

PHYSICS and SOCIETY

THE NEWSLETTER OF THE FORUM ON PHYSICS AND SOCIETY, PUBLISHED BY
THE AMERICAN PHYSICAL SOCIETY, 335 EAST 45th ST., NEW YORK, NY 10017
PRINTED BY THE PENNY-SAVER, MANSFIELD, PA 16933

Volume 12, Number 3

July 1983

TABLE OF CONTENTS

A Message from Gorky by Andrei Sakharov.....	2
What's Wrong With the Nuclear Freeze? by Lewis A. Glenn.....	3
Minutes of the Executive Committee Meeting.....	5
Forum Studies: Progress Reports.....	8
APS Council Report by Brian Schwartz.....	10
COPS Report by Earl Callen.....	11
Noteable Quotes and Spectator's Notes.....	11

PHYSICS AND SOCIETY is a quarterly newsletter of the Forum on Physics and Society, a division of the American Physical Society. The newsletter is distributed free to members of the Forum and also to physics libraries upon request. It presents news of the Forum and of the American Physical Society and provides a medium for Forum members to exchange ideas. PHYSICS AND SOCIETY also presents articles and letters on the scientific and economic health of the physics community; on the relations of physics and the physics community to government and to society, and the social responsibilities of scientists. Contributions should be sent to the Editor: John Dowling, Physics Department, Mansfield State College, Mansfield, PA 16933, 717-662-4275.

**Forum on Physics and Society
Physics Department
Mansfield State College,
Mansfield, PA 16933**

BULK RATE U.S. POSTAGE PAID Mansfield, Pa. Permit No. 3 Educational Non-Profit

A MESSAGE FROM GORKY by Andrei Sakharov.

This is the text of the letter from Academician Sakharov (translated by Tatiana Yankelevich and Richard Lourie). It is his response to being awarded the 1983 Szilard Award of the Forum and was read at the Awards Session at the 1983 Baltimore APS meeting.

I am grateful and proud to accept this award, named for a remarkable man and scientist, Leo Szilard. I know of Szilard's outstanding scientific merits and of his public activity, which sprang from his innate, acute feeling of personal responsibility for the fate of mankind on our planet, and for the possible consequences of science's great victories.

In the years of Szilard's life and activity it became clearer than ever before how great the responsibility of scientists is to the society. And, to a large extent, it is due to Szilard that this awareness began to spread in the scientific community. Unfortunately, today, almost 20 years after Szilard died, the problems that disturbed him are not less acute or tragic.

Today, as then, the world is politically and ideologically divided into two opposing camps. Both sides are threatening each other with missiles and nuclear weaponry. Destructive capacity increases every year and has already reached a level at which its uses would cause the deaths of hundreds of millions of people and cause destruction unprecedented in the history of mankind; create chaos, devastation and suffering; and hurl human society back centuries. The total annihilation of mankind and life on Earth is not out of the question - perhaps even with the existing reserves of nuclear arms - and is even more probable with the further quantitative and qualitative development of the means for mass destruction.

Meanwhile, the confrontations are not static. One glance at the map of the world today and in the first post-war years is enough to realize that the line separating the areas of prevailing influence has been continuously moving in one direction - to the benefit of the socialist camp. One could call this a manifestation of the laws of history; some might say of historical justice. Others might call this a socialist expansion replacing one sort of social and legal problems with others, no less acute and tragic. The most important thing is the objective result, which is a further aggravation of the international situation and an increasing danger of local conflicts growing into a worldwide clash.

The problems of the underdeveloped countries are as acute as they were earlier. There is no doubt that unevenness of development creates enormous suffering for the greater part of mankind and poses a threat to world stability. Maybe that is the main source of danger. To decrease the unevenness is one of the chief tasks of our times, demanding coordinated action by all countries, developed and developing. Unfortunately, the division of the world produces

negative results in this matter as well. At present, the Soviet Union provides the developing countries with only very small amounts of technological and economic assistance - and only to those under its influence. Having practically withdrawn from participation in worldwide joint efforts, the Soviets have, however, become a major supplier of arms.

Since the late 1960's international terrorism, a sort of terrorist international of "left" and "right" groups, has become a serious destabilizing factor. Those states that directly or indirectly encourage these destructive forces are undoubtedly causing great harm to the entire world, their own people included.

One of the most tragic and dangerous events of recent years was the Soviet invasion of Afghanistan. Many tens of thousands of Afghans have died in the three years of war; according to some estimates, the number of victims exceeds 100,000. Many Soviet soldiers have died. Millions of Afghans have fled the horrors of war and left the country; about one-third of the population have become refugees. The Soviet invasion seriously aggravated the international situation, affected the rate of the arms race and, in particular, the fate of SALT II. If there are not changes for the better in the world, Afghanistan could become the Abyssinia of a new world war!

Today we ask ourselves once again: Does mutual nuclear terror serve as a deterrent against war? For almost 40 years the world has avoided a third world war. And, quite possibly, nuclear deterrence has been, to a considerable extent, the reason for this. But I am convinced that nuclear deterrence is gradually turning into its own antithesis and becoming a dangerous remnant of the past. The equilibrium provided by nuclear deterrence is becoming increasingly unsteady; increasingly real is the danger that mankind will perish if an accident or insanity or uncontrolled escalation draws it into a total thermonuclear war. In light of this it is necessary, gradually and carefully, to shift the functions of deterrence onto conventional armed forces, with all the economic, political and social consequences this entails. It is necessary to strive for nuclear disarmament. Of course, in all the intermediate states of disarmament and negotiations, international security must be provided for, vis-a-vis any possible move by a potential aggressor. For this in particular one has to be ready to resist, at all the various possible stages in the escalation of a conventional or a nuclear war. No side must feel any temptation to engage in a limited or regional nuclear war.

There are two specific problems. One is that the main part of the Soviet Union's nuclear potential is concentrated in gigantic land-based missiles. Essentially, this is a first-strike weapon. It is necessary to strive to eliminate these weapons or to reduce their number. There is little chance of this happening before the west has analogous missiles and is ready to eliminate them as well as the other means of nuclear war. The second problem is that the Soviet Union is not likely to eliminate its powerful medium-

range missiles, which have upset the nuclear equilibrium in Europe and which threaten China and Japan, before the West deploys analogous missiles.

Certainly the ultimate goals are international security, the elimination and demolition of nuclear weaponry, and rapprochement - convergence by countries with different political systems. In the long run, convergence is the only alternative to global destruction. This goal cannot be achieved without profound political and ideological changes - both in the relations between socialist and western countries, and within the countries themselves.

In the postwar years Nils Bohr, as well as Szilard and many other like-minded people, dreamed that open societies would provide an important and dispensable guarantee for international security. Since then, Stalin's tyrannical regime with its monstrous mass crimes has become a thing of the past in the Soviet Union. But the key features of the system formed under Stalin have basically survived. They are: the monopoly of the Party and the state in economics and ideology, which is even harsher in the political and military spheres; and the attendant violation of freedom of conscience and the free flow of information; of the right to choose one's country of residence and place of residence within the country; the unfounded persecution of dissidents and prisoners of conscience. Of course, the scale of persecution cannot at all be compared to that of Stalin's times. But to persecute people for their convictions, people who have not resorted to violence or advocated it, is in essence inadmissible. I am certain that the plight of the prisoners of conscience-many of whom are sentenced to seven and even 15 years of deprivation of freedom-cannot help but disturb us. It is very important to fight for each prisoner as an individual. Universal amnesty for prisoners of conscience in the Soviet Union and throughout the world would not only be an act of humanity but an important step on the path of strengthening international trust and security.

I would like once more to remind you of the profound alarm felt by our great predecessors - Einstein, Bohr, Russell, Szilard - for the fate of mankind, and of the ideas they left us. These ideas - about peace, about the importance of mutual understanding and tolerance, about the openness of society, the respect for human rights, the convergence of states with different political systems, the responsibility of scientists are as important today as when they were expressed for the first time.

Андреи Сахаров

WHAT'S WRONG WITH A NUCLEAR FREEZE?

by Lewis A. Glenn, L-387, Physics Dept.,
Lawrence Livermore National Lab.
Livermore, CA 94550.

Advocates claim that a nuclear freeze will

- Put an end to an arms race that otherwise can end only in holocaust
- Ensure that there will be no future generations of nuclear weapons.

The freeze proposal would ban the manufacture, testing, and deployment of any new nuclear weapons, while allowing the maintenance of existing nuclear forces **only** until reductions could be agreed on with due deliberation. What's wrong with this idea?

The main problem is verification. Most proponents of a freeze agree on the importance of verification by prefacing their proposal with the adjectives **mutual** and **verifiable**. The reason for this is that, without adequate verification, one side could clandestinely acquire and deploy new weapons while the other does not. The problem is aggravated if this happens while both sides are supposedly reducing their arsenals since, in this case, the numerical superiority of the evader is quickly magnified. The risk of nuclear confrontation is then very much enhanced because the evader may perceive that a surprise strike would eliminate any possible counter-strike by the victim. The possibility of a successful first strike becomes a reality when the aggressor has the task of only locating the few remaining weapons of the victim (the main body having been dismantled by agreement) and can target each with several of his own to ensure their complete destruction. Conversely, the risk of confrontation is much less with large numbers on both sides. Even with multiple targeting, the aggressor is assured by the laws of probability that at least a small fraction of the victim's arsenal will remain after his onslaught. If the initial arsenal is large enough, the remnant will be sufficient to wreak havoc on the aggressor's homeland - thus serving as an effective deterrent to any nuclear exchange.

Freeze advocates generally react to this MAD (for Mutual Assured Destruction) scenario with the claim that it is too dangerous and that adequate verification is possible with "national" methods. By this they mean methods that can be managed independently, without cooperation of the other party - an especially important consideration in view of the closed nature of a totalitarian society like that of the Soviet Union. In fact, there are three items that need to be verified in the event of a freeze: testing, manufacture, and deployment. The detection of nuclear weapons testing is relatively easy, at least up to a point. Neither the Soviet Union nor the United States is currently testing in the atmosphere, such testing having already been proscribed by the Limited Test Ban Treaty of 1963: satellite surveillance and extra-territorial atmospheric sampling virtually ensure that no violations have occurred. Underground testing is still permitted, however, although by mutual agreement (the unratified Threshold Test Ban Treaty of 1974) testing is limited to explosive yields not exceeding 150 kilotons.

Extra-territorial seismic monitoring has guaranteed the acceptance of this limit, although the Soviets have been accused of a few isolated violations. Moreover, the state-of-the-art is such that seismic monitoring could detect underground explosions with yields in excess of only a few kilotons. This would require the installation of a number of "tamper-proof" instruments **within** the national frontiers of both sides, as well as the provision for periodic maintenance, and perhaps occasional on-site inspections. It is important to note, however, that weapons with yields equivalent to those dropped on Japan could probably still be secretly tested by a determined evader, even with the best currently-available seismic equipment in place. Some have argued that satellite surveillance would be effective in detecting any nuclear testing since a great deal of surface activity is involved in conventional underground experiments. It goes without saying that such activity is easily avoided - at very moderate cost increases - in the event that it matters.

The detection of the manufacturing and deployment of nuclear weapons is infinitely more difficult. Again, it is claimed that production plants and transportation routes are well-known and can easily be kept under satellite scrutiny; new ones can be similarly identified. Our satellites are far from infallible, however, as has recently been demonstrated anew by the "discovery" of hundreds of previously unaccounted for new Soviet T-80 tanks, the production facilities for which were supposedly under constant surveillance. Moreover, it is tacitly assumed that facilities to assemble and transport new nuclear weapons must resemble the present, "well-worn" plants and routes. Unfortunately, the state-of-the-art has advanced considerably in the past few years. Much less special nuclear material (SNM) is required in modern, compact weapons systems and world inventories have increased dramatically. Those few facilities - such as uranium enrichment plants - that were large, specialized, and therefore highly visible, can now be replaced with much smaller and concealed operations. In the case of uranium enrichment, for example, gaseous diffusion can be substituted for by either mechanical centrifuging or laser isotope separation, both of which would require far less space. Warhead fabrication would require even less subterfuge, since nuclear and conventional warheads are now interchangeable on many weapons. Nuclear warheads could be assembled right alongside conventional explosives. Once so assembled, they could be transported just as ordinary missile components or munitions. Moreover, a clever evader would design his systems to be highly modular. Components would be separately transported to disparate locations and stored for rapid assembly at a later date. The genesis of such a program is probably already in place in the Soviet Union, with the appearance of the mobile, solid-fueled ICBM designated the SS-16.

Nuclear freeze proponents concede the possibility - even the likelihood - of some cheating. They claim, however, that the "number of weapons that could be produced clandestinely would be very small (some tens or hundreds) with respect to the size of current arsenals...". Whether or not these low estimates are accurate, even they are most disquieting. If the

Soviets could secretly stockpile only two weapons per week, while both sides had supposedly first frozen production and then staged "verified" reductions at the modest rate of, say 10% per year, in ten years time they would be left with 1000 and we with none!

Finally, we come to the important question of motivation. It is claimed that the Russians do not want a nuclear war any more than do we. In a recent speech, George Kennan is quoted as saying: "There is no issue at stake in our political relations with the Soviet Union - no hope, no fear, nothing to which we aspire, nothing we would like to avoid - which could conceivably justify the resort to nuclear weaponry". While we must agree with this homily, there is good reason to suspect that the same view is not held by the other side. When one reads Kennan's remark, there is a great temptation to substitute **German government for Soviet Union and armed conflict for nuclear weaponry**. The result is virtually a transcript fragment from Neville Chamberlain's speech to the Commons just prior to his departure for Munich in 1938. If the communist leader, like his national socialist counterpart 45 years ago, perceives that political advantage can be derived by agreeing to a nuclear freeze, there is no doubt that he will make the most of it; there is considerable doubt whether he will live up to it. And just as in 1938, there is an upswell in public opinion in the democracies, especially amongst the "better-educated" contingent, that decries any dissent from these views and labels as a warmonger any dissenter.

Some will read these words and recoil in horror. They will cry out about an endless arms race, with ever increasing numbers of missiles and megatonnage. Endless it may be, but unbounded it will surely not be. Competition for increasingly scarce federal funding is the viscosity that will put a lid on our strategic arsenal, and this process is already underway. New weapons systems are coming under increasing scrutiny (witness the MX and B-1 programs) and these will have to compete for limited funds with other defense needs, as well as with social programs. Still, it is vital that we continue nuclear weapons research if we wish to minimize the risk of a surprise attack. In the real world of today perhaps an endless arms competition is a necessary component of eternal vigilance which, as Jefferson would have it, is the price of liberty.

This article was prepared for submittal to *Physics and Society*. The opinions expressed are those of the author and do not necessarily represent those of any agency of the United States Government or of the University of California.

*This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under contract No. W-7405-Eng-48.

DISCLAIMER

This document was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor the University of California nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial products, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government thereof, and shall not be used for advertising or product endorsement purposes.

MINUTES of the EXECUTIVE COMMITTEE Meeting at the FORUM on Physics and Society, April 17, 1983 at the Baltimore APS Meeting.

The Executive Committee meeting was called to order by William Chinowsky at 11:30 a.m. on Monday, April 17, 1983, in the Convention Center in Baltimore, MD. Executive Committee members present were Nina Byers, William Chinowsky, Bernard R. Cooper, Carol Jo Crannell, John Dowling, Eric Fawcett, Kenneth W. Ford, Ernest C. Hammond, Natalia Meshkov, Leo Sartori, and Dietrich Schroeer. Other interested persons attending included Earl Callen, David Hafemeister, Chuck Hebel, Brian Schwartz, and Peter Zimmerman.

1. Forum Arms-Race Studies

Leo Sartori reported on the progress of the Forum-sponsored arms-race studies. Starting early this year five groups had been formed to look at problems of missile survivability, EMP, proliferation, verification, and civil defense. All the groups had reported that morning on their progress. The present studies are more in the nature of self-education, asking what the major problems are that might be addressed by a larger-scale study. The next step is a small workshop to plan possible big studies. The Panel on Public Affairs under Tony Nero is reviewing a request for \$5K to \$7K to hold that conference later this summer. (Will there be a problem with classified data?) Millie Dresselhaus (future APS President) is supportive of this idea. Bernard Cooper felt that the Ford Foundation might be approached to fund this meeting, with the APS as guarantors. Nina Byers believed that APS funding might give the planning workshop greater credibility. Brian Schwartz wanted to use the APS money as leverage to get Ford funding for a larger topical conference. David Hafemeister thought one could do this meeting cheaply, but most felt that travel money, etc., would be required. Peter Zimmerman argued the APS should carry it as far as possible. Brian moved, and John Dowling seconded:

Motion No. 1: Leo Sartori should encourage arms-race studies over the summer, using APS funding. He should use his own judgement, based on progress, whether to approach the Ford Foundation, etc., for money to run a larger topical conference on the topic to push such studies further.

The motion passed unanimously. Nina Byers moved that

Motion No. 2: POPA and the APS Council are to be thanked for their support of the Forum arms-race studies.

This motion passed by acclamation, Willie Chinowsky will write such a letter of thanks. Each of the subgroup chairmen will send a summary of their progress to John Dowling for the Newsletter.

2. International Contacts

Eric Fawcett suggested the Forum might send copies of the Newsletter plus descriptions of these arms-race studies to physical societies throughout the world, e.g. to Japan, Canada. The Forum would thereby discover not only what others are doing, but also could ask whether they might want to participate in these studies in some way. Would the Forum want to contact also other organizations like Pugwash, NAS, etc.? It was suggested that the Forum should be very careful about such organizational contacts on this potentially politized issue. Eric will circulate all letters and names of potential recipients before sending anything out. Nina moved and Leo seconded:

Motion No. 3: A foreign-relations committee should be established for contact with Forum equivalents of foreign physical societies.

The motion passed unanimously, Willie Chinowsky will appoint this committee.

3. Topical Conferences

Bernard Cooper moved and Nina seconded:

Motion No. 4: Planning shall be initiated for a topical conference on arms-race issues, going beyond the workshop of this summer.

This motion passed unanimously. Willie will appoint Joe Lach to be chairman of this committee. Lach should talk to Leo, Bernard, and the studies directors. June 1984 sounds like a good time. A note from Willie on this proposed conference should appear in the Newsletter.

4. Forum/AAPT Publications

Kenneth Ford reported on the progress of publications by the AAPT of Forum symposia: the proliferation session is published, the nuclear-war symposium is to appear, the summer session on women in physics may be published, the symposium on alternative energy sources is still limping along. Could these items be published in the APS Bulletin? Who would pay the costs of \$100 per page? Ken will pursue that question. Comments were made about the refereeing, reprinting and copyability of these publications.

5. Freeze

There is an international move to endorse a freeze, saying "We call for an agreement to the testing, production, and deployment of nuclear weapons and nuclear-weapons delivery systems. Meanwhile, no further nuclear weapons or delivery systems should be deployed anywhere." Should the Forum circulate this petition? Brian felt the Forum should not do this. The APS Council statement has had sufficient impact, coupled with the May issue of *Physics Today* in which Keyworth and Marshak square off. There is no need

for the Forum to stick its neck out further at this point. Considerable debate about this proposed Forum involvement ensued. In the end Nina simply asked for help of anyone who cared to assist in circulating this petition.

6. Report of the Council Representative

Since the resignation of Barry Casper, Brian Schwartz has been acting as an unofficial Forum Representative to the Council. He reported on the most recent Council meeting:

a. He discussed reactions to the Council's nuclear-arms statement. Presidential Science Advisor Keyworth was very unhappy about it, a letter exchange will be printed in **Physics Today**.

b. The AIP issued a statement in favor of science education, the Council worried whether that statement was properly issued on its behalf - the AIP Governing Board will review how such statements should be issued.

c. The APS treasurer handles \$10 million each year; some money is "surplus" as the APS wants to have a reasonable cash reserve. The costs of APS journals to libraries are going up, in exchange the size of the pages is going up by 20%. A discussion followed about charges to the third world - it is pretty liberal already.

d. The Nuclear Regulatory Commission proposed the APS might want to undertake a study of "Radionuclide Release from Reactor Accidents." POPA was not too enthusiastic, liking neither the short time schedule nor the idea of a NRC observer. The APS Council would approve if it could be properly done, if the right chairman and group members could be found.

e. The APS Council strongly favored continuation and expansion of the APS Washington Office of Public Affairs: it is receiving \$50K this year, \$100K next year. A report by Bob Park (the "chairman of the office") on the office might be put in the Newsletter. Does he know anything about funding sources? He does know about matters of international security and scientific information, even though the APS recommendations on that issue were not accepted by the Administration. He is continuing to let the press know about difficulties with such policies as an early-warning system.

Willie moved to commend Brian for taking over this "temporary" position, the commendation was seconded by acclamation.

If the Forum can get the election of a new Council Representative completed by November 20, then she/he could attend the fall meeting of the Council.

7. Newsletter Report

The Newsletter Editor John Dowling reported on the

state of the Newsletter. That state is satisfactory, and the Forum membership is growing. John pointed out that if necessary for financial reasons, three issues of the Newsletter could be made to suffice -but everyone urged him to continue with four. He suggested that Krystal Hathaway be asked again to design questions for the APS candidates. Ballots will be included as part of a newsletter issue. The committee nominating candidates for Forum offices should think about student candidates.

8. Treasurer's Report

Dietrich Schroeer reported on Forum finances. His best guess is that \$1500 may be left in the Forum treasury at the end of FY-1982-3, including \$1000 from the 1982 short course on the arms race. He suggested that the chairman again ask for a \$3500 subsidy from the APS Council like last year. It was recommended that he redo the budget to set aside the short-course income as a reserve for conferences, etc.

On behalf of the ad hoc travel committee Dietrich proposed limitations on travel expenses paid by the Forum, seconded by Willie:

Motion No. 5: Travel funds for one trip per year for the chairman, vice-chairman, and secretary/treasurer shall be assured; this would probably be to the April meeting. If hopefully - these funds are not used, or if only some partial expenses are paid, then other members of the executive committee may ask the chairman for travel support of no more than transportation and two day's expenses. Travel expenses for speakers at Forum sessions must be approved by the chairman in advance, preferably there will be no such expenses, but if there are any then they are very unlikely to be approved if they exceed \$200. It is recommended that no sessions be planned where a significant number of speakers might need subsidies - unless the APS can be persuaded to fund it directly.

The chairman should seek additional budget contributions beyond the \$3500 to expand such travel funds. Earl argued that the Forum was set up to allow such travel pay for speakers. The motion passed.

Earl suggested the Forum institutionalize "Forum Contributed Sessions." But then one must watch out for co-authorship problems for people who want to contribute both to this session and to a "real" physics session.

9. Secretary's Report

The Minutes of the January 1983 meeting of the Forum Executive Committee were approved.

10. APS Fellowships

Peter and Dietrich suggested that a committee be appointed to nominate candidates for APS Fellowships under the sponsorship of the Forum. ½ %

of the Forum membership can be nominated in any one year.

11. The Technology Export Issue

Chuck Hebel reported on the state of the technology export act. The Corson committee report was not followed by the Administration in setting up guidelines. Instead more hardline guidelines have been proposed by the Mantulle committee. Some physics items may be controlled - e.g. solid-state devices. A new study of the problem is in progress. Some unclassified items/ideas could come under export controls. Should a summary of the Corson report be put in the Newsletter? Research fares well in the FY-1984 budget; but increases come mostly in the DoD, which may be moving some money into areas that could be controlled. Continued vigilance is needed to keep the debate in the goldfish bowl.

Submitted by Dietrich Schroerer, Dept. of Physics and Astronomy, U. of North Carolina, Chapel Hill, NC 27514.

deter or contribute to the threat of nuclear war, 2) are studies of Soviet CD germane to the discussion, 3) does CD treat only the symptoms, 4) what is the impact of CD on peacetime diplomacy or crisis stability, and 5) what problems arise if CD plans are inadequate or unworkable when the public has been led to believe otherwise.

So far the Forum Study Group on CD has started an examination of the above issues and has volunteers for special items such as a computer code for nuclear explosion effects, and a search of RAND and FEMA reports. Finally, a bibliography containing over 250 articles, reports, books and films has been compiled.

.....

Planned Study on Electromagnetic Pulse and Its Implications Including Effects on Command, Control, Communications and Intelligence. By Bernard R. Cooper, Dept of Physics, West Virginia University, Morgantown, WV 26506.

A nuclear explosion generates an intense electromagnetic pulse (EMP) likely to cut off communications and power. As a consequence, a central factor in current plans for designing U.S. war capabilities is the strengthening of the communications and control system. The key question is whether such "hardening" to the necessary technical level can be achieved. Does EMP of itself eliminate the possibility of limited nuclear war involving "controlled" retaliation? The Forum sponsored study will attempt to delineate and characterize various effects that define the quantitative basis for the credibility of the EMP threat. Insofar as is possible through the use of unclassified information, we will also attempt to gather information on differing perceptions of the EMP threat held by various armed services, contracting companies, committees, government agencies, and countries.

The disruptive effects of EMP resulting from a nuclear explosion give rise to a grave element of uncertainty about the U.S. power and communications system. For example, the July, 1962 test of a 1.4 megaton bomb 248 miles above the earth and about 800 miles southwest of Hawaii caused multiple electrical problems in Hawaii.

EMP is characterized by an electric field of approximately 50000 to 100000 volts/meter. W.J. Broad in the Jan.-Feb. Science articles on EMP claims that pulses may be as high as 1,000,000 volts/meter! The risetime of the pulse is about 10 to 20 nanoseconds which is 100 times faster than for lightning, and hence too fast for standard lightning protection devices. This electric field results from the outgoing pulse of gamma rays from the explosions interacting with molecules in the air between 40 and 20 km above the earth's surface. These gamma rays travel long distances and can interact with the system. Free electrons are ejected which produce secondary electrons. Enough of these electrons persevere and spiral along the geomagnetic field lines and hence create an electric field. Thus there can be systems-generated EMP, internal EMP,

FORUM STUDIES: Progress Reports from the Baltimore APS Meeting.

The Forum Looks at Civil Defense by John Dowling, Physics Dept., Mansfield State College, Mansfield, PA 16933

Civil Defense (CD) presents the Forum with an interesting paradox: since CD obviously has the potential to reduce both casualties and economic damage in the short term and speed up recovery in the long term, why does it suffer such a lack of credibility, or worse, such apathy?

The Forum can contribute to a CD study in the following areas: 1) what real physics applies, 2) what is practical, and 3) what is needed to make CD work.

The "practicality" deals with the extent to which people and structures can be protected from the blast, heat and direct radiation of nuclear explosions and the extent to which crisis relocation can be executed. Correspondingly, the limitations of expense, national resources, and common sense have to be applied to the above. Finally, we will examine what steps are most appropriate to initiate the study.

The Forum can also help in determining what is needed to make CD work, e.g., what steps are necessary for general public education and to establish a trained cadre of workers. The Forum may also contribute by examining present plans for stockpiling, shelter plans, and the crisis relocation plan.

It is not clear how much the political questions which surround CD can be or should be examined. CD is intimately tied up with such issues as 1) does CD

cavity EMP, and Compton charging unique to each particular system. Other factors may enter in, e.g., rate of change of E and H fields, polarizations, and pulse shapes.

Although electronic components can be acted on directly by an EMP, the main threat to electrical components is the induced transients generated by EMP-system interaction. The large electric field from an EMP pulse causes avalanche breakdown at a p-n junction. Thus there is a large energy to be dissipated at the junction which gives rise to extreme localized heating. Because semiconductor thermal diffusion time constants are long compared to EMP pulse times, great heating changes the conductivity at the junction. The result is short circuit and permanent damage to most very vulnerable solid state devices.

Vacuum tubes have thick metal parts, and hence much better protection (whether this is a deliberate or inadvertent Soviet advantage is arguable). Regardless, it is very difficult to avoid the use of solid-state devices in modern communications technology. Shielding communications lines and centers is very difficult since wires, pipes, and metal objects penetrate shielded structures. Electromagnetic energy must be transmitted as well as received, therefore antennae and input couplings are vulnerable sections. Long distance ground communication lines and fiber optics lines are fine. But switching centers still use solid-state circuitry and require large expenditures to shield. Airplanes used as control centers in the atmosphere can be shielded at great expense, but whether pulses of 100,000 volts/meter can be handled is uncertain. Satellites are vulnerable with regards to both the shell and to the devices within.

A system can be hard enough for one application and yet fail in another. For instance, a low-frequency radio transceiver might be adversely affected by EMP when operating alone as a relay station atop a remote hill, whereas it might not be affected at all by EMP when used as part of another system inside operational headquarters.

Several new technologies may be of use to reduce EMP effects. While shielding does not work well to protect satellites, special circuits (filter antenna inputs) and cables from low atomic number metals (Al not Cu; so electrons are less readily released) may be of help. Emergency communications systems can be set up using ground wave signals. Finally, EMP pulses can be clipped by new fast-acting types of Zener diodes. While this may not work for power grid or long communications lines it may be all right for small things like field radios. C.N. Vittitoe of Sandia National Labs is working with me to direct this study. The probable goal is pedagogical review. The three stages of the study are 1) self education, 2) selection of individual areas to write on and individual writing, and 3) a coherent review article.

The basic topics to be examined are

High-altitude EMP:

Of the many general types of EMP (ground-burst, air burst, dispersed, magnetohydrodynamic...), this is the most widespread in its influence and has generated the greatest alarm.

Inputs to EMP:

Air chemistry, weapon gamma-ray and x-ray (and perhaps neutron) outputs, models for the atmosphere, interactions between the photons, electrons, atmospheric parameters, resulting conductivity and current density that serve as drivers for the EMP.

Direct system interaction with EMP:

Photon interaction with a system and subsequent alteration in conductivity, current density and boundary conditions, breakdown effects.

EMP threats:

To C₃I systems, to power systems, to civil defense.



VULNERABILITY: Some Questions for an APS Study on the Future of Land-Based Strategic Missiles by Peter D. Zimmerman, Physics Dept., Louisiana State Univ., Baton Rouge, LA 70803.

- I. Are land based missiles presently vulnerable?
 - A. Absolute missile/MIRV accuracy
 1. Bias errors
 2. Applicability of CEP as figure of merit
 3. Use of MARV and terminal homing.
 - B. Likelihood that an attack can be executed
 1. Reliability
 2. Fratricide
 3. Adequacy of the offensive C-3 system to initiate the attack under conditions of peace, nominal peace and high tension.
 - C. Possibility of a satisfactory point defense
 1. Adaptability of existing types of systems (Sprint/Spartan)
 2. "New" or "novel" systems (Swarmjet, guns, pebble screens, etc.)
 3. Impact on the ABM treaty as seen by both sides.
 - D. Structure of likely attacks
 1. EMP precursor shots and effect on C-3 of any system
 2. Likelihood of disarming first strike vs protracted exchanges
 3. Cost of knocking out ICBMs in terms of MIRVs not available for other purposes.

- II. Alternative land based systems
 - A. MX/Trident D-4 large payload, highly MIRV-ed, highly accurate systems
 - 1. Relatively heavy and expensive per missile. Expensive support infra-structure.
 - 2. Basing mode or modes
 - B. Small, single-warhead launchers
 - 1. Size, type and number to meet general USAF-SIOP goals
 - 2. Basing mode
 - 3. Employment doctrine
- III. The Other Two Legs of the TRIAD
 - A. Submarines
 - 1. Vulnerability of submarines to present and future sensors
 - 2. Limiting accuracy of SLBM warheads.
 - B. Manned bombers and cruise missile launchers
 - 1. Vulnerability and survivability of the system
 - 2. Ability of the system to deliver weapons to their targets
 - C. Contribution to crisis stability of long reaction time systems
- IV. The Future of the TRIAD
 - A. If land-based ICBMs are truly vulnerable, should they be retained?
 - B. Can a 'strategic tetrahedron' (my phrase) be developed?
 - C. Is it necessary for political reasons to retain nuclear missiles on the North American continent?
 - 1. U.S. inter-service rivalries
 - 2. Need to demonstrate to allies that our cities and population are at risk

THE WAY WE'LL REALLY ORGANIZE IT: Three main topics, taken from the outline

- I. Guidance Problems (Chairman: T.M. Eubanks, J.P.L.)

This group will look at the physics of guiding a missile over a non-spherical earth in the presence of uncertainties in the local gravitational potential, particularly at the launch point; of magnetic anomalies; of winds. Using open sources they will attempt to determine the theoretical vulnerability of the Minuteman system in particular and of land-based missiles in general. The topics under I.A.
- II. Attack and Defense (Chairman: Dave Hafemeister, Cal Poly, San Luis Obispo)

This group will study the various ways in which an attack might be structured, for example to take advantage of EMP effects, or to avoid fratricide. It will also look at defense schemes ranging from the Star Wars space-based systems to the "new", "novel" or "simple" ones such as pebble screens and Swarmjet. The topics include those listed under I.B - I.D. of the outline.

- III. Future Imperfect (Chairman: Pete Zimmerman, LSU)

We will look at proposed missile and basing schemes, including abandonment of the TRIAD and restructuring of the TRIAD. Although there was some interest in looking at the ASW problem, Mark Sakitt of Brookhaven (the ASW haven) and I decided that we lacked the manpower to include ASW in the study.

What we hope to accomplish:

By the end of summer we hope to have compiled some first-order calculations and some more sophisticated ones in vulnerability and on defensive systems. We will certainly have taken a hard look at the Midgetman/Armadillo proposal and the Scowcroft Commission's recommendation to base 100 MX's in Minuteman silos. Some of us hope to get together for a week at Brookhaven during the summer to try and get some detailed calculations done and to put a report together.

We intend to prepare a document which can serve as the basis of a proposal for a one-year professional study to be supported by the APS or a foundation.



Progress Report on Forum Verification Study by Dietrich Schroeer, Dept. of Physics and Astronomy, U. of North Carolina, Chapel Hill, NC 27514.

The volunteers for a verification study were bombarded early in 1983 with a long list of possible study items, and were asked to suggest modifications of the list - and what might be studied, and how. Three reactions predominated in the responses. (i) Many apologized for the slowness of their response; and indicated that they were looking forward to the summer to have some "real" time to work on this. (ii) The technical expertise seemed to lie in areas most closely allied to photo reconnaissance from satellites, including UV, visible, and IR. (iii) But the underlying interest did not reside in technical questions per se. Rather, most seemed to want to look at "real" verification problems, wanting the technical focus to be on systems to verify aspects related to specific treaties. The general question of "can verification work" seemed to be on everyone's mind.

It has been proposed to reconcile these time constraints, technical expertise, and policy concern in the following way, keeping in mind that some thought should be given about a possible final product to come out of the study, and that a topical conference on the arms race is a possibility for summer of 1984.

Each member of the study group has been asked to find time during April, May and even some of June to write a "termpaper" (or a sketch of one) about the topic that interests them the most, possibly following a set of suggestions made by the chairman of the group. Once these papers are collected, they will be circulated to all members. Hopefully these term-papers will help everyone to get started, will reveal to everyone what they know - and what they don't know! - will inform everyone about the other's knowledge and interest, and will provide starting points for a more detailed and interlocking study. If these "termpapers" are available early enough in the summer, then a real study can be outlined, and some spare time may still be left in the summer to do a little more detailed work. One might ultimately think in terms of a longer report of 50-100 pages, which could be condensed into a publishable paper, and which might provide the starting point for getting some funding for a more detailed technical study of some specific aspects of verification.

The chairman's inclination is to initially focus on satellite reconnaissance using UV, visible and IR radiation, because there is some expertise available, e.g., about charge-coupled devices. But if anyone wants to outline the methods available to verify some specific arms-control treaty, that would also be very satisfactory.

References to be used as starting points might include: Bhupendra Jasani (SIPRI), Ed., **Outer Space - A New Dimension of the Arms Race**, Cambridge, MA; Oelgeschlager, Gunn & Hain, 1982; and W. C. Potter, Ed. **Verification and Salt: The Challenge of Strategic Deception**, Boulder, CO: Westview Press, 1981, particularly Chapter 1 on the technology.

Report of the Acting Forum Representative to the Meeting of the Council of the American Physical Society by Brian Schwartz, Office of the Vice-President for Development, Brooklyn College, CUNY, Brooklyn, NY 11210.

This is a summary of relevant parts of the meeting of the Council of the American Physical Society, 17 April 1983, Baltimore, Maryland. My comments are to be regarded as informal and not in any way minutes of the Council meeting. For specific details please feel free to contact Bill Havens, Executive Secretary of the American Physical Society.

A major item was a report by President Marshak on one of the responses to the American Physical Society's statement on nuclear-arms limitation. Dr. G.A. Keyworth, II, Presidential Science Advisor sent a letter to the American Physical Society expressing his concerns with the actions taken by the Council of the American Physical Society. He was particularly concerned that the Council had taken an "official" stand on nuclear arms reduction. After some revisions of his original letter, Dr. Keyworth sent a letter to **Physics**

Today to be published as a Guest Comment with the heading "APS Steps Into a Political Vortex" expressing his viewpoint on the APS Council's statement. President Marshak prepared a reply to Dr. Keyworth in a letter, entitled "APS and Public Issues". Both comments appear in the May 1983 issue of **Physics Today**.

The second important matter was discussed by the Panel on Public Affairs (POPA). The Nuclear Regulatory Commission approached the APS to help in a study to determine the behavior of radioactive emittance from possible accidents with nuclear reactors. The APS study would review current NRC studies and other relevant data on this subject. POPA agreed that the project was important and would fall under the charge of the POPA Study Committee. POPA felt that it was uncertain that the proper study could get underway by late August, when the NRC wanted the study to begin. The Council debated the issue and set up an advisory committee to POPA to help develop names for a possible chairperson of the study, possible members of the study group and a review committee. The Executive Committee of the Council was empowered to take action on getting the study approved if high quality leadership could be identified, and if the Executive Committee felt that sufficient time, resources, interest, and expertise existed so that a first rate study could be instituted.

POPA also reported on the Forum study groups with respect to nuclear arms issues. The Council would be willing to consider APS studies in these areas, and the Forum should develop its plans and submit them through the appropriate channels to POPA.

Another issue debated was the recent news release by the AIP entitled "AIP Resolutions Address National Crisis in Science Education" dealing with FY84 NSF budget funds for Pre-college Math and Engineering Education. The APS was concerned that there were not sufficient procedure and safeguards for these public statements of the AIP on behalf of its member societies such as the APS. Dr. William Koch, Executive Director of the AIP was very sympathetic to this viewpoint and felt that the AIP Governing Board would consider this topic at its next meeting. The APS Council members, who are also members of the AIP Governing Board, were advised to work with the AIP to establish appropriate guidelines and procedures.

Dr. Joe Burton, treasurer of the APS, reported on the past, current and future budgets of the society. The society is committed to developing an appropriate reserve fund and is continually working to build up this reserve. The Council voted \$25,000 in support for the physics part of the National Academy of Sciences study chaired by Dr. William Brinkman of Bell Laboratories. The Council also approved the Congressional Fellowship Program for up to two fellows. The Council suspended the industrial based doctoral fellowship program since it feels that there are currently sufficient changes and motivation for new PhD physicists to enter careers in industry.

The Publications Committee reported on the status of the APS journals and changes in the cost of the library subscription to journals. The new costs are meant to reflect the different total number of pages published by each of the journals. A decision was made to use a larger page for the journals resulting in an increase of about 20% in content without an increase in the page charge to authors.

In addition Dr. Robert Park, Executive Director of the newly established office of Public Affairs of the APS summarized a report of his activities in Washington, D.C. The first part of the report dealt with details of the Office and the fact that *Physics Today* had hired a reporter, Mr. Irwin Goodman, as their Washington editor. A long report was presented on issues of scientific communication and national security. This is a complex and constantly changing issue and the American Physics Society, POPA, and the Office of Public Affairs are keeping very close watch on the policy developments. Mr. Louis Montulli, a security policy analyst in the Office of Science and Technological Policy was invited to present a summary of the current administrative activities with respect to the President's National Security Study Directive and Policy. Dr. Park also discussed items in the President's 1984 budget concerning physics and physics related funding. Dr. Park also outlined what he saw were the needs for continuing the office in the future.

APS Committee on Opportunities in Physics. A Report on the COPS Meeting, Baltimore, April, 1983 by Earl Callen, Physics Dept., American University, Washington, DC 20016.

Start Your Own Business. The November 1983 meeting of the APS will be in Silicon Valley, the valley of the deals. COPS may run a symposium on entrepreneurial physics.

Retiring Physicists. Everyone knows that physics faculty are tenured in and getting older. To retain vitality the profession and physics departments need to find ways to create openings for young faculty. Without growth, that can only happen if older physicists retire, and they will retire only if it is attractive to do so. It's an old story, but what to do about it? No one can know what is attractive to 30,000 physicists, what are their needs and motivations, but society can at least offer a diversity of opportunities, options, flexible and reversible transitions. Peter Kahn, chairman at Stony Brook, has been working on retirement options. Roland Good, long-time chairman at Penn State, will work with him. It's an enormously complex, delicate and important problem. Anyone with ideas should get in touch with the COPS subcommittee on retirement.

Science Teaching. The idea of getting retired physicists to assist science teachers in the high

schools is moving. All of a sudden the whole country is in an appropriate frenzy about the deplorable state of science teaching. It's the usual U.S. manic response to crises, but it does get things done. But I think an idea has got lost along the way. Part of the original COPS plan was to encourage local industry and colleges to donate a couple hours a week of their scientists' time to teach in community high schools.

APS Washington Office. Everyone is happy with the way the Washington office is coming along. Robert Park, our Washington representative, is doing a lot. He welcomes ideas and visits from APS members: Suite 739, Joseph Henry Building, 2100 Pennsylvania Avenue, N.W., Washington, D.C. 20037. Phone: (202) 429-1946. Park shares offices with a new *Physics Today* Washington writer, Irwin Goodwin. Suggestion: The APS Washington representative should write a regular column in the Forum newsletter.

Immigration Legislation: The APS has been corresponding with the Senate Subcommittee on Immigration (Alan Simpson, Wyoming, Chairman), but the proposed regulations remain excessively restrictive. We do hope Bob Park is following .

Technology Transfer. The President's Office of Science and Technology has a new man, Dr. Louis Montulli, in charge of keeping scientific knowledge from leaking to the USSR. Dr. Montulli spoke at the Baltimore meeting. No doubt his intent was to reassure us, but he scared me half to death. It was freaky. Those guys just don't think like we do. Let me quote from Thucydides, "The Peloponnesian War", Book Two, Pericles' Funeral Oration:

"Then there is a great difference between us and our opponents in our attitude toward military security. Here are some examples: Our city is open to the world, and we have no periodical deportations in order to prevent people observing or finding out secrets which might be of military advantage to the enemy. This is because we rely, not on secret weapons, but on our own real courage and loyalty...."

Notable Quotes and a Spectator's Notes.

"The Atomic Artist" is an extremely interesting film which tells how sculptor Tony Price converts junk from Los Alamos experiments and weapons tests into art: "...most of the things they were making were pure art in themselves...[I] mean, here are the best minds on our planet creating these experiments, chopping them up, and throwing them out as salvage...[I]t's taking these materials that were built for extremely destructive purposes and building things that are a lot more peaceful...[t]o take something that was really negative and turn it into something positive."

FORUM PUBLICATIONS

Nuclear Weapons and Nuclear War: This booklet consists of papers by Philip Morrison: "Caught Between Asymptotes," Hans Bethe: "We Are Not Inferior to the Soviets," and Wolfgang Panofsky: "MAD Versus NUTS" which comprised the Awards Session of the Forum at the Washington APS Meeting in April, 1982. The booklet is available from AAPT Publications Dept., Graduate Physics Bldgs., SUNY, Stony Brook, NY 11794. cost is \$2 (U.S.), \$2.50 (outside U.S.). Also available from the AAPT is **Nuclear Energy, Nuclear Weapons Proliferation, and the Arms Race.** Cost is \$2.50 (U.S.), \$3.00 (outside U.S.).

Second Short Course on the Arms Race - Dave Hafemeister and Dietrich Schroer did an excellent job on this special topical conference which proceeded the Baltimore Spring, 1983 APS Meeting. There were excellent talks on the effects of nuclear war, the physics and technology of the arms race, image enhancing, seismic verification of weapons test, teaching about the arms race, limiting technology, Congress and national security, and the SALT process. The conference talks will be published by AIP and will be available shortly. The title is **Physics and Technology of the Nuclear Arms Race.** It should be ready by early fall, write AIP Conference Proceedings, 335 E. 45th St., New York, NY 10017 to order.

FORUM FELLOWS

The Forum, along with all of the other divisions of the APS, is entitled to nominate distinguished physicists for election as Fellows of the American Physical Society. The Forum Fellowship Committee is now accepting suggestions and nominations from members of the Forum. Candidates for Fellowship from the Forum should have distinguished themselves by their contributions to the interface between physics and society. We are looking for candidates in arms control, human rights, physics education (particularly education of the general public), science policy and any other area which falls closer to "Physics and Society" than it does to another Division (e.g. History of Physics).

Sponsors should send in not just the name of their candidate, but also a few paragraphs describing why they feel the candidate is worthy. In addition, the APS requires a *Vitae* and publication list. Most physics departments have nominating forms, but they are also available from the Forum Fellowship Committee, c/o Peter Zimmerman, Dept. of Physics and Astronomy, Louisiana State U., Baton Rouge, LA 70803 - 4001. Fellowship nominations are limited to .5% of the membership (17.8 this year). Nominees selected will be elected in 1984.

Speakers Bureau. If you want someone to speak on foreign and military affairs contact the "Consolidated Speakers Bureau" which maintains a centralized, computerized list of 400 speakers by region and area of expertise. Sponsors are American Committee on East-West Accord, Arms Control Association, Coalition, Committee for National Security, Council for a Livable World, FAS, SANE, UCS, etc. Contact Jo Husbands at the Committee for National Security, 2000 P Street NW, Washington, DC 20036 (202-833-3140).

"Schwerter zu Pflugscharen" When 4000 youths gathered in Dresden they wore an armband, pictured below. This armband is a representation of the statue of a man beating a sword into a plowshare. It was donated to the U.N. by the Soviet Union. The armband is now forbidden by East German authorities, because it is being "misused" to express a way of thinking hostile to the government, and to promote participation in illegal political movements. We do have it nice here in the U.S., but remembrances of American flags on arm bands and burning draft cards do cloud the picture.



From the May F.A.S. Public Interest Report, pg. 1: "Arms control seems to have become the gift wrapping in which new weapons procurement is presented to the public. The arms race itself is increasingly an arms control scam."

From *Physics Today* 36 (5), 65 (1983) "Defense R&D Grows to become 67% of all Federal R&D"