



ON 23 MARCH 1983 President Ronald Reagan announced his Strategic Defense Initiative on television. The first three-quarters of the speech was spent justifying dramatic increases in the US defense budget, "to make America strong again after too many years of neglect and mistakes." The photograph behind the president shows a Soviet MIG-23 fighter-bomber base in Cuba.

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# Sakharov, Gorbachev, and nuclear reductions

Frank N. von Hippel

**Two years before his death in 1989, Andrei Sakharov's comments at a scientists' forum helped set the stage for the elimination of thousands of nuclear ballistic missiles from the US and Soviet arsenals.**

**T**he great Soviet dissident physicist Andrei Sakharov and Soviet Union leader Mikhail Gorbachev met for the first time in January 1988. That was a little more than a year after Gorbachev had given Sakharov permission to return to Moscow from the closed city of Gorky, to which Sakharov had been exiled for seven years.

When Sakharov returned, US–Soviet nuclear arms control was at an impasse; Gorbachev was insisting that the US commit to keeping its ballistic missile defense (BMD) program within the constraints of the 1972 Anti-Ballistic Missile (ABM) Treaty, and President Ronald Reagan was refusing to do so. Sakharov publicly argued that Reagan's program, ridiculed as “Star Wars” by its US critics, would never produce militarily significant capabilities and that Gorbachev therefore should seize the opportunity for nuclear arms reductions. Two weeks later that view was endorsed by the Soviet leadership and opened the path to deep cuts in Soviet and US nuclear forces.

In 1987 I coorganized a scientists' forum in Moscow on nuclear disarmament, where Sakharov went public with his views, and I was present at his first meeting with Gorbachev a year later. I also took part in a private discussion with Sakharov in his apartment before the forum. Five years later I received a copy of a partial transcript of that discussion, which had been delivered to Gorbachev by the head of the Soviet secret service, the KGB.

For the younger generation, many of whom may know little about Sakharov, I start this article with a brief summary of the man's remarkable career.<sup>1</sup> I then describe how he helped delink nuclear



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reductions from the issue of BMD at that key moment in the history of nuclear arms control; the meeting in his apartment; his meeting with Gorbachev; and finally how relinking arms reductions and BMD has now returned to hobble progress on nuclear disarmament.

## Andrei Sakharov

Sakharov (1921–89) was recruited into the Soviet Union's nuclear weapons program in 1948, a year after he completed his doctorate. In 1949 the US detected the first Soviet test of a fission bomb, and the two countries embarked on a desperate race to design a thermonuclear hydrogen bomb that was a thousand times more powerful. The race ended in a rough tie five years later. (See the article by Alex Wellerstein and Edward Geist on page 40 of this issue.)

Sakharov made key contributions to the Soviet effort and was awarded the honorary title Hero of Socialist Labor three times, in 1953, 1956, and 1962. During the same period, he coined the tokamak (see *PHYSICS TODAY*, December 2005, page 15), a toroidal magnetic plasma confinement device that is still the main focus of international efforts to develop a fusion reactor.

Like his US counterparts, Sakharov justified his H-bomb work by pointing to the danger of the other country's achieving a monopoly. But also like some of the US scientists who had worked on the Manhattan Project, he felt a responsibility to inform his nation's leadership and then the world about the dangers from nuclear weapons.

Sakharov's first effort to influence policy was stimulated by his concern about possible genetic damage from long-lived radioactive carbon-14 created in the atmosphere from nitrogen-14 by the enormous fluxes of neutrons released in H-bomb tests.<sup>2</sup> In 1961 he urged Soviet leader Nikita Khrushchev to maintain the bilateral Soviet-US testing moratorium that had begun in 1959. Khrushchev told him that tests were required to show the US that the Soviet Union could not be intimidated. In the subsequent final spasm of Soviet and US atmospheric testing, the Soviet Union exploded a 50-megaton bomb, by far the highest-yield nuclear explosion ever set off. (Yield refers to the amount of TNT needed for an equivalent explosion.) The next year the Cuban Missile Crisis sobered both sides, at least temporarily, and in 1963 they agreed on an atmospheric test ban.

In 1968 a friend suggested that Sakharov write an essay about the role of the intelligentsia in world affairs. Samizdat (self-publishing) was the method at the time for spreading unapproved manuscripts in the Soviet Union. Many readers would create multiple copies by typing with multiple sheets of paper interleaved with carbon paper. One copy of Sakharov's essay, "Reflections on Progress, Peaceful Coexistence, and Intellectual Freedom," was smuggled out of the Soviet Union and published by the *New York Times*. More than 18 million reprints were produced during 1968–69. I still remember my excitement on reading that call for cooperation between East and West coming from the heart of the closed Soviet nuclear weapons complex. It was also a call, as Sakharov put it, for "freedom to obtain and distribute information, freedom for open-minded and unfearing debate and freedom from pressure by officialdom and prejudices."

After the essay was published, Sakharov was barred from returning to work in the nuclear weapons program and took a

research position in Moscow. With his political views known, however, dissidents began to ask him to lend his name to their appeals for more freedom—requests he could not refuse. His status as coinventor of the Soviet H-bomb protected him, but as other dissidents were sent to prison, he became more and more outspoken and joined vigils outside the courtrooms where they were being tried.

In 1980, after an interview with the *New York Times* in which he denounced the Soviet invasion of Afghanistan, the government's patience finally ran out. To put him beyond the reach of Western journalists, the Soviet Union exiled Sakharov and his wife, Elena Bonner, to Gorky (now known as Nizhny Novgorod). There he undertook prolonged hunger strikes. The longest, which lasted for about a year, was to get permission for Bonner to go abroad for heart-bypass surgery. During that period he was repeatedly force-fed before the government finally relented. (See the article by Sidney Drell and Lev Okun, *PHYSICS TODAY*, August 1990, page 26.) Under the stress, Sakharov suffered three heart attacks.

Foreign supporters—including Jeremy Stone, president of the Washington-based arms-control group the Federation of American Scientists—campaign tirelessly to keep Sakharov's case in the spotlight of public and government attention. As chairman of the federation, I was a supporting character in that effort.

In March 1985 Gorbachev became general secretary of the Soviet Communist Party. More than a year and a half later, he persuaded the Politburo, the party's executive committee, to allow Sakharov and Bonner to return to Moscow. (For more details about Sakharov's life and work, see the special issue of *PHYSICS TODAY*, August 1990.)

## The US–Soviet nuclear impasse

Reagan's election in 1980 led first to the intensification of the nuclear arms race and then to the largest ever public uprising against it. A powerful advocacy group, the Committee on the Present Danger (CPD), had convinced Reagan that the US was falling behind in the nuclear arms race and was in mortal danger of a Soviet first nuclear strike. Many of its members obtained high-level positions in the administration, including in the Department of Defense, where they proposed to add almost 10 000 ballistic and cruise missile nuclear warheads to the US arsenal. The new weapons would threaten Soviet intercontinental ballistic missiles (ICBMs) in their hardened underground silos in the same way that the CPD claimed Soviet ballistic missiles already threatened US silos. (See the article by Harold Feiveson and me, *PHYSICS TODAY*, January 1983, page 36.)

The proposed buildup and public statements by some middle-level DOD appointees that it might be possible to win a nuclear war led to huge public demonstrations in the US, Europe, and elsewhere against the nuclear arms race.<sup>3</sup>

In March 1983 President Reagan announced the Strategic Defense Initiative (SDI), which would focus on developing technology to make Soviet ballistic missiles "impotent and obsolete." The initiative communicated a less threatening image than the CPD buildup to the US public and allies. In Moscow, however, it suggested a scenario in which the US could threaten to destroy most of the Soviet Union's missiles in a first strike and then use its BMD to block the ragged counterattack by the surviving Soviet missiles.



**FIGURE 1. ANDREI SAKHAROV (RIGHT) AND I** speak in his Moscow apartment on 11 February 1987, three days before a scientists' forum at which he made public his proposal to delink Soviet-US negotiations on nuclear reductions from the Reagan administration's Star Wars program. (Photo by Jeremy Stone.)

In early November 1983 the Reagan administration created a severe nuclear crisis with a NATO exercise, Able Archer, that Soviet intelligence mistook for preparations for an actual nuclear attack. Two years later the situation finally began to diffuse. At the recommendation of UK prime minister Margaret Thatcher, Reagan in November 1985 had a get-acquainted meeting in Geneva with Gorbachev, who had just become general secretary after two elderly predecessors, in quick succession, had died in office.

In their legendary October 1986 Reykjavik summit, Reagan and Gorbachev agreed on the goal of nuclear disarmament. But they could not agree on a first tranche of cuts because Gorbachev insisted that Reagan commit to remaining within the constraints of the ABM Treaty for 10 years. The treaty limited both sides to 100 ground-based interceptors at a single site. At the time, the Reagan administration was focused on a concept in which hundreds of orbiting, high-power lasers would burn holes in Soviet booster rockets as they rose out of the atmosphere.

Arms controllers on both sides, meanwhile, had found each other and were brainstorming about how to end the nuclear arms race. Stone and I had become involved in such discussions in November 1983. We met with a group headed by Evgeny Velikhov, a vice president of the Soviet Academy of Sciences. After Gorbachev came to power in March 1985, we learned that Velikhov and his colleagues had been advising Gorbachev (see my article, *PHYSICS TODAY*, September 2013, page 41).

Gorbachev's first move, in August 1985, was to declare a unilateral moratorium on nuclear testing, now underground because of the 1963 atmospheric test ban. The Reagan administration disparaged the initiative, but the Democrats, who controlled the House of Representatives until 1995 and the Senate during 1987–95, were impressed. In 1992 they were able to force the Bush administration to end US testing on the condi-

tion that other countries not test either. In 1996 the Clinton administration negotiated the Comprehensive Nuclear-Test-Ban Treaty (CTBT). Although that treaty has not yet been ratified by the US, China, India, Pakistan, or North Korea, only North Korea has tested since 1998 (see the article by Pierce Corden and David Hafemeister, *PHYSICS TODAY*, April 2014, page 41).

In February 1987 Velikhov and I organized the scientists' forum on nuclear disarmament in Moscow. Sakharov's release from Gorky may have been timed so that his exile would not become an issue at the forum. Stone and I arrived with our wives in Moscow a few days early, and Stone arranged a meeting with Sakharov and Bonner in their apartment (see figure 1). Now that he was able to speak out again, we knew the world was eager to hear what Sakharov had to say. We saw the forum as an opportunity for him to lay out his views on nuclear disarmament at that critical time.

Stone started the discussion by suggesting that Sakharov urge Gorbachev to ignore the SDI and seize the opportunity for arms reductions. He argued that Reagan's successors would abandon the program as unaffordable and that the US would not break the ABM Treaty if progress was being made on nuclear reductions. Sakharov responded that he had been thinking along the same lines.

My part of the discussion was not so easy. I told Sakharov that my colleagues and I were publishing estimates of the civilian consequences of US and Soviet nuclear "counterforce" attacks on each other's nuclear forces. We had found that the direct consequence would include tens of millions of civilian deaths. I argued that both sides should settle for "minimum deterrence" or what McGeorge Bundy, President John F. Kennedy's national security adviser, called "existential deterrence," a situation in which just the fact that a country has nuclear weapons instills caution—like a policeman's holstered gun—in other countries.

Sakharov argued that persuading both countries' military leaders to abandon counterforce strategies would be virtually impossible. In the two decades since our conversation, the numbers of warheads deployed on Russian and US strategic missiles have come down by a factor of about five, to less than 2000 each, but the two missile forces' highest-priority targets remain each other.

During our discussion, the apartment doorbell rang every 10 minutes or so. Bonner told us to ignore it, saying, "It's just

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the KGB.” It turned out that the KGB was also recording our conversation.

### The KGB transcript

In 1992, after the collapse of the Soviet Union, the new Russian government made public a collection of Communist Party documents, including a KGB transcript of parts of our conversation in Sakharov’s apartment. Matthew Evangelista, a historian at Cornell University, obtained a copy and shared it with me.

Certain passages of the transcript were underlined. If that was done by Gorbachev—or by the KGB for his benefit—they indicate that he was interested in learning more about the nuclear balance. Among the underlined parts were my statements that Soviet warheads had higher explosive yields than US warheads and that the Soviet Union was about five years behind the US in reducing the weight of its warheads per unit of explosive power. That information may have been relevant to the debate within the Soviet leadership over Gorbachev’s unilateral nuclear testing moratorium, which was about to end.

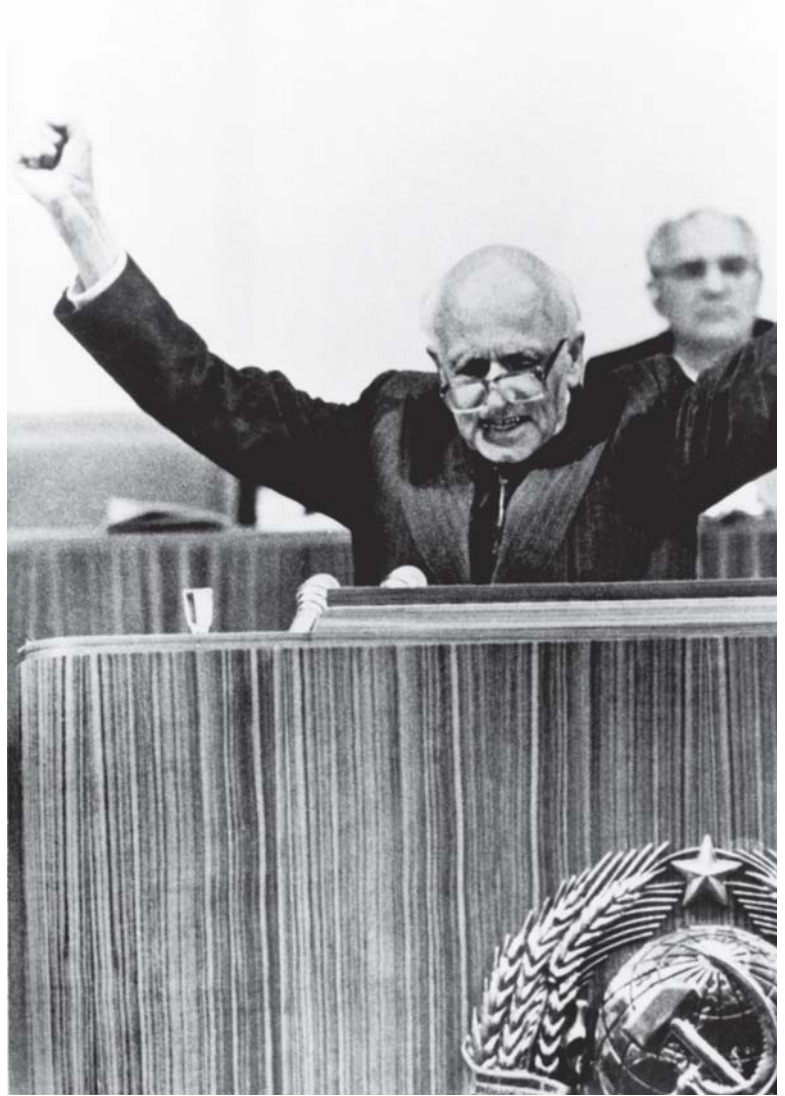
Sakharov’s statement that silo-based ballistic missiles accounted for a much larger fraction of Soviet than US strategic warheads also was underlined, as was his response when Stone conveyed an invitation from Senator Edward Kennedy for Sakharov to visit the US. Sakharov said he would not be allowed to travel abroad in the absence of “very strong pressure” from “foreign political leaders and organizations,” and he added that an effort of such magnitude would be “disproportionate to the goal.”

### Delinking missile defense from nuclear reductions

Sakharov argued at the scientists’ forum that the Soviet Union should delink its objections to Reagan’s SDI from the issue of bilateral nuclear cuts. He was heavily criticized for that by some Soviet nuclear strategists at the meeting. Later, at an event at the Kremlin, in a speech summarizing the conclusions of the scientists’ forum for Gorbachev and a large audience, I presented Sakharov’s recommendations.<sup>4</sup> In his book *Perestroika*, published later that year, Gorbachev recounted,

At the Moscow International Forum “For a Nuclear-Weapon-Free World and the Survival of Humanity”—a meeting unprecedented in the number of participants and their authority—I had the opportunity to feel the moods and hear the thoughts and ideas of an international intellectual elite. My discussions with them made a great impression on me. I discussed the results of the congress with my colleagues in the Politburo and we decided to make a major new compromise—untie the Reykjavik package and separate the problem of medium-range missiles in Europe from the other issues.<sup>5</sup>

Sakharov was not the only one arguing for delinking. The day before the crucial 26 February 1987 Politburo meeting, Alexander Yakovlev, a close adviser, sent Gorbachev a memo arguing passionately for the delinking; his argument was based primarily on an analysis of European and US public opinion. Also, Velikhov’s group had convinced Gorbachev that any SDI system could be handled with countermeasures. As Gorbachev said it, “A tenth of the US investments would be enough to create a counter-system to frustrate SDI.”<sup>6</sup>



**FIGURE 2. SAKHAROV SPEAKS** as Mikhail Gorbachev presides at the new Congress of People’s Deputies in June 1989. The proceedings were carried live on television and radio and riveted a public that had never heard a real democratic debate.<sup>14</sup> Sakharov fought for many reforms, including a repeal of the Soviet Constitution’s Article 6, which gave the leading role in government to the Communist Party. He died on 14 December, after speaking again for that reform, which was adopted three months after his death. (*Priroda* magazine and Nauka Publishers, courtesy of the AIP Emilio Segrè Visual Archives, PHYSICS TODAY Collection.)

Later that year Gorbachev and Reagan signed the Intermediate-Range Nuclear Forces Treaty, which eliminated about 2700 medium- and intermediate-range nuclear missiles. The two men also agreed in principle on 50% cuts of strategic warheads, which laid the basis for the Strategic Arms Reduction Treaty (START) that entered into force in 1994. In the meantime, with both houses of Congress under solid Democratic control, Senator Sam Nunn, the chairman of the Senate Armed Services Committee, informed Reagan that if his administration reinterpreted the ABM Treaty to allow testing of a space-based BMD, funding for SDI would be cut deeply.

### Meeting with Gorbachev

Sakharov’s meeting with Gorbachev in January 1988 came about because of another Velikhov initiative, the establishment of an independent, international foundation in Moscow to work on global problems. Velikhov invited Sakharov to be on

the foundation's board, along with several foreign luminaries and me. The foundation's creation was announced at the scientists' forum, and the board was invited to meet with Gorbachev in the Kremlin.

I sat with Sakharov on the bus to the Kremlin. He told me about Gorbachev's call to Gorky to inform him that he was free to return to Moscow. Sakharov said that his immediate response to Gorbachev had been that freeing him was not enough. It was necessary to free all political prisoners.

At the Kremlin, there was first a reception outside Gorbachev's office. Gorbachev greeted Sakharov, who thanked him for "restoring my freedom and responsibility" (someone translated the exchange for me). Gorbachev responded that he was happy to hear Sakharov connect those two words.

Then the foundation board members sat down with Gorbachev around a conference table, and each of us had an opportunity to address him. According to my recollection, when it was Sakharov's turn, he started, "Mikhail Sergeevich, when we spoke during your call, I raised the issue of other political prisoners. Today I have brought with me a list." Gorbachev responded, "Andrei Dmitrievich, we can't go too quickly. Remember what happened with the Red Guards in China," referring to the chaos that resulted when Mao Zedong unleashed young activists on China's establishment during the late 1960s. Gorbachev did, however, have an aide take Sakharov's list. A year later Sakharov could say, "The majority of prisoners of conscience have been freed."<sup>7</sup>

The foundation operated for a few years, which gave me an opportunity to get to know Sakharov better. He was absolutely uncompromising, starting with the foundation's name. He insisted that it be called the International Foundation for the Survival and Development of Humanity. I commented that was a rather long name but Sakharov responded, "What do you want to leave out? Humanity? Development? Survival?" I surrendered. On another occasion, he suggested that members of the board personally pay half of their travel expenses to make sure that we weren't being motivated by the opportu-

nity to travel. That idea did not attract support from any other board member.

I had the opportunity to see another side of Sakharov when I accompanied him to a lunch with Sweden's ambassador to the Soviet Union. The subject was Raoul Wallenberg, a heroic Swedish diplomat who in 1944 saved thousands of Jews in Budapest from being shipped to Nazi extermination camps. After the Soviet Union occupied Hungary, Wallenberg was sucked into the KGB's prison system. The KGB said that he died in 1947, but from time to time released prisoners reported having seen him. Sakharov had come to discuss the latest rumor. I was moved to see how, in the midst of his battle for democracy in the Soviet Union, this great man was still pursuing the cases of individual political prisoners.

Sakharov was elected as an opposition member to the Soviet Congress of People's Deputies in 1989 (see figure 2). Later that year he had a heart attack and died in his apartment. He left behind a draft of a new Soviet constitution that emphasized democracy and human rights. In a poll taken shortly thereafter, Sakharov was found to be the most revered person in Soviet history.<sup>8</sup>

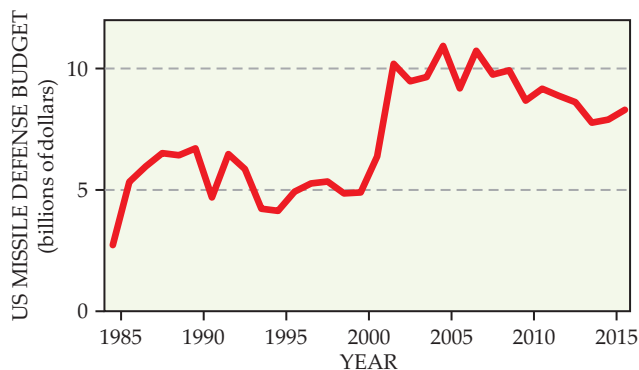
Sakharov stood up for the principles that he had enunciated in "Reflections on Progress, Peaceful Coexistence, and Intellectual Freedom," and for that he was recognized with the 1975 Nobel Peace Prize. The European Parliament honored him by establishing the Sakharov Prize for Freedom of Thought in 1988. The American Physical Society created a Sakharov Prize in 2006 for physicists who uphold human rights.

## Relinking

US presidents George H. W. Bush and Bill Clinton did not have the same enthusiasm for BMD as Reagan did. But weapons programs are difficult to kill, and its funding continued at about \$5 billion per year, as shown in figure 3.

In 1996 a new Republican majority in both houses of Congress established the Commission to Assess the Ballistic Missile Threat to the United States, chaired by Donald Rumsfeld. The commission reported back in 1998 that within five years Iran and North Korea could have intercontinental ballistic missiles armed with weapons of mass destruction. It also said that Iraq could do the same within 10 years or, if it used ship-based ballistic missiles, "within a very short time" and that those capabilities might emerge with little warning.<sup>9</sup>

After his election in 2000, President George W. Bush appointed Rumsfeld to be his secretary of defense. In 2002 he took the US out of the ABM Treaty and committed to fielding missile defenses by the end of Bush's first term in 2004. The annual budget for BMD was quickly doubled to \$10 billion (in 2016 dollars), a level from which it dropped only slightly during the Obama administration. Currently the US has 30 land-based interceptors deployed in Alaska and California and 33 Aegis cruisers and destroyers equipped with missile-detection radars and launchers for interceptor missiles (see figure 4). The most advanced Aegis interceptor, the Standard Missile 3 Block IIA, which was first tested in 2015, has sufficient speed, if launched from ships near the continental US, to intercept intercontinental ballistic missiles sent from Russia or China. The same system is being deployed on land in Romania and Poland. Designed to intercept missiles above Earth's atmosphere, the systems could be defeated by lightweight decoys and other countermeasures.



**FIGURE 3. BUDGET OF THE US MISSILE DEFENSE AGENCY** and its predecessors, the Strategic Defense Initiative and Ballistic Missile Defense Organizations. The initial rise followed President Ronald Reagan's Star Wars speech in 1983. The second major increase followed President George W. Bush's announcement in 2002 that he was taking the US out of the 1972 Anti-Ballistic Missile Treaty, which had limited ballistic-missile defenses. (Data from ref. 15, converted to constant 2016 dollars.)



**FIGURE 4. THE LAUNCH OF AN INTERCEPTOR MISSILE from the rear vertical launch magazine of a US Aegis cruiser. The cruiser's phased-array radars can detect incoming warheads at a range of about 300 kilometers. To defend the US against long-range missiles, the Aegis missiles would have to be given their interception points by more powerful early-warning radars. (Courtesy of the US Navy.)**

The ABM Treaty came about in part because US physicists in the late 1960s explained the many obvious countermeasures to both Congress and their Soviet counterparts. Sakharov's 1968 essay cites a key article that informed the debate:

... the practical impossibility of preventing a massive rocket attack. This situation is well known to specialists. In the popular scientific literature, for example, one can read this in an article by Richard L. Garwin and Hans A. Bethe in the *Scientific American* of March 1968.

When Garwin and Bethe wrote their article, the proposed US interceptor missiles were nuclear tipped. That was one reason for public interest in the issue. Suburbanites did not want nuclear-armed interceptors in their backyards. Today the interceptors are terminally guided with IR sensors. But the problem of decoys and other countermeasures remains.<sup>10</sup>

Both Russia and China have expressed concern about the US deployments. Russia cites US BMD as a principal reason why it is not interested in negotiating further reductions in strategic nuclear weapons.<sup>11</sup> And although it would make it easier for Russia and the US to further reduce their arsenals if China committed to not build up, China is increasing its small force of intercontinental ballistic missiles, in part because of its own concerns that US BMDs could neutralize its deterrent.<sup>12</sup>

The original justification by the Bush administration in 2002 for deploying a BMD was the imminent threat of weapons of mass destruction carried by missiles launched by Iran, Iraq, and North Korea. Today there are no such threats from Iran or Iraq. But the US BMD program goes on, including the provocative deployments in Poland and Romania. A North Korean threat of a nuclear-armed intercontinental ballistic missile has materialized, but there are alternative, potentially more effective defenses that would not threaten the deterrents of large countries such as China and Russia. Specifically, North Korean missiles still in their boost phase could be within reach of in-

terceptors based off the country's shores or to the north in China or Russia.<sup>13</sup>

Gorbachev had the wisdom to ignore the Reagan administration's fantasies about space-based BMD. But this time, the US should take responsibility for weighing the questionable advantages of exo-atmospheric missile defense against the obstacles that it poses to further nuclear reductions. Physicists could again make an important contribution by explaining the technical issues in the debate.

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