3. P. M. Williams, G. S. Parry, C. B. Scruby, Phil. Mag. **29**, 695 (1974).

4. C. B. Scruby, P. M. Williams, G. S. Parry, Phil. Mag. **31**, 255 (1975).

5. D. C. Moncton, J. D. Axe, F. J. DiSalvo, Phys. Rev. Lett. **34**, 734 (1975).

6. J. Van Landuyt, G. Van Tendeloo, A. Amelinckx, Phys. Stat. Sol. (a) (to be published).

S. AMELINCKX
Studiecentrum voor Kernenergie
Mol, Belgium

Breeding with tokamaks

The articles on Soviet physics in your November issue are excellent. The authors and your staff merit congratulations for the informative, justifiably laudable and polite style in which the material is presented.

In view of worldwide emphasis on fusion as an ultimate and inexhaustible source of energy, the last paragraph in the fusion article merits the most serious attention. I believe it says that the Soviets are deferring their goal of constructing tokamak reactors because their technological feasibility is still not established and, even if such reactors were scientifically feasible, no one knows how to surmount the foreseeable materials and engineering difficulties. We have here a classic example of the fallacy of proceeding to engineering before the basic knowledge base has been built. As an interim goal the Soviets are now considering using tokamaks to produce neutrons for breeding Pu and/or U^{233}, because the difficulty of achieving the economic "break-even" point is thought to be less severe for this modality of operation.

Over the past several decades we have seen an interesting interplay between the US and USSR efforts in fusion. We invented stellarators and abandoned them only to see them assiduously pursued in the USSR. The Soviets invented tokamaks, are temporarily abandoning them as far as original goals are concerned, while we are pursuing them with great enthusiasm.

I think it might be a great loss were we to proceed into large-scale endeavors to breed fissionable material, with devices as uncertain and as difficult as tokamaks, if this occurred at the expense of performing the really basic research that is necessary at least to determine whether controlled fusion reactors are indeed feasible.

Before we follow the Soviet lead in the direction of tokamaks as "breeders," the following additional points are worth discussing.

Deuterium–tritium fusion reactors are attractive because they require much lower plasma temperatures than do D–D reactors, and because they can breed at least as much tritium as they consume.[1] However, you cannot use the same neutron for breeding Pu or U^{233}. You may have one or the other. A Pu atom is worth about 180 MeV, including two and one-half 1-MeV neutrons. (Also, 14-MeV neutrons interacting with U^{233} give rise to neutrons of average energy about 1 MeV.)[2] A tritium atom is worth about 18 MeV including one 14-MeV neutron. This looks like you can make a large profit by breeding Pu and then making up the tritium by irradiating Li in a reactor. However, there are some penalties. Fourteen-MeV neutrons can convert Li^7 into tritium[1] while 1-MeV neutrons cannot. They require, for tritium production, the much rarer isotope, Li^6.

If breeding fissionable material is to be the name of the game, would it not make sense to do this with D–D neutrons, which can be obtained (perhaps quite economically) from explosively driven fission–fusion devices? One thereby avoids both the high cost and high radioactivity associated with large tritium inventories. Our technology for underground nuclear explosions is far more advanced (it even works safely) than our CTR technology. Should we not at least be prepared to use that technology, to breed Pu and U^{233} in case all else fails?

Going one step further, since reactors will be required to utilize the fissionable material, however it is produced, how about building breeder reactors? We might even consider giving them French names, since those with French names appear to work.

References

1. L. Rosen, L. Stewart, Phys. Rev. **126**, 1150 (1972).

2. L. Rosen, L. Stewart, "Neutron Emission Probabilities from the Interaction 14-MeV Neutrons with Be, Ta, Bi, and U^{238}," Los Alamos Report No. 2111, January 1957.

LOUIS ROSEN
Los Alamos Scientific Laboratory

Improving peer review

Several years ago, on behalf of the Netherlands government, I studied review methods practiced by a number of US research agencies, including NSF, AEC, and NIH. Since NSF provided host facilities for me, it was inconvenient to concentrate most of my efforts on NSF itself. At the time I was impressed by the skill with which program officers especially in the physics section of NSF carried out their task. They were extremely well acquainted with their fields and had thorough methods of continuously finding new names to add to the list of future referees. If necessary, they made use of foreign specialists and in *their referee files* I hap-