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letters

development and rocket launches. Let those who directly benefit pay the bill, and let the rest of us spend our money on items we deem important.

Market forces are no panacea. Space exploration will continue to be the domain of brave, intelligent and courageous men and women who are willing to risk their lives pushing technology to its limits. There is no shortage of such people and there is also no shortage of space entrepreneurs willing to push our people and technology to their limits to create a reliable, cheap and safe space transportation system. All we need do is get government out of the way and let them do it. If we learn this lesson from the Challenger loss, then we will have created the most suitable memorial to the individuals who died on that flight.

JOHN BARTEL

TOM COUGHLIN

2/86

Charlestown, Massachusetts

SDI: The debate continues

The "debate" between Richard Garwin and Robert Jastrow in your Letters section has elicited a letter I feel is of great importance, that from Lieutenant General James A. Abrahamson, director of the Strategic Defense Initiative Organization (March, page 11). In this letter Abrahamson comments on the question of payload reduction of the Soviet SS-18 due to the addition of eight tons of laser shielding. He says:

Jastrow's book states that all ten warheads would be lost. I asked our systems-analysis contractors to check these calculations. They concluded that Jastrow's calculations, reported in *How To Make Nuclear Weapons Obsolete*, are correct. Quite simply, Garwin is wrong.

In his reply Garwin supplied a calculation showing that the payload need be reduced by only about two warheads. The calculation is a simple one and can be understood by students of freshman physics. There is only one correct answer to such a straightforward calculation and it is Garwin's.

Are the contractors selected by Abrahamson really that incompetent? If so, they should be replaced. Knowing where to turn for correct advice is an especially important function for any director, and especially for the director of the SDI Organization. Perhaps Abrahamson should also be replaced. I fear that at a higher level there is a similar problem. Leading American physicists have been unable to get their message through to President Reagan. I have reason to believe that the members of the council of The Ameri-

can Physical Society personally agree that no amount of effort and cost could provide a defense of population so efficient and reliable that it would make nuclear weapons impotent and obsolete.

A foolproof argument against Reagan's "space shield" is that there are delivery systems that would be unaffected by any space shield. One of the several delivery systems that would be unaffected by space weapons is the diplomatic pouch. In a similar vein, nuclear weapons could be smuggled in as successfully as marijuana by wrapping each bomb in marijuana. In fact the pursuit of SDI on our part will encourage this kind of response.

The world now seems to have its first real chance to reduce nuclear weapons swiftly by 50%. If our President continues to listen to Abrahamson, or to the kind of people Abrahamson listens to, rather than to the established scientific community (such as The American Physical Society), he will continue to believe that his dream of making nuclear weapons obsolete may work. He will then continue to refuse to give up SDI and thereby lose this precious and fleeting chance for a real arms reduction.

JAY OREAR

Cornell University

Ithaca, New York

7/86

JASTROW REPLIES: Jay Orear apparently failed to notice the sleight of hand in Garwin's analysis that struck me and Albert Petschek, as well as two MIT students (PHYSICS TODAY, July, page 15). To wit, Garwin did a different calculation from the one Abrahamson was writing about.

I had said in my book that eight tons of mass spread over the skin of an SS-18 would force the Soviets to offload the ICBM's entire complement of warheads. Abrahamson's SDI contractors checked this statement and found it to be correct. Garwin calculated the number of warheads lost if eight tons are spread over the first stage only. That number is, of course, considerably smaller. Garwin presented his result as if the two calculations were the same—and seems to have misled Orear thereby—but in fact they lead to entirely different results.

Once you notice that Garwin has switched calculations and do the calculation over with Garwin's own formulas, but for the problem Abrahamson and I described, you get, of course, the result we obtained.

Orear suggests that SDI contractors are incompetent and that Abrahamson should perhaps be replaced because he does not know "where to turn for correct advice." The shoe may be on the other foot; perhaps the Union of Concerned Scientists should turn else-

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where for its technical advice.

Regarding bombs in diplomatic pouches and bales of marijuana, it is hard to consider these as a serious threat in comparison with the possibility of 3000 megatons of explosive delivered over the polar cap in 30 minutes.

ROBERT JASTROW

Dartmouth College

8/86

Hanover, New Hampshire

I have just read Lieutenant General James Abrahamson's response (March, page 11) to Richard Garwin's review of Robert Jastrow's book *How To Make Nuclear Weapons Obsolete* (December, page 75). Abrahamson makes the startling statement "I asked our systems-analysis contractors to check [Garwin's] calculations. . . . Quite simply, Garwin is wrong." This is stunningly naive. Would those contractors really have returned the opposite opinion if they had found it? A manager who did so would surely have been fired.

WILLIAM C. MEECHAM

University of California

Los Angeles, California

5/86

May I pose one simple question to those who oppose SDI? Without President Reagan's proposed "Star Shield" or an equivalent ABM system, how would we prevent the precipitation of nuclear war by the accidental launching of one missile by either the Soviets or ourselves? Even a modest system should be able to handle one missile. No amount of negotiated reductions, short of total disarmament, will eliminate this danger. At the moment, our entire civilization is at the mercy of faulty microchips, itchy fingers and bumbling technicians.

LEE A. BREAKIRON

Allegheny Observatory

University of Pittsburgh

Pittsburgh, Pennsylvania

5/86

In the April issue (page 88), Wolfgang Panofsky answers only one of Pieter van Heerden's arguments for the Strategic Defense Initiative. I would like to make a constructive suggestion toward answering van Heerden's second argument, namely that the current SDI program is the only route out of a policy of mutually assured destruction.

There are many other possible routes that to many thoughtful, informed Americans are more plausible or less potentially destabilizing than that of high-tech space warfare. Suggestions for initial consideration have included massive population exchanges, international "peace universities," mechanisms for strengthening international



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economic cooperation and dependency, increasing cooperation in space research and various suggestions for graduated nuclear de-escalation with a concomitant greatly increased research effort in inspection and monitoring techniques. At this time, even some tongue-in-cheek solutions such as RASNAB—a high-tech, space-based ray to stimulate nonaggressive behavior (a form of "love ray")—have as much surface plausibility as SDI as a means of deterring nuclear conflict without violence. As van Heerden says, "As a scientist, one would say, 'Because we are so ignorant, by all means let's go and find out.'" Or, as often argued by other SDI advocates, "Even if it doesn't eliminate the nuclear threat, just imagine the spinoffs."

The problem, of course, is that at one end of the controversy we have ideologues who dismiss *a priori* any nonmilitary elements of a solution, while at the other end we have ideologues who dismiss any military aspects of a solution, with the rest of us arranging our biases along the intervening continuum. As a means out of this dilemma I would like to suggest a political compromise, namely *two* research programs, one along the lines of SDI, and another focusing on nonmilitary solutions. Most important to this concept is that both programs would be funded identically. Each would be able to support a wide range of basic research in its purview. In the non-Strategic Defense Initiative program, areas such as economics, sociology, anthropology, philosophy and conflict resolution would presumably be emphasized. The only significant stipulation that I envision at this point is that neither group could engage in research, development or testing efforts that could be seen as potentially destabilizing or contrary to existing treaty commitments.

In this way we would be truly unfettering our collective imaginations, but not only in terms of high-tech hardware. After a suitable time interval, say ten years, we could have a national debate as to the progress in each area and reevaluate our priorities.

MARTIN ROTHENBERG
Syracuse University
Syracuse, New York

4/86

PANOFSKY REPLIES: Martin Rothenberg notes correctly that I responded to only one of two points of Pieter J. van Heerden's letter. Van Heerden's second argument is:

The alternative, "We now have secure mutual assured annihilation capacity; for heaven's sake, let's not rock the boat," seems rather unappetizing, in particular because it is permanent. Because

we are so much more sensitive about these things than the Russians, does anyone think that they will ever negotiate themselves out of what for them is a comfortable situation?

Rothenberg interprets this to state "that the current SDI program is the only route out of a policy of mutual assured destruction." I interpret it as a simple expression of pessimism about the prospects for negotiated arms control.

I maintain that mutual assured destruction is not a *policy* that can be imposed or abrogated by the decision of national authorities, but a *condition* beyond the reach of policy, caused by the magnitude and lethality of the nuclear-weapons stockpiles in the world. I remain pessimistic that any path other than negotiated arms control drastically reducing nuclear stockpiles together with a general political relaxation and reorientation will reduce the risk of nuclear disaster. A technological fix such as the one proposed by SDI is not the answer.

Rothenberg proposes increased research efforts into mechanisms for strengthening international economic cooperation and dependency, into increasing cooperation in space research, and into nuclear de-escalation, inspection and monitoring techniques. Such efforts are in progress, sponsored principally by foundations as well as by the Federal government, at universities and research institutions. Greater efforts in this respect are clearly commendable to increase our pool of knowledge in pursuit of political solutions to the arms race. Yet I see little value in mandating that SDI, on the one hand, and such peace research, on the other, be funded at an equal level. SDI, whatever its merits, is largely an experimental research program, while the type of peace research discussed by Rothenberg is largely a matter of thought and analysis. Thus equalizing the budget between the two would have no more meaning than funding theoretical and experimental physics at the same level. This remark should in no way detract from Rothenberg's main thrust: that we need an increased effort toward studying constructive, non-SDI solutions to replace the search for a "technological fix" as promoted through SDI. During the past decades I have never seen as wide a gap between policy and the technical and scientific realities as is the case in respect to SDI.

WOLFGANG K. H. PANOFSKY
Stanford University
Stanford, California

9/86

Representative Marilyn Lloyd's letter in the October 1985 issue (page 9) astounds me. She attacks Wolfgang

letters

Panofsky's article on the Strategic Defense Initiative (June 1985, page 34) and states, "We in the Congress look to Panofsky for the wisdom of his technological evaluations rather than his civics lesson." Apparently, Lloyd does need a civics lesson; members of Congress do not have a monopoly on political or ethical wisdom. It is their duty to listen to the people.

Lloyd writes: "I would hope that Panofsky could demonstrate a bit more faith in the politicians and the American system. We in the Congress deal with 'perception versus reality' every day." Her reaction to Panofsky's dissent appeared so extreme that I wondered if there was some hidden reason for her support of massive SDI spending. Perhaps it is because her district in Tennessee includes Oak Ridge National Laboratory—one center of the military-industrial complex certain to benefit from Star Wars spending.

I also wondered why Lloyd did not mention the failure of the Maginot line, Hadrian's Wall or the Great Wall of China to give final protection to the people behind them. Surely these examples are more relevant to the SDI question than the "buoyant optimism" concerning the Superconducting Super Collider project that she does cite. SSC is too expensive for our nation to fund, but Panofsky notes (PHYSICS TODAY, October 1985, page 13) that at least it would "pit man's ingenuity against Nature, not against other human opponents. The Moon did not fight back [against the Apollo program]."

BRAD MARSTON

Princeton University
Princeton, New Jersey

4/86

Physics and society's needs

The April special issue of PHYSICS TODAY on "Physics Through the 1990s" devoted 24 pages to particles, nuclei, condensed matter, molecules, plasmas and cosmology. There was one small paragraph on biophysics. If this really represents the priorities of physicists, I believe that the emphasis is sadly misplaced, and that the result will be a growing abdication of social responsibility and consequent isolation of physicists from the community.

One way of setting priorities is to formulate objectives that are both desirable and attainable and that would have widespread benefits. As an essential condition, situations threatening the survival of human civilization must be eliminated, for otherwise priorities have no meaning. It seems appropriate therefore to consider some areas of physics where there have been, and are

likely to be, significant advances, and to assess each in its relation to the needs of society:

► The understanding of atoms and solids has resulted in noninvasive medical techniques (for example, ultrasound and lasers) and in the development of better materials, but one serious problem remains: the disposal of nondegradable wastes and the elimination of pollution (acid rain).

► The nuclear-fission reactor has proven to be a good source of energy, but it must be operated by competent personnel to avoid accidents. The public is worried by the problem of radioactive-waste disposal, even though this is less of a problem than that of disposing of chemical wastes. Nuclear fusion, if it becomes a reality, will probably take care of all our energy needs. However, reliance on nuclear bombs is dangerous to civilization, especially if irresponsible people should gain access to them.

► Whether research on nuclear constituents will ever "pay off" is highly problematical. So far, as accelerator energies have increased, so has the number of problems, without many apparent spinoffs to benefit society. As one colleague told me, "When you get to the horizon, there is always another horizon." The Superconducting Super Collider will probably provide answers to only a limited number of questions. Paul Ginsparg and Sheldon Glashow are somewhat pessimistic (PHYSICS TODAY, May, page 7). If we are coming to a blank wall here, it would seem prudent to back off, take a breather and concentrate on avenues where success is more probable.

► Great advances have been achieved in communications, with obvious benefits to everyone. The serial computer enables one to handle problems hitherto impossible. Parallel computers are gradually emerging and these will bring still greater capability. However, computers will be able to match the human brain only when they can recognize patterns, and this will require network inputs (see Scott E. Fahlman, *NETL: A System for Representing and Using Real-World Knowledge*, MIT Press, 1979). A concentrated effort here by physicists and mathematicians could well result in a breakthrough, and we might have some really intelligent robots.

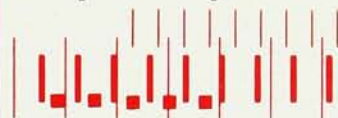
► Physicists, among them Hans Delbrück, George Gamow and the discoverers of the α helix, have contributed greatly to modern genetics and to our knowledge of protein structure. Much more remains to be done, especially in elucidating the conditions for the initiation of metastasis and how some immune systems can block it. Another problem is to learn how biological patterns arise. In both of these areas, physicists seem to know too little bio-

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