LETTERS

Preventing Nuclear War

In his editorial "A run worth making" (23 Dec., p. 1281), William D. Carey suggests that the long-term global environmental and biological consequences of nuclear war provide a new basis for dialogue between Soviet scientists and scientists in this country. He is right. The key addresses of the Conference on the World after Nuclear War, Washington, D.C., 31 October and 1 November, were transmitted via satellite to Moscow. The Soviet scientific community was represented at the preparatory meeting for the conference in Cambridge, Massachusetts, 25 and 26 April 1983. Soviet scientists (V. Aleksandrov, G. Golitsyn, and N. Moiseev) were active participants in the conference. At the conclusion of the conference, a "Moscow link" was established enabling participants in Washington to carry on a real-time audio-visual exchange of views with their counterparts in Moscow. This exchange was witnessed by audiences in Washington and Moscow. The moderator of the Soviet panel was E. Velikhov, Vice President of the Soviet Academy of Sciences. I performed that function in Washington.

To sum up 90 minutes of "live" conversations via satellite (restricted to scientific issues), there was unanimity that first-order effects are so large, and the implications so serious, that the scientific issues need to be "vigorously and critically examined," as urged by R. P. Turco *et al.* (23 Dec., p. 1290).

This examination is under way by the world scientific community in the Scientific Committee on Problems of the Environment of the International Council of Scientific Unions. The chairman is Sir Frederick Warner of the University of Essex. The dialogue between the Soviet and U.S. scientists is thoughtful, lively, and constructive. It is enriched by the participation of scientists from other countries. This is appropriate, since one of the implications in the concern over the prospects of a nuclear winter is that the survival of individuals in noncombatant countries may be in jeopardy. The nongovernmental framework facilitates frank discussion.

Carey wisely uses the word "probabilities" to convey the limitations of the scientific method in specifying the consequences of an exchange of nuclear weapons on the biosphere. The full power of the scientific method cannot be brought to bear on this issue because of understandable constraints on validating calculations with experimental results. This places heavy responsibility on modeling the relevant physical processes.

I am persuaded that a substantial research effort will be required to confirm or modify the tentative conclusions published in the 23 December issue of *Science*. This research provides "a new basis for dialogue" that can "make a difference in the one matter that transcends all others," in Carey's words.

If cooperation in helping to prevent a nuclear holocaust achieves a modicum of success, perhaps the groundwork will have been laid for addressing in a positive fashion those global issues that must be resolved to achieve a more harmonious world.

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Science and Mathematics Education

Former Representative Mike McCormack, in discussing our current problems in mathematics and science education, states (Letters, 25 Nov., p. 874) that "this country cannot wait for a generation or more for quality education." Accurately noting that most proposals for improving the quality of science and mathematics education "would be long-range in their impact," he reasonably advocates support for legislation like the Glenn-McCurdy bills, which would have some short-term impact on this problem.

But as useful and desirable as various proposals that would quickly improve science and mathematics education may be, there is no significant hope that we can "catch up with the rest of the industrialized world" in less than a generation. Tax savings to businesses who release their employees to spend some time teaching in local schools and other comparable mechanisms will at best scratch the surface of the problem we face. Indeed, this is a case where the standard American solution of throwing money at a problem may be necessary, but is far from sufficient. Not until societal attitudes toward education itself and toward teachers change substantially and, perhaps, not until the organization of education in the United States is changed considerably are we going to be able to rebuild our science and mathematics teaching to where we would like it. In the meantime it is likely that there will be a substantial decline in the scientific prowess of the United States relative to that of our main industrial competitors.

What this country badly needs now is a commission that will assess the probable effects on our scientific establishment over the next, say, two decades of the current perilous state of scientific and mathematics education and will make recommendations on how to ameliorate these effects in the period before any solutions can become effective. Central to any such commission's task would be the recommendation of ways to try to change the societal attitudes that have brought us to our present predicament.

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Spin Correlation

Fritz Rohrlich's article on "quantum reality" (23 Sept., p. 1251) leaves out an important fact. In considering the significance of the spin correlation experiment, it is essential to keep in mind one simple prediction of the quantum theory: If the two spin measurements are along the same direction a, then whatever the value of $s_1(a)$ yielded by a measurement on particle 1, a subsequent measurement on particle 2 of $s_2(a)$ will invariably produce the opposite value.

In interpreting this fact, the quantum theory quite reasonably maintains that after $s_1(a)$ has been found to have a given value from a measurement on particle 1 it is meaningful and correct to attribute to particle 2 the opposite value, even before its direct confirmation by a measurement on particle 2. However, the theory also maintains that before the measurement on particle 1 it is meaningless to speak of a definite value of $s_2(a)$ that will be revealed by a subsequent measurement on particle 2.

Einstein objected to the idea that a measurement made on particle 1 could change in this way the status of particle 2, even when the two particles were very far apart. He preferred to believe that particle 2 must have carried the value subsequently confirmed by its direct measurement, even before the measurement on particle 1, whether or not the quantum theory was capable of assigning meaning to such a value. The "hidden variable" in this case need be nothing more than that value—not some obscure set of parameters required to satisfy de-

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