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Science and civil society in Japan: Physicists as public men and policymakers

BEGINNING OVER FIFTY years ago, with the dropping of the atomic bomb on Hiroshima, Japanese physicists struggled to establish a type of civil society. They turned to science as a form of world culture, a way to transcend nationalism and bond with colleagues abroad. Many were to prove influential as public men and policymakers. They became engrossed in rebuilding their country, acting as social spokespersons, experts, technocrats, and international men of science. Foremost in their thoughts were the desire for professional autonomy, the commitment to democratic representation, and the notion that science would solve the nation's ills. But others, notably politicians, bureaucrats, and business leaders, had plans for Japan as well, which often differed from the scientists'. This paper outlines the interrelationship and conflict among physicists and these groups in their attempt to direct science for the "public good." Now with the end of the Cold War and increasing globalization, political change is occurring throughout East Asia and objectives of the Japanese physicists are becoming a reality.

Introduction

In the late 1990s, Japan's failure to separate its business community, its bureaucracy, and the political system was considered by many to be at the heart of the country's economic problems. It is only now, at the end of the twentieth century, that changes are being made in new legislation and reorganization of the bureaucracy.[1] Non-governmental organizations have become increasingly impor-

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The following abbreviations are used: ESS, Economic and Scientific Section; GHQ, General Headquarters; JAEC, Japan Atomic Energy Commission; JAERI, Japan Atomic Energy Research Institute; JAPCO, Japan Atomic Power Company; JASL, Japan Association for Scientific Liaison; JSC, Science Council of Japan; KEK, Kô Enerugi Butsurigaku Kenkyûjo; LDP, Liberal Democratic Party; NGO, non-governmental organization; RIFP, Research Institute for Fundamental Physics; SCAP, Supreme Commander for the Allied Powers; SCNR, Special Committee for Nuclear Research; UNESCO, United Nations Educational, Scientific, and Cultural Organization.

1. For details see Morris Low, Shigeru Nakayama, and Hitoshi Yoshioka, *Science, technology and society in contemporary Japan* (Cambridge, U.K., 1999).

tant in helping to bring about social change. But these voices of civil society have only had a short history.[2] In the period immediately after World War II, it was arguably scientists, especially physicists, who provided new and contentious ideas, calling for change and greater public participation in policymaking. They assisted Japan in re-entering the international community through the world of science and in making the transition to a civil society. Despite the fact that almost all were employed by the state, the physicists considered their status as being closer to that of non-state actors, and they believed that they could provide independent, objective advice to the public. It was they who, through their high profile, helped develop and circulate these ideas in the broader society. They were clearly men before their time.

Shin'ichi Yoshida interprets civil society as "a spontaneous, concerned group of citizens who interact independently of government, while collaborating with it at certain times and opposing it at others."[3] Likewise if we define the term as David Holloway has, in the self-organization of autonomous groups to balance the power of the state, physicists were a major force in Japan in the struggle for civil society and the maintenance of a public sphere.[4] What prompted Japanese physicists as individuals and as a group to speak out and seek a better society? It is difficult to pinpoint any one common feature apart from their science. Nonetheless, while their experiences, attitudes, and beliefs varied, their interest in science policy tended to lie in basic rather than applied research, in the regulation rather than the promotion of the commercialization of science, and in science as a vehicle for a more international Japan. United by class, education, and mental ability, they articulated their ambitions to direct Japan's research effort by speaking of the benefits of science, democracy, internationalism, and the public good. A measure of their success can be seen in the many research institutes established through the Science Council and in scientists' participation in various policymaking bodies. The complex decision-making structure that emerged reflects the efforts of physicists to assert their professional expertise and social responsibility against the political authority of the governing Liberal Democratic Party (LDP), the bureaucracy, and big business. In order to gain some sense of how Japanese physicists were active as public men and policymakers, this paper outlines the lives of seven of Japan's most prominent physicists: Yoshio Nishina, Shôichi Sakata, Mituo Taketani, Hideki Yukawa, Sin-itirô Tomonaga, Ryôkichi Sagane, and Satio

2. Clifford Chanin, "Voice of the people: The development of NGOs in Japan," paper presented at "Civil society in Japan (and America): Coping with change" (Washington, D.C., 1998).

3. Shin'ichi Yoshida, "Rethinking the public interest in Japan: Civil society in the making," in Tadashi Yamamoto, ed., *Deciding the public good: Governance and civil society in Japan* (Tokyo, 1999), 13-49, esp. 14.

4. David Holloway, "Physics, the state, and civil society in the Soviet Union," in this volume.

Hayakawa. Brief biographies will be interwoven with accounts of their different approaches to science, and the institutions with which they were involved.

The emergence of physics in Japan

Educated people took up science in nineteenth-century Japan in a manner reminiscent of the samurai pursuit of learning, serving to bond science with the public sphere and to establish the notion of science in service to the state. The Japanese created the institutional structures necessary for transmitting science before the scholars and students were in place. Bartholomew suggests that in the seventeenth century commoners mainly accounted for the activity in the physical sciences, such as astronomy and calendrical studies, while by the mid-eighteenth century samurai had become the dominant group. He argues that there might well have been a scientific revolution in Japan, had it not been for the social division of knowledge that prevented a late eighteenth-century marriage of mathematical skills (the domain of relatively lower status groups) with the more prestigious physics and astronomy (in which samurai were taking an interest).[5] Andrew Barshay has further written of the emergence of a "public" sphere in the Meiji period (1868-1912), which produced the intellectuals he refers to as "public men." This public sphere went beyond official and private activities. While "publicness" related to public activity, "insiders" (with links to large organizations) were viewed more highly than "outsiders" (dissidents and independents). "Public" thus came to be viewed as being associated with the state, and the intellectual elite of both persuasions derived their status from their position as experts in their chosen areas of imported knowledge.[6]

Both Bartholomew[7] and Nakayama[8] have examined how Germany was promoted as an academic model at this time, one of the many organizational models that Japan introduced during the Meiji period.[9] Interest in German scholarship intensified in the 1880s; Japanese scientists studying in Europe gravitated towards Germany and government ministers looked to German higher education as a model. It would only be after World War II that the American style of graduate school education would have an impact.[10]

5. James R. Bartholomew, "Why was there no scientific revolution in Tokugawa Japan?," *Japanese studies in the history of science, 15* (1976), 111-125.
6. Andrew E. Barshay, *State and intellectual in imperial Japan: The public man in crisis* (Berkeley, 1988), xiii, 24.
7. James R. Bartholomew, *The formation of science in Japan: Building a research tradition* (New Haven, 1989), 133.
8. Shigeru Nakayama, *Teikoku daigaku no tanjô* (*The birth of imperial universities*) (Tokyo, 1978), esp. 34-71.
9. For details of this process, see D.E. Westney, *Imitation and innovation: The transfer of Western organizational patterns to Meiji Japan* (Cambridge, 1987).
10. Shigeru Nakayama, trans. Jerry Dusenbury, *Academic and scientific traditions in China, Japan and the West* (Tokyo, 1984), 219-220.

Bartholomew has also remarked on how education and research in the physical sciences in the Meiji (1868-1912) and Taishô (1912-1926) periods were reliant on the public sector. Scientists, as a result, were considered government officials. Most physicists tended to have a samurai background, and almost all went on to become professors. Confucian-trained officials had greater access than other Japanese to the physical sciences, activity in the field focused on Tokyo, and Japanese physicists were likely to take up positions as university professors and rely on government support for their activities.[11] This required Japanese physicists to continually confront the problem of balancing a desire for professional autonomy with the demands of the nation. By the 1930s, however, the professorial "chair" system had become unwieldy, preventing students and scholars from performing collaborative work of both civilian and military nature.

Institutional developments were underway. In 1877, the Tokyo Mathematical Society was established and became known as the Tokyo Mathematico-Physical Society (Tôkyô Sûgaku Butsuri Gakkai) in 1884. Kenjirô Yamagawa became the first Japanese professor of physics at the University of Tokyo in 1879. By the turn of the century, Kyoto Imperial University and Tohoku Imperial University were also educating physicists,[12] with the Tokyo Imperial University producing over 100 physics graduates by 1900. Until 1918, when the Ministry of Education began providing grants for scientific research, Japanese physicists tended to pursue theoretical rather than experimental topics. During and after World War I, a number of research facilities were then established. In Tokyo the Institute of Physical and Chemical Research (abbreviated in Japanese as "Riken") was the largest pre-World War II scientific research organization in Japan, analogous to the Imperial Institute of Physics and Technology in Germany (established in 1887).[13] Formed in 1917 with funds from government and the private sector, Riken provided relief to the inefficiencies of the university system and established a model for later common-use research institutes. Until at least 1921, it was divided into two divisions, physics and chemistry, and beginning in 1922 a laboratory system was established. Many of its researchers were affiliated with major universities but found Riken attractive because of the research opportunities. Despite the vigor of research at Riken, the formal teaching of physics occurred at the seven imperial universities: Tokyo, Osaka, Nagoya, Kyoto, Hokkaido, Kyushu, and Tohoku. By 1940, the number of university science graduates was double that in the first year of the Showa period, 1926. Five years later it would be over double that again. Between 1931 and 1940 it was estimated that around 1159 doctorates in science, technology, agriculture, and forestry were awarded in Japan.[14]

11. James R. Bartholomew, "The Japanese scientific community in formation, 1870-1920: Part 1," *Journal of Asian affairs, 5:1* (1980), 62-84.

12. Hiro Tawara, *Pioneers of physics in the early days of Japan* (Amsterdam, 1989), 57-58.

13. David Cahan, *An institute for an empire: The Physikalisch-Technische Reichsanstalt, 1871-1918* (Cambridge, 1989).

14. General Headquarters, Supreme Commander of the Allied Powers, *Japanese natural resources: A comprehensive survey* (Tokyo, 1949), 506.

Yoshio Nishina

Riken attracted many promising young researchers, many of whom worked towards a doctoral degree there. One of them was Yoshio Nishina, one of Japan's most important physicists. Indeed, Nishina never occupied an academic post in a university, but was instead attached to the autonomous research institution that was Riken. Nishina was born on December 6, 1890, into a privileged family with a tradition of public service, in the southwestern part of Okayama prefecture. His ancestors had held the position of "daikan" ("local officials") who performed tasks of a financial nature for feudal domains. In 1914, Nishina entered the Department of Electrical Engineering in the School of Engineering of Tokyo Imperial University, graduating top in his field in 1918. Thereupon Nishina entered the newly established Riken as a research student, and, soon afterwards, entered graduate school where he chose to study physics and mathematics. In 1921 he went to Europe as a Riken "kaigai ryû gakusei" ("overseas student"), first studying with Ernest Rutherford at the Cavendish Laboratory, Cambridge University, then at Göttingen University from November 1922 until March 1923. He subsequently spent about five years (April 10, 1923-September 30, 1928) with Niels Bohr in Copenhagen, for a total of seven years in Europe. At Copenhagen, Nishina co-authored a famous theoretical paper with Oskar Klein on the rate and angular distribution of Compton scattering.

Upon his return to Japan, Nishina was given a position in the Hantarô Nagaoka laboratory at Riken. In 1930 Nishina obtained his Doctor of Science degree.[15] In May 1931, he gave a series of intensive lectures on quantum mechanics at Kyoto University which would be attended by a number of budding physicists, including Hideki Yukawa, Sin-itirô Tomonaga, Shôichi Sakata, and Minoru Kobayashi. Shortly afterwards, on July 1, Nishina was appointed a chief researcher at Riken with strong backing from Nagaoka. Nishina was the youngest person to hold this position, which came complete (in 1932) with his own laboratory. Early members of Nishina's laboratory were Masa Takeuchi, Sin-itirô Tomonaga, and Hantarô Nagaoka's son, Ryôkichi Sagane.[16]

In 1931, scientists called for an increase in government funding of research. The government contributed to Riken 250,000 yen (equivalent to U.S. $125,000),[17] whereas the overall research funding provided by the Ministry of Education for the natural sciences in Japan was a measly 60,000 yen, or around U.S. $30,000.

15. Shimpei Miyata, *Kagakushatachi no jiyû na rakuen: Kôei no Rikagaku Kenkyûjo* (*The scientists' paradise: The famous Institute of Physical and Chemical Research*) (Tokyo, 1983), 186.

16. "Nishina kenkyûshitsu no hassoku" ("The establishment of the Nishina Laboratory"), *Mugendai, 85* (Fall 1990), 46.

17. This is based on an exchange rate of 2 yen per U.S. dollar. After 1931, the yen was devalued, with a new rate of about 4 yen per U.S. dollar remaining in place for the rest of the 1930s. From Al Alletzhauser, *The house of Nomura* (London, 1990), Appen. 6.

The Japan Society for the Promotion of Science (Nihon Gakujutsu Shinkôkai) was established in December 1932 to provide further support. Matters were helped along when interest in nuclear physics increased dramatically in Japan in 1934. The neutron and positron had been discovered in 1932, and Nishina used cosmic rays and the military potential of physics research as a fund-raising argument.[18] In 1935, plans were laid for a new laboratory at Riken to be equipped with a Cockcroft-Walton apparatus and a cyclotron, and the Nishina laboratory took charge of the cyclotron project. In mid-1935 Nishina arranged with Ernest Lawrence for Sagane to go to Berkeley where he served a short apprenticeship in the fine art of cyclotron-making. Nishina completed his cyclotron in April 1937, a machine boasted as being second in workmanship only to that of Lawrence's. Thus, with help from Lawrence and Sagane, Nishina became Japan's expert on things nuclear. It is therefore not surprising that the military would turn to Nishina when canvassing the idea of an atomic bomb. Whereas elite scholars had previously employed the public discourses of Confucianism, Meiji modernization, and self-sufficiency, it was up to budding public men such as Yoshio Nishina to invent a new vocabulary. Nishina co-opted state discourses relating to Japan's war effort, participating in Japan's atomic bomb project and encouraging students to participate in radar and "death ray" research.[19] He ingratiated himself with the military to protect his own agenda and to sustain the research careers of his students.

Thus in the early 1940s Japanese physicists studied the theory of chain reactions and conducted experiments to determine the neutron capture cross-section of uranium 235. Attempts were made to construct apparatus to separate uranium isotopes by thermal diffusion and by centrifuge, but the physicists came to the conclusion that it would be impossible to produce the atomic bomb during the war.[20] Japanese physicists also busied themselves with the development of meson theory. In 1949 Yukawa became the first Japanese Nobel laureate for his work in theoretical physics, part of which he carried out during the war; in 1965 Tomonaga received the Nobel Prize for his contribution to elementary particle physics, again for work which evolved partly during the war.

Building cyclotrons required Nishina to project a public face, perhaps not at one with his shy character, but essential to mobilize the necessary resources and personnel for American-style big science.[21] This projection allowed Nishina to

18. Tetu Hirosige, *Kagaku to rekishi* (*Science and history*) (Tokyo, 1970, 1980), 228.
19. See Morris F. Low, "The useful war: Radar and the mobilization of science and industry in Japan," in Roy M. MacLeod, ed., *Science and the Pacific War* (Lancaster, U.K., in press); Yutaka Kawamura and Masakatsu Yamazaki, "Butsuri Kondankai to Kyû-Nihon Kaigun ni okeru kaku oyobi kyôryoku magunetoron kaihatsu" ("The Physics Committee and the former Japanese Navy's project for the development of atomic energy and a powerful magnetron during the Second World War"), *Kagakushi kenkyû, 37:207* (1998), 163-171.
20. Charles Weiner, "Retroactive saber rattling? A note on nuclear physics in Japan," *Bulletin of the atomic scientists*, *34:4* (Apr 1978), 10-12.
21. Morris F. Low, "Japan's secret war? 'Instant' scientific manpower and Japan's World

influence science policy and Japan's reconstruction after World War II, but new beginnings required a new rhetoric, even if the call was once again to mobilize science and technology for the nation's good.

While Nishina worked with the state, he nevertheless urged scientific workers to organize themselves for political action and to help solve Japan's grave economic condition. He set the stage for the identification of physicists as "experts" who could solve social problems via the scientific method. While they might be employed by the state via the universities where many of them worked, many felt that they possessed know-how that was perceived as going beyond narrow nationalisms. They saw this expertise as helping Japan to enter a world culture of science. Although the physicists differed in their philosophical beliefs, they converged in their conviction that science would lead the Japanese to a better world. While this attitude might be described as a scientistic ideology, this belief, common to many scientists throughout the world, informed their lives and actions.

The rise of the public man

Resourceful physicists such as Nishina were public men who co-opted state discourses relating to Japan's war effort and postwar democracy to further their own aims. Elite scientists in universities have continued to operate in Japanese society somewhat removed from the mainstream, away from the everyday pressure of development at all costs. While institutions like the strong bureaucracy, the former *zaibatsu* (business conglomerates), and the banking system have been more geared to achieving high economic growth,[22] scientists, who were rooted in a largely Western tradition, have championed European-inspired goals for science and served as a moderating force. Their efforts to bring about social change and to create a society more oriented to encouraging individual creativity have led to conflict.

J.A.A. Stockwin argues that the three decades following Japan's defeat in 1945 were a period of national renewal on a par with the Meiji period. Why had the latter been so important, and what does the comparison teach us? The Meiji Restoration of 1868 had marked the transition in Japan from feudal government under the ruling Tokugawa family to a new political system placing the Emperor at the center. In 1889 the Meiji Constitution had been introduced, setting up a state on the Western model. A parliament known as the Imperial Diet had been established, consisting of a House of Peers and an elected House of Representatives. Whereas in the 1890s only about one per cent of the population could vote, in 1925 univer-

War II atomic bomb project," *Annals of science, 47:4* (1990), 347-360; R.W. Home and Morris F. Low, "Postwar scientific intelligence missions to Japan," *Isis, 84* (1993), 527-537; John Dower, *Japan in war and peace: Essays on history, culture and race* (London, 1995), 55-100.

22. Chalmers Johnson, *M.I.T.I. and the Japanese miracle: The growth of industrial policy, 1925-1975* (Stanford, 1982), 307.

sal male suffrage had been introduced. Ironically, intolerance of political dissent had grown: the 1930s had seen the rise of nationalism, the decline of party politics, and the increasing influence of the armed forces. In the lead-up to the Pacific War in 1941, strong ties had been forged between government and industry which would re-emerge in postwar Japan.[23]

The Allied Occupation (1945-52) was of central importance to Japan's future. Under the cry of democratization, reforms were put into place which determined the country's postwar direction. In a book series entitled *The twenty-year whirlwind: Exposing the inside story of the Showa period*,[24] the first volume of which was published four months after the surrender, a team of journalists developed the thesis that military leaders (especially in the army), along with right-wing elements, academics, some industrialists, and politicians were primarily responsible for Japan's defeat. These militarists were seen as having been irrational and unscientific in the way they had waged war, the ultimate proof being their inability to understand Japan's backwardness in science and technology. Indeed many Japanese believed that they had lost the war largely because of superior American know-how, as shown by the atomic bomb. As the historian John Dower argues in his important new book, science became at once both a reason for explaining Japan's defeat and a symbol of where Japan's future lay.[25]

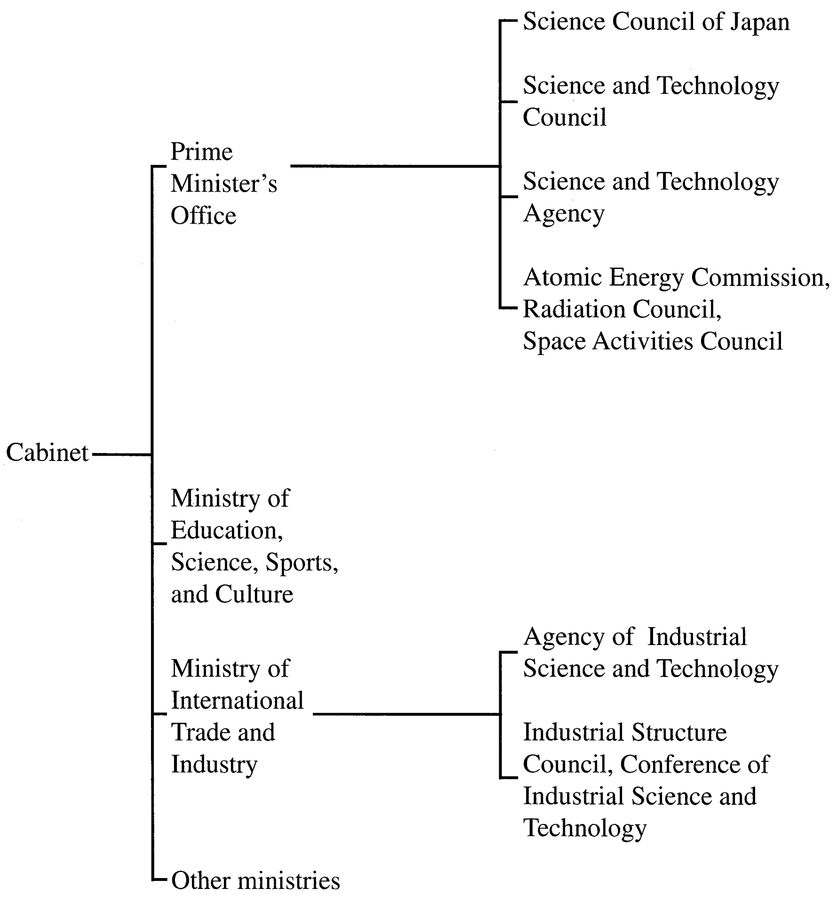
The Emperor was persuaded to renounce his divinity on January 1, 1946. Having become disenchanted with the manipulation of their emotions and beliefs during the war, the Japanese embraced science and technology in the spiritual vacuum in the years that followed, and physicists were among their heroes. But the physicists had other players to contend with, most notably politicians, bureaucrats, and big business. The purging of politicians and the military who had been involved in the war effort left a power vacuum that the bureaucrats filled.[26] Moreover, the Allied Occupation effectively strengthened government ministries in order to carry out its reforms. In fact, until recently it has been difficult to make any changes to the bureaucratic structure that came into being in 1947. Major elements of this framework are shown in the figure below.

President Truman and others argued that for science to flourish, "a spirit of freedom" was necessary.[27] This attitude fueled calls by the scientific community in Japan for a more rational and democratic society in which scientists were prominent. After the war, sovereignty no longer rested with the Emperor, but was lo-

23. J.A.A. Stockwin, *Governing Japan: Divided politics in a major economy*, 3rd edn. (Oxford, 1999), 17-36.
24. Shôzô Mori, ed., *Senpû nijûnen: Kaikin Shûwa rimen shi* (*The twenty-year whirlwind: Exposing the inside story of the Showa period*) (2 vols., Tokyo, 1945, 1946). Cited in John W. Dower, *Embracing defeat: Japan in the wake of World War II* (New York, 1999), 490.
25. Dower (ibid.), 494.
26. Stockwin (ref. 23), 43.
27. *Asahi shinbun*, 14 Sep 1945. Cited in Dower (ref. 24), 495.

cated in the people. The House of Peers was replaced by an elected House of Councillors, and women were given the vote. The voting age was lowered from twenty-five to twenty, and in the name of democratization labor unions and other independent groups were encouraged to speak their mind. Nishina's call to scientific workers reflected the new situation in which public men were no longer required to frame their views in terms of the interests of the state. Left-wing scientists were actively encouraged to organize, freedom of thought being one of the civil liberties written into the postwar Constitution.[28] The political structure estab-

Major Elements of Government Research and Development Policymaking Structure



28. Stockwin (ref. 23), 38-40.

lished under the constitution (promulgated in 1946 and effective as of 1947) is reminiscent of the British "Westminster model": The electorate chooses members of parliament, and a government is formed by the majority of members. For the period from 1955 to 1993, a single party was consistently returned to power, the LDP.[29]

In countries around the world, the end of the war gave rise to efforts to make better use of research for national and international objectives.[30] Nishina, who had played a significant role in the mobilization of science during the war, was also important in the "remobilization" of science and technology afterwards. Occupation authorities sought to demobilize Japanese science, remobilize it to meet U.S. goals, and reorganize scientific bodies along more democratic lines. The proposal for a National Science Foundation in the U.S.A. was echoed in Japan, in the attempts by the Economic and Scientific Section (ESS) of the headquarters of the Supreme Commander for the Allied Powers (SCAP) to set up a democratic science policymaking structure. Towards the end of 1945, after initial investigations had ascertained there was no Japanese A-bomb, restrictions on Japanese nuclear physicists were relaxed, although prohibitions on research relating to atomic energy remained. The U.S. Army dispatched American physicists Gerald Fox and Harry Kelly to Japan to liaise with Japan's scientists. Kelly remained for four years in ESS, providing the Japanese physicists with a link to the outside scientific world and working with Nishina and others to mobilize science for Japan's postwar reconstruction.[31]

On March 12, 1946, Nishina took an initiative in calling for a representative organization for Japanese scientists along union lines, to fight to ensure scientists at least the minimum conditions for survival and help make them more politically aware. Given the linkage between democratic politics, party politics, and the views of the people, Nishina felt that political parties would determine the fate of science in the future.[32] His message, published as an essay in the science magazine, *Shizen* (*Nature*) in May 1946, called for scientists to translate their authority into political clout through representation and participation in the policymaking process.

29. Ibid., 95.
30. Jean-Jacques Salomon, "Science policy studies and the development of science policy," in Ina Spiegel-Rösing and Derek de Solla Price, eds., *Science, technology and society: A cross-disciplinary perspective* (London, 1977), 43-70, esp. 48.
31. The Japanese reforms "reflected the full range of the then American political spectrum: left, liberal, New Deal, mainline American, conservative, military." Herbert Passin, "The Occupation: Some reflections," *Daedalus, 119:3* (Summer 1990), 107-29, on 114. See also Hideo Yoshikawa and Joanne Kauffman, *Science has no national borders: Harry C. Kelly and the reconstruction of science in postwar Japan* (Cambridge, 1994); Jessica Wang, "Liberals, the progressive left, and the political economy of postwar American science: The National Science Foundation debate revisited," *HSPS, 26:1* (1995), 139-166.
32. Yoshio Nishina, "Nihon saiken to kagaku" ("Science and the reconstruction of Japan"), *Shizen, 1* (May 1946), essay dated 12 Mar 1946, reprinted in *Shizen, 300* (Mar 1971), 15-18, on 17, my translation.

Other steps were also under way between April and June 1946. The Japanese Association for Science Liaison (JASL) (Kagaku Shôgai Renraku Iinkai) was formed as an advisory group to the Occupation. On October 28, Sagane suggested a similar group specifically for engineers, a body whose formation, as the Engineering Liaison group, was underway by December.[33] The JASL, whose forty members included Nishina, consisted of a network of regional branches at imperial universities and was a forerunner of the Science Council of Japan. With a view to establishing the latter, a preparatory committee (Sewaninkai), consisting of forty-four mainly Tokyo-based academics, was formed in January 1947. This committee was responsible for electing a representative Renewal Committee for Science Organization (Gakujutsu Taisei Sasshin linkai), upon whose deliberations, through March 1948, the Science Council of Japan would be established. The Renewal Committee, for its part, was to be made up of 108 members, with fifteen members each from basic natural science, engineering, medicine, agriculture, law, literature, and economics, and the remaining three forming a special "composite" category representing broad interests. Progressive groups were active during the Renewal Committee election in 1947; eleven people considered communist sympathizers were elected, two of whom belonged to the "composite" category and were members of the Democratic Scientists' Association (Minshushugi Kagakusha Kyôkai or Minka, a body about which we will hear more below) and the Democratic Technologists' Association (Minshushugi Gijutsusha Kyôkai).

The government, fearful of a left-wing takeover of the Science Council, proposed that that body should be independent: the government could seek the Council's advice but was not bound to do so, thus opening the gate for the government's "own" advisory bodies to be given preference. On July 5, 1948, the Diet approved the establishment of the Council, which would consist of 210 elected members, thirty from each of seven divisions: (1) literature, philosophy, and history; (2) law and politics; (3) economics and commerce; (4) fundamental science; (5) engineering; (6) agriculture; and (7) medicine, dentistry, and pharmacy. The "Science Council," then, was more of a "Research Council," literally "Council for Scholarship"; but suffice it to say that physicists were prominent. Members were elected in December 1948, and Yoshio Nishina was chosen second vice-president at the inaugural meeting on January 20, 1949.[34] According to SCAP, approximately forty of the 210 representatives were known to be Communists or Communist sympathizers.

For their part, the Allied Occupation authorities made efforts to take advantage of research activities for Japan's benefit and America's own Asian agenda.[35] SCAP

33. Draft of "Summary of activities of Scientific and Technical Division in science reorganization," GHQ/SCAP records, ESS (B) 11598. National Diet Library, Tokyo.
34. For details of the voting see "Minutes of 1st general meeting of J.S.C., 20 January 1949 at the Japan Academy Auditorium," GHQ/SCAP records, ESS (B) 11634.
35. Bowen C. Dees, *The Allied Occupation and Japan's economic miracle* (Richmond, Surrey, 1997), 188-193.

thus encouraged the formation of the Japanese Association for Science Liaison, the Renewal Committee for Science Organization, and later the Science Council of Japan to centralize scientists and enhance monitoring of their actions. The emergence of the Cold War suggested to I.I. Rabi that Japanese physicists could provide skilled manpower in time of war in the Far East.[36] This idea meshed nicely with the perception that solutions to many of the problems that the Japanese were facing could be found in the U.S.

Nishina, for his part, continued to play an important role in other ways. In July 1946, as part of the dissolution of the *zaibatsu* (prewar business combines), Riken was reorganized, with Kelly and Nishina making great efforts to preserve it. Nishina was chosen to represent Riken, became its director, and in November 1946 was chosen as its new head. The language that Nishina used in the postwar period was one of peace, internationalism, democracy, and the scientific method. These were keywords in postwar Japan, forms of universalism for a country intent on rejoining the world. In September 1949, Nishina attended the general meeting of the International Council of Scientific Unions in Copenhagen as Science Council representative and then went on to the General Assembly of UNESCO (United Nations Educational, Scientific, and Cultural Organization) in Paris in his capacity as President of the Federation of UNESCO. Cooperative Associations in Japan. In late November 1950, he was taken ill with liver cancer and died on January 10, 1951.[37]

There are startling continuities between the wartime mobilization of science and the Occupation efforts to direct science for the reconstruction of Japan and an American Cold War agenda. Being under the U.S. security umbrella meant that Japan could focus on economic growth. Nishina responded well to the change in authority after the Pacific War, maintaining a high public profile and continuing to appeal to the public good. He suppressed his interest in basic research and proposed that physicists respond first to the practical needs of the nation. His sense of priorities was not shared by all. Nishina's greatest legacy was in fact the many students he nurtured who would go on to lead the scientific community and be influential in policymaking. Unlike him, most would hold university positions. This generation of physicists would struggle with the tensions of being employees of the state and working with the state to implement policy, and yet claiming to provide independent advice in the interests of the Japanese people.

Shôichi Sakata and Mituo Taketani

Many scientists hoped that the Science Council would be the central organization for science and technology in Japan. The two physicists Shôichi Sakata and

36. This is discussed in both Shigeru Nakayama, *Science, technology and society in Japan* (London, 1991), 117-119; and Dees (ibid.).
37. Fumio Yamazaki, "A short biography of Dr. Yoshio Nishina," in Sin-itirô Tomonaga and Hidehiko Tamaki, eds., *Nishina Yoshio: Denki to kaisô* (*Yoshio Nishina: Biography and reminiscences*) (Tokyo, 1952), 3-15, esp. 14.

Mituo Taketani considered the new-found democracy to be an opportunity to empower scientific workers to influence their research environment and work for the people. Sakata and Taketani argued for research autonomy and a commitment to basic science. Despite great differences in family background both shared an interest in Marxism and were outspoken regarding the need for science and democracy in "modernizing" Japan. Both physicists promoted scientism and equated reconstruction with a type of revolution: society had to be changed to allow science to become a force for social change. Despite the more liberal postwar political environment, the Occupation Forces saw to it that left-wing physicists such as Sakata and Taketani were kept under surveillance and their research monitored. Why? The importance of nuclear expertise and the idea that physicists had the key to nuclear weapons and the world's future are not to be underestimated. In the first fifteen years after Japan's defeat, poor conditions encouraged many Japanese in their attraction to ideas like Sakata's and Taketani's. In the later period of economic prosperity, by contrast, the Japanese became more optimistic and proved in less need of a revolution and less reliant on physicists.

Shôichi Sakata was born on January 18, 1911, the eldest son of Mikita and Tatsue Sakata. He lived in the Prime Minister's residential compound in Tokyo, as Mikita, who had graduated from the Faculty of Law at Tokyo Imperial University, was secretary to Prime Minister Tarô Katsura. In March 1912, Mikita took up a new position in Fukuoka prefecture, but he returned to Tokyo as Secretary to the Minister for Commerce and Agriculture (1914) and Secretary to the Minister for Home Affairs (1915). He later went on to become governor of Ehime (1916) and Kagawa (1917) prefectures and mayor of Takamatsu city in 1919, retiring from politics in 1920.[38]

Shôichi studied at Kônan High School (1926-1929) during the early years of the Shôwa period. At Kônan, he became close friends with Tadashi Katô, who in 1929 translated (with Eijirô Kako) Engels' *Dialectics of nature*. After graduating from Kônan, Sakata became an auditor student in the Department of Physics at Tokyo Imperial University and visited Nishina, a distant relative, who had returned from Copenhagen the year before. In April 1930, Sakata entered the Department of Physics at Kyoto Imperial University. In 1932, he chose nuclear theory as the subject of his graduation thesis, and in March 1933 he graduated, some four years after the physicists Yukawa and Tomonaga.[39] Sakata then made his way to Nishina's laboratory at Riken, where he was first a research student and then an associate (April 1933-March 1934). There he worked with Tomonaga and befriended Mituo Taketani. After Riken, Sakata moved to Osaka Imperial University, where he worked with Yukawa on topics such as meson theory. In 1938 he was appointed lecturer.

38. Shôichi Sakata, *Kagakusha to shakai, ronshû* (*Scientists and society, collected papers*), Vol. 2 (Tokyo, 1972), 422-423. Shunkichi Hirokawa and Shuzô Ogawa, "Shôichi Sakata: His physics and methodology," *Historia scientiarum, 36* (1989), 67-81, esp. 67.
39. Sakata (ref. 38), 424.

Yukawa subsequently moved to Kyoto Imperial University, where Sakata also sometimes lectured.[40]

In May 1941, Sakata received his Doctor of Science and almost one year later presented the two-meson theory with Yasutaka Tanikawa at Riken. Sakata then moved to Nagoya to become professor at the new imperial university. In April 1945, the Nagoya theoretical physics group moved to Fushimi in Nagano prefecture. During his spare time at Fushimi, Sakata read J.D. Bernal's *The social function of science* (1939), eventually co-translating the book into Japanese in 1951. To Sakata, it seemed a natural extension of Marxist thought. He was particularly impressed by Bernal's concept of "laboratory democracy,"[41] for it offered a way of overcoming the dominant role of professors in Japan. His view of democracy involved not only physicists but representation and participation by a much wider group of people. In this respect, he may well have been influenced by Taketani, who came from a less wealthy background.

Taketani was born in 1911 in the city of Ômuta in Fukuoka prefecture, the third son of a technical expert at the local Mitsui-owned Miike coal mine. The family moved to Osaka when he was six, his father working as an engineer at a nearby factory which was owned by an uncle. At the end of World War I, Taketani's father was forced to find a new job at a coal mine in the northern part of Taiwan. The family followed. Taketani eventually returned to Japan and entered the Department of Geophysics in the Faculty of Science at Kyoto University. In his second year, he switched to a physics major. Taketani graduated in 1934, with a final year thesis, later published, titled "How should we study nuclear physics?" In late 1934, Taketani became involved in an intellectual group which would publish a journal entitled *Sekai bunka* (*World culture*) aimed at protecting anti-fascist culture. In the autumn of 1936, however, half the core members were rounded up by the Special Higher Police[42] and interrogated. Taketani helped develop Yukawa's meson theory during 1937/8. In September 1938, however, Taketani was taken to Kyoto and detained, made to sign a statement that *Sekai bunka* supported the Japanese Communist Party, and kept in detention until April 1939, when he was released with Yukawa acting as guarantor.[43]

Beginning around April 1941, Taketani went to Tokyo to help Sin-itirô Tomonaga in Nishina's laboratory. The Nishina lab by this time included a cosmic ray experiment group, a cyclotron group, a theory group, and a biology group; Tomonaga was one of the leading members of the theory group, and Ryôkichi Sagane was the core of the group working on the cyclotron. The Army-funded atomic bomb project began in 1943 and Taketani was mobilized for it. The aim was to separate uranium 235 by gaseous thermal diffusion. Taketani's work was

40. Ibid., 424-425.

41. J.D. Bernal, *The social function of science* (London, 1939), 267.

42. For details of the activities of the Special Higher Police, see Elise K. Tipton, *The Japanese police state: The Tokkô in interwar Japan* (North Sydney, 1990).

43. Taketani, *Shisô o oru* (*The interweaving of ideas*) (Tokyo, 1985), 76-84.

interrupted in May 1944 when the Special Higher Police detained him for a second time.[44] During his detention, Taketani worked on the theory of the thermal diffusion process and also calculated the potential damage from an atomic bomb. He returned home in September 1944.[45] With the end of the war, Taketani, along with Yukawa, Tomonaga, and Sakata, became one of Japan's best physicists—not so much for his physics, however, as for his role as a social spokesperson, organizer of the Elementary Particle Theory Group, and commentator on the social responsibility of scientists.[46]

After Japan's defeat, as we saw, there was much debate on how and for what purposes science might be put to use. Left-wing scientist-intellectuals such as Sakata and Taketani emphasized the need for a democratic administrative structure and the importance of working to improve the people's welfare. Socialism was portrayed as scientific and an aid in solving Japan's problems. Science, therefore, was of central importance, and scientists were not only to take social responsibility for it, but also to protect it from abuses by the state or private sector. Sakata felt, like Bernal, that society would need to change for science to prosper.

The Democratic Scientists' Association (abbreviated in Japanese as "Minka") has already surfaced in our account. Its inaugural meeting was held on January 12, 1946. Minka has parallels with the Association of Scientific Workers in England and the Federation of Atomic Scientists in the U.S.[47] The program was far-reaching: it aimed to (1) build a "democratic" science; (2) resist feudalism and militarism in science; (3) obtain freedom in the pursuit and publication of scientific research; (4) fight an anti-democratic education system and its policies; (5) democratize scientific facilities and organization; (6) ensure that science and technology contribute to the enrichment of the lives of the people; (7) train and encourage promising scientists; (8) strengthen cooperation and dialogue among natural scientists, social scientists, and technologists; (9) support the social role of scientists and technologists; (10) facilitate national and international liaison between democratic science and technology groups; and (11) assist in the absorption of scientific findings of democratic countries.[48] Its advocates hoped to build a Minka network of branches throughout Japan. At the height of its popularity in late 1949, it had 110 branch offices, a specialist membership of 2000, and a student and nonspecialist membership of 11,000. It was headed by the historian of science Kinnosuke Ogura, and the many secretaries included Taketani and Sakata. The

44. Ibid., 92-97, 104-106.
45. Ibid., 107-108.
46. Ibid., 118-19.
47. See Alice Kimball Smith, *A peril and a hope: The scientists' movement in America, 1945-47* (Chicago, 1965); William McGucken, *Scientists, society and state: The social relations of science movement in Great Britain, 1931-1947* (Colombus, 1984).
48. Masanori Ônuma, Yôichirô Fujii, and Kunioki Katô, *Sengo Nihon kagakusha undôshi, jyô* (*The history of the postwar Japanese scientist movement, Part one*) (Tokyo, 1975), 23-24.

membership register included the names of Sin-itirô Tomonaga and Hideki Yukawa, with Yukawa's membership marked as being under negotiation.[49] While none of these four physicists (Taketani, Sakata, Tomonaga, and Yukawa) is known to have joined the Communist Party, the Occupation authorities considered Minka to be a front for Communists.[50] For its members, however, science and democracy were matching wheels for social progress. The spread of such associations, growing networks of scientists, and the emergence of a public sphere contributed to the transition to a civil society in Japan.

Minka was responsible for producing a long list of periodicals which were part of the "literary renaissance" that occurred soon after the surrender. Between 1946 and 1949, despite various shortages, 110 serious literary magazines were in publication in Japan. It was within this postwar milieu that Taketani became a major contributor on scientific and technological themes to literary magazines, becoming very much an established Marxist intellectual For instance, an essay on his Marxist-inspired theory of technology[51] appeared in the February 1946 edition of *Shinsei,* and he was one of the founding members of the intellectual group centered around the magazine *Shisô no kagaku* (*The science of thought*). He also participated in some activities of the Japanese Communist Party. He was particularly concerned about the neglect of the welfare of workers and felt that industrialists were more interested in maintaining a low-wage labor force and using imported technology. Taketani's influence as a left-wing intellectual did not simply derive from intellect and connections, but relied substantially on his writings in the media and their coverage of his activities. Conversely, in an interview in *Minshû hyôron* (*People's review*) in June 1949, Taketani criticized the accuracy of reporting in all the major Tokyo papers. Taketani suggested that a weekly publication be produced to act as a media watchdog,[52]

> reviewing on a nation-wide scale, all newspaper articles on peace movements sponsored by intellectuals, and...warning the publishers against any possible mistake they may make in the handling of news concerning such movements.

Like other physicists, Taketani stressed that the value of physics lay in the physi-

49. A list of foundation members and office bearers is included in Hideomi Tuge, *Minka to watakushi: Sengo hito kagakusha no ayumi* (*The Association of Democratic Scientists and I: The postwar story of a scientist*) (Tokyo, 1980), 294.
50. There are strong parallels with England. See Gary Werskey, *The visible college* (London, 1978).
51. For an explanation of Taketani's concept of technology see Yoshirô Hoshino, "On concepts of technology," in Shigeru Nakayama, David L. Swain, and Eri Yagi, eds., *Science and society in modern Japan* (Tokyo, 1974), 39-50.
52. Translation of summary of interview with Mituo Taketani, *Minshû hyôron* (*People's review*), June 1949, GHQ/SCAP records, Item no. 10, ESS (E) 06394, National Diet Library, Tokyo.

cist as moral character, an ideal type of person.[53] Through his high media profile, he increasingly fashioned himself as a public man.

Sakata also sought public platforms for his views. On April 30, 1946, at the inaugural meeting of the Physical Society of Japan,[54] he spoke on democratization in the Department of Physics at Nagoya University, where he worked. He advocated that individual laboratories be run so that each scientist could be empowered and work free of the feudalistic domination of professors.[55] Laboratories, then, should be organized according to two basic principles: freedom for each individual researcher and effective cooperation. For liaison and deliberation among the groups within a department, Sakata proposed a Laboratory Council, allowing all researchers a voice in policy. Behind this vision stood the hope that research themes rather than actual laboratories would become the basic unit within a department, whose highest deliberative organ would be the Department Council. These principles provided the basis of the new Constitution of the Nagoya University Department of Physics and were put into effect beginning June 13, 1946. In an article in the *Tokyo Imperial University newspaper* Sakata suggested,[56]

> "Laboratory Democracy" is an only effective means for the prevention of vicious growth of feudalism....It must be extended not only to all the scientific organizations but also to the development of a whole community.

Sakata was elected to the Science Council of Japan (JSC) in December 1948. Continually re-elected, he devoted twenty-two years of his life to its activities.[57] His colleague Taketani was also elected.

One key theme for both physicists was atomic energy. In his writings, Taketani helped educate the public about its facts and implications.[58] Hoping to prevent its

53. This is discussed in Paul Forman, "Social niche and self-image of the American physicist," in Michelangelo De Maria, Mario Grilli, and Fabio Sebastiani, eds., *The restructuring of physical sciences in Europe and the United States, 1945-1960* (Singapore, 1989), 96-104, esp. 98.
54. The Physical Society of Japan was established from part of what had previously been the Physico-Mathematical Society of Japan. A particle theory sectional meeting was formed at the same time. This group later divided up into a particle theory and nuclear theory group. Tetu Hirosige, *Sengo Nihon no kagaku undô* (*Postwar Japan science movement*) (Tokyo, 1960), 181-182. Bi-annual meetings of the Elementary Particle Theory Forum (as part of Physical Society conferences) have provided and do still provide an occasion for group decision-making, while administrative work has been shared by an "Elementary Particle Theory Group Secretariat" which rotates every 3 to 4 months from campus to campus.
55. Cf. Bernal (ref. 41), 265.
56. Draft translation by "George" of Shôichi Sakata, "Abolish the sectionalism: On the democratization of [sic] research system," *Tokyo Imperial University newspaper*, no. 1004 (Wed., 13 Nov 1946), GHQ/SCAP records, ESS (E) 06393, National Diet Library, Tokyo.
57. Sakata (ref. 38), 48.
58. Japan Atomic Industrial Forum, *Nihon no genshiryoku: 15 nen no ayumi, jyô* (*Atomic energy in Japan: A 15-year history, part 1*) (Tokyo, 1971), 12-14.

use for military purposes, Taketani proposed the famous three principles for the peaceful use of atomic energy, calling for public disclosure, democratic management, and research autonomy. Sakata's further advocacy of the importance of the "three principles" ensured that public debate over atomic energy continued. The two physicists' actions had a major impact on the formulation of the Basic Atomic Energy Law passed by the Diet in 1955, which forbade use of atomic energy for military purposes and incorporated the three principles.

Finally, Sakata and Taketani's aspirations found a home in a larger collection of physicists, the Elementary Particle Theory Group. The group can first be traced back to symposia on meson theory held before and during World War II, with around twenty participants principally from Riken and the imperial universities of Tokyo, Kyoto, Osaka, and Nagoya.[59] Through the Elementary Particle Theory Group physicists sought to influence science policy and bring about the "modernization" of the research system. At the end of 1949 a university-based network of nine branches was set up throughout Japan, and by 1950, membership had grown to well over one hundred, with some estimates as high as double that figure.[60] The award of the 1949 Nobel Prize for Physics to Hideki Yukawa boosted the group's profile, with the result that the group became somewhat of a favorite of the media.[61] (The Nobel Prize, Japan's first, also led the National Diet to recommend an increase in government funding of research and development.)

By the end of the 1950s, membership of the Group exceeded three hundred. Despite its democratic aspirations, it displayed a definite hierarchy along generational lines: "daibosu" ("big bosses"), "chûbosu" ("middle bosses"), and "kobosu" ("little bosses"): Hideki Yukawa, Sin-itirô Tomonaga, Shôichi Sakata, and Mituo Taketani were the first generation, the "middle bosses" included Seitarô Nakamura, Takeshi Inoue, Nobuyuki Fukuda, Satio Hayakawa, Yôichi Fujimoto, Hiroomi Umezawa, and Eiji Yamada, and the "little bosses" were the postwar generation who followed.[62]

By means of all these channels—the Elementary Particle Theory Group, the media, Minka, and the Science Council—Taketani and Sakata struggled to create a space to fight for not only the particular interests of scientists, but their version of the public interest and demands for a public sphere. But shortly before his death,

59. Elementary Particle Theory Group, Nagoya University Branch, "A short history of the research group of the theory of elementary particles of Japan," mimeographed article, Sakata Archival Library, Nagoya University, 5.

60. For a list of these members see Yoshinori Kaneseki, "The Elementary Particle Theory Group," in Nakayama et al. (ref. 51), 221-252, esp. 222-229.

61. Tetu Hirosige, *Sengo Nihon no kagaku undô* (*Postwar Japan science movement*) (Tokyo, 1960), 184-185.

62. Kiyonobu Itakura, "Kagakusha no jishuteki na soshiki" ("An independent organization of scientists"), in Mituo Taketani, ed., *Shizen kagaku gairon, daiikkan: Kagaku gijutsu to Nihon shakai* (*An introduction to the natural sciences*, Vol. 1: *Science, technology and Japanese society*) (Tokyo, 1962), 155-173.

reflecting on more than two decades of the Science Council, Sakata bemoaned how the "logic of government" dominated the "logic of science." Although the Science Council had been active, moves to bypass it were increasing.[63] With failing health, Sakata resigned from his JSC Committee chairmanship and died on October 16, 1970.[64] Taketani, who taught at Rikkyo University then left the education sector to pursue fulltime writing, out-lived Sakata and continues to write to this day. Nonetheless, Sakata's death marked the end of a period of the physicist as general expert on things scientific: the increased number of specialists made "expertise" more accessible and fragmented any political influence that expert authority wielded.[65]

Hideki Yukawa and Sin-itirô Tomonaga

In his voluminous writings, Yukawa highlighted the importance of cultural traditions to his work in physics.[66] These writings, his status as Japan's first Nobel laureate, and his long directorship of the Research Institute for Fundamental Physics earned him a special place among physicists. Like Sakata, he came from a privileged background. He was born in Tokyo on January 23, 1907, the third son of Takuji Ogawa, who was a staff member of the governmental Geological Survey Bureau, part of the Ministry of Agriculture and Commerce.[67] In 1908, Takuji moved to Kyoto University to take up a chair in geography in the Faculty of Arts. Hideki learned the Chinese classics from his grandfather, Nanmei Asai, a former Confucian scholar for the Tanabe feudal clan. Hideki's maternal grandfather, Komakitsu Ogawa, had been a samurai at the Tokugawa castle in Wakayama.[68] Both sides of his family had a tradition of learning.

Hideki gained admission to Kyoto Imperial University in 1926. He graduated in 1929 and stayed on that year as an unpaid associate pursuing theoretical physics in the lab of Professor Kajurô Tamaki in the Faculty of Science. Hideki studied there with his colleague Sin-itirô Tomonaga.[69] Hideki Ogawa married Sumiko

63. "Kagaku no ronri to seiji no ronri: Gakujutsu Kaigi nijûnen" ("The logic of science and the logic of government: Twenty years of the Science Council of Japan") (1968), in Sakata (ref. 38), 389-393.
64. Sakata (ref. 38), 430.
65. This was also the case in the U.S. See Brian Balogh, *Chain reaction: Expert debate and public participation in American commercial nuclear power, 1945-1975* (Cambridge, 1991).
66. See for example, Hideki Yukawa, trans. L.M. Brown and R. Yoshida, *Tabibito* (*The traveler*) (Singapore, 1982); Hideki Yukawa, trans. John Bester, *Creativity and intuition: A physicist looks at East and West* (Tokyo, 1973).
67. Takashi Hayakawa, *Nihon no jôryû shakai to keibatsu* (*Japan's social elite and matrimonial influence*) (Tokyo, 1983), 232.
68. Yasutaka Tanikawa, "Introduction and biographical sketch," in Hideki Yukawa, *Hideki Yukawa: Scientific works* (Tokyo, 1979), vii-viii.
69. Yukawa, *Traveler* (ref. 66), 170.

(Sumi) Yukawa on April 23, 1932, and was adopted into her family,[70] taking on the family name of Yukawa and moving to nearby Osaka. Appointed lecturer that year at Kyoto's Faculty of Science, Yukawa taught quantum mechanics and carried out theoretical research in nuclear physics and cosmic rays. There second-year students included Shôichi Sakata and Minoru Kobayashi, who attended Yukawa's first lectures; Mituo Taketani would take the quantum mechanics course the following year.[71] Yukawa continued to teach at Kyoto until March 1934.[72]

In his research Yukawa thought that the "strong" force at work within the nucleus could be reduced to the exchange of a new particle between proton and neutron, the meson.[73] Meson theory was developed in a number of papers in collaboration with Sakata, Taketani, and Minoru Kobayashi. Along the way Yukawa was promoted to Associate Professor in 1936 and in 1938 received his D.Sc. Yukawa returned to Kyoto Imperial University in 1938 to replace the recently deceased Prof. Kajurô Tamaki. From that year onward, Yukawa was a member of the National Research Council (a prewar government body for the promotion of research) and beginning in the following year became formally affiliated with Riken as well as Tokyo Imperial University, where he taught from time to time. During the war he continued his theoretical research and is listed as one of the participants in a small-scale, Kyoto-based atomic bomb project towards the end of the war.[74]

After the war, Yukawa founded the journal *Progress of theoretical physics*; the first issue appeared in July 1946.[75] He left Japan on September 2, 1948, to take up Robert Oppenheimer's invitation of a visiting professorship at the Institute for Advanced Study in Princeton,[76] and on July 1, 1949, accepted an appointment to the physics staff at Columbia University.[77] While away he was awarded his Nobel Prize and elected to the Science Council of Japan. On his return in 1953, Yukawa was installed as director of the Research Institute for Fundamental Physics (RIFP)

70. "Translation of Yukawa family record register," ESS files, GHQ/SCAP records, ESS (B) 11648, National Diet Library, Tokyo.
71. Yukawa, *Traveler* (ref. 66), 188.
72. Takeo Kuwabara, Ken Inoue and Michiji Konuma, eds., *Yukawa Hideki* (*Hideki Yukawa*) (Tokyo, 1984), 325; Yukawa, *Traveler* (ref. 66), 196-197.
73. Yukawa (ref. 68).
74. History of Science Society of Japan, ed., *Nihon kagaku gijutsushi taikei, 13: butsurigaku* (*An outline of the history of science and technology in Japan,* Vol. 13: *Physics*) (Tokyo, 1970), 441.
75. Michiji Konuma, "Social aspects of Japanese particle physics in the 1950s," in Laurie M. Brown, Max Dresden, and Lillian Hoddeson, eds., *Pions to quarks: Particle physics in the 1950s* (Cambridge, 1989), 536-548.
76. For details see Michiji Konuma, Chieko Masuzawa, and Yoshio Takada, "Resumption of international relationship of Japanese particle physicists after World War II," *Historia scientiarum, 36* (1989), 23-41.
77. H.C. Kelly to Colonel L.K. Bunker, "Award of Nobel peace prize to Dr. Hideki Yukawa," 4 Nov 1949, ESS files, GHQ/SCAP records, National Diet Library, Tokyo. Laurence Bunker was a close military aide of General MacArthur.

at Kyoto University. In 1956 he became a member of the newly-established Japan Atomic Energy Commission, while the Elementary Particle Theory Group provided him with organizational support and a wide national network. The press considered Yukawa's presence on the JAEC as an important voice of caution. On March 18, 1957, however Yukawa resigned from the Commission, citing ill-health; to some extent he was replaced in this official function by physicists such as Ryôkichi Sagane and Seishi Kikuchi.[78]

The more outgoing Tomonaga, for his part, had long been considered Nishina's successor. In the Science Council, whose president he became, his strong interpersonal skills were put to good use. Like Yukawa, he came from a highly cultured family and was renowned for his literary ability.[79] Born less than a year before Yukawa, on March 31, 1906, he was the eldest son of Sanjurô Tomonaga, who in turn was of Nagasaki samurai background. Sanjurô had studied philosophy and history of philosophy at Tokyo Imperial University and at the time of Sin-itirô's birth was professor of philosophy at Shinshû University (later known as Ôtani University) in Tokyo. The following year he took up the position of Associate Professor at Kyoto Imperial University and in 1909 decided to go to Europe for further study, leaving his wife and child in Tokyo.[80] Yoshio Nishina would later provide a father-figure for the mentor-less young man.

Sanjurô returned to Japan in 1913 and the entire family took up residence again in Kyoto, where he was made professor. In 1926, Tomonaga gained admission to the Faculty of Science at Kyoto Imperial University, where he majored in physics. He and Hideki Yukawa both chose to specialize in quantum mechanics in their third year in 1928. Tomonaga graduated in 1929 and like Yukawa chose to remain at the university as an unpaid associate. Tomonaga joined the Nishina lab at Riken in 1932 where Sakata followed in 1933. After a period of studying nuclear theory at Leipzig University under Werner Heisenberg from June 1937 to August 1939, Tomonaga returned to Japan and received his D.Sc. from Tokyo Imperial University. In June 1940 he became a Riken research fellow, and, beginning in 1941, a professor at the Tokyo University of Science and Literature.

From around mid-1943, Tomonaga was mobilized with other physicists to carry out research on magnetrons and ultra-shortwave circuits at the Naval Research Institute laboratory at Shimada. In 1946 he won the Asahi Cultural Prize (a prestigious prize awarded by the *Asahi Shinbun* newspaper for cultural achievement) for his work on meson theory and his super-many-time formulation of quantum field theory. With Nishina busy with administration after the war, the leadership of the Tokyo group of physicists shifted to Tomonaga. The Tomonaga Seminar be-

78. For details of Kikuchi's career see Kikuchi Kinen Jigyôkai Henshû Iinkai, ed., *Kikuchi Seishi: Gyôseki to tsuisô* (*Seishi Kikuchi: Achievements and reminiscences*) (Tokyo, 1978).
79. His writings have been published as a 15-volume set entitled *Tomonaga Shinichirô: Chosakushû* (*The collected works of Sin-itirô Tomonaga*) (Tokyo, 1984, 1985).
80. Kennosuke Matsui, ed., *Kaisô no Tomonaga Sin-itirô* (*Reminiscences of Sin-itirô Tomonaga*) (Tokyo, 1980), 3-6, 8.

came a mecca for physicists, and in 1948 he was elected to the Science Council of Japan. The following year, Tomonaga visited the Institute for Advanced Study at Princeton.[81] He received the Nobel Prize in 1965, shared with Richard Feynman and Julian Schwinger for their contributions to quantum electrodynamics.

Already with the death of Nishina in 1951, Tomonaga took on further responsibility for nuclear physics and science policy.[82] These matters were discussed at various meetings of the Physical Society of Japan and at the JSC Special Committee for Nuclear Research (SCNR), which, under Tomonaga's chairmanship, played an important role in formulating plans. In 1959 he was appointed to the new Science and Technology Council (the government's rival to the Science Council) and in 1963 elected president of the Science Council itself, remaining in that post until 1969. The Science and Technology Council was of the government's own making and effectively the highest science policymaking body in Japan. It enjoyed strong ties with the Liberal Democratic Party and bureaucracy. While Sakata criticized its overly cozy relationship with the establishment, Tomonaga's attraction to it may have been due to its focus on science and technology (rather than coverage of all fields of scholarship, like the Science Council of Japan) and the hope of greater influence in policymaking. Scientists had long been perceived as left-wing, anti-big business and keen to distance themselves from the bureaucracy. Tomonaga arguably attempted to break down this stereotype. Facilities for big science could only be established with cooperation. Subsequently, the president of the Science Council automatically became a member of the Science and Technology Council.

Tomonaga and Yukawa both put their prestige behind antinuclear and world government efforts. The Japanese movement to ban atomic and hydrogen bombs effectively started only after the Bikini Atoll hydrogen bomb test on March 1, 1954, when a small Japanese fishing boat, the "Lucky Dragon" was showered with radioactive ash. Yukawa was a member of the organizing committee for the World Conference Against Atomic and Hydrogen Bombs held at Hiroshima during August 6-8, 1955, and one of eleven signatories to the Russell-Einstein Manifesto, promulgated by eight Nobel prize winners and other scientists. In 1955, Yukawa became a member of the World Peace Appeal Group of Seven Committee, later to be joined by Tomonaga and the Nobel-prize-winning novelist Yasunari Kawabata; the group served as part of the League for the Establishment of a World Federation of Nations. In 1957 Yukawa and Tomonaga attended the First Pugwash Conference, held in Canada. Continuing his efforts on behalf of world government, in 1958 Yukawa became an adviser to the World Association of World Federalists and a few years later, in 1961, was elected President, continuing in that

81. "Japan's hidden physicists: Men who will follow in Yukawa's footsteps," *Nippon times* (22 Nov 1949), GHQ/SCAP records, ESS (E) 06365, National Diet Library, Tokyo.
82. Satio Hayakawa, "Kenkyû shinkô ni tsutometa Tomonaga sensei" ("Prof. Tomonaga: A man who strove for the advancement of research"), *Kagaku* (*Science*), *49:12* (Dec 1979), 799-803, on 799.

position until 1965. In 1962, the first meeting of the Kyoto Conference of Scientists was held, with Yukawa, Tomonaga, and Sakata as the key organizers. Yukawa in particular hoped to use the conference to develop a strategy of nuclear deterrence more in keeping with the original Russell-Einstein Manifesto, which called for the abolition of nuclear weapons.[83]

The Nobel prize winners Hideki Yukawa and Sin-itirô Tomonaga differed from Sakata and Taketani in that it was more their physics than their political philosophy that provided the backbone for the high esteem in which they were held. They illustrate yet another variation of the public man. Background factors such as family, upbringing, and education can account for some of the differences among the four, but the award to Yukawa and later Tomonaga of the ultimate accolade in physics, the Nobel Prize, served to separate them from other physicists in the minds of the public. Yukawa tended to advocate a solitary symbiosis with Japan's traditions, drawing on Eastern philosophies to account for the success of his ideas. Tomonaga had a more open and engaging personality. In his spare time, he indulged in *rakugo* comic storytelling, a pastime that requires an audience. Each of the four key physicists mapped out his respective territory of influence with Yukawa in Kyoto, Tomonaga in Tokyo, Sakata in Nagoya, and Taketani occupying the periphery where intellectual free spirits reside. All four portrayed themselves as bulwarks against the profit-hungry private sector and military-minded politicians. A notable exception was Ryôkichi Sagane, son of Hantarô Nagaoka.

Ryôkichi Sagane

Ryôkichi Sagane was a physicist who left academia and immersed himself in the technocracy. Sagane's background in experimental physics gave him the technical experience to pursue the development of civilian nuclear power, and Japan's fledgling atomic energy program provided him with a reason to return from the U.S. in the mid-1950s.

Sagane was born in Tokyo on November 27, 1905, the fourth son of the eminent physicist Hantarô Nagaoka. In 1914, he was adopted by Mrs. Chiyo Sagane, thenceforth taking on her family name.[84] He entered the Department of Physics, Tokyo Imperial University, in 1926, where he continued with graduate school beginning in 1929. In 1931 he became one of the first members of Nishina's new lab, where he remained heavily engaged despite being appointed lecturer in April 1933 at Tokyo Imperial University. From August 1935 to November 1936, he conducted research at Ernest Lawrence's Radiation Laboratory in Berkeley. Construction of a 26-inch cyclotron subsequently commenced at Riken and was completed by April 1937. Sagane received his D.Sc. in December 1939 with a dissertation entitled,

83. Yukawa, *Creativity* (ref. 66), 191.
84. "Translation of extract of census register, Ômura city, Nagasaki prefecture, 17 September 1949," GHQ/SCAP records, ESS (B) 11649, "Travel abroad of Dr. Sagane" file, 9, National Diet Library, Tokyo.

"On artificial radioactivity."[85] Around the beginning of the Pacific War, Sagane was called upon often to help in military research and in May 1942 was made a full research member of Riken. In March 1943 he was promoted to Professor at Tokyo Imperial University. He was involved in policymaking from 1943 when he became a member of the National Research Council.

After the war, Sagane's ability to speak some English enabled him to make representations to SCAP on behalf of his fellow scientists. He was a member of a variety of committees, including the Renewal Committee for Science Organization (August 1948—January 1949). Sagane left Japan the following year to accept a visiting professorship in the Department of Physics, Iowa State College, from January 1 to July 1, 1950,[86] thus joining the brain drain of outstanding young physicists who went to the U.S., such as Yukawa, Tomonaga, Seishi Kikuchi, Satio Hayakawa, and Yôichirô Nambu. Sagane stayed overseas for over five years and even resigned from Tokyo University due to his lengthy absence.

Upon his return from the U.S. in 1955, Sagane facilitated the implementation of Japan's nuclear policy, from negotiating the importation of reactor technology to advising on the construction of power plants and ensuring their successful operation. In March 1956, he signed on as a consultant to the JAEC and on June 26, 1956 became a director of the Japan Atomic Energy Research Institute (JAERI). In May 1960, he was made part-time executive director of Japan Atomic Power Company (JAPCO), advancing a year later to full-time executive director. His views differed from Sakata, Taketani, Yukawa, and Tomonaga, who were all theoretical physicists lacking experience in building apparatus. Sagane, an experimental physicist, had more in common with his former boss, Nishina, who had originally been trained as an engineer.

Sagane changed the meaning of physicist as public man, for he engaged in non-university, public corporation science. He then redefined the idea of scholar in public service.[87] Sagane represented a new breed of physicist turned technocrat, opting to leave academia to become an insider in Japan's civilian nuclear power program. Sagane was a far less visible public man than his physicist colleagues, but it was perhaps a sign of the times, as "public" came to be associated with public corporations such as JAERI, and public enterprises like the JAPCO. Indeed, by the 1960s, the bureaucracy had become a very powerful political force, with former bureaucrats becoming politicians and joining the private sector on retirement. The ruling LDP had formed in 1955 from various conservative parties, and it continued in power until 1993. The LDP, bureaucrats, and big business formed

85. Kôji Fushimi, "Sagane Ryôkichi sensei no mutsu no katsudô sô" ("Six aspects of the activities of Prof. Ryôkichi Sagane"), in Publication Committee, ed., *Sagane Ryôkichi kinen bunshû* (*Collection of writings to commemorate Ryôkichi Sagane*) (Tokyo, 1981), 121-124, on 121 and iii.

86. Fox to Kelly, 27 Oct 1949, GHQ/SCAP records, ESS (B) 11649, National Diet Library, Tokyo.

87. Publication Committee, ed. (ref. 85).

a triumvirate of political power that blurred the boundaries between the state and civil society, and between the public and private sector.[88] Public discussion as embodied by Sakata and Taketani and their calls for openness and transparency in policymaking tended to retreat; dealings between politicians and the private sector became the norm. The experience of Satio Hayakawa, finally, shows that access to politicians and bureaucrats can be more important to doing big science than a high public profile.[89]

Satio Hayakawa

Satio Hayakawa (born in Niihama city, Ehime prefecture in 1923) was one of the "chûbosu" ("middle bosses") of the Elementary Particle Theory Group who graduated from the university around World War II. In his case, he entered Tokyo Imperial University in October 1942, majoring in physics. He completed his studies at the end of the war in September 1945. His subsequent career provides a useful window from which to view the role played by physicists in policymaking and the broader society up until 1970.

Hayakawa initially worked on nuclear physics and elementary particle theory, concentrating especially on cosmic rays and astrophysics. As a member of one of Tomonaga's study groups, he helped to develop the super-many-time theory and renormalization theory immediately after the war. His earliest papers were co-authored with Tomonaga.[90] From mid-1949, Hayakawa lectured in the Faculty of Science and Engineering at Osaka City University where there was a group of outstanding young physicists including Yoshio Yamaguchi and Yôichirô Nambu.[91]

88. The diversity inherent within each group of actors goes beyond the scope of this paper, but it is fair to say that organizations such as Keidanren (Federation of Economic Organizations) serve as the leading voice and interest group for big business. Similarly, the ministries and agencies the bureaucracy each have their own characteristics and culture, but they are a highly educated elite with a number of common traits. Tokyo University graduates have dominated the civil service, with Law School alumni being particularly influential. There have been strong ties among the bureaucracy, Liberal Democratic Party and private sector, with many cases of public officials retiring from government ministries and standing for Parliament as LDP candidates or taking up positions on the boards of companies in areas related to their former ministries. See Johnson (ref. 22).

89. Satio Hayakawa and Morris F. Low, "Science policy and politics in post-war Japan: The establishment of the KEK High Energy Physics Laboratory," *Annals of science, 48* (1991), 207-229; Lillian Hoddeson, "Establishing K.E.K. in Japan and Fermilab in the U.S.: Internationalism, nationalism and high energy accelerators," *Social studies of science, 13* (1983), 1-48.

90. Satio Hayakawa, "List of academic publications," Hayakawa collection, Sakata Archival Library, Nagoya University.

91. "Personal history of Satio Hayakawa," GHQ/SCAP records, ESS (E) 06383, National Diet Library, Tokyo. Laurie M. Brown, "Yoichiro Nambu: The first forty years," *Progress of theoretical physics supplement*, no. 86 (1986), 1-11, draft of manuscript, 5, courtesy of Laurie Brown, Northwestern University.

In May 1950, Hayakawa left Japan to participate in the Foreign Student Summer Project at M.I.T., where he worked for seven months with Bruno Rossi in the Laboratory for Nuclear Science and Engineering.[92] Hayakawa went on to England, France, and then India before returning to Japan in January 1952. In his absence, he received his D.Sc. from Tokyo University in November 1951 for research on cosmic ray high energy phenomena.

Hayakawa's experience abroad confirmed for him the benefits of science as an international and progressive force, something that would enable Japan to pick itself up from defeat, win friends, and gain international prestige. From July 1952 to October 1953, he was a member of the organizing committee for the International Conference on Theoretical Physics held in Tokyo and Kyoto in September 1953 under the auspices of the Science Council. In January 1954, Hayakawa took up a professorial position—at the young age of 30—at the new Research Institute for Fundamental Physics at Kyoto University. In April 1956 he became a specialist member of the Tokyo University Institute for Nuclear Study preparatory committee, and, in May 1958, the Japan Atomic Energy Commission. Committee memberships continued with the Science Council of Japan's Special Committee for Nuclear Research in December 1958, the SCNR's Subcommittee for Future Plans for Nuclear Research in July 1959, and the Cabinet's Council for Space Development in December 1960. Hayakawa also made a point of traveling overseas during these years. In March 1959 he became professor at Nagoya University, specializing in astrophysics, especially infra-red astronomy. In the early 1960s, with the discovery of x-ray emission from space, Hayakawa began cosmic x-ray observations and helped to clarify the existence of high temperature plasmas in the vicinity of the sun.

Hayakawa became increasingly well-known among the international physics community. For at least the first ten years of the Kyoto-based, English-language journal *Progress of theoretical physics*, Hayakawa was the largest single contributor of papers, with research that spanned elementary particle theory, nuclear physics, solid state theory, relativity, cosmic rays, and astrophysics. He also played a formative role in the establishment of the Institute of Plasma Physics (Nagoya University), the Institute for Space and Astronautical Science (Tokyo University), and the KEK High Energy Physics Laboratory (Kô Enerugi Butsurigaku Kenkyûjo) at Tsukuba. In the process Hayakawa helped bring "big science" to Japan. As with Sagane, this demanded certain skills of scholarly judgment, leadership, and an ability to communicate with bureaucracy and foreign scientists: an outgoing "international scientist" with good English skills like Hayakawa was key. Through his career, we can also see how Japan's space program owed as much to a desire for international prestige as to any perceived need to keep up with the forefront of science. The International Geophysical Year (1957-58) and Sputnik were strong

92. Bruno Rossi to Hayakawa, 3 Apr 1950, GHQ/SCAP records, ESS (E) 06384, National Diet Library, Tokyo.

incentives to expand Japan's own research.[93] But to do so required the nurturing of an astrophysics community, which Hayakawa duly did. Likewise with fusion, Hayakawa set about encouraging local research interest.

Physicists as public men

The ideas of modernity—progress, science, and rationalism—have been important to the Japanese people since the nineteenth century. The postwar goal of reconstruction and economic growth provided a public space even for physicists. Physicists had internalized a set of normative ideals and rules required by membership of the international scientific community. This included professional integrity, honesty, and standards of scholarship and technical competence. Such commitments arguably facilitated the emergence of a public sphere and, belatedly, a rational and more publicly accountable bureaucracy.[94]

In all of this the role of the public man and the concept of public interest were changing, dependent on the actor, his background and beliefs, and the context within which he worked. These physicists' "objectivity" hid different worldviews and different assumptions about their science.[95] Given these variables, it is not surprising that their impact on policymaking would differ, depending upon the actor and time. Nonetheless one commonality is striking: the physicists' attempt throughout this period to transcend the devastation of a defeated Japan, to help rebuild their country, and above all to seek an idealized truth. Indeed a book written by some of the physicists was given the title *Standing in the field of truth*.[96] While it is easy to trivialize such pursuits, given our understanding of views on the social construction of knowledge, it is nevertheless impressive how these men's lives were motivated by the unattainable goal of a complete knowledge of the world. They sought to instill their values in the broader society, values that were distinct from those of business. But by the late 1960s, the image of the physicist as moral character was no longer plausible. It became clear that the production of knowledge was tied to politics. University unrest and environmental problems in the late 1960s and early 1970s created disillusionment with not only the bureaucracy but with scientists too. The quality of life that many Japanese had hoped for seems to have eluded them. In October 1970, the Science Council of Japan re-

93. Fae L. Korsmo, "Science in the Cold War: The legacy of the International Geophysical Year," paper presented at the International Conference on Science, Technology and Society, Hiroshima, 20 Mar 1998.

94. This idea is discussed in Víctor M. Pérez-Díaz, *The return of civil society: The emergence of democratic Spain* (Cambridge, 1998), 50-51.

95. Morris F. Low, "Japan: The political economy of Japanese science — Nakasone, physicists and the state," in Etel Solingen, ed., *Scientists and the state: Domestic structures and the international context* (Ann Arbor, 1994), 93-125.

96. Hideki Yukawa, Shôichi Sakata, and Mituo Taketani, *Shinri no ba ni tachite* (*Standing in the field of truth*) (Tokyo, 1951).

solved to devote greater energy to examining the problems that had accompanied Japan's high economic growth, and sought scientific and technical solutions to them.[97]

The Science Council has long been seen as a parliament of scientists, a way by which more than 200,000 research workers in Japan could express their opinions to government through their directly elected representatives. Although under the jurisdiction of the Prime Minister and funded out of the national budget, the Council has functioned independently of the government and is only responsible to the scientists and the scholars who elect it. The Science Council makes recommendations and proposals to the government relating to science-related matters. "Science" is interpreted as meaning not only natural science but the humanities and social sciences as well.

The Science Council has been important in helping to shape the Ministry of Education's grants policy, lobbying for the establishment of new research institutes, and protecting the rights of scientists and scholars. A longstanding concern has been the development of Japan's nuclear power program, which the Council has tended to oppose. By the 1980s its influence had greatly diminished, and the Ministry of Education has tended to rely on its own internal council and advisors. There were attempts to reform the Science Council since the mid-1980s, with representatives being appointed by scientific societies.[98]

Physicists as policymakers

The postwar policymaking system was complex. Uniting one group of actors, the Elementary Particle Theory Group exercised much influence. While this circle can be viewed as an interest group with the concerns of its membership at heart, and somewhat like a club with a hierarchy of different levels of "bosses," it nevertheless framed its activities in terms of the public good. Soon after the end of the war, physicists promoted research conducted in a "democratic" way that would encourage greater sharing of scarce resources. They sought to overcome the dominant role of the professor in academia and encourage greater participation in decision-making. A major activity of the group was promoting an awareness of the social responsibility of scientists. The group was one of many opposing the hydrogen bomb in 1950. The physicists grappled with problems raised by the civilian atomic energy program and promoted a more open approach to developing nuclear power. They fought to ensure "peaceful" uses of the atom by objecting to visits to Japanese ports by U.S. nuclear submarines. And for some such as Sakata and Taketani, there was also a clear ideological mission to apply dialectical materialism as a methodology to develop elementary particle physics.[99]

97. Yuichi Ochi, "The organization and activities of the Science Council of Japan," *Nature, 240* (24 Nov 1972), 187-190.
98. Alun Anderson, "Elected body goes out fighting," *Nature, 315* (2 May 1985), 4.
99. Tokyo-Nagoya Working Group of Physics for 1964 Peking Symposium, "Methodology of elementary particle physics in Japan," Sakata Archival Library, Nagoya University.

Yukawa's Nobel prize gave the group media attention and provided opportunities to influence public opinion. The establishment of the Research Institute for Fundamental Physics at Kyoto University then provided a power base. The Group's "big bosses" were Yukawa, Tomonaga, Sakata, and Taketani, with Hayakawa, Tomonaga's student, as one of the up-and-coming "middle bosses." The RIFP and its democratically-run management committee provided a model for an array of joint-use research institutes that followed.

Within the Group, different actors followed different strategies. Yukawa and Tomonaga had more interaction with the power elite. Yukawa's scientific prestige and academic power were co-opted by the Japan Atomic Energy Commission when it appointed him a member in 1956. Tomonaga contributed to policymaking mainly through the Science Council, of which he was President. While Yukawa was ensconced in Kyoto as RIFP director, Tomonaga set about establishing the Institute for Nuclear Study in Tokyo. Through their public activity Sakata and Taketani, by contrast, carried their commitment to democracy in science into policymaking, arguing that atomic energy research and development should be performed and managed in as open a manner as possible. Unlike the situation in France and the U.S., atomic energy for military purposes in Japan was not an option. Sakata and Taketani helped shape the Basic Atomic Energy Law of 1955 and influenced the Three Non-Nuclear Principles declared in 1967. Despite their accomplishments, Sakata and Taketani were "outsiders," seeking to influence government policy from beyond the establishment. Taking into account their role enables us to form a fuller, more pluralistic image of power and influence in Japan.

Unlike the big four of Yukawa, Tomonaga, Sakata, and Taketani, Sagane rejected academia and plunged into the technocracy. The rise of Sagane as technocrat coincided with the decline of the Science Council as an important forum; the establishment of the rival Science and Technology Council in 1959 provided the government with a high-level body with its own interests at heart. Sagane influenced policy and its execution as only a true insider could. His family background, career in experimental physics, and research experience abroad provided him with the technical expertise, contacts, and language skills for the successful introduction of U.S. civilian nuclear technology. His two long stays in Berkeley enabled him to facilitate the growing technological ties between the U.S. and Japan.

Sagane's experience also shows that internationalism in science was a prerequisite for accessing the latest know-how. Satio Hayakawa also understood from an early date that Japan's future in science was linked with the U.S. He and many of his generation relished the opportunities that the U.S.-Japan relationship created. He, too, joined the postwar brain drain to the U.S., studying at M.I.T. and Cornell. What is outstanding about his career is his breadth of research and his ability to establish infrastructures for nuclear fusion, space science, and accelerator physics. This facility, combined with a thorough-going internationalism, helped ensure that Japan would not be left behind in these critical fields. Playing a formative role the Institute of Plasma Physics (Nagoya), the Institute for Space and Astronautical Science (Tokyo), and KEK High Energy Physics Laboratory (Tsukuba),[100] he helped bring big science to Japan.[101]

Hayakawa's story most importantly reveals the dynamics of policymaking and the re-emergence, after the war, of a multi-layered policymaking system. The Japan Atomic Energy Commission, the Science and Technology Agency established by the government in 1956, the Science and Technology Council, and other bodies displaced the Science Council in areas where physicists considered they had territorial rights. The all-important autonomy they had fought for was increasingly constrained. Indeed the complex system of policymaking that emerged in the postwar period is reminiscent of the wartime mobilization of science. SCAP was careful to give the Science Council only limited power, thus ensuring from the outset that physicists as policymakers would only enjoy limited effectiveness. The government, concurring, could seek the advice of the Council but was not bound to do so. This set in course the emergence of government bodies more attuned to the needs of the state and big business. In the 1960s, left-wing parties and unions had become somewhat marginalized. Japan's high economic growth and growing prosperity tended to make social protest less urgent.

The physicists discussed in this essay deployed their idea of science as a globalizing force for change. Many of them can be regarded as nonstate actors who—with the exception of Sagane—saw themselves as largely autonomous of the state and transcending private and individual interests. Through organizations such as the Science Council of Japan, they sought to influence governance, especially in science-related matters. In many ways, then, they were seeking to establish a type of civil society, albeit with scientists as the bearers of expertise. The samurai had previously created a public sphere of sorts, accustoming the Japanese to the role of intellectuals in public debate. Defeat in the Pacific War and the reforms encouraged by the Allied Occupation forced the Japanese to move away from an authoritarian style of politics to one in which the military was no longer a major force. In the wake of Japan's defeat, physicists sought to reimagine Japanese society.[102] Yoshihiko Uchida and Kiyoaki Hirata have argued that civil society has traditionally been weak in Japan, and that individual deference to power has meant that capitalism has developed with little social resistance.[103] Japan's physicists did attempt to resist. They help us to understand how civil society developed in Japan

100. Hayakawa and Low (ref. 89); Hoddeson (ref. 89).

101. Nagoya University, *Hayakawa Sachio sensei tsuisôroku* (*Collection of reminiscences of Professor Satio Hayakawa*) (Nagoya, 1994).

102. Victoria Lynn Bestor, "Reimagining 'civil society' in Japan," paper presented at "Civil society in Japan (and America): Coping with change" (Washington, D.C., 1998).

103. Yoshihiko Uchida, *Nihon shihonshugi no shisôzô* (*Images of Japanese capitalism*) (Tokyo, 1967); Kiyoaki Hirata, *Shimin shakai to shakaishugi* (*Civil society and socialism*) (Tokyo, 1969), Kiyoaki Hirata, Keizaigaku to rekishi ninshiki (*Economics and the philosophy of history*) (Tokyo, 1971). Cited in John Keane, *Civil society: Old images, new visions* (Cambridge, U.K., 1998), 12-13.

in its interaction with other sectors such as the bureaucracy and the corporate community. The Elementary Particle Theory Group and its like can be considered forerunners of, or models for, civil society organizations. But many of the prewar and wartime institutions, namely the bureaucracy, continued largely unchanged or even strengthened their role in the postwar period.

The physicists contributed to the formation of a postwar public sphere, a place where all citizens could discuss matters of mutual interest, especially issues relating to science, but also a place where scientists could pursue their own political goals.[104] The relationship between scientific expertise and public policy was sometimes confusing, with scientists actively seeking to make their expertise relevant and further their own political aims. There were tensions between the perception of physicists as an interest group and spokesmen for a public good. The push, especially in the mid-to-late 1960s, for the establishment of an accelerator facility that would eventually be called the KEK High Energy Physics Laboratory, stretched the notion that they could simultaneously be both.

The physicists did not deny the utilitarian ends, to which science could be put, but in contrast to the position of big business and the bureaucracy, they lobbied for the creation of a domestic research and development capability rather than reliance on technology transfers from overseas.

The reorganization of science in contemporary Japan

The lives of these seven physicists provide an understanding of only part of the policymaking picture. Nonetheless, they allow a representative picture of the dynamics and conflict between different elements of what, to date, has been the Japanese research and development policymaking structure. In retrospect, emphasis on the commercial exploitation of foreign technology may have led to economic success and rapid modernization, but it has served to weaken fundamental research and has prevented the Japanese from fully embracing the Western vision of science. While it has not prevented Japan from taking the lead in certain technologies, it is now seen as hampering further technological development.[105] Japan thus faces the challenge of building for itself a new vision of science with different priorities.

The contemporary call for creativity in science and technology and the concurrent emergence of civil society have the potential to recast the "role" of scientists. What is different is that there is no longer an understanding that those who produce knowledge deserve a special role in politics. Thus in closing I outline some

104. This idea is discussed in Arthur Edwards, "Scientific expertise and policymaking: The intermediary role of the public sphere," *Science and public policy, 26:3* (June 1999), 163-170.

105. See for example, Christopher Freeman, "Japan: A new national system of innovation?", in Giovanni Dosi et al., eds., *Technical change and economic theory* (London, 1988), 330-348, on 345-346.

exciting changes that may lead to the reorganization of science in Japan and the realization, in transmuted form, of some of the things the physicists called for.

In the 1990s, many politicians and members of the public called for reform of the political system. Japan is currently undergoing that transformation. It has become clear to the Japanese that public good and national interest (as determined by politicians and bureaucrats) do not necessarily converge. The physicists discussed in this essay found this out firsthand. By examining the causes and enactment of recent administrative reforms in Japan we can also better understand the political context in which those physicists worked.

Recent years have seen widespread public uproar in Japan over a number of controversies, including an attempted cover-up of an accident at a fast breeder reactor in 1995, the world's worst case of dioxin contamination,[106] lack of public consultation in the construction of Narita Airport,[107] and a medical care system that has been slow to protect the rights of individuals.[108] On September 30, 1999, Japan's worst nuclear accident occurred at a uranium-processing plant in Tokaimura, Ibaraki prefecture. These controversies have highlighted the inadequacies of the bureaucracy, the overly close ties with the private sector known as "crony capitalism," and the inability of government to fulfill its responsibilities. Indeed, the relationship between the Liberal Democratic Party, bureaucracy, and big business with which the physicists long grappled, is now viewed as Japan's central problem rather than the secret of its success. The end of continuous LDP rule in 1993 and changing political landscape can be interpreted as breakdown in the system of governance that oversaw Japan's postwar modernization. Recent controversies have taught politicians to be more receptive to the needs of the people. With the end of the Cold War, the collapse of the 1955 political regime that placed the LDP in continual power, the increasing pluralism of Japanese society, and greater individual awareness of rights, the Japanese have even been prompted to reconsider the postwar Constitution.[109] Japan is experiencing another crisis (an economic recession), and the nation, with a stronger civil society in place, is once again trying to reinvent itself. This time, Japan looks better placed to meet the needs of its citizens, and the citizenry is drawing a less fuzzy line between itself and the state.

The reorganization of the bureaucracy and reduction in the number of ministries has the potential to reduce the hierarchy and create a space in which NGOs (non-governmental organizations) and individuals can play a greater part in work-

106. Japan Times Staff, "Obuchi urges quick dioxin review," *Japan times international* (1-15 Mar 1999), 5; Mick Corliss, "Panel urges stricter dioxin standards," *Japan times international* (16-30 June 1999), 15.

107. Michael Millett, "Sell? You gotta be dreamin'," *Sydney morning herald* (22 May 1999), 22.

108. "Pill for Japan," *Courier mail* (3 June, 1999), 19; Low, Nakayama, and Yoshioka (ref. 1).

109. Keizo Nabeshima, "A political taboo is shattered," *Japan times international* (16-31 Aug 1999), 18.

ing for the common good.[110] The Ministry of Finance has lost some of its power and will be renamed the Treasury Ministry. The Ministry of Health and Welfare will merge with the Ministry of Labor. And the new Ministry of Education, Science and Technology will combine the Ministry of Education and the Science and Technology Agency.[111] Along with recent Freedom of Information legislation,[112] the passing of an environmental impact assessment law, and the implementation of a new framework to encourage voluntary associations, these new arrangements and other reforms, to be put into place by 2001, may mean that the interests of the public receive higher priority.

There are strong parallels between the rise of civil society in Japan today and what physicists were seeking to achieve immediately after the war. The difference is that Japan is now an affluent society, more concerned by questions of quality of life than was the case fifty years ago. The new standards of accountability that the Japanese are seeking in many aspects of science, technology, and medical care today remind us of the concerns of physicists regarding policymaking, especially for atomic energy.

110. "Final reform report trims government to 13 entities," *Japan times* (4 Dec 1997), 1. Kan Kato suggests that the changes may only be superficial. See Kan Kato, "Administrative reform: Government reorganization a sham," *Japan times international* (16-30 June 1999), 19.

111. Kyodo News, "What's in a name change?", *Japan times international* (16-30 Apr 1999), 10.

112. Kyodo News, "Freedom-of-information bill wins Diet approval," *Japan times international* (1-15 May 1999), 6.