Anti-satellite treaties

Model agreements prepared by scientists have helped make anti-satellite weaponry the focus of efforts to revive US–Soviet talks on arms control

William Sweet

One of the most surprising developments in arms control during the past two years was the emergence of anti-satellite weaponry as the main focus of efforts to revive serious negotiations. Anti-satellite weapons (ASATs) can be based on a variety of technologies, including ground-based interceptor systems, space mines and lasers; and their evaluation presents formidable difficulties. The story of how the ASAT issue came to be the central focus of arms-control efforts, despite its technical complexity, is an unusual tale in which physicists have played prominent roles.

At the beginning of 1983, all eyes were fixed on the impasse in the parallel Geneva talks over intermediate-range and strategic missiles, the meteoric growth of the European peace movement and the ascendant freeze movement in the United States. The issue of anti-satellite weaponry was generally regarded as not particularly interesting, important or promising. While the Russians had proposed an ASAT treaty in 1981, the Reagan administration seemed unshakable in its conviction that an ASAT agreement would be unverifiable.

In mid-1984, the Reagan administration rather abruptly adopted a more flexible attitude, signaling Soviet leaders that it might, after all, be willing to enter into talks on an ASAT ban. After the Soviet government extended an invitation to meet in Vienna for talks in September, complicated maneuvering followed in which each side seemed intent on keeping the possibility of negotiations open without making a commitment to actually begin them before the US election.

The emergence of the ASAT issue as the focus of efforts to reopen US–Soviet arms-control talks can be attributed, in part, to pressure from scientists specializing in arms control and to public-interest science organizations, notably the Union of Concerned Scientists and the Federation of American Scientists. Starting last year, in an effort to rebut the Administration's claim that an ASAT treaty could not be verified, specialists connected with UCS and FAS drafted model ASAT treaties, in which they spelled out in legalistic detail how such an agreement could be written. The scientists got their case heard in Congress, which in turn restricted the Adminstration's freedom to forge ahead with ASAT testing. At every stage, Congressional Fellows sponsored by The American Physical Society helped legislators grapple with technical aspects of the ASAT question.

Needless to say, UCS and FAS do not speak for all scientists, and not all the physicists in APS favor promotion of an ASAT treaty. Some physicists with very considerable experience in weapons and arms-control issues consider negotiation of an ASAT treaty unimportant, unnecessary, improbable or even impossible.

The skeptics include physicists Harold M. Agnew, former director of the Los Alamos Scientific Laboratory, and Herbert York, director of defense research and engineering under President Eisenhower and President Kennedy. Agnew, taking note of the fact that any long-range missile can be targeted against an object in space, wrote in *The Washington Post* on 28 August that "as long as any nation has an intercontinental missile, it will possess an ASAT capability—either with a nuclear or a conventional 'kill' capability." Agnew, who currently is president of GA Technologies (formerly General Atomic), concluded that "today's flurry of proposed treaties barring ASATs is really an unwarranted effort." In an interview, Agnew said that "the whole world is militarized, and to put such emphasis on one minor part is silly . . . I don't know whether it is pride of authorship or what, but we're so desirous of making treaties that we'll sign anything, and the Russians will just sit and wait."

York, current director of the Institute on Global Conflict and Cooperation at the University of California, San Diego, is inclined to think that negotiation of an ASAT treaty may be impossible because satellites are becoming too important militarily to be left alone in the event of war. Given the fact that satellites are used or soon will be used not only for photoreconnaissance, but also for the coordination of conventional and strategic sea and land forces, York believes that "trying to eliminate ASATs might be like trying to eliminate submarines." York's opinion is especially noteworthy because he does not generally subscribe to the philosophy that negotiations must always bow to the march of technical innovation. In his book on the decision to build the H-bomb (*The Advisors: Oppenheimer, Teller and the Superbomb*), York argued that the United States could have afforded to delay development of the hydrogen bomb, pending the outcome of exploratory talks with the Soviet Union.

If, as York and Agnew observe, space is becoming highly militarized and both superpowers already possess overpowering ASAT capabilities in the form of reprogrammable intercontinental missiles, what indeed is the point of promoting an ASAT treaty? In a nutshell, treaty advocates argue that a wasteful and possibly destabilizing race in new ASAT technologies would be worth preventing or inhibiting, even if countries retain some residual ASAT capabilities. Beyond that, treaty propon-

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A US Air Force F-15 fighter carrying an anti-satellite missile under its belly. The missile is designed to carry a miniature homing interceptor vehicle into space.

ents believe that an agreement barring ASATs also would make it much more difficult to develop "Star Wars" defense systems based on directed-energy technologies (see PHYSICS TODAY, August 1983, page 17). As the treaty proponents see it, an ASAT agreement would complement and fortify the 1972 treaty limiting anti-ballistic missile systems—not to mention the Outer Space Treaty of 1967, the SALT I agreement on strategic arms and the (unratified) SALT II treaty, all of which guarantee the integrity of satellites used for arms-control verification. "The existence of any ASAT weapons poses a real and symbolic threat to these guarantees," Donald M. Kerr, current director of Los Alamos, observed in a paper on the ASAT–ABM link that he presented to a symposium at the Stockholm International Peace Research Institute in September 1983.

Anti-satellite weapon types

Existing ASAT technologies consist of ground-launched intercept vehicles developed by the United States and the Soviet Union, starting in the 1960s. From 1963 to 1967, the United States deployed an operational ASAT system based on the Nike–Zeus ABM missile system at Kwajalein Atoll in the Pacific, and from 1964 to 1975, it had a thrust-augmented Thor ASAT system on Johnston Island, though the Thor system was on standby status from 1970 on. Both systems were ditched in part because they relied on high-yield nuclear weapons that would damage US communications if they ever were used against Soviet satellites.

The Soviet Union began to test an ASAT interceptor on an augmented SS-9 missile in 1968, using an active radar to home in on the target after two orbits with a conventional warhead. According to John Pike, associate director of the Federation of American Scientists, the two-orbit interceptor was successful in five of seven tests between 1968 and 1971. In 1976, the Russians began testing an active radar interceptor designed to attack its target after one orbit, and it apparently failed in two of four tests, Pike believes. In 1976, they also started to test a more advanced heat-seeking ASAT, but it failed in at least five of six tests. Renewed testing of the two-orbit interceptor in 1976 produced two successes and one failure, Pike says.

The Soviet direct-ascent anti-satellite system is relatively slow and cumbersome, and it has been targeted only against satellites in low orbits—the satellites that are militarily used by the United States mainly for photo- and radar-reconnaissance and electronic intelligence. A Soviet interceptor has not been tested against targets in high-altitude geosynchronous orbits, where the US has stationed most of its satellites for early warning of nuclear attack and for military communications. (The USSR, in contrast, still has most of its early warning satellites in elliptical orbits with perigees close to the Earth.)

The renewal of Soviet ASAT testing in 1976 prompted President Ford to authorize a new US program, involving the development of a missile that would be launched from an F-15 fighter and would destroy its target by direct impact. Like the Soviet interceptor, the US "air-launched miniature vehicle" can reach only low-orbit satellites, but it would be faster and more versatile than the Soviet system. After President Carter took office in 1977, the development program was continued but the Administration also proposed to the Soviets talks on limiting ASATs.

Carter and his top military officials were ambivalent about the importance of the Soviet program, and talks were delayed until 1978, only to be left in suspension after the Soviet invasion of Afghanistan in late 1979. Physicist Harold Brown, Carter's defense secretary, said he found the Soviet program "somewhat troublesome" but that he hoped it would be possible to "damp down" the race in ASAT weaponry, if not completely "stop it."

UCS and FAS model treaties

The first legislative move to stimulate ASAT negotiations occurred in spring 1982, when Democratic Representative Joe Moakley and some 50 cosponsors offered a resolution calling for immediate talks. The resolution never came to a vote, but in early 1983, Congressional aides formed a space working group and began to meet regularly with lobbyists and outside experts in Moakley's office to exchange information and plan strategy. By this time, the Union of Concerned Scientists and the Federation of American Scientists were preparing model ASAT treaties. The UCS version, a highly polished document published with explanatory materials as a booklet last year, was written by a committee chaired by Kurt Gottfried of Cornell. The committee included physicists Richard Garwin (IBM), Hans A. Bethe (Cornell) and Henry W. Kendall (MIT), astronomer Carl Sagan (Cornell) and chemist Franklin Long (Cornell). The FAS treaty, which has circulated much less formally, was written by the Federation's space weapons specialist, John Pike.

Both model treaties are formal documents that contain the standard types of provisions found in all arms-control agreements: preambles stating general intentions, specific prohibitions, methods for resolving disputes over suspect activities, procedures for ratification, and a withdrawal clause that can be activated when extraordinary events jeopardize a country's supreme interests. The main difference between the two documents is that Pike's version contains detailed prohibitions specified for a variety of potential ASAT systems, including bans on deployment of ground-based directed-energy systems and "any system that has been tested in a prohibited mode," while the UCS version confines itself to a general ban on tests of weapons against objects in space and a specific ban on deployment of ASATs in space.

Despite their different approaches and the greater caution of the UCS scientists on the question of deployment, the authors of the FAS and UCS model treaties seem to be in agreement on the main points affecting verification, namely that:

- Significant expansion of the current Soviet system to threaten more US satellites could be detected because the SS-9 launcher must be modified to carry an ASAT, and because the very large modified missile is readily recognized from space with its support facilities.
- Further testing of the US miniature homing vehicle would be readily detected by the Soviets, but a ban on deployments of the very small vehicle would be very hard to verify once it were fully tested.
- Deployment of space mines disguised as satellites might escape detection, as long as the number of mines were small, but deployment of mines near a significant proportion of the adversary's satellites would not escape detection.
- Any directed-energy weapon in space would be detectable and highly vulnerable to attack, including attack by nuclear explosives detonated at a large distance away.
- Testing of a ground-based directed-energy system also could be detected

(though possibly not without special precautions) because the system would have to be quite large and have distinctive characteristics to overcome disruptive atmospheric effects, and because there is only a small number of suitable locations where such a system could be built.

The last point, concerning ground-based laser systems, is the most controversial of the verification issues connected with ASATS. Allegations about Soviet work on directed-energy weapons have given rise to heated arguments in recent years, but hard evidence is extremely scarce. The 1984 edition of the Pentagon's booklet on "Soviet Military Power" is surprisingly cautious on the subject. "The Soviets could test a prototype laser and anti-satellite weapon as soon as the later 1980s," the Pentagon says, and a particle-beam weapon "designed to destroy the satellites could be tested in space in the mid-1990s."

Congressional action

The Soviets proposed an ASAT treaty to the US in August 1981, but this draft was "seriously flawed" and "indeed . . . did not preclude the deployment of either the US or Soviet ASATs," as James Treglio observed in a paper on the issue. Treglio, an APS Fellow, served on the staff of Senator Paul E. Tsongas from fall 1982 through summer 1983, when he was succeeded by another APS Fellow, Aviva Brecher. (Tsongas, now retired, was a Democratic Senator from Massachusetts and was actively interested in science and high technology issues as well as arms control.)

In May 1983, Treglio arranged with other Senate aides for UCS to present its case for an ASAT treaty to the Senate Foreign Relations Committee. The Committee also heard testimony from Kenneth Adelman, who had just been confirmed as director of the US Arms Control and Disarmament Agency after a bruising Senate battle. Adelman said that an ASAT treaty posed "daunting problems" of verification and that "we should not rush into negotiations on these subjects unless we are ready with verifiable proposals that will enhance national security."

According to Treglio, members of the Arms Control Subcommittee and their staff came away from the hearing "with a feeling that something had to be done to slow the US program" because otherwise it would "reach a point where a low-orbit ban would no longer be verifiable from the Soviet point of view." Taking the initiative, Tsongas introduced an amendment to the defense authorization bill barring tests of an ASAT against a target in space unless the President (1) sought ASAT negotiations with the Soviet Union, or (2) certified that testing was necessary to prevent irreparable harm to US national security.

To their surprise, the backers of the Tsongas amendment found that Senator Henry Jackson (now deceased) was willing to go along with the amendment, provided the wording was modified to specify testing of an "inert or explosive anti-satellite warhead," so as to leave open the possibility of laser ASAT tests. In negotiations with Senator John W. Warner (R-Va.), chairman of the Subcommittee on Strategic and Theater Nuclear Forces, backers of the amendment agreed that the President would not be required actually to enter negotiations, but merely to express his willingness to do so.

With these two changes, the Tsongas amendment passed the Senate by a 91–0 vote in July 1983. Even now, backers of the amendment are somewhat baffled about how they won without opposing votes, but the general consensus is that they owed a good deal to the element of surprise. Apparently, White House aides did not grasp initially how hard it would be to claim that ASAT tests against targets in space were vital to US national security. Following the Senate vote, the White House reversed its position and lobbied, with success, to get the House to defeat the amendment. Despite that, Congress retained the amendment in the defense authorization conference.

In August 1983, one month after the Senate adopted the Tsongas amendment, the Soviet Union submitted a new draft ASAT treaty to the United Nations. While it contained provisions considered unverifiable or unnegotiable, such as a clause banning military uses of the US space shuttle, the new draft represented a considerable improvement over the earlier one in the eyes of arms control specialists. The Reagan administration, however, continued to insist that an ASAT treaty could not be negotiated.

White House position

In a report to Congress, submitted on 31 March 1984 in response to a mandate contained in the 1984 defense appropriation bill, the White House said that "no arrangements beyond those already governing military activities in outer space have been found to date that are judged to be in the overall interest of the United States and its Allies. The factors that impede the identification of effective ASAT arms control measures include significant difficulties of verification, diverse sources of threats to US and Allied satellites, and threats posed by Soviet targeting and reconnaissance satellites that undermine conventional and nuclear deterrence." The report said that "in present circumstances, a US capability to destroy satellites clearly responds to the need to deter such Soviet attacks on US satellites in a crisis or conflict."

Specific problems highlighted in the White House report to Congress included the following:

- "The satellites which serve US and Allied security are few in number. Cheating on anti-satellite limitations, even on small scale, could pose a disproportionate risk to the United States."
- "The Soviet interceptor is relatively small and is launched by a type of space booster that the Soviets use for other

In a US Army test in June 1984, an interceptor launched at Kwajalein missile range destroyed a reentry vehicle from an intercontinental ballistic missile. On the photo, the first stage of the rocket carrying the interceptor is seen piercing the clouds at roughly 10 000 feet and rising to a level of 150 000 feet, where it detaches from the second stage and starts falling back to Earth, leaving a dotted track. The interceptor relied on an infrared guidance system similar to the one used in the US miniature homing anti-satellite weapon.

space launch missions. . . . The USSR could maintain a covert supply of interceptors."

► "Tests of a ground-based laser ASAT weapon could be concealed."

► "Breakout potential could exist even if the Soviets, upon agreeing to a ban on ASAT systems, were to destroy all of their existing systems. The Soviets could retain the capability to redeploy quickly a system in which they would have confidence. If prior to the ban the United States had not tested its [maneuverable vehicle] ASAT system, the Soviets alone would possess such proven technology."

The White House report made few concessions to backers of an ASAT treaty. The report did say that the US could adopt a defensive strategy by "procuring sufficient satellite and booster spares," but it mentioned this possibility without enthusiasm, noting that it would run "counter to current US trends of developing space systems of greater sophistication and longer expected useful mission."

In January 1983, two months before the White House issued its report, the Office of Technology Assessment held a workshop on ASAT issues at the request of Senator Larry Pressler (R-S.D.), chairman of the Senate Subcommittee on Arms Control. Participants in the workshop represented a wide range of viewpoints and institutions, and when a summary of their proceedings was published last May, the consensus among the experts differed in many respects from the conclusions of the White House. The participants agreed that "no arms-control agreement can eliminate all anti-satellite capability," but they thought that a "ban on testing ASAT weapons would greatly increase the difficulty of developing a high-confidence, high-quality dedicated ASAT system." They disagreed "regarding how much significance can be attributed to residual or covert ASAT capability," but "the idea that the United States needs an ASAT weapon in order to deter enemy ASAT attacks was not strongly supported."

Recent legislative moves

In 1984 Congressional action, the Senate passed what most observers regarded as a watered-down version of the Tsongas amendment permitting ASAT tests against targets in space provided the President certified he was endeavoring to "negotiate in good faith the strictest possible limitations." Meanwhile, the House passed a tighter limit barring ASAT tests against space targets for a year, provided the Soviet Union did the same. The House victory was attributable to sustained work by treaty backers such as Representatives Moakley, George E. Brown Jr (D-Cal.) and Matthew F. McHugh (D-N.Y.); efforts by Representative Lawrence Coughlin (R-Penn.) to win support for negotiations among Republicans; and support from key "arms control moderates" in the House, notably Representatives Les Aspin (D-Wis.), Norman D. Dicks (D-Wash.), and Albert Gore Jr (D-Tenn.). Brown sponsored the 1983 ASAT amendment in the House, and Coughlin joined him as cosponsor in 1984.

The compromise Senate amendment was engineered largely by Senator Sam Nunn, a Georgia Democrat who ordinarily acts as a leader of hard-line arms-control critics. Days after the Senate vote on the Nunn compromise, President Reagan unexpectedly said at a press conference that "we don't have a flat no" on the possibility of negotiating ASAT verification measures and that "we haven't slammed the door on that [ASAT talks] at all." Two weeks later, the Soviet Union formally invited the United States to open ASAT talks in Vienna, only to pull back when the Reagan administration promptly accepted.

The Soviets accused the Reagan administration, which wanted to link ASAT talks to a resumption of negotiations on intermediate-range and strategic missiles, of trying to set preconditions. Reagan aides made similar charges about Soviet demands that the talks embrace all space weapons, that the United States join in a moratorium on ASAT tests and that it agree in advance of talks that a treaty would be concluded. Thus began the parrying that may, or may not, lead to serious negotiations in 1985.

If negotiations are resumed, some kind of provisional agreement on ASATs is very likely to be the starting point, but it is questionable how important the ASAT issue will be overall. Solomon J. Buchsbaum, Executive Vice-President of AT&T Bell Labs, who is head of the White House Science Council, thinks that "arms-control negotiations are very important," but he says that "the ASAT issue would not be at the top of my list of priorities," though it is an "issue that must be taken into account at the table."

Reviewing the record of political maneuvering on ASATs, the technical complexity of the issue stands out as an important explanatory factor in its own right. In 1983, when the issue first came up, most people in Congress knew little about it, and the few who were able to learn fast secured an advantage quickly. Tsongas, who together with Pressler was the key initiator, gives a lot of credit to APS Fellows Treglio and Brecher for educating his staff. "Without their technical expertise we would never have been competitive on that issue," Tsongas says. "Whatever difference we made . . . is almost exclusively attributable to their efforts."

When the key action shifted to the House, the level of education members had attained again played an important role. According to Sybil Francis, an aide to Representative George Brown, and Jim McGovern, who works for Moakley, members of the House responded strongly to the idea that space should not become the next arena for a new arms race, but they did not generally understand the technical links between the ASAT and ABM technologies.

Treaty prospects

In the next round of legislative maneuvering over ASATs, if there is one, members of Congress may have to confront the ABM–ASAT links head-on for the first time. Specialists are increasingly convinced, as Garwin observes, that you "can't have an ASAT ban without a Star Wars ban." In Garwin's view, if either side were to begin deployment of a Star Wars ABM system, the obvious and immediate reaction of the other side would be to surround it with space mines—relatively cheap conventional or nuclear explosives that could be detonated by remote control at the first hint that a nuclear war might break out. Because of the transcendent importance of the ABM issue, Garwin considers it clear that neither side would agree to give up ASAT systems such as space mines as long as the Star Wars issue were open. On the other hand, Garwin does not consider the ASAT–ABM connection so close that ratification of an ASAT treaty would lead ineluctably to termination of all funding for research on directed energy weapons.

Ultimately, of course, whether or not a treaty is concluded will depend on US and Soviet political leaders and the domestic constituencies they are beholden to. It bears noting though, that nuclear arms-control issues have become increasingly sensitive in both the Western alliance system and the Soviet bloc.

The militarization of space is an issue of growing concern to scientists in many countries besides the US and the Soviet Union. Earlier this year, a group of German scientists prepared yet another model ASAT treaty, which goes further than the UCS and FAS drafts in that it seeks to bar all military uses of space except for reconnaissance, verification and early warning. At the annual Pugwash meeting, which took place in Sweden this year, physicist H. P. Dürr of the Max Planck Institute circulated the German model treaty. Meanwhile, in early July, the treaty was given prominent attention at an international scientific conference on the militarization of space that was held at the University of Göttingen.

Participants in the Göttingen conference included physicists Daniele Amati and Jack Steinberger of CERN, Victor Weisskopf of MIT, and Nina Byers of UCLA. Representative George Brown also attended and reports that he was "amazed to find such a high level of interest in weapons issues," not just among the conference participants, but among Germans from all walks of life.

Pike, commenting on the German draft ASAT treaty, says he is "sympathetic" to the goal of trying to prevent the militarization of space on a broad front, but he considers it impolitic to set such an ambitious objective. If one takes on all kinds of space weapons simultaneously, Pike points out, the military constituencies "you're up against are orders of magnitude greater."

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The American Physical Society, AIP, and the other Member Societies have agreed to give the Chinese Academy of Sciences and the Ministry of Education of the People's Republic of China ten copies of each available journal issued through 1979. These same back volumes are also being made available to physicists in developing countries.

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Education

Science and engineering groups launch new education effort

A new effort to mobilize private resources for science education was launched last summer at the Triangle Conference on Science and Technology, which took place in Washington, D.C. from 31 July to 3 August. The conference brought together representatives from three overlapping circles: education; business, industry and labor; and the professional science and technology associations, including APS, AAPT, AAAS and IEEE.

Participants in the Washington conference decided to establish a formal organization called the Triangle Coalition for Science and Technology Education, which is to devise ways its three kinds of constituent groups can cooperate to improve education without sinking large sums of money into a big bureaucracy. The conference authorized the beginning of a small staff effort at the Washington headquarters of the National Science Teachers Association, to be coordinated by John M. Fowler, Director of Special Projects at NSTA. Financial backing for the founding conference and initial staff work has been provided by NSF and the Carnegie Corporation in New York.

The Triangle Coalition's Secondary Education Subgroup, one of five committees formed in Washington, issued a report in August in which it recommended that the coalition:

- distribute regular news releases to participating groups on activities sponsored by the Triangle
- organize a "minigrant" program to provide teachers with support for special projects
- compile a computerized inventory, or clearinghouse, of activities and resources relevant to Triangle programs
- prepare a study on what kind of science education is appropriate for students who are not bound for college
- write guidelines for state use of Federal block grants
- promote the development of "model teaching centers"—places where teachers could meet, interact with local scientists and engineers, exchange ideas and gather instructional materials provided by local business, labor and education organizations.

According to Fowler, the Coalition staff is likely to focus initially on establishing the clearinghouse and the minigrant program. Fowler hopes to obtain support for the minigrant program from foundations and participating business and labor organizations, which include Chevron, the United Auto Workers, The American Federation of Teachers, Standard Oil Company of Indiana, Hewlett Packard Company, Exxon Research and Engineering Company, General Electric Company, and E. I. DuPont de Nemours & Company.

On 8–9 November, at a conference the IEEE is sponsoring in Washington, there will be discussion of the roles professional science and engineering associations can play, separately and cooperatively, in pre-college education. IEEE, independently of the Triangle, has been considering how professional organizations can help improve science instruction.

Lewis Slack, associate director of AIP for education, considers the Triangle and IEEE efforts to have the "most promise" of the cooperative education projects thus far proposed by professional organizations. Judy Franz, the head of the APS Committee on Education, believes that "support for the Triangle Coalition from business and industry is strong and sincere." She says that we are "on the right track, but what matters is whether anything happens now." □