will surely know otherwise. The American delegation, if no other, will go to Hamburg determined to bring forcibly to the attention of the delegates from all of Eastern Europe those concerns that, understandably and rightly, trouble Turchin.

The boycott he advocates is equivalent to the boycott of *all* exchanges that has been advocated by others. I welcome the fact that some Americans are so moved and publicly so indicate. They arm those of us in position to communicate their concerns, face to face, to those scientists who represent the Soviet bloc in these arrangements. Only so can the force and legitimacy of our moral position be made clear—and reported back to those governments. The struggle for human rights, like the struggle for a stable peace, requires that we continue to discuss these difficult matters. If we stop talking, we will have given up.

Finally, it should be recognized that Turchin would introduce to the varied and complex Soviet–American agenda the single-issue tactic that has proved so destructive of our national political life. In the end, both at home and abroad, that tactic must be self-defeating.

PHILIP HANDLER
President
National Academy of Sciences

Dating with accelerators

The account of "Radioisotope Dating with Accelerators" by Richard A. Muller in February (page 23) contains a section called the "History of direct detection." That section treats the use of the cyclotron and tandem accelerator simply as two alternative methods of generating high-energy ions, thereby obscuring both the different physical principles involved and the different historical developments of the two approaches to radioisotope dating by direct detection. The confusion in the author's mind seems to have arisen because the large tandem accelerators and the cyclotrons used for the early C^{14} studies generate similar particle energies. In contrast to the cyclotron work, however, the tandem accelerator work[1,2] has been followed rapidly by the design and funding of quite small tandem accelerators used basically as molecular disintegrators within almost conventional mass-spectrometer systems. The quite different motivation for the work on the

two types of accelerator, which this demonstrates, is missed by the author in his highly simplified and speculative "History of direct detection." The work at Rochester, for example, was not inspired by Muller or by discussions at the archaeometry conference as implied in the article.

The real key to the first successful detection and measurement of natural C^{14} by atom counting lay not in the use of a high-energy accelerator but in the demonstration[1] that $(N^{14})^-$ ions are so unstable that C^{14} ions could be detected without the direct interference from N^{14}. This fact alone, which was suspected for many years, could form the basis for a high-resolution ($M/\Delta M > 1250$) low-energy mass spectrometer for the direct counting of C^{14} atoms. (In the pioneering work of Anbar, mentioned in the article, the fragmentation of the $(C^{14}N^{15})^-$ molecule would have resulted in a low-efficiency C^{14} counting device. For a variety of reasons the $(C^{14})^-$ ion is now known to be a better starting point.) The use of even a small tandem accelerator as a molecular disintegrator, however, avoids the need for very high resolution[3] and the concomitant low efficiency. Any other method for destroying or eliminating mass-14 molecules completely and efficiently would be acceptable.

The suggestion for using negative ions in the cyclotron, made in the article, illustrates this point further. The high mass resolution of the cyclotron would result in the acceleration of $(C^{14})^-$ ions only and the energy of the output would be irrelevant. High energy is simply not the key to the radiocarbon dating nor is it correct to say, as the article does later, that particle identification is necessary to eliminate the molecular fragments C^{12} and C^{13} shown in figure 6. A simple electrostatic analyser[4] or velocity filter[2] suffices. The size of the molecular disintegrator, for the C^{14} dating devices being constructed at the Universities of Arizona and Oxford, was chosen[2] to eliminate the interference from the metastable $(C^{12}H_2)^{+2}$ ($\tau \approx 10$ microsec) molecule[5] by optimizing the yield of $(C^{14})^{+3}$ ions. Smaller but less efficient machines could be made.

Similar principles can be applied to many other radioisotopes. For example, there is no need to accelerate I^{129} to high energy to distinguish it from Xe^{129}, as the separation can be accomplished by exploiting the high stability of $(I^{129})^-$ and the high instability of $(Xe^{129})^-$. The destruction of molecules of mass 129 must also be accomplished, and one would naturally first try a tandem accelerator. Particle identification at high energies in this case would be very difficult. Acceleration to energies higher than used in conventional mass spectrometry does have advantages in cases such as the detection of Cl^{36}. This is because at present the isobars Ar^{36} and S^{36} must be discriminated against by rate-of-energy-loss measurements. In this case, however, the more abundant Ar^{36} isotope is completely eliminated[4] by using negative ions and the tandem accelerator, whereas Ar^{36} is also a problem when positive ions are used.

An important omission from the article is the significance of the use of solid samples in the sputter ion source on the tandem accelerator. The use of solid samples in such ion sources economizes on material and drastically reduces the ion-source memory effect. (The total system efficiency for counting the C^{14} atoms contained in a sample used in a sputter ion source has been estimated to be 4%. See reference 5, page 92.) The absence of a discussion of the memory effect by the author, who used CO_2 for his C^{14} work, is puzzling.

In our opinion the article on "Radioisotope dating with accelerators" misses the significance of many of the technical developments that have taken place recently in ultra-sensitive mass spectrometry. The advances are on a much broader front than indicated in the article.

References

1. K. H. Purser et al., "An attempt to detect stable N^- ions from a sputter ion source and some implications of the results for the design of tandems for ultra sensitive carbon analysis"; Revue de Physique Appliquée, **12,** 1487 (1977).
2. G. Doucas et al., Nature, **276,** 253 (1978).
3. K. H. Purser, US Patent 4037100 (1977).
4. D. Elmore et al., Nature, **277,** 22 (1979).
5. Proceedings of the First Conference on Radiocarbon Dating with Accelerators, (H. E. Gove, ed.), University of Rochester, 20, 21 April 1978, page 88.

A. E. LITHERLAND
University of Toronto
Canada
H. E. GOVE
University of Rochester
K. H. PURSER
General Ionex Corporation

3/26/79

THE AUTHOR REPLIES: A. E. Litherland *et al* claim that high energy is unnecessary for direct detection, but their speculation is not supported by their examples or by their arguments. They say that it is the negative ion source that is the "key" to direct detection, yet the natural radioisotopes H^3, Be^{10}, C^{14}, and Al^{26} have all been detected using positive ions. High (multi-MeV) energy rather than negative charge is the feature common to all the successful experiments.

Although different background ions are encountered in tandems versus cyclotrons, the physics of background separation is the same. The ions must be accelerated to sufficient energy to pass through dense matter and be stripped of their electrons; the stripped ions can be

continued on page 102

letters

continued from page 15

deflected, stopped, or identified by their charge. Calling a tandem a "molecular disintegrator" cannot hide the fact that it accomplishes the suppression by virtue of its high energy.

The long history of failure at low energy is in striking contrast to the quick successes of the seven groups that have now made sensitive measurements with multi-MeV machines. Litherland *et al* speculate that low-energy methods "could" or "would" work, but they never mention a specific low-energy technique. In fact the only alternative they suggest is a "small tandem accelerator"!

RICHARD A. MULLER
University of California
6/26/79 *Berkeley, California*

Straightening the record

I feel compelled to correct your footnote on electron monochromators in October (page 48). The 127° monochromator was originally conceived by Hughes and Rojansky[1] and then constructed by Hughes and McMillen.[2] Most papers subsequently published on this device were concerned with its refinements or the rehash of the original work. The group of workers at Laval University, being the most prolific publishers on this subject, have been mistakenly assumed by some to be its originator. I hope to put the record straight.

References

1. A. Ll. Hughes, V. Rojansky, Phys. Rev. **34**, 284 (1929).
2. A. Ll. Hughes, J. H. McMillen, Phys. Rev. **34**, 291 (1929).

MURRAY ARNOW
Zenith Radio Corporation
10/25/79 *Melrose Park, Illinois*

The Booth effect

High fluxes of D-T neutrons are of very great importance for the materials-testing program for fusion reactors and for use in the treatment of cancer. It is appropriate, therefore, that PHYSICS TODAY should have featured on its cover for April a photograph of a tritium-loaded metal target that produces sustained yields of D-T neutrons of exceptional intensity and stability under intense deuteron bombardment. But that is only part of a fascinating story.

More than ten years ago, Rex Booth of Livermore, the designer of the target, made the seminal observation[1] that a tritiated metal target bombarded by a mass-analyzed deuterium ion beam gave far larger total neutron output over its useful life than when bombarded by an unanalyzed beam. This observation has proven to be the essential key to the attainment of levels of D-T neutron production now being attained, and which are of such great technical importance.

It is eminently appropriate that this observation should be designated the "Booth Effect."

The interpretation of this effect that is now generally accepted[2,3] is that the projectile ions supplant target tritium at the end of their range, and that the target ions at the end of the relatively short-ranged diatomic ions coincide pretty nearly with the layer from which the atomic ions produce their peak yield from the 110-keV resonance of the D-T reaction. Eliminating the diatomic ions from the target area impinged by the atomic ions therefore eliminates the principal source of tritium depletion for the peak-yielding target layer excited by the atomic projectiles, and prolongs the target life by a factor of ten or more.

References

1. R. Booth, University of California Radiation Laboratory Report No. UCRL 70183, February 1967, and private communication.
2. R. Booth, H. H. Barschall, Nucl. Inst. Meth. **99**, 1 (1972).
3. J. H. Ormrod, Can. J. Phys. **52**, 1971 (1974).

LAWRENCE CRANBERG
9/21/79 *Austin, Texas*

Another vote for Esperanto

Attendance at the 17th General Assembly of the International Astronomical Union delayed my reaction to the Guest Comment (July, page 9) by B. A. Sherwood discussing the need for an international language.

The meeting however verified once more the correctness of the various points stressed by Sherwood and mainly the difficulties foreigners encounter with spoken English.

Originally French-speaking, I learned Esperanto when quite young and it has been a real window open onto the world (and not only to a restricted intelligentsia). As I am now mastering other languages, Esperanto is less important now; but I still use it as a working language with some astrophysicist colleagues (the papers are, however, published in English).

Although I am pessimistic on its future because of numerous unfounded prejudices and cultural "imperialism" of other languages, Esperanto has considerable advantages we should consider. Besides the ones already pointed out by Sherwood, I should like to add it is the most precise language I know, not only because of the extensive vocabulary, but also because of the many nuances it contains. How efficiently it could be used for science, saving us the time we are compelled to spend in studying several foreign languages!

ANDRÉ HECK
IUE Observatory
10/3/79 *Madrid*

A legacy and a hope

A few weeks before his untimely death, Nathan Sanders Wall, a distinguished nuclear physicist from the University of Maryland, forwarded to the Committee of Concerned Scientists a letter pleading for action to help Soviet colleague Vladimir Kislik. The fact that this letter was directed to Wall reveals that even in the Ukraine his years of dedicated service to the cause of human rights is well known. Our Committee feels a special commitment to act on Sandy Wall's legacy to scientists to speak out on behalf of oppressed colleagues—particularly in the case of Vladimir Kislik.

We believe that the best way to effect this is to have our American colleagues read this letter for Kislik by a fellow scientist who was recently released from the Soviet Union.

Dear Dr. Wall,

I am writing to you at the request of my Kiev colleague Dr. Vladimir Samuilovich Kislik. Since all of his mail is opened by the KGB, and since I myself have now emigrated from the USSR, he asked me to write this letter to you.

At the present time Dr. Kislik's situation has significantly worsened. He has been summoned to the KGB a number of times in the course of 1979.

The essence of the matter is as follows: Although for the past six years he has not been permitted to work at his specialty, he has continued to publish the results of his activity in the international press. One of his recent works published abroad is on the evaporation of helium by irradiation of a certain type of construction steel. Naturally, both in the title of the article and in the article itself the specification number for this steel was mentioned. For a number of years this steel has not been on the secret list.

Earlier, when Dr. Kislik was still on the staff of the Nuclear Research Institute (NRI) of the Academy of Sciences of the Ukrainian SSR, he had intended to publish the results of this steel research. In accordance with Soviet regulations, he submitted the article for pre-publication clearance by an expert commission of the NRI. It was duly found to be free of classified material and was cleared for publication in the press. Dr. Kislik has a copy of this clearance decision signed