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U.S.-China scientific exchange: A case study of state-sponsored scientific internationalism during the Cold War and beyond

IN FEBRUARY 1972 President Richard Nixon of the United States embarked on his historic journey to Beijing. The dramatic trip not only opened a new era in U.S.-China relations, but also began an exciting process of mutual discovery between the two peoples. If it is true that, as the China scholar A. Doak Barnett wrote, "never in the modern period have two major societies been so isolated from each other for so long in peacetime," the end of the schism also brought forth unprecedented exchanges in many walks of life, especially in academia.[1] The geopolitical move by the two countries to counter Soviet aggression paved the way for interactions in science and other fields. The contacts flourished through the 1970s and expanded even further after the establishment of diplomatic relations and the launching of China's economic reforms by the end of the 1970s. This intellectual open door proved to have profound social and political, as well as scientific, impact, especially in China, which had just begun to emerge from the devastating Cultural Revolution of 1966-1976.

Despite its considerable significance, scientific exchange has often been treated as a sideline in U.S.-China relations. Several excellent studies examine U.S.-China academic and educational exchanges, but they barely touch on the scientific com-

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1. A. Doak Barnett, *China and the major powers in East Asia* (Washington, D.C., 1977), 178, as quoted in Harry Harding, *A fragile relationship: The United States and China since 1972* (Washington, D.C., 1992), 33; Leo A. Orleans, *Science in China and U.S.-China scientific exchanges: Assessment and prospects* (Washington, D.C., 1976), 11, estimated in 1976 that about 10,000 Americans visited China between 1971 and 1976.

ponents, thus obscuring the part that science and technology played in the developing relationship. Most of these studies focus on the impact of academic exchanges in the U.S. and leave the political, social, and cultural impact of such exchanges on Chinese society unexamined.[2]

This paper examines the U.S.-China scientific reopening as a case study of scientific nationalism and internationalism. Here we are concerned not so much with specific exchange projects as with the political context and implications of the exchange as a whole. What, for example, did the exchange mean to Chinese science and Chinese scientists, many of whom had suffered, along with other intellectuals, horrible persecution at the hands of Mao Zedong's radical Red Guards during the Cultural Revolution? How did American scientists respond to the new opportunities? Above all, what does this story of scientific exchange tell us about scientific nationalism and internationalism during the Cold War?

In considering these questions, we will look not only at the two national scientific communities involved but at also the special subnational group of Chinese American scientists who were crucial in the forging of this new international scientific network. They, along with Chinese scientists who were trained in the U.S. in the 1930s and 1940s, helped to stimulate and sustain the exchange program. In turn, the U.S.-China reopening did much to give them a political voice and helped them form a distinct scientific community. The narrative covers mainly the period from 1971, when the first moves in the reopening took place, up to 1989, when the Chinese government's crackdown on the pro-democracy demonstration at Tiananmen Square produced a hiatus in the exchange and introduced new dynamics in U.S.-China relations. But we will also take a brief look at the 1990s, when this community of Chinese American scientists evolved into a transnational scientific network of the Chinese diaspora and when some of these scientists were accused by the U.S. government of spying for China in the areas of nuclear and defense technologies. The present study thus examines interactions of scientific communities at three levels, the subnational, the national, and the international, during the Cold War and beyond.

2. David M. Lampton, *A relationship restored: Trends in U.S.-China educational exchanges, 1978-1984* (Washington, D.C., 1986); Leo A. Orleans, *Chinese students in America: Policies, issues, and numbers* (Washington, D.C., 1988). See also Kathlin Smith, "The role of scientists in normalizing U.S.-China relations, 1965-1979," and Richard P. Suttmeier, "Scientific cooperation and conflict management in U.S.-China relations, 1978 to the present," unpublished papers, 1998, courtesy of the authors; Denis Fred Simon, "The role of science and technology in Chinese foreign relations," in Samuel S. Kim, ed., *China and the world: Chinese foreign policy in the post-Mao era* (Boulder and London, 1984), 293-318. There is also little written about U.S.-Taiwan scientific exchange, which should make a fascinating comparison with the U.S.-China case. Although it is beyond the scope of the present paper, I intend to address aspects of that story in the future.

State-sponsored scientific internationalism

The U.S.-China scientific exchange provides a case of what might be termed state-sponsored scientific internationalism during the Cold War, when nation-states, often for geopolitical reasons, established the framework for communication and collaboration among scientists across national boundaries. This was in contrast to the more traditional, private form of scientific internationalism that relied on personal scientific communication before World War II. Prominent examples of the latter included the travel of scientists to enemy territories in the eighteenth and nineteenth centuries to conduct scientific research.[3] The state was mostly absent or passive. Nationalism did surge during and immediately following World War I, as Entente scientists launched a boycott against their German colleagues. Max Planck lamented the division as an "unnatural mixture of science and politics."[4] Yet, it was often the national scientific communities, in Germany and elsewhere, rather than the governments, that most actively promoted or manipulated the ideology of scientific nationalism.[5] In the interwar years, "private" internationalism soon revived as physicists from around the world, often financed by the Rockefeller Foundation, traveled to Germany, Denmark, and England to study the new quantum mechanics and nuclear physics. Chinese scientists also benefited from and joined in this movement of people and ideas. Most pioneering Chinese physicists in the modern era, for example, received their graduate training in the U.S. or Europe in the early twentieth century. Chinese biologists exchanged specimens with colleagues in the West.[6]

World War II, especially the Manhattan Project, started state internationalism in science in earnest, although traditional, personal networks among scientists continued to play an important role. To make the atomic bomb, the U.S., Britain, and Canada pooled resources and scientists under formal governmental agreements. During the ensuing Cold War, state internationalism flourished when the world was divided into two hostile camps in the late 1940s and 1950s, and persisted even when realignment and détente in the 1960s and 1970s changed the early pattern of bipolar conflict. Both the NATO and Warsaw-pact alliances sponsored fraternal scientific cooperation. The U.S. and Britain exchanged information, albeit limited, on nuclear weapons. Scientists from the Eastern bloc worked with each other

3. Lawrence Badash, "British and American views of the German menace in World War I," Royal Society of London, *Notes and records, 34* (1979), 91-121.
4. J.L. Heilbron, *The dilemmas of an upright man: Max Planck as spokesman for German science* (Berkeley, 1986), 104.
5. Ibid., 109; Paul Forman, "Scientific internationalism and the Weimar physicists: The ideology and its manipulation in Germany after World War I," *Isis, 64* (1973), 151-180; Daniel Kevles, "'Into hostile political camps': The reorganization of international science in World War I," *Isis, 62* (1971), 47-60.
6. Peter Neushul and Zuoyue Wang, "Between the devil and the deep sea: C.K. Tseng, ocean farming, and the politics of science in modern China," unpublished paper.

at the Dubna nuclear research center in the Soviet Union.[7] Using Dubna's 10-GeV accelerator, Chinese physicists led by Wang Ganchang discovered an elementary particle, the anti-sigma negative hyperon, in the late 1950s, widely regarded as the only major achievement in the history of that machine.[8] Until the Sino-Soviet split became public in the early 1960s, thousands of Soviet scientists and engineers also went to work in China as advisors. China sent students, scientists, and engineers to study and visit the Soviet Union.[9] Indeed, state-sponsored scientific internationalism was used both to heighten and mediate tensions in the Cold War.[10] Throughout the Cold War, the U.S. and the Soviet Union implemented cooperative projects in science, technology, and education—for example, an agreement on co-operation in peaceful nuclear energy was signed in 1959—but such exchanges were often marred by suspicion and heavy political control on both sides.[11]

U.S.-China scientific contacts

U.S.-China scientific contacts during the Cold War followed the same pattern of state domination, as the governments determined the nature and degree of exchanges, if any, on the basis of international and domestic politics. When the Chinese Communists took over the mainland in 1949, American scientists lost touch with their many former students and colleagues in China. The situation improved somewhat after the end of the Korean War in the mid 1950s, but the poor relationship between the U.S. and China resumed and caused great difficulties in several international scientific projects in this period, such as the International Geophysical Year of 1957-58. China withdrew from the IGY when the U.S.-led organizing

7. In 1961, for example, the U.S. National Institutes of Health (NIH) spent about $20 million overseas and planned to double it the next year. Eugene B. Skolnikoff to Jerome B. Wiesner, 13 Oct 1961 (National Archives, Office of Science and Technology Records (RG 359), box 87, folder "International—T[itle] F[older] 1961"). On the Soviet imposition of its state-dominated model in the East bloc, see Gábor Palló, "Internationalism in Soviet world-science: The Hungarian case," in Elisabeth Crawford et al., eds., *Denationalizing science* (Dordrecht, 1993), 209-232.
8. Hu Jimin et al., eds., *Wang Gangchang he tade kexue gongxian* (*Wang Ganchang and his scientific contributions*) (Beijing, 1987).
9. Mikhail A. Klochko, *Soviet scientist in Red China*, trans. Andrew MacAndrew (New York, 1964).
10. The tortuous histories of the Geneva conference on Atoms for Peace of 1955, the International Geophysical Year (IGY) of 1957-1958, and the 1958 Geneva Conference of Experts on a nuclear test ban illustrate the tension between international science and national security concerns. See Walter McDougall, *The heavens and the earth: A political history of the space age* (New York, 1985), 118-121; Robert A. Divine, *The Sputnik challenge* (New York, 1993).
11. Robert F. Byrnes, *Soviet-American academic exchanges, 1958-1975* (Bloomington, 1976); Glenn T. Seaborg, *Kennedy, Khrushchev, and the test ban* (Berkeley, 1981), 201-203.

committee allowed Taiwan, which China regarded as a renegade province, to join.[12] The few contacts that did take place between American and Chinese scientists in this period produced only misunderstandings and frustrations on both sides, often in highly politicized circumstances. At the Pugwash conference in Moscow in 1960, for example, Jerome Wiesner, then a professor of electrical engineering at MIT and soon to be appointed science advisor to President-elect John Kennedy, shook hands with Zhou Peiyuan, a U.S.-trained physicist and chairman of the Chinese delegation. Wiesner told Zhou that he was a close friend of Kennedy's and was interested in contacts with China. Before the Chinese could make a positive response to this overture, however, they found in Wiesner's paper distributed at the conference statements on the need for the U.S. and the Soviet Union to work together to contain a militant China. Belligerency became self-perpetuating at the very forum that was designed to prevent.[13]

Wiesner's conflicting signals reflected Kennedy's ambivalence. On the one hand, Kennedy believed that China was a more unpredictable and dangerous threat to world peace than the Soviet Union. Thus, he hoped that the Limited Test Ban Treaty among the U.S., Britain, and the Soviets in 1963 would help curb Chinese nuclear ambitions. This proved an unrealistic goal, given the little leverage either the U.S. or the Soviet Union had on China.[14] On the other hand, Kennedy believed that scientific exchange across the Iron Curtain, especially with Eastern Europeans, would help relax the Cold War tension. His liberal policy encouraged American scientists to knock on China's door. In 1962, Luis Alvarez, a Berkeley physicist whose mother was born in China to missionary parents, contacted John Tizo Wilson, a Canadian geophysicist who had recently visited China, in the hope that Wilson and his connections would help him secure an invitation to visit the Chinese Academy of Sciences. To Wilson's skepticism about whether U.S. officials would approve the trip, Alvarez responded that "the State Department has been under new management for the past year" and that he was confident that his government would "consider such a trip in a favorable light."[15]

Months earlier, Walt Whitman, science advisor to the Secretary of State, had advised Harrison Brown, a geochemist at the California Institute of Technology who wanted to invite Chinese scientists for a conference, that the State Department saw no objection, provided that Brown would "select those for invitation whose primary interests are scientific rather than political." Whitman could not,

12. Walter Sullivan, *Assault on the unknown: The International Geophysical Year* (New York, 1961).
13. Yu Guangyuan, "Enshi he zhanyou" ("Beloved mentor and comrade in arms") in *Kexue jujiang, shibiao liufang* (*A great scientist and teacher, a festschrift for Zhou Peiyuan on his 90th birthday*) (Beijing, 1992), 80-86.
14. Gordon H. Chang, "JFK, China, and the bomb," *Journal of American history, 74* (1988), 1287-1300.
15. Luis Alvarez to Claude T. Bissell, 9 Apr 1962 (National Archives, Office of Science and Technology Records (RG 359), box 141, folder "International—Title Folder 1962").

however, guarantee that "anyone invited will be admitted to the U.S."[16] Little success came to these private initiatives by American scientists. Under President Lyndon Johnson, the Vietnam War, which was ostensibly fought to contain Chinese expansion, coupled with the Chinese Cultural Revolution made scientific communication between the two sides all the more difficult.[17]

The door for scientific and cultural exchange opened finally with Nixon's trip in 1972.[18] In the famous Shanghai Communiqué signed by Premier Zhou Enlai and Nixon during the visit, science and technology figured prominently in the new bilateral relationship:[19]

> The two sides agreed that it is desirable to broaden the understanding between the two peoples. To this end, they discussed specific areas in such fields as science, technology, culture, sports, and journalism, in which people-to-people contacts and exchanges would be mutually beneficial. Each side undertakes to facilitate the further development of such contacts and exchange.

Both the U.S. and China saw scientific exchange as a neutral, non-ideological route to mutual understanding after so many years of isolation.[20] The U.S. recognized the military implications of technological exchange, but decided to take a calculated risk in the hope that a modernized China would help in the balance against the Soviet Union and thus work in the U.S. national interest. In 1973, for example, U.S. Secretary of State Henry Kissinger made a secret proposal to Premier Zhou Enlai that the U.S. was willing to provide China with early warning intelligence information for satellite images on Soviet missile launchings through a hotline. "We could also give you the technology for certain kinds of radars," Kissinger told Zhou, "but you would have to build them yourselves." Probably due to domestic politics, the Chinese government did not follow up on the offer.[21]

The exchange carried great significance for Chinese leaders concerned with rapid economic development, especially Premier Zhou and his protégé Deng Xiaoping, who would become supreme leader of China in 1978 after Mao and

16. Walter G. Whitman to Harrison Brown, 10 May 1961 (National Archives, Office of Science and Technology Records (RG 359), box 87, folder "International—Chicom [Chinese Communists").
17. Neushul and Wang (ref. 6).
18. Henry Kissinger, *White House years* (Boston, 1982), 693, 705; Harding (ref. 1), 35-36, 394-395.
19. Kissinger (ref. 18), 1490-1492, quote on 1492.
20. Another example of scientific internationalism paving the way for sensitive diplomatic overtures occurred in Chinese-Israeli relations. See "Israel will open liaison office in China," *Los Angeles Times* (11 June 1990), A7; Lena H. Sun, "China sets official ties with Israel," *Washington Post* (25 Jan 1992), A14.
21. Memorandum of conversation between Kissinger, Zhou, and others, Beijing, 13 Nov 1973, in William Burr, ed., *The Kissinger transcripts: The top-secret talks with Beijing and Moscow* (New York, 1998), 204.

Zhou died in 1976. These modernizers had always viewed science and technology as the key to Chinese modernization and sought ways to import foreign technology.[22] For this purpose, they had turned to the Soviets in the 1950s and the Europeans in the 1960s. In early 1966, Zhou had urged in a talk with Chinese diplomats that they should learn enough science and technology to be able to coordinate the process of absorbing scientific and technological information from the countries where they were stationed.[23] During the latter phase of the Cultural Revolution, Zhou and Deng again attempted to revitalize Chinese science and technology. Shortly after the Nixon trip in 1972 Zhou Enlai presented to the country an ambitious plan of modernizing Chinese science and technology, agriculture, industry, and defense.[24]

In many ways, Zhou became the gatekeeper in scientific exchange with the U.S. in the early 1970s. He personally negotiated the first formal academic exchange agreement with the Committee on Scholarly Communication with the People's Republic of China (CSCPRC) in 1973, a semi-official group formed in the U.S. in 1966 by the National Academy of Sciences, the American Council of Learned Societies, and the Social Sciences Research Council to promote contacts with Chinese scientists. During a session with the CSCPRC delegation on May 27, 1973, in Beijing, Zhou gave his blessing to nine scientific areas of cooperation that ranged from earthquake predictions to acupuncture to anthropology. But he excluded three social science projects (China studies, urban studies, and science and technology in China's development) as requiring further preparation.[25]

Zhou viewed scientific exchange with the U.S. with great personal interest and sought to ensure that the framework of exchange would survive personnel changes at the top of both governments, especially in view of Nixon's domestic political troubles. Glenn T. Seaborg, Nobel laureate and professor of chemistry at UC Berkeley, who was a member of the CSCPRC delegation, recorded a telling anecdote.

22. Zhou Enlai, "Jiancheng shehuizhuyi qiangguo, guanjian zaiyu shixian kexue jishu xiandaihua" ("To build a strong socialist nation, the key is modernization in science and technology"), a talk at a conference on science and technology in Shanghai on 29 Jan 1963, *Zhou Enlai xuanji* (*Selected papers of Zhou Enlai*) (2 vols., Beijing, 1984), *2*, 412-416.
23. Zhou Enlai, "Zhuajin kexue jishu kaoca" ("Strengthen the study of [foreign] science and technology"), a talk with Chinese diplomats on 13 Feb 1966, *Zhou Enlai waijiao wenxuan* (*Selected diplomatic papers of Zhou Enlai*) (Beijing, 1990), 458-459.
24. Zhou Enlai, "Xiang sige xiandaihua de hongwei mubiao qianjin" ("March toward the grand goal of the four modernizations") excerpt from "Report on the work of the government" at the Fourth National People's Congress delivered on 13 Jan 1975, *Zhou Enlai xuanji* (ref. 22), *2*, 412-416. The full report is reprinted in *Renmin Ribao* (*People's daily*) (21 Jan 1975).
25. Although disappointed by these deletions, the American group was nevertheless delighted to hear Premier Zhou promise that China would consider sending some students to study in the U.S. See Glenn T. Seaborg, "China journal: Report of a visit to the People's Republic of China," 22 May—10 June 1973; unpublished manuscript courtesy of Professor Seaborg, 29-39; Smith (ref. 2).

When the CSCPRC meeting in the Great Hall ended, Seaborg wrote in his diary, Zhou shook hands with delegation members and commented to Emil L. Smith, biochemist at UCLA and CSCPRC chairman, that he understood that the committee was formed in the mid-1960s but was only effective after Nixon's contacts with the Chinese leaders. "Doesn't this mean that President Nixon has done something good?" Zhou asked. Emil Smith agreed. Then the premier threw up his hands and said, "But oh, Watergate!" When Smith reassured Zhou that he did not think that the political turmoil in the U.S. would affect U.S.-China relations or scientific exchanges, "the premier took Smith's hand in both of his hands and gripped it."[26]

Reactions of American scientists

Following this meeting with Zhou Enlai, the CSCPRC, operating within the National Academy of Sciences and with funds from the U.S. government and private foundations, became the *de facto* liaison in the U.S. for academic exchanges with China. It sponsored American delegations in almost all major scientific fields to visit China, usually for several weeks. Upon their return, these groups published detailed reports about the status of Chinese science, technology, and education and made suggestions for future exchanges.[27] The committee also arranged for the visits of Chinese delegations to the U.S.[28] Although these early, brief exchanges were sometimes criticized as "scientific tourism" by American scientists who wanted to expand the depth and length of contacts, they proved to be enormously useful to Chinese scientists who needed information about the state of the art in various fields of science, information which could only come from personal contacts. More substantial collaboration became possible following the establishment of diplomatic relations in 1979.

The U.S.-China exchange also gave American scientists, especially former government advisers such as the alumni of the President's Science Advisory Committee (PSAC), a chance to pursue arms control through an outside channel. For many of them, the Federation of American Scientists (FAS) now became their institutional platform of choice, and the FAS happily met with a favorable reception by the Chinese government as a progressive scientific group. American scientists seized the opportunity to show a skeptical U.S. government that traditional

26. Seaborg (ref. 25), 39.
27. See, for example, the following trip reports published by the CSCPRC: *Astronomy in China: A trip report of the American Astronomy Delegation* (1979); *Oceanography in China: A trip report of the American Oceanography Delegation* (1980); *Pure and applied mathematics in the People's Republic of China: A trip report of the American Pure and Applied Mathematics Delegation* (1980); *Solid state physics in the People's Republic of China: A trip report of the American Solid State Physics Delegation* (1976); *Nuclear science in China* (1980).
28. Anne Keatley, ed., *Reflections on scholarly exchange with the People's Republic of China, 1972-1976* (Washington, D.C., n.d.).

scientific internationalism could still play a positive role in international Cold War politics. Thus, Wiesner, now president of MIT, and IBM's Richard Garwin, a former member of PSAC, both active in the FAS, sought and received opportunities to engage Chinese physicists in arms-control discussions, even in the early 1970s. Despite their earlier conflict at the Moscow Pugwash meeting in 1960, Zhou Peiyuan hosted a visit by Wiesner to China and arranged his meeting with other scientists interested in arms control.[29] In contrast to the high visibility and formality of U.S.-Soviet conferences on arms control throughout the Cold War, contacts in arms control by Chinese and American scientists have been kept low-key, even to the present day. They are believed by the participants to be useful in helping educate the Chinese government and scientists about the dynamics of the arms race and the need for arms control.

Impact on Chinese scientists

Despite, or perhaps because of, the geopolitical designs of the Chinese government, Chinese scientists stood to reap the greatest benefit from the U.S.-China reopening and scientific exchange. During the Cultural Revolution, thousands of Chinese scientists, especially those senior scientists trained in the U.S. and Europe, were accused of being reactionary bourgeois academic authorities and American or Western agents and spies. Hundreds were killed or committed suicide and many more suffered persecution.[30] Chinese scientific and educational institutions stopped functioning from the beginning of the Cultural Revolution in 1966 to about 1970. Universities admitted no new students for those years; laboratories and libraries were abandoned; professors and students, like much of the rest of the society, were engaged in political campaigns, either as victims or victimizers. International exchange stopped completely.[31] By the early 1970s, the Cultural Revo-

29. Richard Garwin, "China trip: Transcribed notes of a trip to the Chinese People's Republic, March 18 to April 17, 1974," 21 June 1974, and Garwin, "Discussion at Chinese People's Institute for Foreign Affairs, December 10-12, 1979," 17 Dec 1979, unpublished manuscripts courtesy of Dr. Garwin; Laya Wiesner, "China notes: Jerome and Laya Wiesner's visit to People's Republic of China, October 1974" (Committee on Scholarly Communication with China Archives, George Washington University Library, Washington, D.C.).
30. Yao Shuping, Luo Wei, Li Peishan, and Zhang Wei, *Zhongguo kexueyuan* (*Chinese Academy of Sciences*), Vol. 1 (3 vols., Beijing, 1994); Zuoyue Wang, "Revolutionary utilitarianism: Science and political ideology in China, 1949-1976," a paper presented at the workshop on "Science and political ideology," Union College, Schenectady, NY, Aug 1997.
31. Only in November 1972 did the State Council approve a report of the Chinese Academy of Sciences that allowed the exchange of scientific books and journals with foreign countries. See Wu Heng, *Keji zhanxian wushinian* (*Fifty years on the scientific and technological front*) (Beijing, 1992), 362. Wu was a long-time science administrator in the Chinese Communist Party. One reason Zhou said that China needed to do some preparation before receiving foreign scientists was that during the Cultural Revolution most research had stopped, so there was not much to show. See Zhu Kezhen, *Zhu Kezhen riji* (*Zhu Kezhen diary*), Vol. 5 (5 vols., Beijing, 1990), 553, entry for 14 Sep 1972.

lution was past its most violent phase, but the national economy neared collapse. Mao decided to reestablish order and revive the institutional structure of Chinese society, including scientific research and higher education.[32] The downfall in this period of Chen Boda, a party ideologue in charge of science, and the death of Lin Biao, chief of the People's Liberation Army and Mao's heir apparent, in a plane crash while fleeing to the Soviet Union after a failed coup against Mao, marked a major turning point in Chinese politics and helped improve the situation of scientists.[33] Some scientists regained limited work possibilities, although ideological control was far from being relaxed. The powerful Gang of Four, led by Mao's wife, Jiang Qing, and often acting with his consent, continued to impose a reign of radical terror. They often targeted and attacked Zhou as a major obstacle on their route to leadership of China after Mao's death.

The stunning reversal of U.S.-China relations and images of Mao Zedong and Zhou Enlai shaking hands with Richard Nixon in the midst of the political turmoil brought political relief to many scientists. When visiting American scientists asked to see Chinese scientists whom they knew from the past, the attention often helped to improve the personal and professional conditions of these scientists.[34] About fifty Chinese scientists and science administrators, for example, participated in Zhou's meeting in 1973 with the CSCPRC delegation. Seaborg recalled that the Chinese scientists showed obvious pleasure in this rare opportunity to meet with Zhou and their American colleagues and that the meeting greatly "increased their legitimacy in China."[35]

Before Mao's death and the arrest of the Gang of Four in 1976, however, Chinese scientists ran political and personal risks by taking part in exchanges. As Seaborg learned when he revisited China in 1978, the cordial reception given to him in 1973 by Qian Sanqiang, a nuclear physicist and a major architect of the Chinese nuclear weapons project, got Qian into trouble with followers of the Gang.[36] Chinese scientists who went on official visits to the West were viewed with suspicion upon their return. The Chinese Academy of Sciences suppressed recommendations on science policy made by the first delegation of Chinese scientists who visited Europe and the U.S. in 1972, for fear of painting too bleak a picture of Chinese science in comparison with Western advances. The act drew the ire of Zhou Enlai, who called it an "arrogant" decision: "This does not correspond to Mao Zedong Thoughts. The purpose of visiting and touring abroad was to learn the advances of others."[37]

32. Wu (ref. 31), 353-354.
33. Ibid., 346-356.
34. Neushul and Wang (ref. 6).
35. Seaborg (ref. 25), 39.
36. Glenn T. Seaborg, "China revisited: May 14 - June 11, 1978," report prepared for the U.S. Department of Energy, courtesy of Professor Seaborg; interview with Seaborg by Zuoyue Wang, 3 Mar 1992, Berkeley.
37. Wu (ref. 31), 361. In 1975, a scientific delegation visited the U.S. under the leadership

The significance of the U.S.-China scientific exchange should also be viewed in the context of a major politically and ideologically charged science policy debate over basic research. During the Cultural Revolution, scientists had defended basic research as the foundation of technological advances; the radicals denounced it as a reactionary bourgeois ideology of science.[38] In early 1970, some senior scientists associated with the Chinese Academy of Sciences, who fortunately had escaped the worst of the violence, sought to rehabilitate basic research and thus reorient Chinese science policy from the radical Maoist emphasis on production.[39] Zhou Enlai encouraged them when he directed on January 2, 1970, that the Chinese Academy of Sciences should aim at advancing research in selected fields: "The Academy of Sciences should utilize the brilliant thoughts of Mao Zedong to critically absorb and develop theories in the natural sciences."[40] To avoid the political problem of pure science for its own sake, Zhu Kezhen, a meteorologist and vice-president of the Chinese Academy of Sciences, proposed that the academy adopt a science policy that would advance both disciplinary development and practical applications. Instead of engaging in Big Science projects on elementary particles, the origin of life, or cosmological evolution, he suggested that the academy focus on the study of the structure of matter, which included not only solid-state physics but also cell biology and polymer chemistry.[41]

Zhu's hope for a moderate science policy was soon dashed, if only temporarily, when the Chinese Academy of Sciences held a lengthy conference on scientific planning that lasted from January 5 to March 17, 1971.[42] At the meeting, Zhou Enlai, despite his own sympathy for basic research, had to implement Mao's policy of closely tying science to practical applications and reducing government bureaucracy by turning over many of the academy's research institutes to local governments, the military, and ministries of production. The academy was nearly dissolved as a result. Furthermore, the official report of the symposium accused scientists of "lacking in political awareness, lacking in feeling for the workers-peasants-soldiers, and lacking in practical skills."[43] Meanwhile, another long-running national conference on education, from April 15 to July 31, 1971, reopened Chinese universities after a five-year hiatus, but with a new radical education policy.

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of Zhou Peiyuan and the marine biologist Zeng Chengkui (C.K. Tseng), including a warm reception with President Gerald Ford in the White House. Upon their return, however, delegation members found that politics had removed their original sponsors from power and they themselves became target of attacks. See Neushul and Wang (ref. 6).

38. Wang (ref. 30); Richard Suttmeier, *Research and revolution: Science policy and societal change in China* (Lexington, MA, 1974).

39. Zhu (ref. 31), entries for 6-14 Jan 1970.

40. Wu (ref. 31), 363.

41. Zhu (ref. 31), entries for 6-14 Jan 1970.

42. Long conferences were common in China, probably due both to inefficiency and to the substantial time devoted to political and ideological studies.

43. Wu (ref. 31), 347-349.

High school students had to work several years after graduation before they could go to college on recommendations of local party leaders. The curriculum emphasized practical skills over theoretical training.[44]

Foreign scientists visiting Chinese universities in the early 1970s were impressed by the emphasis on practical applications, but many of them also questioned the lack of balance. Among those who raised the issue of basic research with Zhou Enlai was Chen Ning Yang. Yang, a Chinese American physicist then at the State University of New York, Stony Brook, was well known in China for sharing the Nobel prize in physics in 1957 with Tsun-Dao Lee, a Chinese American physicist at Columbia. When the U.S. lifted its ban on travel to China in early 1971, Yang was one of the first Chinese American scientists to take advantage of it. In July 1971, during a meeting with Zhou in Beijing, Yang expressed his concern about the neglect of theoretical training and basic research. This talk gave Zhou a rationale to cast doubt on the effectiveness of the new science and educational policy. In his meeting with the organizers of the education conference, Zhou mentioned his discussion with Yang and told the educational officials to treat the new policy in a spirit of experiment.[45] On his return visit in 1972, Yang made a stronger push for basic research.[46]

Zhou discussed Yang's suggestion with Mao, as he told a group of visiting Chinese American scientists and scholars on July 14, 1972. "Yang's talk was very honest," Zhou said, "the Chairman praised him after reading [the transcript of] his talk." Zhou called on Zhou Peiyuan, present at the meeting as vice-president of Beijing University and the Chinese Academy of Sciences, to help him promote basic research at Beijing University and the country.[47] "I believe that the research institutes in the Academy of Sciences should focus on basic science," the premier wrote Zhou Peiyuan following the meeting. He continued:[48]

> Whenever there was a [political] movement, basic research was always the first to be targeted. For this, the Academy of Sciences should also take some blame, because it was afraid of producing no achievement in the short term and thus becoming a target of attacks. [In fact] the consistent policy of the Party Central

44. Ibid., 349-352.
45 . Ibid., 351; Chen Ning Yang, *Selected papers, with commentary* (San Francisco, 1983), 76-77.
46. Yang (ref. 45), 77-78.
47. Zhou Peiyuan, "'Sirenbang' pohuai jichu lilun yanjiu yongxin hezai" ("Why did the `Gang of Four' sabotage basic theoretical research"), *Renmin Ribao* (*People's daily*) (13 Jan 1977), reprinted in *Chedi jianfa pipan "sirenbang" cuanda duoquan de taotian zuixing* (*Thoroughly disclose and criticize the great crimes of the "Gang of Four" who wanted to seize the power of the party*) (Beijing, 1977). Zhou Ruling, "Fuqin" ("Father"), *Kexue jujiang, shibiao liufang* (*A great scientist and teacher, a festschrift for Zhou Peiyuan on his 90th birthday*), 274-307, on 284; Chi-Kung Jen, *Recollections of a Chinese physicist* (New York, 1991); Yang (ref. 45), 77-78.
48. Zhou Enlai to Zhou Peiyuan, 23 Jul 1972, quoted in Wu (ref. 31), 364.

> Committee has always been that the Academy of Sciences should be responsible for basic research, only in the past this was not realized.

Chinese scientists seized the opportunity afforded by the visiting American scientists' advocacy for basic research to advance not only the cause for basic research, but also the political fortunes of Chinese science in general.

High energy physics in China

High energy physics is not representative of all scientific fields in China (or in the West): it is big, expensive, and often highly politicized science with attendant controversies. Yet, an examination of the development of this field in China gives a good example of how Chinese scientists took advantage of the U.S.-China scientific exchanges both scientifically and politically. For several reasons, high energy physics became the most prestigious field of all the sciences in China in the 1970s. Mao Zedong's philosophical penchant for the infinite divisibility of matter gave the study of the structure of matter a welcome ideological justification on which the physicists capitalized.[49] During the Cultural Revolution, a group of Chinese theorists devised the ideologically correct "straton model" to explain the structure of elementary particles, which resembled in some ways the quark theory developed in the West.[50] The fact that some of the major participants in the bomb projects turned to high energy physics gave credibility to the enterprise in the eyes of government officials. The high visibility of the Chinese American particle physicists Yang and Lee in China also helped ensure a great following for the field among Chinese students.

Seeing high energy physics as a frontier field in science that happened to enjoy Mao's personal interest, Zhou Enlai sought to promote its development as a way to revitalize Chinese science and technology in general and to facilitate international scientific exchange. When a group of nuclear physicists in the Second Ministry of Machinery (nuclear weapons) began to agitate for a Chinese program in high energy physics in 1972, Zhou quickly responded.[51] On September 11, 1972, in a letter to Zhang Wenyu, the leader of the group who was trained in Britain and worked in the U.S. in the 1940s and 1950s,[52] and Zhu Guangya, another U.S.-

49. For Mao's interest in high energy physics, see Mao Zedong, "Guanyu Bantian wenzhang de tanhua" ("A talk on the articles of Shoichi Sakata"), 24 Aug 1964, *Mao Zedong Sixiang Wansui (Long live Mao Zedong thoughts)* (n.p., n.d.), 561-567.
50. Yao et al. (ref. 30), 386.
51. The group was called the first division of the 401 Institute of the Second Ministry of Machinery. See *Zhou Enlai xuanji* (ref. 22), *2*, 535, n368. On August 18, 1972, the group wrote a letter to Zhou Enlai describing the status of high energy physics in China and proposing that China promote research in that field. Ibid., 534, n366.
52. Although Zhang was apparently not involved in nuclear weapons research, his wife, Wang Chengshu, a Ph.D. from the University of Michigan, was in charge of the diffusion

trained nuclear physicist who participated in the Chinese bomb projects and who was then deputy director of the powerful Defense Science and Technology Commission,[53] Zhou asked them to coordinate the formation of a national program:[54]

> This matter cannot be delayed any longer. The Academy of Sciences must focus on basic science and theoretical research, and at the same time also closely unite theoretical research and scientific experiment. High energy physics research and the preparatory research on high energy accelerators should be one of the main projects of the Academy of Sciences.

On September 18, 1972, Zhu Guangya gathered people from the Second Ministry, the academy, and Beijing University for a conference on the topic. They wrote a report to Zhou Enlai on January 8, 1973, proposing that the Chinese high energy program focus on elementary particle research, without neglecting nuclear physics and applications. Institutionally, the group advocated that China establish an Institute on High Energy Physics based on Zhang's group and construct experimental sites, including preparatory work on accelerators and detectors. It also suggested that Beijing University, Lanzhou University, and Yunan University (the last two in southwestern China) strengthen their high energy physics programs by conducting research and training scientists. Internationally, the group proposed that the government send a delegation to CERN (European Center for Nuclear Research). The State Council approved the report and a national conference on high energy physics was held from March 13 to April 7, 1973.[55] In a written statement for the conference, Zhou quoted Mao to the effect that "China should make a greater contribution to humankind" to justify an expensive national program in high energy physics.[56]

The efforts of the Chinese high energy physicists received a boost from the visit of T.D. Lee in 1972. In a wide-ranging discussion with Zhou Enlai on science and education in Beijing on October 14 of that year, Lee encouraged Zhou to

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process to enrich uranium for the bomb. See Peng Jichao, *Dongfang jiuxiang: Zhongguo hewuqi shiyan jishi* (*China's nuclear weapon tests*) (Beijing, 1995), 52-55, 146-150.

53. The Chinese (Nationalist) government sent Zhu Guangya and T.D. Lee to the U.S. in 1946 with the hope that they would study nuclear physics and return to build atomic bombs for China. See Qiu Zhaoming, "Li Zhengdao" ("T.D. Lee"), Lu Jiaxi, editor in chief, *Zhongguo xiandai kexuejia zhuanji* (*Biographies of modern Chinese scientists*) (Beijing, 1994), 153-178, on 154; "Zhu Guangya Li Zhengdao chuan ceng lai mei xue zao yuanzidan" ("Zhu Guangya and T.D. Lee reportedly came to the U.S. to learn how to make atomic bombs,") *Shijie Ribao* (*World Journal*) (7 June 1998), A9.

54. Zhou Enlai, "Zhongshi jichu kexue he lilun yanjiu" ("Take basic science and theoretical research seriously"), a letter to Zhang Wenyu and Zhu Guangya on 21 Sep 1972, in *Zhou Enlai xuanji* (ref. 22), *2*, 473.

55. Wu (ref. 31), 369-370.

56. Ibid., 370.

launch China's own high energy physics program. He also urged Zhou to invite foreign scientists for visits and to send Chinese students and scientists abroad for study and research.[57] Lee assured Zhou that CERN and many other laboratories in the West would welcome Chinese scientists and that the exchanges would not create a "Two Chinas" problem because he did not believe that Taiwan was interested in high energy research.[58]

Lee and other Chinese American scientists brought to China not only the state of the art in science, but also social, cultural, and institutional approaches to the modernization of Chinese science and technology. Zhou was curious about science policy in the U.S. and the West. He asked Lee about how collaboration was carried out in the U.S., to which Lee responded by describing the peer review process and highlighting, perhaps inadvertently, the autonomy of the scientific community. "A group of scientists makes a proposal after discussions among themselves," Lee said, "then [the government] selects about ten renowned scientists from all over the country to evaluate the proposal, deciding which will be done first, which will be done later, and which would not be done at all. The national government provides all the laboratories. As to research that could lead to development and applications, such as semiconductors and computer research, capitalists provided some of the laboratories."[59]

As a result of Lee's urging and Zhou's backing, high energy physics became one of the first fields where extensive exchange with the West began. In May 1973, Zhang Wenyu led a high energy physics delegation to the U.S., visiting Brookhaven National Laboratory, Fermilab, and the Stanford Linear Accelerator (SLAC) Center. The group next stopped at CERN before returning to China in early July 1973. Upon their return, the Chinese physicists recommended a 40-GeV proton synchrotron "comparable with the world's biggest accelerator," evidently aiming for both scientific achievements and national prestige. The move disappointed T.D. Lee and Wolfgang Panofsky, then director of SLAC, who had suggested a less expensive electron-positron collider with lower energy but high intensity and potential for applications in other fields.[60] Zhou gave the proton

57. Ibid., 368-369.

58. Ibid., 368.

59. Ibid., 368-369; Zhou also relied on Lee to certify discoveries made by Chinese physicists. At a meeting, Zhang Wenyu asked Zhou whether Chinese scientists should publish the discovery of a new particle and Zhou said that he would need to discuss it with Lee first. See Zhu (ref. 31), 558-559, entry for 5 Oct 1972.

60. Wu (ref. 31), 370-371; interview with Panofsky by Zuoyue Wang, Jan 1998, Berkeley. According to Ye Minghan, long-time Vice Director of the Institute for High Energy Physics, Zhang initially proposed a machine in the 20-30 GeV range, but C.C. Ting, the third Chinese American physicist to win the Nobel prize, persuaded the Chinese scientists and government that to make new discoveries they needed 40-50 GeV. C.N. Yang recommended that instead of building the accelerator by itself, China should purchase a small one from abroad. Fan Dainian emails to Zuoyue Wang, 14 and 20 Mar 1998.

project the green light when he approved a report on the subject by the Chinese Academy of Sciences in March 1975.[61]

Despite Zhou's repeated personal interventions on its behalf before his death in January 1976, the project did not begin in earnest until after the collapse in 1976 of the Gang of Four, who attacked the high energy physics program as one of Zhou's pet projects. The Chinese Academy of Sciences organized a national symposium on high energy physics in Beijing in March 1977, with the participation of 220 scientists from all over the country. The conference confirmed the earlier decision to build a proton synchrotron at 40 GeV.[62] Shortly thereafter, the Chinese government under Hua Guofeng, who backed a grandiose modernization plan on the expected revenue from oil exports, decided to push the energy level to 50 GeV.[63] Hua's "great leap outward" (*yang yuejin*), as his modernization plan came to be called, turned out to be terribly unrealistic.

Economic retrenchment ensued in 1980-1981, which forced the cancellation of the proton accelerator. After two years of soul-searching among Chinese and Chinese American scientists, the Chinese Academy of Sciences came back, in 1983, to Lee's original proposal of building an electron collider, with an energy level now set at 2.2 GeV. Deng Xiaoping, who emerged as China's supreme leader, personally approved the new design.[64] On October 7, 1984, Deng, along with other top party and government leaders, joined Chinese and American physicists at a much-publicized ceremony marking the start of the construction of the Beijing Electron Positron Collider (BEPC). The operation of the machine since its successful completion in October 1988 has been hailed both as a contribution to world science and as an example of how basic research could bring practical benefits in the form of medical and industrial applications, an emphasis that was in line with the new utilitarian science policy in the Dengist era of market reform.[65]

Chinese American scientists

The pivotal roles of C. N. Yang in the debate over basic research and T.D. Lee in the development of the high energy physics program provide examples of the

61. The enterprise was dubbed "Project 753," in honor of the month. Wu (ref. 31), 371.
62. Ibid., 372.
63. Yao et al. (ref. 30), 414-415. On Hua's program, see Roderick MacFarquhar, "The succession to Mao and the end of Maoism, 1969-82," MacFarquhar, ed., *The politics of China: The eras of Mao and Deng* (New York, 1997), 248-339, esp. 316-317.
64. Yao et al. (ref. 30), 414-415. Even before this decision, SLAC had maintained extensive exchange and cooperation with Chinese high energy physicists. See Wolfgang Panofsky to Ingrid H. Hoffmann, 12 Apr 1986, and attached draft article by Ingrid Hoffmann on U.S.-China cooperation in high energy physics (Committee on Scholarly Communication with China archives, George Washington University Library, Washington, D.C.); Panofsky interview (ref. 60); Liu Huaizu, *Beijing zhengfu dianzi duizhuangji* (*Beijing electron positron collider*) (Beijing, 1994), 36-45.
65. Yao et al. (ref. 30), 415-418; Liu (ref. 64).

profound and at times conflicting influence of Chinese American scientists in Chinese science and politics. Hundreds of Chinese American scientists and professionals visited China in the 1970s, including such prominent figures as the mathematician S.S. Chern of UC Berkeley, the architect I.M. Pei, and physicists C.K. Jen of Johns Hopkins, Samuel Ting of MIT, and C.S. Wu of Columbia. Wu was the first (and so far only) female and Chinese physicist elected president of the American Physical Society, in 1975. Many of these Chinese American scientists were first-generation immigrants, who received their undergraduate education in China and came to the U.S. in the 1930s and 1940s for graduate training, often with funding from the then Nationalist government of China. In the 1970s, they carried out scientific exchanges with China in the name of scientific internationalism, but their strongest motivation was probably nationalism in the sense of an identity with the developmental aspirations of their country of origin.[66]

Their active participation in the U.S.-China scientific exchange was perhaps the single most important factor in determining the success and character of this transnational scientific network, and in many ways reflected the unique history of this subnational scientific community. In turn, the U.S.-China reopening energized Chinese American scientists who had until then maintained, as a group, a minimal presence in the U.S. scientific community or the public at large. It aided in the formation of the Chinese American scientific community and gave it a voice not only in science but in public policy in the U.S. and China.

For all their contributions to American science, Chinese scientists had a bittersweet history in the United States. Racial discrimination often marked their earliest social experiences in the United States during the era of Chinese Exclusion, which lasted from the turn of the century to World War II, when most Chinese were not allowed to become permanent residents or citizens. Even as late as 1954, developers in New Jersey refused to sell a house to Yang, then a member of the Institute of Advanced Studies at Princeton. The developer was afraid that "our being Chinese might affect his sales," Yang recalled.[67] When the Chinese Communists won the civil war against the U.S.-backed Nationalist forces in 1949, many Chinese students decided to return to China. Having detested the corrupt Nationalist government and experienced humiliating discrimination in the U.S., these students placed great hope in a new China, where the government appeared to focus on national reconstruction and appreciate the role of science and scientists.

The Korean War that broke out in the summer of 1950, however, soon closed the window of opportunity for Chinese students and scholars who wanted to return

66. Chinese leaders, especially Zhou Enlai, adroitly tapped into the home-country nationalism of Chinese Americans. During a meeting with C.S. Wu and her physicist husband, Luke Yuan, Zhou showed his deeply moved guests a map indicating how much Chinese territory formerly under Russian control he was able to get back from the Soviet Union through negotiations in the 1950s. See Ts'ai-chien Chiang, *Wu Chien-hsiung: wu li k'o hsueh ti ti i fu jen* (*C.S. Wu: The first lady of physical science*) (T'ai-pei, 1996).
67. Yang (ref. 45), 57.

to their homeland. The U.S. government forbade Chinese nationals, especially those specializing in science and engineering, to return to China. The ensuing McCarthyist Red Scare targeted, among others, Chinese scientists suspected of left-wing activities and associations. All of these measures further alienated many Chinese scientists and engineers.

The best known example of the disillusioned Chinese scientist in the U.S. was Qian Xuesen (Hsue-Sen Tsien), an aerodynamic scientist at the California Institute of Technology. As a favorite student of Theodor von Kármán, Qian rose to the top of the profession in the 1940s, helped found the Jet Propulsion Laboratory, and contributed to U.S. weapons development during World War II. As an indication of his expertise and of the U.S. government's trust in him, Qian was selected to be a member of von Kármán's expedition to Europe during World War II to investigate the progress of German aerodynamics. In the postwar period, Qian became a member of the influential Air Force Scientific Advisory Board, despite the fact that he remained a Chinese national. He applied for U.S. citizenship in 1949.[68] Trust turned into suspicion during the McCarthy era when he was charged as a Communist Party member and a spy for Communist China. The U.S. government put him under house arrest for five years and prohibited him from leaving the country. At a dramatic government hearing on Qian's case, an official asked Qian: "In the event of conflict between the United States and Communist China, would you fight for the United States?" Qian, after a long pause, answered, "my essential allegiance is to the people of China. If a war were to start between the United States and China, and if the United States war aim was for the good of the Chinese people, and I think it will be, then, of course, I will fight on the side of the United States."[69]

Qian and hundreds of other Chinese scientists and engineers were eventually allowed to return to China as a result of the Geneva Conference in 1955. The profound ambivalence in loyalty expressed by Qian continued, however, to haunt those who chose to remain in the U.S. To stay out of trouble, many in the Chinese American community, including scientists, adopted the strategy of striving for achievement in professional fields while shunning politics.[70] After the purge of intellectuals during the Anti-Rightist campaign in China in 1957, few Chinese scientists in the U.S. returned to their home country.[71] Many, including C. N. Yang and T.D. Lee applied for and were granted U.S. citizenship.[72]

In the 1960s, the civil rights and anti-Vietnam War movements stirred Asian Americans to activism; they began to fight for their own rights in American soci-

68. Iris Chang, *Thread of the silkworm* (New York, 1995), 143.
69. Ibid., 170.
70. Ibid., 196-198.
71. Li Peishan, "Science and technology: U.S. impact on China," *Beijing review*, *34* (18 Nov 1991), 35-37.
72. Yang (ref. 45), 56-57.

ety and culture.[73] The Asian American Movement of the late 1960s and early 1970s, according to one commentator, "made Asian Americans more American and less Asian."[74] Chinese American scientists did not play a prominent role in the movement, although some joined the anti-war protests.[75] The emotional soul-searching that accompanied their decision to become U.S. citizens, however, led many of these scientists to discover the early, bitter history of Chinese Americans in the U.S. They began to identify with the plights not only of early Chinese immigrants in the U.S., but also of contemporary Chinese American communities cloistered in the Chinatowns in major U.S. urban centers, previously a different world from that of Chinese American professionals.[76] They often drew inspiration from examples of community solidarity provided by other ethnic groups, especially the African American civil rights struggle and the Jewish people's fight to remember the Holocaust.[77] By all indications prominent members of the nascent Chinese American scientific community were becoming politically active and were waiting for a suitable venue to express their political opinions at the time of the U.S.-China rapprochement in the early 1970s.

The official reopening of this relationship provided Chinese American scientists with a golden opportunity both to satisfy their nationalistic impulse to help their homeland and to emerge from public obscurity in their adopted country. Along the way, they created a sense of their own distinct scientific community. Tu Wei-ming, the scholar of neo-Confucianism at Harvard, has noted that "The phenomenon of Chinese culture disintegrating at the center and later being revived from the periphery is a recurring theme in Chinese history."[78] For many overseas Chinese, as Tu explains, "the state, either Nationalist or Communist, controls the symbolic resources necessary for their cultural identity."[79] In this regard, it was remarkable that few Chinese American scientists seemed to have exhibited much loyalty to Taiwan when they decided to travel to China despite explicit expressions of displeasure from the Nationalist government. Indeed, some scientists

73. William Wei, *The Asian American movement* (Philadelphia, 1993).
74. Shih-Shan Henry Tsai, review of *The Asian American movement* by William Wei, *Pacific historical review, 64* (1995), 154-155.
75. Chi-Kung Jen, *Recollections of a Chinese physicist* (Los Alamos, 1991).
76. Yang (ref. 45), 56-57. Yang, "My reflections on some social problems," a speech delivered to the Hong Kong Student Association in New York on 3 Oct 1970, Yang, *Dushu jiaoxue sishi nian (Forty years of studying and teaching)* (Hong Kong, 1985), 55-61.
77. Yang, "My reflections" (ref. 76); Ruan Beikang and Ouyang Yingzi, "Zhongmei de huagong yanjiu he yingyong: Fang Wei Qianguang jiaoshou" ("Research and applications of chemical engineering in China and the United States: An interview with Professor James Wei" on 21 Aug 1978), Ruan and Ouyang, *Xueren Zhuanfang Lu* (*Interviews with scholars*) (Hong Kong, 1980), 124.
78. Tu Wei-ming, "Cultural China: The periphery as center," *Daedalus, 120* (Spring 1991), 1-32, quote on 12.
79. Ibid., 16.

went to China in the face of anonymous threats attributed to pro-Taiwan forces.[80] For example, Chang-lin Tien, a professor of mechanical engineering at UC Berkeley and later chancellor of the campus in the 1990s, was black-listed by Taiwan for several years because of his trips to China in 1973.

Among Chinese American scientists, the physicists C.N. Yang and T.D. Lee were the most active, and certainly the most visible, in the U.S.-China scientific exchange. Each in his own way sought to revitalize Chinese science and society in the aftermath of the Cultural Revolution, whose destructiveness they, along with most other visitors, learned of only after it was over in the late 1970s. Yang and Lee were representative of Chinese American scientists' home-country nationalism. The most important contribution of his life, Yang said on January 28, 1995, in Hong Kong, was "to help the Chinese change their perception that the Chinese were not as talented as others."[81] Indeed, for Chinese all over the world, Yang and Lee represented the height of their ethnic pride ever since the announcement of their Nobel prize in 1957.

Despite their common goal of helping China, Yang and Lee held sharply different visions for the direction of Chinese science policy, which led them to give radically divergent advice to China's policymakers.[82] Generally speaking, Yang recognized the importance of basic research and was instrumental in Zhou Enlai's and the Chinese scientists' drive to rehabilitate basic research in China, yet he thought that much more should be done in applied research. To him, applied research, in areas such as computers or biochemistry, served as a link in the chain that would transform scientific ideas into technologies that would expedite national economic development. For this reason, he advised against an expensive high energy physics program in China.[83]

With memory of China's sufferings in the first half of the twentieth century in mind, Yang regarded poverty as the source of most of China's problems. "The most important thing for China," he said in 1986, was "to advance its economy." He did not want China to engage in high energy physics because it had nothing to do with economic development; it "might even have negative effects, because it is

80. Jen (ref. 75); interview with Chang-lin Tien by Zuoyue Wang, 19 Mar 1999, Berkeley. Elizabeth Venant, "A position of prominence," *Los Angeles times* (27 Aug 1990), E1-3, on E3. In a way, Tien represented the second generation of Chinese American scientists, who usually grew up in mainland China, fled with their families to Taiwan in the 1940s, then came to study in the U.S. in the 1950s and 1960s. I intend to study their experiences in a future project.
81. C.N. Yang, *Dushu jiaoxue zhai shinian* (*Ten more years of learning and teaching*) (Taipei, 1995), back cover.
82. The difference perhaps reflected in some ways the well-known personal animosity between the two early collaborators. See, for example, T.D. Lee, "Broken parity," *T.D. Lee selected papers*, G. Feinberg, ed. (3 vols., Boston, 1986), vol. 3, 487-509.
83. Zhu (ref. 31), 544, entry for 4 Aug 1972.

too expensive."[84] The same concern for economic development also led Yang to give priority to stability over political reform, such as democratization and human rights, even in the aftermath of the Tiananmen Square crackdown in 1989. "Let the economy grow and later on reform," he told the New York Academy of Sciences' Committee on the Human Rights of Scientists in 1996. "Eventually we will reach a more open, more democratic society," Yang said, "but we don't want to go through the problems they had in the Soviet Union."[85]

Lee, on the other hand, advocated that China invest in basic research. He thought that China should develop its own high energy physics program, including building accelerators, as a way to keep Chinese scientists abreast of advances at the frontiers of science. In 1972, Lee expressed to Zhou Enlai his skepticism toward the Maoist educational policy of sending high school graduates to work in the countryside for two or three years. He thought it was a waste of time and was instrumental in changing that policy.[86] Lee also created, in 1980, the popular China-U.S. Physics Examination and Applications (CUSPEA) program, which, until 1988, brought annually about one hundred top Chinese physics students each year for graduate study in the U.S.[87] His other projects included a continuing special class for science prodigies at the University of Science and Technology of China, Hefei, the establishment of the Chinese Center for Advanced Science and Technology in Beijing, the initiation of a system of postdoctoral research in China, and, of course, the Beijing Electron-Positron Collider.[88]

Despite the divergence in their advice, the prominent role of the Chinese American scientists helped moderate the obvious concern in China about the political

84. C.N. Yang, "Tantan wulixue yanjiu he jiaoxue: zai beijing zhongguo kexue jishu daxue yanjiushengyuan de wuci tanhua" ("On research and teaching in physics: Five talks at the Graduate School of the University of Science and Technology of China in Beijing," 27 May-12 June 1986), *Yang Zhenning Yanjiang Ji* (*Speeches of Chen Ning Yang*) (Tianjin, China, 1989), 145-160, on 149.

85. Burkhard Bilger, "Holding pattern: Chinese science has arrived, but the fate of dissident scientists is still up in the air," *Sciences*, *36:4* (Jul-Aug 1996), 10-11.

86. Zhou responded that the reason was not ideological but material: the government could not accommodate all the students in universities. But he agreed that some of the more talented ones should be allowed to enter university directly. See Zhou Enlai, "Zhongxue biyesheng keyi zhijie shang daxue" ("Middle school students can go directly to university"), *Zhou Enlai xuanji* (ref. 22), *2*, 473-474.

87. William Sweet, "Future of Chinese students in US at issue; CUSPEA program nears its end," *Physics today*, *41* (June 1988), 67-71; Robert Novick, ed., *Thirty years since parity nonconservation: A symposium for T.D. Lee* (Boston, 1988), 169.

88. See T.D. Lee, *Li Zhengdao wenji* (*Essays of Lee Tsung-Dao*) (Hangzhou, China, 1999). T.D. Lee founded the Center (Zhongguo Gaodeng Kexue Jishu Zhongxin) in 1986, with funding from the Italian government. It sponsored colloquia, workshops, and other activities where Chinese scientists could meet and talk to visiting foreign or overseas Chinese scientists. See articles about or by Lee in *Zuji* (*Footprints: C.N. Yang's, T.D. Lee's, Samuel Ting's, and Yuan T. Lee's routes to successes*) (Beijing, 1989), 95-166.

and cultural values that came with scientific exchange. The patriotic, nationalistic motive of these Chinese American scientists made the transmission of such values more acceptable. The identification of Chinese American scientists with Chinese culture also helped alleviate any affront to national pride when they, rather than westerners who were not ethnically Chinese, promoted ideas that challenged Chinese orthodoxy. Their close personal ties with Chinese leaders and their international prominence also enabled them to speak out on sensitive issues without being censored; for similar actions Chinese scientists got in trouble. T.D. Lee, for example, told a group of Chinese graduate students in 1979 that he did not think that philosophy had any impact on physics.[89] In 1986, C.N. Yang similarly dismissed this privileged branch of scholarship in China: "Physics influenced philosophy, but philosophy never influenced physics."[90] Such views, when advocated by people like Fang Lizhi, the Chinese astrophysicist and dissident who wrote a book entitled *Philosophy is a tool of physics*, were officially denounced as attacks on Marxism's guiding role in Chinese science and society.[91] Both Lee's and Yang's speeches were officially published in China even after Fang was purged from the Communist Party for expressing the same views.[92]

The U.S.-China reopening gave Chinese American scientists a real sense of community for the first time. The widely dispersed Chinese American scientists and scholars forged networks in the early 1970s, when they sought to organize into groups to expedite their visits to China. They were invariably impressed by the social and material progress in the People's Republic and upon their return helped shape the American perception of the New China by giving public lectures and writing articles in the mass media.[93] For the first time in the history of Chinese American scientists, they became a prominent voice in American public policy-making.[94] Since then, common interest in the development of Chinese science,

89. T.D. Lee, "Wulixue ji qita" ("Physics and beyond"), a talk with graduate students at the graduate school of the University of Science and Technology of China, Beijing," 12 May 1979, in *Zuji* (ref. 88), 98-102, on 101.
90. Yang (ref. 84).
91. See Fang Lizhi, *Bringing down the Great Wall: Writings on science, culture, and democracy in China*, ed. James H. Williams (New York, 1991); H. Lyman Miller, *Science and dissent in Post-Mao China: The politics of knowledge* (Seattle, 1996).
92. Yang also criticized the Chinese emphasis on collective research in favor of more individual choices. Chen Ning Yang, "Fahui qiaoliang zuoyong, cujin zhongguo fazhan" ("Playing the role of a bridge, and promoting Chinese development"),Ning Zhiping, Tang Xianmin, and Zhang Qinhua, eds., *Yang Zhenning Yanjiangji* (*Collected speeches by Chen Ning Yang*), 195-197.
93. *Qishi Niandai* (*The seventies journal*), *Liumei huayi xuezhe chongfa zhongguo guangan ji* (*Reflections on revisiting China by Chinese American scholars*) (Hong Kong, 1974).
94. See, for example, Edward David, Jr. to Henry Kissinger, 22 Sep 1971, on "Visit of U.S. physicist, C.N. Yang, to the People's Republic of China" (National Archives, Nixon Presidential Materials, White House Central Files, Subject Files, FG 6-9, box 1, folder "[EX] FG 6-9 Office of Science and Technology 1/1/71-"). David was Nixon's science advisor at the time.

technology, and education has continued to unite them. They urged the American government, for example, to loosen control of high-technology exports to China.[95]

Institutionally, Chinese American scientists, especially physicists, also began to organize themselves at the national and, later, international levels. In 1977, Yang became the first president of the National Association of Chinese Americans, composed mostly of scientists and other professionals and designed to lobby for the normalization of the U.S.-China relationship.[96] The influx of Chinese scientists and engineers who settled permanently in the U.S. after the reopening of U.S.-China relations also infused the Chinese American scientific community with much vitality. According to one survey, there were by the mid-1990s over 1,000 academics above the rank of university lecturers in the U.S. who came from mainland China. Among these, about 800 were in the sciences and engineering, 300 in social sciences and humanities, and 80 in other fields.[97] Their entrance into the research community helped change the race and gender structure of American science: new Chinese American scientists and engineers increased the proportion of Asian Americans, and a significant percentage of the physicists, at least, were women.[98] While the Chinese government has been concerned with this obvious "brain drain," these expatriates were not a complete loss for China, as many of them became entrepreneurs who have done much to promote U.S.-China trade and have contributed to the Chinese economic boom of the 1990s.

The loose connections among Chinese American scientists soon developed into a transnational network of the Chinese diaspora, with potentially significant political implications. In 1980, a conference on particle physics theories in Guangzhou, China, drew together for the first time many ethnic Chinese physicists from around the world.[99] Later, Chinese American physicists organized an Overseas Chinese Physicists Association, including physicists from mainland China, Taiwan, and Hong Kong, which sponsored sessions at American Physical Society meetings.[100] Most significantly, the First International Ethnic Chinese Physics Conference was held in Shantou, China, in 1995, just after the Chinese govern-

95. Yang (ref. 92), 197.
96. Nie Huatong, "Wo suo zhidao de Yang Zhenning" ("The Chen Ning Yang that I know"), reprinted in Pan Guoju and Han Chuanyuan, eds., *Ning zhuo wu qiao: Yang Zhenning fangtai lu* (*Interviews with C.N. Yang*) (Singapore, 1988), 101-119.
97. Wang Xi, "Dalu lumei xueren ziyuan yu ershiyi shiji zhongguo de fazhan" ("Mainland scholarly personnel in the United States and China's development in the twenty-first century"), *Shijie Ribao* (*Chinese daily*) (9 Nov 1997), A5.
98. According to a survey conducted by the American Institute of Physics in 1996, women make up 12% among the 144 Asian or Pacific Islander U.S. Ph.D. physicists, but only 6% of the 1,942 U.S. Ph.D. physicists of all other ethnic groups. Email from Raymond Chu of AIP to Zuoyue Wang, 5 Mar 1998.
99. Yang (ref. 76), 89.
100. Tung-Mow Yan, "Professor C.N. Yang's impact on physics," C.S. Liu and S.-T. Yau, eds., *Chen Ning Yang, A great physicist of the twentieth century* (Boston, 1995), 451-456.

ment conducted a series of menacing missile tests near Taiwan as a warning against the independence movement on the island. The fact that scientists from the official Academia Sinica of Taiwan came to the conference was viewed by many as an encouraging sign that scientists might play a crucial role in the eventual peaceful unification of China.[101]

Shih-shan Henry Tsai, a historian of China and Chinese Americans, has used the term "subnationalism" to depict the activism of Chinese Americans who are occupied with and try to influence politics in their home country.[102] It is perhaps another case of the periphery, in the form of the overseas Chinese, saving the collapsing center.[103] In the case of the Chinese American scientists, this ethno-subnational scientific community has largely turned itself, under the guise of scientific internationalism, into the core of an international network for both science and nationalism.

Post-Nixon exchange

Scientists became privileged politically in the Chinese society of the late 1970s and 1980s, not only because of their role in the modernization drive, but also, as Richard Suttmeier points out, because of their perceived importance in China's international relations, especially with the U.S.[104] Such prominence gave scientists a measure of protection from politics and helped the formation of a nascent civil society, similar to the protection of Soviet physicists by the Soviet bomb project, as described by David Holloway.[105]

The establishment of diplomatic relations in 1979 opened the way for a great expansion in China-U.S. scientific exchanges, including the arrival of large numbers of Chinese students in the U.S. In May 1979, the two governments signed an agreement on collaboration in a wide range of topics in oceanography and fishery, including exchange of oceanographic data, joint research on the sedimentation process in the ocean, mariculture, oceanographic instruments, marine environment, computer simulation, interaction between the ocean and the atmosphere, remote sensing in the sea, and fishery management. As a result, the two nations exchanged dozens of delegations in various fields by 1984. One of the most significant projects undertaken as part of this agreement was the study of sedimentation at the mouth of the Yangtze River. It lasted for four years, involving more than 100 Chinese and

101. Ted Plafker, "Physics meeting unites the two Chinas—briefly," *Science, 269* (18 Aug 1995), 916.
102. Shih-shan Henry Tsai, *The Chinese experience in America* (Bloomington, 1986).
103. Tu (ref. 78).
104 . Richard Suttmeier, *Science, technology, and China's drive for modernization* (Stanford, 1980), 67-94.
105. David Holloway, *Stalin and the bomb: The Soviet Union and atomic energy, 1939-56* (New Haven, 1994). On Chinese scientists' evolution toward political dissent, see Miller (ref. 91).

30 American scientists and several research vessels on both sides, apparently with good results.[106]

In the 1980s, while the Soviet invasion of Afghanistan helped to sustain a strategic alliance between China and the U.S., a new motivation emerged in the U.S. to continue and expand scientific exchanges with China. As China under Deng Xiaoping launched economic reform, the Reagan administration promoted contacts as a way both to encourage Chinese reform and to expand the potential market for American products and technology. In testimony before a congressional task force on science policy in 1985, John P. McTague, deputy director of the White House Office of Science and Technology Policy, illustrated the administration's emphasis on international cooperation in science:[107]

> The example that I find most intriguing, and perhaps most pertinent to discussions here today, is the People's Republic of China. In spite of the fundamentally different philosophies of government that guide our two nations, we have found a strong mutual bond in science and technology. Over the past 10 years, that shared interest in both basic research and in how technology can speed industrial modernization has been the essential basis on which we have steadily narrowed the gap between countries and dramatically improved relations...As we have seen time and time again, probably the most effective channel we have found for nations to cooperate has been through science and technology. The example I cited earlier of the People's Republic of China may be the most spectacular success.

In response to questioning from Congressmen, McTague stated that "by increasing technological capabilities in other countries, we then open up new markets for ourselves and, I think, help stabilize the world situation."[108] He then went to explain why the U.S. was more liberal in its collaboration with China than with the Soviet Union:

> The Soviet bloc has a clearly expansionist policy right now—Afghanistan is an example—as opposed to the internal policies where it is clear that the People's Republic of China has decided to make a very major effort to utilize science and technology to modernize its nation, to increase its industrial base, to increase the standard of living for its people, to open its markets with the West. I don't see signs of similar things happening in the Soviet Union.

106. Luo Yuru, Zeng Chengkui, and C.K. Tseng, eds., *Dangdai Zhongguo de haiyang shiyan* (*Oceanography in Contemporary China*) (Beijing, 1985), 416-418.
107. Testimony of John P. McTague, 20 June 1985, *International cooperation in science*, Task Force on Science Policy Committee on Science and Technology, House of Representatives, 99th Congress, 1st session, *Hearings, 7* (Washington, D.C., 1985), 235-236.
108. Ibid., 249.

Impact of Tiananmen, 1989

In June 1989, the Chinese government's violent crackdown on the peaceful, student-led demonstration at Tiananmen Square in Beijing drew global condemnation. The United States and many other nations imposed diplomatic and economic sanctions against China. The American scientific community interrupted bilateral scientific and technological exchanges in protest against the violence. The National Academy of Sciences and several other American organizations suspended most of their joint projects with China in "outrage and sadness." The Royal Society in Britain and other European organizations followed suit. While these measures received general approval, more radical forms of protest threatened far-reaching curtailment of scientific contact and therefore divided the scientific community in the West.

A subject of soul-searching debate, the dilemma facing many scientists was how to punish the Chinese government but avoid isolating their Chinese colleagues. On the one hand, proponents of radical measures, such as boycotting scientific exchange with China, argued that only an unambiguous public stand could help improve the situation of scientist-dissidents in China. They not only urged colleagues to boycott meetings in China, but also campaigned to prevent holding future conferences there until repression stopped. Business as usual, as James C. Wang argued, was unconscionable:[109]

> The stark contrast between the recent events in Eastern Europe and those in China since [June 1989] argues strongly that all scientists should continue to boycott activities in China. Any resemblance to normalcy in our interactions with our friends in China can only prolong the status quo and confirm the belief of those now in power that memory is short and history can be rewritten overnight.

On the other hand, there were scientists who insisted that a boycott would interrupt the free flow of scientists and scientific ideas, push China back to intellectual isolation, and hurt both Chinese science and scientists. As T.D. Lee put it:[110]

> The universality of science and the free exchange between scientists of all nations has been a powerful force in helping to preserve civilization in difficult times. This is something I believe in deeply. Only through continuous contact with our colleagues in China can we help them in a genuine way.

Still others believed that quiet diplomacy was more effective than open sanctions. Sharp objections were also raised about the need to base actions on the interests of working scientists in China and not on dissidents or exiled scientists.

109. James C. Wang, "U.S. scientists and China," letter to the editor, *Science, 246* (22 Dec 1989), 1547. Wang is professor of biochemistry and molecular biology at Harvard University.
110. T.D. Lee, "U.S.-China relations," letter to the editor, *Science, 246* (17 Nov 1989), 873.

The debate polarized the vast Chinese American scientific community; supporters of continuous contact with Chinese colleagues, such as Lee and Yang, were denounced as tools of Chinese propaganda. Nor could the institutions of American science, such as the National Academy of Sciences, the American Association for the Advancement of Science, and the American Physical Society, agree on a concerted course of action.

By the early 1990s, as the political environment in China improved and interest in trade with China grew, scientific and technological exchanges resumed. Yet, with the end of the Cold War in the late 1980s and early 1990s, the strategic balance shifted and scientific exchange with China came under increased scrutiny by the U.S. government. In 1997, Peter Lee, a Taiwanese-born Chinese American physicist who once worked at the Los Alamos National Laboratory, was arrested by the FBI for transmitting secret technology on lasers and detection of submarines to Chinese scientists. In a plea bargain, Lee admitted that he leaked classified information to the Chinese but insisted that it was unintentional—he was carried away by his enthusiasm for scientific exchange. In view of his cooperation and the fact that the information Lee leaked was soon declassified, Lee was given a very lenient sentence, one year in a half-way house. The event received scant media attention.[111]

In early 1999, the *New York Times* reported, based on leaked information from the government, that Wen Ho Lee, another Taiwanese-born Chinese American scientist working at Los Alamos, was accused of transferring information on U.S. warhead design to China. It immediately became a prominent national political controversy. Lee was fired from his position for violation of security rules (not for spying) and, as of October 1999, was still not formally charged but under investigation by the FBI. In May 1999, a congressional committee under Rep. Christopher Cox (R-Calif.) issued a report that claimed that many Chinese students and scientists in the U.S. were engaged in spying for the Chinese government.[112] The spy cases and the Cox charges, true or not, had a chilling effect on international

111. See Eric Lichtblau, "Physicist admits passing laser secrets to Chinese scientists," *Los Angeles Times* (9 Dec 1997), B1. A group of Chinese scientists who hosted Lee have denied that Lee passed any military secrets. The open letter by Wang Ganchang et al. is published in *Renmin Ribao* (*People's Daily*), overseas edition (11 Feb 1998), 4. See also Rone Tempest, "Chinese scientists defend southland spy," *Los Angeles Times* (11 Feb 1998), A4; James Brook, "An earlier China spy case points up post-Cold War ambiguities," *New York Times* (13 Mar 1999); Jeff Gerth and James Risen, "Reports show scientist gave U.S. radar secrets to China," *New York Times* (10 May 1999).
112. *U.S. national security and military/commercial concerns with the People's Republic of China* (the "Cox Report"), U.S. House of Representatives, 106th Congress, 1st session (Washington, DC, 1999). The full text is available on the U.S. House of Representatives website: http://www.house.gov/coxreport/.

scientific communication and led some members of Congress to call for a moratorium on exchanges with foreign scientists.[113]

Conclusion

Despite these recent setbacks, U.S.-China scientific exchange has had profound impact on both countries and proved to be remarkably resilient. Geopolitics motivated the U.S. and China to sponsor scientific internationalism to accomplish essentially nationalistic goals. The U.S. aimed to counter Soviet expansion, as did China, but China also sought the exchange as a crucial part of its modernization drive. Yet, the scale of the exchange and enthusiasm of the participants cannot be explained only by the interest of the state. Traditional scientific internationalism played a crucial role in the exchange, as historical connections between Chinese and American scientists from the 1930s and 1940s and especially the activism of Chinese American scientists gave the exchange programs drive and momentum.

The home-country nationalism that motivated Chinese American scientists to promote the U.S.-China scientific exchange, in the name of scientific internationalism, actually helped undermine the authority of the Chinese nation-state. Consciously or unconsciously, the extensive scientific and cultural exchanges they encouraged helped introduce liberal-democratic ideas and values into China, which challenged the orthodoxy of Marxist ideology. The party and government could no longer control every step of the exchange process, nor could they keep an iron grip on whom to send, in terms of ideological correctness, where to send them, and what they would be exposed to. The exchange promoted meritocracy and facilitated the creation of a public sphere as de-ideologization continued. Indeed, the clearest indications of this democratic process were seen in the party's reaction to it: the drive against western "spiritual pollution" in 1982-1983 and then the anti-liberalization campaign in 1986-1987.

A comparison of the U.S.-China scientific exchange with that between the U.S. and the Soviet Union, which has been judged less successful, helps illuminate aspects of Cold War science.[114] Geopolitics played an important role in defining the characters of the two exchanges. There was much unease in the U.S.-Soviet exchange on both sides, probably because the contacts were to serve the purpose of defusing the danger of war. In contrast, the U.S.-China exchange was designed more to build an alliance. Also, the historical ties between senior members of the Chinese and U.S. scientific communities and the active role of Chinese American scientists—not to mention the traditional missionary spirit to change China toward an American model—gave the U.S.-China exchange an emotional appeal that was missing in the U.S.-Soviet case.

113. James Brooke, "Senator tells nuclear bomb labs to end foreign scientists' visits," *New York Times* (13 Apr 1999), A14.
114. Linda L. Lubrano, "National and international politics in U.S.-U.S.S.R. scientific cooperation," *Social sudies of science, 11* (1981), 451-480; Byrnes (ref. 11).

One can also compare the U.S.-China exchange with that between China and the Soviet Union in the 1950s. Although China gained much industrial technology from the Soviets, the effect of the exchange on Chinese science and education proved problematic. The imposition of the Soviet model of narrow, technical education broke up the structure of Chinese universities, which had been based largely on the American model of a liberal, general education. It also led to the emergence of a generation of technocrats, who tended to ignore the human factors in big technology projects, such as the controversial Three Gorge Dam on the Yangtze river. Some of the Western-trained scientists also got into political trouble for disagreeing with the Soviet advisors. Then the decision in the early 1960s of the Soviets to withdraw all advisors, with their blueprints, created chaos and irrevocable damage in many technological projects. The arrogance and patronizing tone of some of the Soviet advisors toward senior Chinese scientists hurt national pride. Again, in the U.S.-China exchange, the participation of Chinese American scientists significantly reduced difficulties in this respect, and the old ties from the 1930s and 1940s also helped promote smooth communication and cooperation.

The U.S.-China scientific exchange benefited much from the intermixing effect of Chinese American scientists as an international ethnic and scientific community, which helped blur national boundaries in science, even at the height of the Cold War. International exchange, which was born of a geopolitical, nationalistic concern about an external threat, and encouraged further by the modernization drive, thus led to the relaxation of control by the nation-state. Even in the post-Cold War era, U.S.-China scientific cooperation remains crucial in meeting major challenges to the world in areas such as environment, energy, and the proliferation of nuclear weapons.[115] In this endeavor, Chinese American scientists, as agents for transnational exchange, have played and will likely continue to play an important role. Yet, the spy cases remind us that in many ways the domination of the nation-state in scientific communication will continue in the post-Cold War period.

115. See, for example, U.S. National Academy of Sciences Panel on Global Climate Change Sciences in China, *China and global change: Opportunities for collaboration* (Washington, D.C., 1992). In the mid-1990s, the NAS also launched a joint project with the Chinese Academy of Sciences on "Cooperation in the energy futures of the United States and China." See http://www2.nas.edu/oia/24ca.html.