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CHAPTER THIRTEEN

Controlled Exchanges

Public-Private Hybridity, Transnational Networking, and Knowledge Circulation in US-China Scientific Discourse on Nuclear Arms Control

Zuoyue Wang

Beijing, May 18, 1988. Wolfgang "Pief" Panofsky, emeritus director of the Stanford Linear Accelerator Center (SLAC), had breakfast with T. D. Lee, the prominent Chinese American physicist from Columbia, before heading to the Institute for High Energy Physics (IHEP) of the Chinese Academy of Sciences. Panofsky was a pioneering particle physicist who, upon Lee's recommendation, had been appointed the official adviser to the Chinese government on its building of the Beijing Electron-Positron Collider (BEPC) at the IHEP. He had come to China to check on BEPC's progress and make recommendations to top Chinese leaders.[1]

But Panofsky also had an ulterior motive for the trip. He had participated in the Manhattan Project during World War II and had served as an experienced adviser to the US government in the postwar years. His experiences led him to become a passionate advocate for nuclear arms control, especially in his capacity as chairman of the US National Academy of Sciences (NAS) Committee on International Security and Arms Control (CISAC, pronounced "see-sak"). CISAC had been established in 1980 and had carried out fruitful back-channel face-to-face discussions with Soviet scientists in the 1980s on nuclear arms control.[2] Now

Panofsky wanted to see whether he could start a similar dialogue with scientists in China, whose government had yet to join any international nuclear arms control agreements. Frank Press, who had served as President Jimmy Carter's science adviser and was now president of the NAS, had arranged with Zhou Guangzhao, his counterpart as the president of the Chinese Academy of Sciences, for Panofsky to meet with a group of Chinese scientists for this purpose on May 23, 1988. Panofsky was uncertain about who would show up and how things would actually work out when he arrived in Beijing on May 15.

Panofsky was given a list of the potential attendees when he got to the IHEP on May 18. A sense of excitement flashed through his mind as he scanned the list and listened to Ye Minghan, IHEP director, identifying the people on it. His diary entry later that day expressed his sentiments: "This is a somewhat frightening list. The level of the attendees is extremely high; in fact it includes several people who are directly involved in atomic weapons work."[3] Heading the group was Zhu Guangya, the technical leader of China's nuclear weapons project, whom Panofsky had been anxious to meet. What may have also made a strong impression on Panofsky was the fact that several of the leading Chinese participants had been educated in the United States in the 1940s and returned to China in the 1950s. The meeting, which would take place five days later and which, as Panofsky wrote in his diary, "went extremely well" (despite the fact that Zhu did not show up), constituted one of the earliest steps taken by China and its scientists to move into international nuclear arms control. The dialogue it started may also have helped convince the authorities to sign a number of arms control agreements, including the Non-Proliferation Treaty in 1992 and the Comprehensive Test Ban Treaty in 1996.[4]

This account of Panofsky's experiences in Beijing demonstrates that scientists can indeed play an effective role in promoting international arms control discussions. That being said, a review of the participation of American and Chinese scientists in national and international nuclear arms control discussions reveals a number of tensions that might help us frame the writing of transnational histories of science and technology.[5] What was the proper role of scientists in public policy in areas such as arms control where the technical mixed intrinsically with the political? What are the potentials and limits of transnational scientific discussions and knowledge circulation in sensitive areas such as nuclear weapons? And what roles did American-educated Chinese scientists as a transnational ethnic scientific network—both those who returned to China and

those who stayed in the United States during the Cold War—play in a hybrid geopolitical theater where state designs framed exchanges but successful implementation also relied on private interactions?

It is important to examine this history of US-China interactions in nuclear arms control not only for its own intrinsic value and interest but also for its policy relevance.[6] Nuclear weapons receded from public concern with the end of the Cold War in the early 1990s but have reemerged in the twenty-first century as a major public policy issue. President Barack Obama won the 2009 Nobel Peace Prize for his advocacy of nuclear disarmament, led the successful push for the 2015 international agreement, with participation by China and others, to curtail the Iranian nuclear program, but disappointed many of his supporters by approving a major program of American nuclear modernization amid a rising nuclear arms race between the United States, Russia, and China. He also failed to commit the United States to a no-first-use policy.[7] The 2016 presidential election of Donald J. Trump was even more troubling for advocates of nuclear arms control. The new US president made conflicting and, to many of his critics, irresponsible statements and took controversial policy stances on nuclear weapons (and climate change) during the campaign and early in his administration. Indeed, only days after his inauguration, alarm over Trump rose high enough for the *Bulletin of Atomic Scientists* to move its famous doomsday clock as close to the cataclysmic midnight as it had been at the height of the Cold War.[8]

The history of US-China interactions in nuclear arms control could also be valuable in providing possible lessons for seeking solutions to other global issues such as climate change. Both issues have strong scientific and technical components and pose grave threats to global security in which the United States and China are major players. Another issue of perhaps equal importance in both cases is the need for information on the Chinese national policy-making processes. I won't be able to tackle all these big questions here, but I will provide information and clues for a fuller treatment as I explore how American scientists used their transnational connections and leverages in promoting nuclear arms control discussions with China. Thus, in this chapter I will first review how American and Chinese scientists came to approach nuclear arms control before detailing and analyzing how they, under the leadership of, respectively, Panofsky and Zhu Guangya, started to engage with each other in this area.

The American Experience

If nuclear arms control can be defined as international efforts to limit the production and use of nuclear weapons, one of the earliest attempts of scientists in this direction took place in 1945 when a group of Manhattan Project scientists under James Franck drafted a report arguing against the US use of the atomic bomb on Japan. They proposed instead a demonstration in an uninhabited area as a step toward achieving international control of nuclear weapons in the postwar period. They failed in their aims, partly because of opposition by other scientists under Robert Oppenheimer who were advising Truman's policy-making Interim Committee.[9]

Yet, only a year later, Oppenheimer helped draft the Acheson-Lilienthal report, which advocated international control of nuclear weapons in order to "create deterrents to the initiation of schemes of aggression [and] even contribute to the solution of the problem of war itself." A foundation for such control is the sharing of nuclear information among all nations, the report argued, for "in the long term there can be no international control and no international cooperation which does not presuppose an international community of knowledge." The report led to the presentation of the Baruch Plan by the US government internationally at the UN and the Scientists' Movement at home to promote international control of nuclear weapons. Both of these initiatives also failed, mainly owing to the conflicting national interests of the United States and the Soviet Union.[10]

The US Atomic Energy Commission's General Advisory Committee report in October 1949 on the hydrogen bomb can be considered the next major attempt at nuclear arms control by American scientists. In it the General Advisory Committee group of scientists under Oppenheimer argued against "an all-out effort" to make the H-bomb, on the basis of both technical and moral considerations, though a division developed as to whether it should be pursued eventually. The majority, including Oppenheimer, argued that the United States should make an unqualified commitment against the making of the H-bomb, which was a possible "weapon of genocide." But a minority of two physicists, Enrico Fermi of the University of Chicago and I. I. Rabi of Columbia, who condemned the H-bomb even more strongly as "an evil thing considered in any light," nevertheless advocated only a qualified commitment against

its development: "it would be appropriate to invite the nations of the world to join us in a solemn pledge not to proceed in the development or construction of weapons of this category." The implication was that if such a pledge was not accepted by other countries, especially the Soviet Union, the United States would probably have had to proceed with the H-bomb program. Once again, the scientists' argument failed, and the Truman administration launched the crash H-bomb program soon thereafter.[11]

On what basis did scientists justify their involvement in policy-making in regard to nuclear arms control? Most of them cited both their special technical familiarity with nuclear weapons and their rights as citizens to speak out on moral and political issues. Sometimes there were tensions over the balance between the two aspects among scientists themselves and among the public. In 1945 the Franck committee, for example, argued that "[w]e believe that our acquaintance with the scientific elements of the situation and prolonged preoccupation with its world-wide political implications, imposes on us the obligation" to advise the government on the atomic bomb. But the Oppenheimer panel responded that "[w]e [scientists] have, however, no claim to special competence in solving the political, social, and military problems which are presented by the advent of atomic power."[12] A year later the *New York Times* editorialized that "not even the fact that a scientist has had a share in making the atomic bomb qualifies him to map national policy or read the future."[13] A group of scientists from the Manhattan Project's laboratory in Oak Ridge, Tennessee, answered that not only did they have the right of ordinary citizens to speak out on political issues, but like the Franck group, they felt that their familiarity with the technical issues obligated them to get involved: "Since we are best equipped with this knowledge, we have assumed the responsibility of aiding in the education of those who are not aware of the revolutionary nature of atomic power. The scientists appear as strangers in the public eye only because they have never before seen a development with such far-reaching implications and they feel compelled to step out of their laboratories and warn the people of impending dangers to civilization."[14]

Why not leave international affairs to the experts? The Oak Ridge scientists questioned whether the latter existed—"Who are the experts, and where is the evidence of their handiwork?"—and concluded that "perhaps the time is ripe for some logical reasoning to be injected into the art of international diplomacy."[15]

Given these debates, it was no surprise that when the General Advisory Committee scientists made their recommendation against the H-bomb, critics attacked not only their conclusion but also their competence and appropriateness in reaching it. Edward Teller, the politically conservative nuclear physicist, for example, argued that "it is *not* the scientists' job to determine whether a hydrogen bomb should be constructed, whether it should be used, or how it should be used. This responsibility rests with the American people and their chosen representatives."[16] His argument, however, did not prevent him from becoming the most forceful advocate for the making of the H-bomb. Later, in the government's case justifying the removal of Oppenheimer's security clearance, Oppenheimer's and other scientists' suitability to play a role in policy once again came under official attack.[17] Everyone tried to patrol the boundary between the technical and the political and reshape it to fit their own largely predetermined policy positions.

If strengthening national security was only implied in the above examples of scientists' advocacy of arms control, it became a central argument in 1958 when the President's Science Advisory Committee (PSAC) suggested that the Eisenhower administration move aggressively to pursue a nuclear test ban with the Soviet Union to freeze the then American superiority in nuclear weapons design. Eisenhower had established the PSAC group of moderate scientists in the aftermath of the Soviet launch of the *Sputnik* satellite in 1957, as he became increasingly concerned over the dangers of nuclear war and the threat posed by the growing military-industrial complex. He accepted PSAC's recommendation for a test ban against opposition by critics such as Teller and thus started the US government on the road that eventually led to the signing of the Limited Test Ban Treaty between the United States, the Soviet Union, and the United Kingdom in 1963.[18]

Even though Eisenhower's trust and the public shock over *Sputnik* elevated the status and self-confidence of scientists advocating arms control, they continued to face the tension between the technical and the political, even within PSAC. When the committee met in 1958 to vote on its resolution that a nuclear test ban was in the overall interests of the United States, one member, Herbert York, a physicist and former director of the Livermore nuclear weapons laboratory then at the Pentagon's Advanced Research Projects Agency, objected on the basis that such a matter was beyond the competence of the scientists. Jerome Wiesner of MIT, speaking for the majority, told York in a private conversation that

he was right that PSAC members were no experts on arms control but neither was anyone else; in addition, the president could ask for advice from anyone on any subject. Rabi went even further in arguing for scientists to lead a broader program of arms control.[19]

PSAC's advocacy of arms control helped make possible the Geneva Conferences on a nuclear test ban in 1958, which, ironically, set a precedent of a split between the technical and the political in arms control: specialists from negotiating parties tackled technical issues first before diplomats tried to reach political agreements. Scientists from the United States, the Soviet Union, and the United Kingdom did reach technical agreements on how to police a test ban, leading many to praise science and scientists for opening a new era of scientific diplomacy, but new nuclear test data and research soon dashed hopes for a prompt political accord when they exposed loopholes in the original scheme. Doubts came back to haunt scientists as to the wisdom of integrating science and scientists into international politics. Even some of the scientist-participants themselves developed skepticism toward the dual-track technical and political negotiations. For example, Panofsky, then a PSAC consultant and soon-to-be member, headed the US delegation in the technical discussions on detecting nuclear testing in space in Geneva in 1959. The experiences convinced him that "[t]he social experiment of separating scientific and political considerations was essentially a failure. One clear symptom of that failure was that whenever disagreements arose between the U.S. and Soviet scientific delegates, the positions were the same: the Soviets argued that verification would be technically easier and more effective than U.S. specialists believed. This polarized disagreement corresponded to the political interests of the two parties involved."[20]

Such experiences transformed PSAC's thinking on arms control. Its early hope of devising a technical solution changed to what I call "technological skepticism," a conviction that technology by itself—in the form of either better weapons or better arms control systems—would never solve the problem of the nuclear arms race. At its meeting with Eisenhower on July 12, 1960, PSAC members told the president that "the United States will have to make a purely political decision" on the desirability of a nuclear test ban.[21]

Indeed, historians generally agree that the 1963 Limited Test Ban Treaty was possible thanks to President Kennedy and the Soviet leader Nikita Khrushchev rethinking the Cold War after the Cuban Missile Crisis of 1962 rather than to any new technological breakthroughs. Kennedy

was further motivated by a hope, in vain as it turned out, to use the test ban to somehow prevent China from becoming a nuclear power.[22] Yet, to say that the limited test ban was a political achievement does not mean that scientists did not contribute to its success: international scientific discussions did help clarify many technical issues involved in monitoring a test ban. According to Panofsky, the eventual treaty's prohibition of nuclear testing in outer space rested "heavily" on the 1959 Geneva negotiations in which he was involved.[23] Perhaps most important, science advising based on international discussions helped to remove what Kennedy called the "vague fears" concerning the risks involved in a test ban and arms control measure, which were often exaggerated by opponents of arms control.[24]

American Scientists, China, and Arms Control

Once China tested its first atomic bomb in 1964, it moved from the background to center stage of the American debate over nuclear weapons and arms control policies. In the American national debate over whether the United States should launch a massive antiballistic-missile (ABM) system in the late 1960s, the Johnson administration conceded that any ABM system technically feasible at the time would not be adequate in dealing with the Soviet nuclear offensive power. But in 1967 it decided to go ahead with the modest Sentinel ABM on the grounds that it was both feasible and necessary to counter the limited but unpredictable Chinese nuclear threat.[25]

Moderate scientists opposed both Sentinel and, later, Safeguard (the name given by the Nixon administration to the repackaged ABM) as a destabilizing development in the nuclear arms race. Frustrated by such internal dissent, Nixon followed earlier critics of scientists' involvement in policy, announcing that there should be a new understanding: "political people stay out of science *and* science people stay out of politics."[26] Following the reasoning to its logical end, Nixon, in 1973, after his reelection, dissolved PSAC and nearly the entire presidential science advising system that Eisenhower had established in the late 1950s.[27]

Now in exile from the federal government, moderate scientists interested in arms control sought to influence policy in two ways. One was by having several of them serve as informal advisers to Henry Kissinger—mainly Panofsky, Richard Garwin of IBM, Sydney Drell, also of the

SLAC, and Paul Doty of Harvard, who was a friend of Kissinger's and acted as leader of the group. Kissinger was involved in arms control policy first as Nixon's national security adviser and then as the secretary of state under both Nixon and Gerald Ford. The activities of the Doty group, all members of PSAC at one time or another, had started before PSAC's dissolution. They now gained added significance as Kissinger negotiated the ABM treaty and other arms control measures with the Soviet Union since PSAC itself was banished from the White House.[28] The other approach was by opening new, nongovernmental channels, such as the NAS, the Federation of American Scientists, and the Natural Resources Defense Council, to engage in nuclear arms control activities with Soviet scientists. Chinese scientists were involved as well after Nixon's historical trip to Beijing in 1972.[29] Under the sponsorship of the American Academy of Arts and Sciences, Doty led another group, with some overlap with those advising Kissinger, that also entered into informal discussions with Soviet scientists on arms control in the early 1970s.[30] Nongovernmental scientific groups and individuals, of course, had been involved in arms control since the beginning of the nuclear arms race, and some of the PSAC insiders had actually participated in some of them themselves. Wiesner, for example, was involved in the Pugwash conferences on policy issues, which were attended by scientists from both the East and the West, before becoming John F. Kennedy's science adviser and PSAC chairman in 1961. But now that PSAC was gone, these outside channels gained added utility.[31]

Between Nixon's 1972 trip and the formal reestablishment of US-China diplomatic relations in early 1979, the Chinese government actually preferred to deal with nongovernmental organizations and private individuals rather than federal agencies in bilateral interactions; official interactions should wait, it argued, until the United States withdrew its recognition of Taiwan and established diplomatic relations with the mainland. In this connection, left-leaning organizations such as Science for the People and even the moderate Federation of American Scientists were given favorable receptions in China. Chinese American scientists such as T. D. Lee led the way for American scientists visiting China but non-ethnic-Chinese scientists also found their paths to the long-closed Middle Kingdom. Luckily for the NAS, in the mid-1960s it had established, in cooperation with the Social Science Research Council and the American Council of Learned Societies, a group that became known as

the Committee on Scholarly Communication with the People's Republic of China (CSCPRC). The CSCPRC played the most active role in sponsoring US-China scientific exchanges in the 1970s.[32]

When leading American scientists, especially those who had been actively involved in nuclear weapons and arms control issues in the PSAC system, visited China, they sought to engage Chinese scientists in nuclear arms control via a strategy characterized by connections and leverages. Despite the cessation of official relations for nearly a quarter of a century, connections between American and Chinese scientists existed and survived via private, personal networking. Many leading Chinese scientists had trained in the United States, especially in the 1940s, returning home in the 1950s. Following Nixon's 1972 trip, a number of them were able to quickly reestablish ties with their American classmates, professors, and friends, especially those fellow Chinese students who had decided to stay in the United States.[33] All these multifaceted ties helped pave the way for US-China scientific dialogue on nuclear arms control. Thus, when Wiesner, then back at MIT after serving as Kennedy's and very briefly as Johnson's science adviser, visited China in 1974, he was able to reestablish connections with Zhou Peiyuan, a leading Chinese physicist who had received his PhD from Caltech in 1928 and who had met Wiesner at several Pugwash conferences in the 1950s and in 1960 in Moscow.[34] As will be detailed later, Panofsky's own efforts to promote arms control discussion with Chinese scientists would also depend on personal connections between him and T. D. Lee and between Lee and Zhu Guangya.[35]

Leverage was another key factor in promoting US-China scientific discussions on arms control: visits of American scientists to China were highly valued by the Chinese government and by Chinese scientists for the introduction of cutting-edge science and technology into a country that was a decade or more behind international developments during and after the destructive Cultural Revolution (1966–1976). Such was the motivation for the invitation from the Chinese Electronics Society to Richard Garwin to visit China in 1974 and for the invitations from the Chinese Academy of Sciences to Panofsky starting in 1976. During their visits, they delivered lectures on a wide variety of technical topics ranging from computers and low-temperature physics in Garwin's case to high-energy physics by Panofsky. Yet, both leveraged their scientific and technological prominence in China to promote their interest in nuclear

arms control by engaging Chinese scientists in discussions and planning future ones.[36]

Panofsky's efforts are also illuminating in showing how China actually started its processes and institutions to engage in technical discussions on nuclear arms control. When Panofsky and the NAS first proposed initiating discussions on arms control with the NAS's Chinese counterpart, the immediate reaction of the Chinese Academy of Sciences was that it, as a formally civilian institution, was not the proper partner for this endeavor. So it was through trial and error and connections, including his friendship with T. D. Lee, that in 1988 Panofsky connected up with Zhu Guangya, who was able to organize the group of Chinese bomb physicists to engage in discussions on arms control with Panofsky and later the NAS's CISAC, as described earlier and as will be detailed later.

Chinese Scientists and Nuclear Arms Control

At this point, one may ask what motivated the Chinese scientists to engage in discussions on nuclear arms control? Here I will focus on Zhu Guangya as a leader of both the bomb project and arms control discussion in China and perhaps one of the most low-key and understudied figures in modern science in China. Zhu studied physics at the famed Southwest Associated University during the War of Resistance against Japan. In 1946 the Chinese government, then still under the Nationalist leader Jiang Jieshi (Chiang Kai-shek), sent him, along with about half a dozen other talented students, including T. D. Lee, to the United States specifically to study how to make atomic bombs. Rebuffed of course by the US security restrictions, Zhu ended up studying and receiving a PhD in nuclear physics at the University of Michigan in 1950. With an older brother being an underground Chinese communist still serving in the Nationalist government, Zhu decided to return to mainland China, now under Communist control, in the same year. Once the bomb project started in the late 1950s, he was appointed its chief overall organizer responsible for making technical and organizational recommendations in meetings with top leaders such as Premier Zhou Enlai and Marshal Nie Rongzhen.[37] When Panofsky visited Beijing in 1988, Zhu was still a top leader in charge of the nuclear weapons complex in his position

as vice chairman of the Scientific and Technological Committee of the Commission on Science, Technology, and Industry for National Defense (COSTIND).

Zhu's first foray into nuclear arms control came in 1963 when Zhou Enlai asked him to draft a report in response to the signing of the Limited Test Ban Treaty that year. His report, titled "The Ban on Nuclear Tests Is a Big Scam," pointed out that the United States and the Soviet Union had already conducted just about all the tests they needed, and whatever they still needed they could now get from underground tests, which were allowed under the treaty. China still needed to make its initial tests in the atmosphere, tests that were banned under the treaty, leading Zhu to conclude that the main purpose of the treaty was to try to prevent China from succeeding in its nuclear weapons program. His main recommendation was that China should accelerate its mastery of underground nuclear testing for its advantages in terms of secrecy, reduction of radioactive fallout, and acquisition of data not possible from testing in the air. He was given the job of organizing such underground tests while testing in the air continued.[38]

Arms control attracted Zhu's attention again in 1986 when Chinese leader Deng Xiaoping—under international pressure and overruling those in charge of the nuclear weapons program—decided that China would stop nuclear testing in the atmosphere.[39] Learning from this experience, Zhu and other Chinese bomb scientists recognized that international politics could suddenly change China's nuclear weapons policy. They foresaw that the United States, having approached the theoretical limit of nuclear weapons design, would soon push for a comprehensive nuclear test ban that would eventually affect all Chinese tests.[40]

The above sequence of events indicates that Chinese scientists' initiation into arms control was mainly a reaction to outside developments, both international and within China, that were external to the nuclear weapons system. This may explain in part Zhu Guangya's and other weapon scientists' initial motivation in engaging with Panofsky and other American scientists in arms control discussions: they needed to know what might be coming in international arms control developments and expected that such developments would eventually affect their work on nuclear weapons through a change in the Chinese government's own nuclear policy (in addition, possibly, to their own independent desires to promote international nuclear arms control).

The Beginning of US-China Scientific Discussions on Arms Control

Thus, the stage was set for Panofsky's first meeting with Chinese scientists on nuclear arms control on behalf of CISAC on May 23, 1988, at the IHEP. Aware of the significance of the moment and the role of the meeting atmosphere in trust building and facilitating communication, Panofsky was grateful, as he noted later in his diary, that "the staff had done a magnificent job setting up a square table to accommodate the 30 or so participants."[41] Besides Panofsky, the only other American present was Oren Schlein, an undergraduate student then studying international relations at Nanjing University whom Panofsky had recruited to take notes. The striking theatrics of Panofsky alone facing dozens of Chinese nuclear weaponeers or analysts in a room might actually have worked to his advantage: the latter might have felt more comfortable in a setting like this and more willing to exchange views with someone who had already gained widespread respect among Chinese scientists for his work on the BEPC, which would bode well for his proposal for continued dialogue.

As Panofsky scanned the room, he found that two prominent Chinese scientists on the list had not shown up, as he noted later in his diary: "We had anticipated that Dr. Zhu Guangya, the Vice Minister and Head of the Commission of Science, Technology and Industry for National Defense, would probably not come and he didn't. To our disappointment Zhou Peiyuan also did not come although he was expected." Zhu's absence was understandable because of his high position with the Chinese nuclear weapons complex and the sensitivity of the subject of the meeting. But Zhou's no-show was puzzling to Panofsky because Zhou had been an early participant in the Pugwash conferences of international scientific discussions on arms control, dating back to the 1950s, and he had also met with several American scientists, including Panofsky, who had visited China and promoted arms control. His absence may have indicated that there was an insider-outsider division of labor in China, as in the United States, between insiders like Zhu's associates and outsiders like Zhou who represented the public, "activist" face of China's interest in arms control.[42]

The meeting, apparently conducted mostly in English, was chaired by Zhou Guangzhao. Before becoming president of the Chinese Acad-

emy of Sciences, Zhou had worked on Chinese nuclear weapons and had, as a distinguished theoretical physicist, been a visiting scholar at Virginia Tech in the mid-1980s. He had also just been elected a foreign member of the US NAS in 1987. The Chinese scientists in attendance included Chen Nengkuan, a metallurgical physicist who had returned from the United States in 1955 and worked on the detonation of the Chinese atomic bombs; Yu Min, the chief designer of the Chinese hydrogen bomb; Cheng Kaijia, a nuclear physicist who had returned to China in 1950 after receiving his PhD two years earlier working under Max Born at the University of Edinburgh and a chief architect of the Chinese nuclear tests; He Zuoxiu, another theoretical physicist who had worked on the bombs and was then at the Chinese Academy of Sciences Institute of Theoretical Physics; and Hu Side, a leader of the Institute of Applied Physics and Computational Mathematics of the Chinese Academy of Engineering Physics, the institution mainly responsible for Chinese nuclear weapons design. Hu would soon become a leader on the Chinese side in dialogues with CISAC. Also present were two participants who were not nuclear physicists but defense analysts, Liu Huaqiu of the COSTIND's China Scientific and Technological Information Center for National Defense and Zou Yunhua, an assistant to Zhu Guangya and one of the few women in the room. Two attendees without any connection to nuclear weapons systems were Ye Minghan and Xie Jialin from the IHEP itself, with whom Panofsky had worked closely on the BEPC for several years.[43]

The meeting opened with Zhou Guangzhao's "somewhat flattering introduction" of Panofsky, followed by Panofsky expressing his gratitude in turn for "the presence of so many distinguished members of the academy and other scientists interested in military affairs." The world was in a "very difficult condition," he said, because it was "complex and difficult" to steer a middle course between "unfettered arms competition" and unilateral disarmament. In solving this dilemma he believed that scientists had a special role to play: "They are first citizens of their country, but they are also an international community that can communicate somewhat easier than officials of government. They are also a resource that can be used by government whenever opinions on difficult subjects are necessary before final decisions are taken."[44] He credited Doty's American Academy of Arts and Sciences group, which had engaged with Soviet scientists in the 1970s, for helping persuade the Soviets that "in nuclear strategic matters offense and defense are very much

inter-related." This in turn had led the latter to reverse its earlier position that "there should be no control of any kind on defense but only on offense," and so to reach agreement on the ABM treaty with the United States in 1972.[45] Bringing this discussion on arms control home to the Chinese scientists—and probably trying to convince them of the merits of continued dialogue with CISAC—Panofsky pointed out, at this juncture, that the ABM treaty was beneficial to all countries but especially to China, whose modest nuclear deterrent "can be continued without concern of a ballistic missile defense being generated."[46]

Panofsky then described CISAC's membership of sixteen with brief comments on each member. What must have stood out to his Chinese audience, mostly bomb and missile makers then contemplating a move into arms control, was the fluidity in the identities of CISAC members, especially across the military/civilian and nuclear arms design/control boundaries. For example, Panofsky described Lew Allen as director of the Jet Propulsion Laboratory, a largely civilian institution managed by the California Institute of Technology (Caltech) for the National Aeronautics and Space Administration, but he also added that "earlier he was chief of staff of the U.S. Air Force."[47] He did not mention but presumably the Chinese side would have learned from public sources that Allen, with a PhD in nuclear physics from the University of Illinois at Urbana-Champaign, had worked on designing nuclear warheads at Los Alamos National Laboratory and served as the deputy to the director of central intelligence and director of the National Security Agency before becoming the highest-ranked uniformed officer in the US Air Force.[48] Similarly, Panofsky mentioned Richard Garwin as "a special science advisor to IBM" who had also been "involved in nuclear weapons designs" (he had helped miniaturize and weaponize the hydrogen bomb in the 1950s); Alexander Flax as the home secretary of the NAS who had been "director of the Institute of Defense Analysis and was involved in major activity in engineering of missiles"; Marshall Rosenbluth as plasma physicist at MIT who had "dealt with fluid dynamics problems of nuclear weapons."[49]

As Panofsky read off the names of other CISAC members to the Chinese scientists in attendance, they might have recognized many of them from their prominence in American nuclear or science policy in the past or from their involvement in US-China scientific exchanges under the sponsorship of other institutions. Indeed, the continuity between PSAC and CISAC under Panofsky was striking, ensuring a sense of continu-

ity in American scientists' advocacy of nuclear arms control. Besides Panofsky and Garwin, other former PSAC members in CISAC in 1988 included Doty; Marvin Goldberg, then director of the Institute for Advanced Study in Princeton; Charles Townes, then a professor of physics at the University of California, Berkeley, who had been another former director of the Institute of Defense Analysis; and Wiesner. Yet another CISAC member, Spurgeon Keeny, had served as a staff member for PSAC. Chinese scientists would also have been familiar with Michael May, a nuclear weapons designer who was then associate director at large of the Lawrence Livermore National Laboratory after having served as its director.[50]

In his introduction Panofsky highlighted for the Chinese scientists the public-private hybrid nature, as well as the broad purview, of CISAC's activities: "The committee's objectives are to study and report on scientific and technical issues germane to international security and arms control; engage in discussions with similar organizations in other countries; develop recommendations, statements, conclusions and other initiatives for presentation to both public and private audiences; to respond to requests from the executive and legislative branches of the U.S. government; and to expand the interest of U.S. scientists and engineers in international security and arms control."[51] Calling CISAC's dialogues with its counterpart in the Soviet Academy of Sciences its "principal current activity," Panofsky further emphasized the public-private duality of the process: "Although these meetings have no official status, appropriate officials of the U.S. Government have been kept fully informed on the plans for and the proceedings of these meetings. In order to encourage frank discussion, it has been agreed that the meetings should be private without communiqués, joint statements, or public reports."[52]

In a way, the low-key manner of these transnational scientific exchanges helped to create a hybrid public-private space in which personal networking and direct contacts on sensitive technogeopolitical issues generated information and understanding not only in keeping with the advocacy of arms control by the scientist-participants themselves but also of value to the nation-states involved, which in turn not only acquiesced to but sometimes even encouraged such undertakings. Indeed, as Panofsky reported to the Chinese scientists, CISAC's arms control discussions had expanded to several Western European academies of sciences, a fact that he probably hoped would help convince his Chinese counterpart to follow suit. "The purpose of our committee is to explore

and study solutions to these problems on which eventually our survival depends," Panofsky declared, "but to do so in a problem solving rather than a negotiating or argumentative spirit." "Therefore we do so in a manner which is private and in no way serves the purpose of public relations or public pressure," he added.[53]

CISAC's public-private duality clearly caught Chinese scientists' attention, perhaps as they themselves pondered a similar institutional setup for their country. They asked Panofsky questions about how CISAC operated, especially how it pulled off its public-private mode of operation, how American scientists more broadly participated in public policy, and specific technical and policy issues related to nuclear arms control. "Where does your budget come from?" was the first question for Panofsky after his introductory remarks on CISAC. "It comes entirely from private foundations and general funds accumulated over the years," Panofsky answered. Responding to another question about what other venues of US-Soviet discussions existed besides CISAC, Panofsky mentioned Pugwash, the Dartmouth conferences on US-Soviet relations, and the Federation of American Scientists, but he distinguished their public activism from CISAC's own back-channel approach: "These differ from our group in that they influence public opinion and increase the sensitivity of people in the world to the problems of arms control. That means that they give not only the opportunity for technical discussions but they also have a public relations purpose. Our discussions must not influence public opinion, but in the interest of having the frankest possible discussion they must be totally private, but with the understanding that our discussions are an open channel to the governments."[54] "Do your conclusions or advice influence government decisions?" a Chinese participant then asked. Panofsky acknowledged that his committee did studies at the request of the government and reported discussions to it, "but we can't be certain if our advice has influenced government decisions."[55] Nevertheless, his account of the existence of such varied institutions and approaches on arms control in the nongovernment sector must have made a deep impression on the Chinese audience.

In the spirit of problem solving and probably as a model for possible future discussions, Panofsky then made a presentation entitled "The Prospects for Deep Cuts in Nuclear Armaments: The Role of China." In it he reviewed the then-current US-Soviet negotiations on reducing nuclear weapons on both sides and expressed his hope that Chinese scientists would join CISAC for "informal but substantial" discussions on

China's entry into nuclear arms control, which would become necessary if the United States and the Soviet Union were to undertake deep cuts in their strategic nuclear weaponry, for example, by more than 75 percent, as China and others had called for and as the superpowers were contemplating.[56]

Much of the discussion following Panofsky's presentation stayed at the general level without much controversy, perhaps naturally, given the sensitivity of the topics and the novelty of the format for the Chinese scientists. Chinese participants asked and Panofsky answered questions on, for example, the American military's attitude toward strategic nuclear reductions, possible American and Soviet nuclear structures after these cuts, technical implementation of such cuts, effects of nuclear test bans on weapon improvements, and the nuclear winter phenomenon.

But at least one contentious technical issue did emerge when discussing the issue of the possible development of nuclear weapons by Japan, a topic that was brought up by He Zuoxiu: whether it was a good idea to reprocess nuclear fuel. Panofsky argued against the technology: "I am concerned with a technical matter about Japan: the reprocessing of nuclear fuel. Reprocessing is a step to acquiring nuclear weapons, and in my view the economic justification for reprocessing is very weak for civilian nuclear power. This is because reprocessing only extends the amount of nuclear fuel by a relatively small amount at a very large capital cost. Therefore, I am suspicious of any nation who wishes to acquire reprocessing capacity because in my view the economic motivation for doing that is not very good."[57] While the transcript of the meeting recorded no further discussion on reprocessing nuclear fuel, He Zuoxiu apparently did not agree with Panofsky's analysis. He claimed to have found an easy way to accomplish reprocessing using an accelerator and attributed Panofsky's continued opposition to his approach to a desire not only to prevent nuclear proliferation but also to protect the market for American nuclear fuel.[58] Panofsky, for his part, was critical toward He Zuoxiu as someone who resisted his and CISAC's efforts to persuade China to give up peaceful nuclear explosions (PNEs) by citing American and Soviet failures in this area.[59] He Zuoxiu later did change his mind on PNEs but he insisted that this was due not to Panofsky's argument but to his own recognition that such uses would create unacceptable nuclear pollution. Without fuller access to Chinese archives, it is difficult to determine whether Panofsky's argument or He's switch of positions had any effect on Chinese policy, but it is possible that they did. China gave

up its insistence on the right to carry out PNEs when it joined the Nonproliferation Treaty in 1992 and the Comprehensive Test Ban Treaty in 1996.[60]

To return to the May 1988 meeting in Beijing, the question of institutional asymmetry also became a major subject of discussion and concern on the part of the Chinese scientists. Everyone, including Panofsky, recognized that CISAC, a private group with support from philanthropic foundations, had no counterpart in China. "There exists no such organization in China to support this kind of research," as one of the Chinese participants pointed out, while expressing his agreement with Panofsky that unofficial exchanges of views between scientists were "very necessary."[61] Even if such an organization were to be established in China, it would by default be a governmental organization with all the restrictions that would come with it. The nonofficial status of Panofsky and CISAC gave them the freedom and independence that might not be available to their Chinese counterparts. At one point, for example, Panofsky expressed his "criticism of the present U.S. doctrine, which has been responsible for driving the numbers [of required nuclear weapons] up to high levels." He and his CISAC colleagues believed that a reduction of nuclear weapons by a factor of 4 would "not change matters much."[62] At another point Panofsky expressed his hope that if the Soviets agreed to reduce asymmetrically its conventional forces in Europe, the United States would not need to pursue the so-called "extended deterrence" of threatening to use nuclear weapons to fend off a conventional Soviet invasion of its allies.[63] In contrast, several Chinese speakers explained China's long-standing pledge of "no first use" of nuclear weapons in any conflict and its insistence on the precondition of deep nuclear reductions by the superpowers before it would enter into a nuclear arms control agreement, but no one questioned directly any aspects of Chinese policy.

Nevertheless, the focus on technical discussions and the promise of confidentiality offered a possible way to solve the problem of asymmetry, as Chinese scientists could also claim to speak as individual specialists and not government representatives. In addition, Panofsky was confident that CISAC's long experience of working with its counterpart in the Soviet Union would help alleviate such problems with China, as he noted in his diary:

> The Chinese expressed concern about the problem of getting financial support on their side in case bilateral meetings were instituted. An interesting

> remark: one speaker said if we accept government support for our bilateral negotiations, then we will not be speaking as independent scientists and you wouldn't want that, would you? I replied that we are fully aware of the fact that in discussions with China or the Soviet Union we were not in a symmetrical situation, that an organization strictly analogous to the National Academy of Science simply did not exist; this would not detract from the value of having informal discussions which then can be briefed to governments.[64]

Indeed, it was with this understanding of informality and confidentiality that Chinese scientists, led by Chen Nengkuan and He Zuoxiu, engaged in an extended discussion with Panofsky on a wide range of issues. At one point, one Chinese participant expressed the view that for China a quota test ban, in which each nuclear state was allowed a limited number of tests, was preferable to a threshold test ban (only underground tests below a certain threshold were allowed) or a comprehensive test ban because China needed the tests to verify the reliability of its nuclear weapons.[65] In general, both sides agreed on the inseparability of reduction in nuclear weapons from conventional weapons and defensive systems in space, the importance of the survivability of the Chinese nuclear deterrent, and opposition to the possible development of nuclear weapons by Taiwan and Japan. Getting back to his criticism of US nuclear doctrine, Panofsky said that he hoped that once the United States abandoned extended deterrence it could also adopt a no-first-use nuclear policy and then "our strategy can become similar."[66]

At the end of the meeting, Panofsky's central objective of setting up a mechanism for CISAC to continue dialogue on arms control with a Chinese counterpart remained uncertain, even though most of the Chinese participants had expressed support for such an idea. "One young member made an eloquent speech about how much he had learned from these discussions," Panofsky noted in his diary.[67] Zhou Guangzhao, who participated actively in the discussion, ended the seminar by thanking Panofsky and by calling for "continuing such discussions, either as an occasional gathering or a more continuous series of meetings."[68] Both he and Panofsky knew that the decision was not Zhou's but would require approval at a higher level in the national security system. Panofsky intuited that Zhu Guangya, as a leader of COSTIND, was likely the pivotal figure in this process. As mentioned earlier, Zhu was on the invitation list as the highest ranking of the Chinese scientists, but he, as Panofsky had expected, did not show up.[69] His absence was likely a reflection of the caution and

sensitivity with which he and other leaders of the Chinese nuclear weapons program approached Panofsky and the NAS's overture.

At this critical juncture Panofsky's friend T. D. Lee came to his rescue.[70] Having signed a statement by American Nobel laureates (Lee had shared the Nobel Prize in Physics in 1957) endorsing the Limited Test Ban Treaty in 1963, Lee supported Panofsky's efforts in arms control in China. The latter happily recorded in his diary that on May 23, 1988, "T. D. Lee arranged for me to have lunch tomorrow with Zhu Guangya who is really the key person who will make the decision on the future arms control discussions."[71] At the same time he had confirmation that he would also meet with Fang Yi, the Chinese vice premier, to report on the BEPC, and with Winston Lord, the US ambassador to China, to debrief him and his staff on his activities, especially in regard to the arms control discussions (when he did, Lord and his staff encouraged his arms control efforts). Not without some excitement and satisfaction, he wrote in his diary on May 23, "so tomorrow is again going to be a day when I will be interacting with three different dignitaries."[72]

Yet, even as he looked forward to a direct contact with Zhu, Panofsky realized that this forthcoming meeting with Zhu but without the presence of Zhou Guangzhao presented him with "a slight diplomatic problem": whether he should "respect Zhou Guangzhou's final indefinite decision" or negotiate directly with Zhu, which amounted to going "over Zhou Guangzhao's head."[73] Not surprisingly he chose the latter and used the lunch with Zhu, with Lee and his wife present, to talk about arms control: "Zhu pointed out that there was some 'political sensitivity' in setting up a similar committee of scientists in China but the conversation ended by [his] saying 'I will do my best.' Nothing better could be expected at this point."[74]

Only years later did we learn, from the recollections of Zou Yunhua, who not only was Zhu's assistant on arms control but would also spend time at SLAC working with Panosky, that Lee did more than just introduce Panofsky to Zhu Guangya for this crucial meeting. According to Zou, on May 23, 1988, the day of Panofsky's seminar at the IHEP, Lee had tried to invite Zhu to attend the meeting in the afternoon after learning that he did not show up in the morning; Zhu declined "due to a busy schedule." Later, after arranging the Panofsky-Zhu lunch meeting, Lee wrote not only to Zhu to convey Panofsky's appreciation of Zhu's "scholarly style" but also to Nie Rongzhen, the Chinese marshal still influential in Chinese nuclear and defense policy-making in the 1980s, to

vouch for Panofsky's goodwill and seek Nie's approval for Zhu's participation in CISAC dialogues: "Professor Panofsky is an internationally well-known physicist with great achievements who has enthusiastically assisted with the building of the Beijing Electron-Positron Collider for many years. Four years ago he even came to work in Beijing only three months after a heart surgery, earning widespread praise from Chinese leaders and scientists. . . . He will be discussing problems of nuclear disarmament with relevant Chinese experts, and he would very much like to see Mr. Zhu Guangya participating in these discussions as a formal member of the Chinese side."[75] It is not clear that Lee's letter to Nie worked, but it is very likely that it helped to make it easier for Zhu to get more involved in arms control in the future.

Indeed, as Zhu promised and as Panofsky hoped, what became known as the Chinese Scientists' Group on Arms Control (CSGAC), with Zhu as chairman, was set up in 1991, initially under the sponsorship of Zhu's COSTIND and later of the ostensibly nongovernmental Chinese People's Association for Peace and Disarmament, as a counterpart to CISAC in arms control dialogue.[76] This was an important step in reaching institutional symmetry in the CISAC dialogue, but important differences remained. For example, there was a disparity between the positions and responsibilities of the leaders on each side: Zhu, as a high-ranking government official, carried active responsibility for China's nuclear weapons program, while Panofsky did not do so with regard to the American program even though, as he made clear to the Chinese scientists, he and his committee maintained close communication with the US government. Similarly, even though some CISAC members were quasi–government employees and the committee maintained close ties with the US State Department, including the US embassy in Beijing, it was a nongovernmental organization, whereas all members of the CSGAC, even though it operated nominally under the nongovernmental Chinese People's Association for Peace and Disarmament, were Chinese government employees with close and often direct ties to the national security system. Perhaps sensitive to this fact, Zhu declined to seek funding from foreign private foundations for Chinese arms control research.[77] Nevertheless, because of the informal nature of the discussions, such institutional differences did not seem to impede the interactions between CISAC and the CSGAC.

Even before the CSGAC was formally established, the COSTIND, as Zhu Guangya had promised Panofsky, arranged for the visit to Beijing of

a delegation from CISAC in October 1988 and sponsored CISAC's first formal, two-day meeting with Chinese scientists on arms control.[78] The timing was designed to coincide with a major meeting of the CSCPRC, of which Panofsky was also a member.[79] Besides Panofsky, who headed the group, the CISAC delegation also included the aforementioned Allen, Garwin, May, and Townes as well as CISAC member John Steinbruner, an influential political scientist and policy analyst then at the Brookings Institute in Washington, DC, and CISAC staff director Lynn Rusten.[80]

As evidence of what Panofsky had described as CISAC's practice of keeping the US government "fully informed," CISAC delegation members met in September 1988 for a daylong pre-trip conference at the NAS in Washington, DC, which included meetings with representatives of the US State Department. The latter not only briefed them on China's security and arms control policy-making processes but also expressed interest in their initiative.[81] On arriving in Beijing CISAC delegation members attended a reception given by the CSCPRC's Beijing office, where they met Ambassador Lord. Lord encouraged CISAC's efforts, as he did in May to Panofsky, calling the forthcoming meeting "the first indication of Chinese scientific interest in arms control at a quasi-official level."[82] Lord also cautioned Panofsky about potential problems in the meeting next day and offered some advice: "Ambassador Lord warned me that the Chinese may be uncomfortable with the arms control meeting and the general tactic would be to have formal presentations take the entire period so that there would be relatively little time for discussions. He suggested one should chair the meeting in such a way that that won't happen."[83] Once again matters of sensitivity and communication took central place in the process of transnational exchanges on nuclear arms control. This perceived reluctance and caution on the part of the Chinese participants in transnational arms control discussions may have also reflected internal debates in China over the propriety of scientists' involvement in policy that mirrored those in the United States, as mentioned earlier.

Meanwhile, the scale and composition of Chinese participants differed from those in the May 1988 meeting, perhaps as a result of a desire for symmetry. Instead of the "frightening list" of around thirty, it was now reduced to six people plus an interpreter. These included He Zuoxiu, Hu Side, Liu Huaqiu, and Zou Yunhua, who all had attended the May meeting, with the addition of Du Xiangwan, Hu Side's chief

lieutenant at the Institute of Applied Physics and Computational Mathematics and later a leader of the CSGAC, and Huang Zuwei, a missile specialist from the Ministry of Aerospace Industry.[84] These Chinese participants were in general younger than the leaders of the Chinese nuclear weapons projects who had attended the May meeting, and their selection probably also reflected Zhu Guangya's determination to professionalize nuclear arms control as a new field of study in China. These participants would form the core of CSGAC later on.

All these activities and developments built up excitement and anxiety for the formal opening of US-China scientific communication on the sensitive topic of nuclear arms control on October 7 and 8, 1988, in Beijing. The site for the conference, the hall of the Union of Chinese Students Who Have Returned from Study Abroad in Europe and America (Oumei Tongxue Hui), was somewhat unusual but fitting in many ways. It not only was located near the Beijing Hotel, where CISAC delegation members had stayed, but also represented one of the few nongovernmental (at least nominally) organizations in China at the time, with a strong transnational symbolism.[85] Thus, the choice of site may have signified the desire on the Chinese side to seek symmetry in terms of the public-private institutional hybridity that marked CISAC's operations.

Compared with Panofsky's May meeting, the October meeting went into more technical depth, at least during the first day, October 7. After opening remarks by Hu Side and Panofsky, May was the first to speak, on the topic of "arms control in space." May gave "a summary update of the major technical problems and of some strategic issues associated with arms control in space . . . intended to be a conversation opener between our two groups on the subject." In fact, he also made arguments that he said represented the views of some or most of the other members of CISAC. For example, he endorsed the Outer Space Treaty of 1967, which China joined in the early 1980s, because it banned stationing weapons of mass destruction in space and was beneficial "both in the arms race sense and in the sense of crisis stability"; he believed that the ABM treaty then in force between the United States and the Soviet Union did "ban the development, test and deployment of space-based ABM systems and components." Perhaps out of sensitivity about his own position as a scientist in a government lab, May did not mention explicitly the Strategic Defense Initiative (SDI) system recently proposed by President Reagan, but it was clear that he believed that carrying it out would have violated the ABM treaty. Finally, May concluded that for

arms control measures such as the ABM treaty to work it was necessary (and possible) to ban antisatellite systems as well.[86] He was followed by two Chinese scientists, Du Xiangwan and Huang Zuwei, who responded to May with their own papers on the subject.[87]

As the workshop got under way, covering not only arms control in space but also nuclear test limitations, drastic US-Soviet nuclear reductions, the role of China and other nuclear states in such scenarios, and the impact of nuclear weapons on regional stability in Asia, it became clear that both sides agreed on the general desirability of arms control but they diverged on technical and political feasibilities. For example, in Du and Huang's responses to May, they advocated nuclear arms control in space in general even more passionately than May but placed most of the burden on the two superpowers. Du ended his presentation with the following plea: "It's a pity that in today's world the force for arms control is still not much stronger than the force for arms race, so scientists should give full play to their knowledge and conscience to promote international justice, peace and development."[88] Huang presented several measures to achieve "the goals of non-weaponization in space," including "bilateral negotiations [that] should be held between two super powers on banning of space weapons."[89] May in turn responded that he "personally agreed with some of the measures discussed in the Chinese papers" but there were strong advocates for both offensive and defensive nuclear weapons systems in the United States who argued that arms control had to be verifiable and "compatible with the standards of present policy." "This sort of reply to the fairly idealistic Chinese proposals, that is, going back to what might be practical in the light of existing policies, was fairly typical of most American replies over the next two days."[90] Despite such problems, CISAC scientists took these exchanges in their stride, according to May: "In general, the Chinese were not prepared at this meeting to go into any quantitative or specific consequences of their views. This was not a surprise to us. Typically, such discussions come after a few preliminary meetings."[91]

It should be noted that despite the overall general nature of the discussions, technical knowledge exchanges did enter into the conversations and played a part in enhancing mutual understanding. At one point, for example, Hu Side, speaking for the Chinese side, explained his skepticism toward a threshold test ban treaty, which had been a topic of discussion at the May meeting. According to May's notes:

> While he [Hu] thought there was little possibility for a CTB (comprehensive test ban) in the near term, he also thought there was little value in intermediate threshold test bans. He thought the 10 kt limit had little military meaning because "the major problem is the primary which is usually below 10 kt," and even the 1 kt limit would permit experiments. He thought that the U.S. and the Soviet Union should instead lead in drastically cutting nuclear tests, to 1 or 2 or 3 a year, in order to restrain the arms race.[92]

May did not record the reactions of the American scientists in the room but one can imagine that they would have understood Du's technical arguments perfectly and would likely have found them helpful in understanding the Chinese position.

As the leader of both CISAC and its delegation in Beijing who had worked hard to bring about this dialogue, Panofsky was greatly encouraged by what happened in the seminar, especially in regard to the main purpose of trust building. During the first day he noted that the "atmosphere at the meeting was good and Chinese had prepared quite a few papers." "In fact," he continued, "the main problem was to keep a discussion going, rather than simply focusing on the papers." This could have been due in part to what Lord had warned about—the Chinese tendency to avoid discussion—but Panofsky took it as a positive sign of Chinese seriousness. At the end of the second day Panofsky again recorded in his diary his feeling that "the sessions went quite well." The second day of meetings was "less technical" than the first day, but included an important session on plans for future dialogues, which concluded, to Panosky's delight, with a "definite agreement that the process should continue."[93] Once again, Panofsky's sense of progress derived from not only the formal meetings but also informal contacts. On October 8, 1988, the last day of the seminar, for example, Panofsky and his colleagues were told "in several private discussions" that the Chinese position had "softened significantly as to the preconditions for participating in the arms control talks from their official position of 'deep cuts and the three stops,'" that is, the superpowers agreeing to stop production, stop deployment, and stop testing of nuclear weapons. And on the important question of the continuation of the dialogue, Panofsky was encouraged once more by his personal contacts with Zhu Guangya himself, who again was absent from the formal discussions but showed up at the official banquet marking the end of the seminar on October 8, seated next to Panofsky.

FIGURE 13.1. Chinese American physicist T. D. Lee brought together Americans and Chinese in scientific discussions on nuclear arms control in 1988 in Beijing. From left: Pan Zhenqiang, Zou Yunhua, Xu Huijun (Mrs. Zhu), Zhu Guangya, Wolfgang Panofsky, T. D. Lee, Du Xiangwan, Jeanette Lee (Mrs. Lee).
Source: Courtesy of the Panofsky family and SLAC Archives.

As Panofsky recorded in his diary: "I gave him a brief report [on] what had been happening in the talks. He did not seem to be interested in any detail, and we switched to small talk and physics. Then at the end he came back to the subject; he expressed the view that the discussion should continue with larger representation on their part, including some social scientists."[94]

Only years later did some of the Chinese decision-making processes become known in memorial articles written after Zhu's death in 2011. Hu Side, who became head of the Chinese Academy of Engineering Physics and a leader of the CSGAC seminars, recalled in a 2012 paper that the cautious Zhu Guangya had to receive clearance from the highest level—the Central Military Commission—to open the dialogue with Panofsky's CISAC in 1988. Then during the October 1988 seminar: "He at first asked us to talk with them. We reported to Chairman Zhu every night on what happened, and he would suggest to us what questions to ask and what opinions to express."[95] No wonder Zhu Guangya was not

interested in Panofsky's telling him about what had happened at the seminar!

The scheduled CISAC-CSGAC meetings in the United States in 1989 or 1990 apparently did not take place, most likely owing to the hiatus in NAS exchanges with China resulting from the Chinese government's crackdown on the prodemocracy student protest in Tiananmen Square in Beijing in June 1989. The seminar resumed, however, in October 1991 at Irvine, California, which gave Zhu a chance to revisit the United States for the first time since he left in 1950, as he led a delegation of CSGAC members to discuss arms control with CISAC. And it appears that the earlier meetings with American scientists had prompted Zhu and other Chinese scientists to strengthen Chinese efforts and institutions pertaining to technical studies on nuclear arms control. On September 14, 1990, most likely in anticipation of the forthcoming Irvine trip, Zhu had held a meeting within the COSTIND to expand personnel on arms control studies. He also helped make arms control physics a new branch of applied physics and started the training of students in this field in China.[96]

At the Irvine meetings in 1991 Zhu did participate in the seminar actively and spoke about his own understanding of the role of nuclear weapons in the world:

> There seems to be a consensus that due to their enormous destructiveness, nuclear weapons play a major role in strategic deterrence. But if one reflects more deeply, one should reach the conclusion that the military significance of nuclear weapons has been exaggerated. . . . We also appreciate this argument in your report, which is that all nuclear powers should reach a political consensus that nuclear weapons would not be used for any other purpose except for deterring others from using them, and that gradually all nuclear powers should solemnly declare their pledge to no first use of nuclear weapons.[97]

From someone who had devoted his entire career to making nuclear weapons for China, it was a remarkable statement on the limits of nuclear weapons as a technological solution to international political conflicts, one that PSAC and Panofsky would endorse. Zhu's transformation from a bomb maker to an advocate of arms control and scientists' social responsibilities also mirrored that of PSAC members and Zhu's American counterparts in the CISAC-CSGAC dialogues such as Panofsky, Garwin, and May. The evident consensus by both sides at the Irvine conference that the only purpose of nuclear weapons should be the

prevention of other states from using them was a remarkable development and came close to China's official position on no first use of nuclear weapons.[98]

Meanwhile, Zhu and his colleagues also used their knowledge of developments in international nuclear arms control to help inform their advice to the Chinese government on both the production and the control of nuclear weapons. In 1986 they had convinced the Chinese government to accelerate its own underground test schedule in anticipation of a possible US proposal for a comprehensive nuclear test ban.[99] When the United States, as expected, made the proposal for a comprehensive test ban in 1992, Zhu and others persuaded the Chinese government to launch a second accelerated test series. All these tests were designed to perfect China's neutron bomb and the miniaturization and weaponization of some of the new warheads. On July 29, 1996, hours after the last shot of the second series took place, the Chinese government announced that it would observe a moratorium on testing.[100] Just as in the United States, national security and arms control were integrated in China.

But to say that Chinese scientists became engaged in arms control out of institutional self-interest does not mean that Chinese scientists did not share the objectives of their American counterparts in trying to reduce and limit the scale of nuclear weapons programs in the world, as Zhu's 1991 Irvine speech and the continued Chinese participation in the CISAC-CSGAC meetings and in international arms control regimes indicate. In a 1992 coauthored paper on the need for technical evaluations of weapons systems, Zhu expressed a view that was close to the kind of technological skepticism to which Panofsky and other PSAC scientists had subscribed in their advocacy for nuclear arms control: "the introduction of a new kind of weaponry usually leads to a new round of arms race. Thus, full evaluations of the effects of weapons could make those decision-makers in charge of the development of such weapons aware that, owing to the existence of countermeasures, the development of such weapons is not very meaningful. In addition, a weapon tends to be glorified or mythologized during its early stage of development; evaluations by scientists could reveal the true functions and practical capabilities."[101] Equally important, the institutional foundation and the training of several generations of nuclear arms control specialists in China under Zhu's leadership, facilitated by the CISAC-CSGAC process, ensured that China would be gradually integrated into the international dis-

course on arms control and that there would be expertise and a vested interest for arms control within China.

The year 2018 marked the thirtieth anniversary of the beginning of the CISAC-CSGAC seminars. Without access to all the relevant information, owing in large part to widespread archival restrictions in China, the sensitivity of the subject matter, and the confidential character of these discussions, it has been difficult to gauge accurately the impact of these interactions. But it is clear that both sides valued the dialogue enough to have continued them, not only during Panofsky's chairmanship of CISAC until 1993 but also through those of John Holdren of Harvard (1993–2004), who would later become President Barack Obama's science adviser, and of Raymond Jeanloz of UC Berkeley (2004–). The CISAC-CSGAC dialogues, which were modeled after CISAC's interactions with the Soviet Academy of Sciences, were in turn replicated in its exchanges with India. Panofsky believed that the clarification of the cost-benefits of PNEs in the CISAC-CSGAC discussions probably helped persuade the Chinese government to withdraw its objection to the prohibition of PNEs and ratify the Non-Proliferation Treaty in 1992, which has been an important step in China's involvement in nuclear arms control.[102] More recently, a direct achievement of the CISAC-CSGAC dialogues, unusually well publicized in view of the traditional reticence associated with such exchanges, is the making and publication of the *English-Chinese Chinese-English Nuclear Security Glossary* in 2008.[103] Its publication and positive reception again indicated the centrality of matters of communication and language in transnational scientific interactions on sensitive subjects.

Garwin, the longest-serving member of CISAC, agreed with Panofsky's positive assessment of the process. As he reflected on the CISAC-CSGAC meetings in 2014, "important achievements of these interactions, which take place without publicity and with no open reports, include a deep understanding of the attitudes on the two sides and, in particular, the Chinese government's signing the Comprehensive Nuclear-Test-Ban Treaty."[104] He also noted that the CISAC-CSGAC mechanism "convened the first meeting between Chinese and US nuclear laboratory and forensic experts," which helped, at least indirectly, initiate the fruitful and extensive US-China Lab-to-Lab Program (CLL), in which American and Chinese nuclear experts worked together on nuclear arms control and nonproliferation.[105]

Remarkably, the CLL followed the CISAC-CSGAC model of high-level but "unofficial" interactions to build trust and enhance mutual technical understanding. In many ways, however, it went beyond talks and into actual technical collaborations. For example, the program's flagship MPC&A Project in the late 1990s aimed to develop "a joint demonstration of technologies for nuclear material protection, control, and accounting (MPC&A)." For this project US nuclear weapons labs provided sensors and computer hardware and software and used them to work with Chinese nuclear institutions to help strengthen China's technical ability to control and secure its nuclear materials and reduce proliferation risks. The CLL ended in 1999 during controversies over the congressional Cox Report and the Wen Ho Lee case and accusations that China stole US nuclear secrets, but its legacy can be seen in renewed US-China collaboration on nonproliferation under Obama, which led to a joint project to remove enriched nuclear fuel from Ghana in 2017.[106] However, as *Science* reported in 2017, the Chinese government insisted on an apology from the US government for the Cox Report and an acknowledgment of "past cooperation," including presumably not only the CLL but also the CISAC-CSGAC dialogues, as "legal and mutually beneficial," before it would be willing to move ahead with broader collaboration in nuclear arms control. The US Congress, dominated by the Republicans, which had directed the making of the Cox Report in the first place, not only refused "to send the letter" but also opposed "such cooperation with an assertive China."[107]

Conclusion

What lessons can we draw from this discussion of US-China scientific interactions in nuclear arms control? First, it appears that American scientist-activists, through nongovernmental channels, took the lead in approaching Chinese scientists on the significance of nuclear arms control. But once the Chinese scientists studied the matter and realized its importance, they actively organized studies, joined international efforts, and persuaded their government to take necessary actions, a pattern that would be repeated in the case of climate change.[108] The CISAC-CSGAC case indicates the importance of transnational face-to-face scientific interactions, especially in sensitive areas such as nuclear weapons, building personal trust and understanding among policy-influencing sci-

entists, which in turn helped their respective nation-states to seek mutually acceptable compromises and common ground. As Zhu's assistant Zou Yunhua observed, the close personal connections that T. D. Lee helped Panofsky and Zhu to develop between each other paved the way for the successful continuation of the CISAC-CSGAC dialogue: "From my perspective, what made it possible for CSGAC under Chairman Zhu and NAS-CISAC under Professor Panofsky to carry out bilateral academic exchanges was that the bridge maker between them was Chairman Zhu's good friend Professor T. D. Lee. Furthermore, Professor Panofsky loved China and made momentous contributions to the development of China's science and technology, which Chairman Zhu appreciated very much."[109] Thus, nation-states framed the context for nuclear dialogue but private or semiprivate transnational networking and scientific interactions played an important, even critical, role in moving the process forward.

Such movements of knowledge and circulation of people across national borders appeared to be effective in bringing China into the international system of nuclear arms control in the past and likely was a key element in dealing with other nuclear cases. For example, in the negotiations over the Iranian nuclear program during the Obama administration, public-private hybridity also played a role as personal and professional connections between the US secretary of energy Ernest J. Moniz and the Iranian nuclear official Ali Akbar Salehi helped reach the international agreement.[110] Former and current members of CISAC made their contributions: in the 2000s Panofsky helped initiate a dialogue between a small group of American scientists and their Iranian counterparts on Iran's nuclear program, and then Richard Garwin, the PSAC veteran who served as a major lieutenant to Panofsky in CISAC's discussions with Russia and China, organized influential public campaigns of American scientists in support of the deal under both Obama and Trump.[111]

But the US-China case also reveals tensions over scientists' identity as both experts and citizens, their choices to be outsider-activists or insiders working within the system, and their understanding of the potentials and limits of technological solutions to social and political problems. In this case, as so often in transnational scientific interactions, trust is a central issue. As John Krige and others have argued, the increasingly stringent national security regimes in the United States and elsewhere have posed growing obstacles to international scientific com-

munication, especially in sensitive areas such as nuclear weapons.[112] Geopolitical disagreements, suspicion, and secrecy certainly often disrupted US-China scientific discussions on nuclear arms control, as happened in the aftermath of the 1989 Tiananmen tragedy and again in the publication of the congressional Cox Report and Wen Ho Lee case in 1999–2000, leading to charges of Chinese theft of US nuclear secrets. It was amply clear that the CISAC-CSGAC exchanges were conducted under the tight framing of geopolitical interests on both sides both before and after the end of the Cold War. Yet, at least in the beginning of the CISAC-CSGAC contacts on arms control in 1988, such difficulties did not seem to pose impassable obstacles to the start of dialogue. Aside from the Panofsky–He Zuoxiu technical dispute over nuclear fuel reprocessing, it appeared that secrecy and security requirements did not prevent the two sides from carrying out discussions at both technical and policy levels. Perhaps therein lies the value of person-to-person communication, in which a certain level of personal trust can be established and can help to overcome or at least lessen institutional and national differences. The public-private hybridity in CISAC and, to a lesser degree, in the CSGAC also probably helped create room for flexibility and maneuverability. By acting as a private organization but keeping the US government "fully informed," CISAC maintained a degree of independence while also alleviating problems with security and export controls.

It should also be noted that in this case scientists with transnational connections and leverages played a low-key but quite effective role in the policy process. As the political scientist Matthew Evangelista noted in his study of US-Soviet nuclear relations in the 1980s, transnational scientific organizations such as the Federation of American Scientists played influential roles, especially when the international and domestic circumstances were favorable.[113] In the beginning of US-China nuclear dialogue in the late 1980s and early 1990s, it was American transnational scientist-activists such as Panofsky who used their international scientific prominence to help promote policy initiatives in arms control; and it was well-placed Chinese scientists like Zhu Guangya who used their own scientific prominence and contributions to China's nuclear weapons program to mobilize efforts in promoting nuclear arms control in China and internationally. Trust that was first built in the area of high-energy physics and then reinforced through face-to-face interactions helped to overcome considerable resistance to the arms control agenda advocated by Panofsky and other American scientists in China. And finally one

should not underestimate the critical roles of other, less visible transnational connectors such as T. D. Lee and other members of ethnic scientific networks who helped bring these scientist-activists together to advocate both science and nuclear arms control. A similar case could be made for the importance of complex personal interactions under state sponsorship in climate change and other areas of international policy discussions. The rich layering in transnational scientific interactions deserves close historical examination.

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Notes

1. Wolfgang K. H. Panofsky, "Diary, May 13–25, 1988," Wolfgang Panofsky Papers, ser. V, box 51, folder 1, SLAC Archives, Stanford, CA.

2. For more on CISAC, see information and links on its official website (accessed Jan. 2018): http://sites.nationalacademies.org/PGA/cisac/index.htm.

3. Panofsky, "Diary, May 13–25, 1988," 16 (entry for May 18). In this chapter, names of Chinese in China are rendered in Pinyin, with family names (e.g., Ye) first and given names (e.g., Minghan) second.

4. Ibid., 31 (entry for May 23); Wolfgang K. H. Panofsky, *Panofsky on Physics, Politics, and Peace: Pief Remembers* (New York: Springer, 2007), 153–154.

5. For a recent review, see John Krige and Kai-Henrik Barth, eds., *Global Power Knowledge: Science and Technology in International Affairs*, Osiris, vol. 21 (Chicago: University of Chicago Press, 2006).

6. For a recent history of Chinese arms control efforts, see Evan S. Medeiros, *Reluctant Restraint: The Evolution of China's Nonproliferation and Practices, 1980–2004* (Singapore: NUS Press, 2009), which mentions CISAC's positive role in the training of Chinese arms control experts (230).

7. Steven Erlanger and Sheryl Gay Stolberg, "Surprise Nobel for Obama Stirs Praise and Doubts," *New York Times*, Oct. 10, 2009, A1; William J. Broad and David E. Sanger, "Race for Latest Class of Nuclear Arms Threatens to Revive Cold War," *New York Times*, Apr. 17, 2016, A1; David E. Sanger and William J. Broad, "Obama Unlikely to Vow No First Use of Nuclear Weapons," *New York Times*, Sept. 6, 2016, A1.

8. Science and Security Board of the *Bulletin of the Atomic Scientists*, "It Is Two and a Half Minutes to Midnight," Jan. 26, 2017, accessed Feb. 2017, http://thebulletin.org/sites/default/files/Final%202017%20Clock%20Statement.pdf. See also Jonah Engel Bromwich, "Doomsday Clock Moves Closer to Midnight, Signaling Concern among Scientists," *New York Times*, Jan. 27, 2017, A17.

9. Richard G. Hewlett and Oscar E. Anderson Jr., *A History of the United States Atomic Energy Commission*, vol. 1, *The New World: 1939–1946*, pbk. ed. (Berkeley: University of California Press, 1990). The full text of the report (accessed Dec. 2013) can be found at http://www.dannen.com/decision/franck.html.

10. Richard G. Hewlett and Francis Duncan, *A History of the United States Atomic Energy Commission*, vol. 2, *Atomic Shield: 1947–1952*, pbk. ed. (Berkeley: University of California Press, 1990); Alice Kimball Smith, *A Peril and a Hope: The Scientists' Movement in America, 1945–47* (repr., Cambridge, MA: MIT Press, 1970). The Acheson-Lilienthal report (accessed Dec. 2013) can be found at http://www.learnworld.com/ZNW/LWText.Acheson-Lilienthal.html.

11. Herbert F. York, *The Advisors: Oppenheimer, Teller, and the Superbomb* (Stanford: Stanford University Press, 1976). The full text of the General Advisory Committee report (accessed Dec. 2013) can be found at http://www.pbs.org/wgbh/amex/bomb/filmmore/reference/primary/extractsofgeneral.html.

12. For a discussion of this issue, see, e.g., Zuoyue Wang, *In* Sputnik*'s Shadow: The President's Science Advisory Committee and Cold War America* (New Brunswick, NJ: Rutgers University Press, 2008), 19–20.

13. "Topics of the Times," *New York Times*, Oct. 21, 1945, E8.

14. "Scientists Not Different," *New York Times*, Nov. 3, 1945, 11. See also Smith, *A Peril and a Hope*, 175–177; Wang, *In* Sputnik*'s Shadow*, 336.

15. "Scientists Not Different," 11.

16. See Wang, *In* Sputnik*'s Shadow*, 29.

17. Ibid., 46. Notably, such questioning of scientists' proper role in policy-making recurred in the debates over climate change as well. In 2004, for example, James Hansen, director of NASA's Goddard Institute and one of the most outspoken scientists advocating actions on global warming, was pressured by the George W. Bush administration to refrain from making public statements on cli-

mate policy. See Andrew C. Revkin, "Climate Expert Says NASA Tried to Silence Him," *New York Times*, Jan. 29, 2006, 1, 20. In response, Hansen, echoing the Oak Ridge scientists, argued that "I don't think my opinion about policies has any more weight than that of anybody else, but I shouldn't be prevented from saying it and I shouldn't be prevented from connecting the dots." Transcript of *Hot Politics*, PBS Frontline program aired in 2007, accessed Dec. 2013, http://www.pbs.org/wgbh/pages/frontline/hotpolitics/etc/script.html.

18. Wang, *In* Sputnik*'s Shadow*, 121–215.

19. Ibid., 125.

20. Wolfgang K. H. Panofsky, "Response to the CTBT Discussion," in *Scientific Cooperation, State Conflict: The Role of Scientists in Mitigating International Discord*, ed. Allison L. C. de Cerreño and Alexander Keynan, Annals of the New York Academy of Sciences 866 (New York: New York Academy of Sciences, 1998), 262.

21. Wang, *In* Sputnik*'s Shadow*, 141.

22. Glenn T. Seaborg with Benjamin S. Loeb, *Kennedy, Khrushchev, and the Test Ban* (Berkeley: University of California Press, 1981); Gordon H. Chang, "JFK, China, and the Bomb," *Journal of American History* 74, no. 4 (Mar. 1988): 1287–1310.

23. Panofsky, *Panofsky on Physics, Politics, and Peace*, 66.

24. Wang, *In* Sputnik*'s Shadow*, 225, 345.

25. Ibid., 274–280.

26. Ibid., 293.

27. Ibid., 305–308.

28. Ibid., 295. For example, Kissinger consulted with some members of the Doty group on August 15, 1975, before meeting with Soviet ambassador Anatoly Dobrynin on arms control. See John H. Kelly, "Memorandum of Conversation," Aug. 15, 1975, accessed Oct. 2016, https://fordlibrarymuseum.gov/library/document/0332/033200495.pdf.

29. On the Federation of American Scientists, see, e.g., Jeremy Stone, *"Everyman Should Try": Adventure of a Public Interest Activist* (New York: Public Affairs, 1999). On the Natural Resources Defense Council, see Kai-Henrik Barth, "Catalysts of Change: Scientists as Transnational Arms Control Advocates in the 1980s," *Osiris* 21 (2006): 182–206.

30. Richard L. Garwin, "Pief's Contributions to Arms Control and Nuclear Disarmament," First Panofsky Lecture, XVII Amaldi Conference, Hamburg, Germany, Mar. 14, 2008, accessed Oct. 2016, http://fas.org/rlg/PIIS10a.pdf.

31. Walter A. Rosenblith, ed., *Jerry Wiesner: Scientist, Statesman, Humanist; Memories and Memoirs* (Cambridge, MA: MIT Press, 2003), 259–263, 277–278. The physicist Leo Szilard was a one-man international institution for nuclear arms control during the Cold War. See, e.g., Barton J. Bernstein, "Leo Szilard: Giving Peace a Chance in the Nuclear Age," *Physics Today* 40, no. 9 (Sept. 1987): 40–47.

32. Zuoyue Wang, "US-China Scientific Exchange: A Case Study of State-Sponsored Scientific Internationalism during the Cold War and Beyond," *Historical Studies in the Physical and Biological Sciences* 30, pt. 1 (1999): 249–277; Wang, *In* Sputnik*'s Shadow*, 303. See also Kathlin Smith, "The Role of Scientists in Normalizing U.S.-China Relations, 1965–1979," in de Cerreño and Keynan, *Scientific Cooperation, State Conflict*, 114–136; Richard P. Suttmeier, "Scientific Cooperation and Conflict Management in U.S.-China Relations from 1978 to the Present," in de Cerreño and Keynan, *Scientific Cooperation, State Conflict*, 137–164.

33. Zuoyue Wang, "The Cold War and the Reshaping of Transnational Science in China," in *Science and Technology in the Global Cold War*, ed. Naomi Oreskes and John Krige (Cambridge, MA: MIT Press, 2014), 343–369.

34. Rosenblith, *Jerry Wiesner*, 259–263.

35. Panofsky, "Diary, May 13–25, 1988."

36. Richard L. Garwin, "China Trip: Transcribed Notes of a Trip to the Chinese People's Republic, March 18 to April 17, 1974," courtesy of Dr. Garwin; Wolfgang Panofsky, "Trip Report: Trip to People's Republic of China, October 5–22, 1976," Panofsky Papers, ser. V, subser. P, box 50, folder 3.

37. Gu Xiaoying and Zhu Mingyuan, *Women de fuqin Zhu Guangya* [Our father Zhu Guangya] (Beijing: People's Press, 2009).

38. Qian Wei, "Zhu Guangya," *Zhongguo xinwen zhoukan* [China Newsweek], Mar. 7, 2011, 71–73, at 73.

39. Gu and Zhu, *Women de fuqin Zhu Guangya*, 136; Qian, "Zhu Guangya," 73.

40. Xi Qixin, *Zhu Guangya zhuan* [A biography of Zhu Guangya] (Beijing: People's Press, 2015), 564–566.

41. Panofsky, "Diary, May 13–25, 1988," 30 (entry for May 23).

42. Ibid. On Zhou Peiyuan and Pugwash, see Gordon Barrett, "China's 'People's Diplomacy' and the Pugwash Conferences, 1957–1964," *Journal of Cold War Studies* 20, no. 1 (Winter 2018): 140–169.

43. Oren Schlein, "[Transcript of] Meeting to Explore Possible Future Discussions between CISAC of the U.S. National Academy of Sciences and an Appropriate Committee of PRC Scientists," Institute of High Energy Physics, Beijing, China, May 23, 1988, and attached invitation list, Panofsky Papers, ser. V, box 51, folder 1. On Panofsky and Xie, see Zuoyue Wang, "China, *Sputnik*, and American Science," *APS [American Physical Society] News* 20, no. 10 (Nov. 2011): 4, 7.

44. Schlein, "[Transcript of] Meeting," 2. See also Panofsky, "Diary, May 13–25, 1988," 31.

45. Schlein, "[Transcript of] Meeting," 2.

46. Ibid., 2–3.

47. Ibid.

48. Douglas Martin, "Gen. Lew Allen, Who Lifted Veil on Security Agency, Is Dead at 84," *New York Times*, Jan. 9, 2010, D8; oral history interviews with Lew Allen Jr. by Heidi Aspaturian, 1991 and 1994, accessed Jan. 2018, http://oralhistories.library.caltech.edu/203/1/Allen%2C_L._OHO.pdf. Allen was the first National Security Agency director to publicly testify in the US Congress in 1975. He was elected a member of the National Academy of Engineering in 1978.

49. Schlein, "[Transcript of] Meeting," 2. For more on Garwin, see Wang, *In Sputnik's Shadow*, esp. 187, 247, 297–298, 303; Joel Shurkin, *True Genius: The Life and Work of Richard Garwin* (Amherst, NY: Prometheus Books, 2017).

50. Schlein, "[Transcript of] Meeting," 3.

51. Ibid., 5.

52. Ibid., 6.

53. Ibid.

54. Ibid., 9.

55. Ibid., 10.

56. Wolfgang Panofsky, "The Prospects for Deep Cuts in Nuclear Armaments: The Role of China," May 23, 1988, Panofsky Papers, ser. V, box 51, folder 1.

57. Schlein, "[Transcript of] Meeting," 21.

58. Interview with He Zuoxiu by Xiong Weimin, July 30, 2014, Beijing, transcript available in Documentation Center of the Research Office on the History of the Chinese Academy of Sciences, the University of the Chinese Academy of Sciences, Beijing; interview with He Zuoxiu by Zuoyue Wang, July 15, 2016, Beijing. On He Zuoxiu's roles in the Chinese politics of science, see also H. Lyman Miller, *Science and Dissent in Post-Mao China: The Politics of Knowledge* (Seattle: University of Washington Press, 1996); H. Lyman Miller, "Xu Liangying and He Zuoxiu: Divergent Responses to Physics and Politics in the Post-Mao Period," *Historical Studies in the Physical and Biological Sciences* 30, no. 1 (1999): 89–114. In the interview with me he did acknowledge Panofsky's contributions to the development of China's high-energy physics and to international arms control efforts.

59. Interview with Wolfgang Panofsky by Zuoyue Wang, Jan. 23, 1998, Berkeley, CA.

60. Interview with He Zuoxiu by Xiong Weimin, July 30, 2014, Beijing; interview with He Zuoxiu by Zuoyue Wang, July 15, 2016, Beijing; Panofsky, *Panofsky on Physics, Politics, and Peace*, 154. In the 2000s and 2010s, He Zuoxiu actually became very critical of rapid Chinese expansion in civilian nuclear power. See He Zuoxiu, "Bixu tingzhi heneng fazhan de 'dayuejin'" [The "Great Leap Forward" in nuclear energy development must be stopped], *Huanqiu shibao* [Global times], Feb. 24, 2012, accessed Jan. 2018, http://opinion.huanqiu.com/1152/2012–02/2466570.html.

61. Schlein, "[Transcript of] Meeting," 28.

62. Ibid., 11.

63. Ibid., 21.

64. Panofsky, "Diary, May 13–25, 1988," 33 (entry for May 23).

65. Ibid.

66. Schlein, "[Transcript of] Meeting," 16–22.

67. Panofsky, "Diary, May 13–25, 1988," 33 (entry for May 23).

68. Schlein, "[Transcript of] Meeting," 30.

69. Panofsky, "Diary, May 13–25, 1988," 30–34 (entry for May 23).

70. On Lee and the test ban, see Wang, *In* Sputnik*'s Shadow*, 229.

71. Panofsky, "Diary, May 13–25, 1988," 31 (entry for May 23).

72. Ibid., 34. As an example of the benefits for internal communication from transnational interactions, Panofsky recorded (35) that his mention of the Chinese interest in a quota test ban caught the attention of Lord and his staff, who had actually never heard of such a proposal before.

73. Ibid., 34.

74. Ibid.

75. Zou Yunhua, "Shenqie huainian enshi yiyou Zhu Guangya" [Cherishing deeply the memory of my mentor and friend Zhu Guangya], in Bianjizu [Editorial group], *Fengfan changcun tiandijian: Zhu Guangya tongzhi shishi yizhounian jinian wenji* [Lasting legacy in the world: Memorial essays one year after the passing of Comrade Zhu Guangya] (Beijing: People's Press, 2012), 228–237, at 233.

76. Xi, *Zhu Guangya zhuan*, 566.

77. Zou Yunhua, "Shenqie huainian," 231. Among CISAC members in this period, Panofsky was director emeritus of SLAC, Michael May was associate director at large of the Lawrence Livermore National Laboratory, and Lew Allen Jr. was director of the Jet Propulsion Laboratory. All three laboratories were owned by the US government but managed by Stanford University, the University of California, and the California Institute of Technology, respectively.

78. Wolfgang Panofsky, "Trip Report: People's Republic of China, October 3–9, 1988," and Wolfgang Panofsky, "Diary, October 3–9, 1988," Panofsky Papers, ser. V, subser. P, box 51, folder 3.

79. Panofsky, "Diary, May 13–25, 1988," 33 (entry for May 23).

80. On Steinbruner, see Bart Barnes and David Hoffman, "John D. Steinbruner, Scholar of Foreign and Defense Policy, Dies at 73," *Washington Post*, Apr. 25, 2015, accessed Jan. 2018, https://goo.gl/DoQ3az.

81. "CISAC China Workshop, September 13, 1988, Participants," Sept. 14, 1988, box 5, folder 4, "Trip Report China and Russia," and "CISAC China Workshop . . . September 13, 1988 Agenda," box 5, folder 5, "Travel China NAS-

CISAC 1988," both in Michael May Papers, Lawrence Livermore National Laboratory Archives, Livermore, CA.

82. Michael M. May, "Foreign Trip Report," 1, Oct. 24, 1988, box 5, folder 4, "Trip Report China and Russia," May Papers.

83. Panofsky, "Diary, October 3–9, 1988," 9 (entry for Oct. 6).

84. "Chinese Participants," undated, box 5, folder 5, "Travel China NAS-CISAC 1988," May Papers. Because of his involvement in discussions with CISAC, Huang Zuwei helped start studies on arms control among China's aerospace experts. See Medeiros, *Reluctant Restraint*, 230.

85. Most leading Chinese scientists in the twentieth century had overseas-study background, and the union in question also included those who had studied in the Soviet Union and Russia. On the transnational features of modern Chinese science, see Wang, "The Cold War and the Reshaping of Transnational Science in China." In 2016 the Chinese party-state made the union much more a part of the government in an effort to attract Chinese scientists and students currently studying abroad to return to China to aid its drive to become a "strong power in science and technology [*keji qiangguo*]." See Xinhua Press Agency, "Zhonggong zhongyang bangongting yinfa 'guanyu jiaqiang Oumei Tongxue Hui (liuxuerenyuan lianyihui) jianshe de yijian'" [The Executive Office of the Central Committee of the Chinese Communist Party prints and distributes "Suggestions on strengthening the Union of Chinese Students Who Have Returned from Study Abroad in Europe and America (Association of Those Who Have Returned from Study Abroad)"], *People's Daily*, Aug. 3, 2016, accessed Jan. 2018, http://politics.people.com.cn/n1/2016/0803/c1001–28608880.html.

86. Michael May, "Arms Control in Space," Sept. 23, 1988, box 5, folder 4, "Trip Report China and Russia," May Papers.

87. Du Xiangwan, "Relations among Space Arms Control, Nuclear Disarmament and Nuclear Test Ban—the Necessity and Possibility for a Convention on the Prohibition of Outer Space Weapons," and Huang Zuwei, "Non-weaponization of Outer Space," Panofsky Papers, ser. V, subser. I, box 138, folder 4, "China Trip—CISAC/PRC Arms Control Discussion."

88. Du, "Relations," 4.

89. Huang, "Non-weaponization," 7.

90. May, "Foreign Trip Report," 2.

91. Ibid.

92. Ibid., 3.

93. Panofsky, "Diary, October 3–9, 1988," 10 (entry for Oct. 8).

94. Ibid.

95. Hu Side, "Zhu zhuren wei women zhiming fazhan fangxiang" [Chairman Zhu pointing the way for our development], in Bianjizu [Editorial group], *Fengfan changcun tiandijian*, 116–117.

96. Gu and Zhu, *Women de fuqin Zhu Guangya*, 199–200.

97. Zhu is quoted in ibid., 200–201.

98. Ibid., 199–202; Panofsky, *Panofsky on Physics, Politics, and Peace*, 163–164. Trump's statements on nuclear weapons, widely viewed as reckless, during his presidential campaign and his early presidency led two Democratic lawmakers to propose a bill in January 2017 to commit the United States to a no-first-use nuclear policy, but it had little hope of passing because of expected opposition by the Republican majority in Congress. See Emily Tamkin, "Lawmakers Introduce Bill Restricting First Use of Nuclear Weapons," *Foreign Policy*, Jan. 24, 2017, accessed Feb. 2017, http://foreignpolicy.com/2017/01/24/senator-and-congressman-introduce-restricting-first-use-of-nuclear-weapons-act-trump/.

99. Gu and Zhu, *Women de fuqin Zhu Guangya*, 130.

100. Qian, "Zhu Guangya," 73.

101. Zhu is quoted in Xi, *Zhu Guangya zhuan*, 570.

102. Panofsky, *Panofsky on Physics, Politics, and Peace*, 154. On recent developments, see Bates Gill, "China and Nuclear Arms Control: Current Positions and Future Policies," *SIPRI Insight on Peace and Security*, Apr. 2010, accessed Dec. 2013, http://books.sipri.org/product_info?c_product_id=406.

103. See the CISAC's website (accessed Oct. 2016), http://sites.nationalacademies.org/pga/cisac/index.htm. The glossary is available there for free downloading.

104. Richard Garwin, "Maintaining International Dialogue," *Proceedings of the National Academy of Sciences* 111, suppl. 2 (June 24, 2014): 9333–9334, at 9334.

105. Ibid. See also Nancy Prindle, "The U.S.-China Lab-to-Lab Technical Exchange Program," *Nonproliferation Review*, Spring–Summer 1998, 111–118.

106. For the Cox Report, see *Report of the Select Committee on U.S. National Security and Military/Commercial Concerns with the People's Republic of China*, House Report 105-851, https://www.gpo.gov/fdsys/pkg/GPO-CRPT-105hrpt851/pdf/GPO-CRPT-105hrpt851.pdf.

107. Richard Stone, "Atomic Bonding," *Science* 357, no. 6354 (Sept. 1, 2017): 862–865.

108. See Zuoyue Wang, "Scientists and Arms Control: The US-China Case and Comparisons with Climate Change," paper presented at the conference "Nuclear Arms Control and Climate Change Negotiations: Shared Lessons and Possibilities," University of Texas, Austin, Jan. 2014.

109. Zou, "Shenqie huainian," 232.

110. David E. Sanger, "No. 2 Negotiators in Iran Talks Argue Physics beyond Politics," *New York Times*, Mar. 29, 2015, A1.

111. Spurgeon M. Keeny Jr., "In Memoriam: Wolfgang K. H. Panofsky," *Arms Control Today* 37, no. 9 (Nov. 2007): 51–52; William J. Broad, "29 U.S. Sci-

entists Praise Iran Nuclear Deal in Letter to Obama," *New York Times*, Aug. 9, 2015, A8; William J. Broad, "Top Scientists Urge Trump to Abide by Iran Nuclear Deal," *New York Times*, Jan. 3, 2017, A13.

112. John Krige, "Elements for a Transnational History of Knowledge Circulation in the Cold War," paper presented at workshop "Writing the Transnational History of Science and Technology," Georgia Institute of Technology, Atlanta, Nov. 2016. See also Barth, "Catalysts of Change."

113. Matthew Evangelista, *Unarmed Forces: The Transnational Movement to End the Cold War* (Ithaca, NY: Cornell University Press, 1999).