hearings in 1940. Finally a "National Television Standards Committee," faced with new proposals from CBS for an incompatible color broadcast system, resolved enough of the differences that license was granted in 1941 for commercial TV. The exigencies of war drastically slowed implementation; but the television that achieved growing application in the postwar period, and that has brought less enlightenment than intellectual torpor to our culture, was essentially the same as that approved in 1941.

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Chronicle of a Program

Fusion. Science, Politics, and the Invention of a New Energy Source. JOAN LISA BROMBERG. MIT Press, Cambridge, Mass., 1982. xxviii, 344 pp., illus. $30.

In reading Joan Lisa Bromberg's *Fusion: Science, Politics, and the Invention of a New Energy Source* one can be both pleased and disappointed. The book, commissioned by the Office of Magnetic Fusion Energy of the U.S. Department of Energy, is a scholarly history of the magnetic fusion program from 1951 to September 1978. In five chapters following an introduction it recounts, with extremely good documentation, the development of the program up to the second Atoms for Peace conference held in Geneva in 1958. The remaining seven chapters are devoted to the subsequent period, after the declassification of the fusion program.

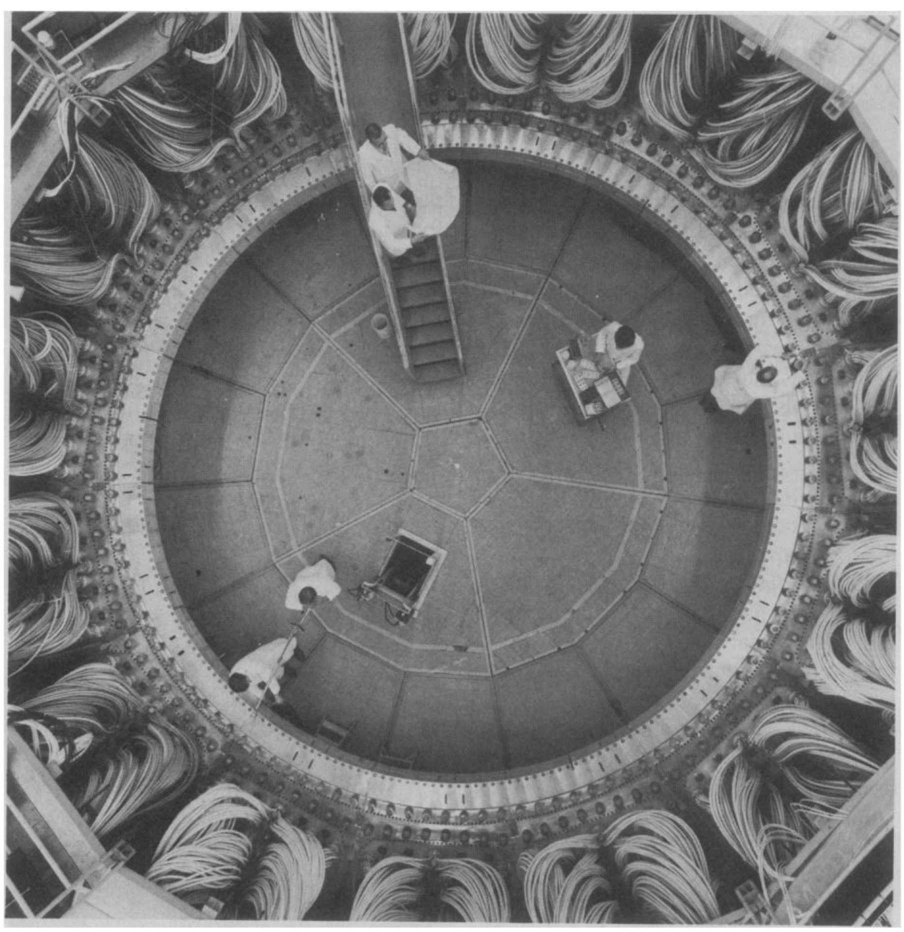
The reader who has been following fusion research as it has developed may well wonder that almost half of this history is devoted to the so-called classified era, especially in light of the large number of approaches that were attempted and the abandonment, at that time, of most of them. This exciting period of fusion research was in fact the beginning of essentially all of the current approaches to plasma confinement. Without Bromberg's serious review of the Atomic Energy Commission files and interviews with key personalities of the time this seemingly remote part of the history would be lost.

One of the particularly interesting bits of history provided by the book is the account of the frantic scrambling that was undertaken by United States politicians and researchers in order to be able to make an impressive showing at the 1958 Geneva conference. The impact on these efforts of the Soviet launch of Sputnik in 1957 is an interesting reflection on the politics of science. A second interesting part of the story has to do with the task of understanding the source of the neutrons that were produced by the Zero Energy Thermonuclear Assembly (ZETA) put into operation by the British in 1957. Runaway electrons, Bohm diffusion, Ioffe stabilization, Soviet tokamak successes, and the difficulty of making experiments work were sources of many frustrations, which the book captures well.

After the early to mid-'60's, during which the program was in a depressed state with progress stalemated and funding inadequate, there came a period, following reports of promising tokamak results obtained in the Soviet Union, of numerous and increasingly expensive experiments. For this period the book falls short because there are too many strong advocates with too many experiments in too many places to be adequately covered in the space allocated to them. A table in the appendix helps the reader follow the experiments at the principal locations, but many are left out since the table stops at 1975. Unfortunately, this useful table is not referred to in the text.

The fusion program has been blessed with many strong, brilliant, and dedicated individuals. Histories will be better able to assess their contributions as the story continues to unfold. In this first attempt, the author was able to capture the strength of key individuals in too few instances. She clearly has identified some, but the balance is uneven. Further, she has not captured the strong camaraderie developed among many of the international players in the world fusion community.

Every reader with a fusion background will see a slightly different twist to the story in each instance where he or she has personal experience. This reviewer, for example, would have liked to see more attention given to the General Atomic program with funding by the Texas Atomic Energy Research Foundation, and perhaps to how the university role in the fusion program was initiated and developed. Even with the painstaking research and many interviews, it has



Los Alamos Scientific Laboratory's Scyllac, 1974. The last of the line of devices that since the late 1950's had been the principal focus of Los Alamos's controlled fusion program, Scyllac was a toroidal machine first proposed in 1966. Its operation was terminated in 1977. [From *Fusion: Science, Politics, and the Invention of a New Energy Source*] not been possible to capture the nuances of many situations, decisions, and complex personalities that have made the program the great scientific effort that it is.

One has to marvel at the author's ability to produce such a well-documented (containing over 700 citations of references of various sorts) and generally well-written history of the program while manifesting a modestly good understanding of plasma theory. There are, however, a few slips that to the knowledgeable reader will be worrisome distractions. The printer's errors are somewhat more disturbing. These include a missing figure 4.1, $v_\perp$ substituted for $v_\parallel$ on p. 57, and some missing material between pp. 253 and 254.

As the fusion program begins to shift from being purely an endeavor of physics to being one where engineering feasibility is a prime concern, the difficulties and frustrations will continue. It will come as a major surprise to this reviewer, however, if the next 30 years of fusion history are as exciting as the past 30. It is unfortunate that the author chose not to present an appraisal of where the program is today and where it must go from here so that future historians can better put her account into perspective. Nevertheless, Bromberg's contribution to the history of this challenge is well worth reading.

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Physics: A View of the Japanese Milieu

"Tabibito" (The Traveler). HIDEKI YUKAWA. Translated from the Japanese edition by L. Brown and R. Yoshida. World Scientific Publishing, Singapore, 1982 (U.S. distributor, Heyden, Philadelphia). vi, 218 pp., illus. Cloth, $33; paper (to individuals and purchasers in developing countries only), $14.

Hideki Yukawa, who died in 1981, was well known in the scientific community for his formulation of the meson particle theory and the 1949 Nobel Prize it brought him, and in this work he presents a detailed and penetrating account of his life up through 1934 when the meson theory first appeared in print. But *Tabibito* is no ordinary description of one scientist's early career. It raises significant questions about and suggests insights into several important aspects of the growth of Japanese science. It is also the first book-length biography of any modern Japanese scientist who did his work at home to appear in English (*1*). For these reasons the work takes on an importance that does not necessarily attach to biographies of scientists in general.

Yukawa's recruitment into physics is a major theme of the book. He had considerable interest in literature as a young student and not much in science, but he did find mathematics exciting and received his best grades in that subject. In elementary school (1912–18) he once figured out his own method for obtaining the sum of an arithmetic progression. He enjoyed problems whose solutions required many hours of thinking, and by high school he was "captivated" by the beauty of Euclidean geometry. Yukawa's interest in mathematics obviously persisted throughout life, but he began to shift toward physics just before entering Kyoto University. The exact sequence of events is unclear, but the combination of an authoritarian mathematics teacher and a stimulating physics course at Kyoto's prestigious Third Higher School appears to have done the trick. Yukawa found that he took pleasure in at least some of his physics experiments. He was stimulated by Hajime Tanabe's popular work in Japanese, *Recent Natural Sciences*, and read in German with particular pleasure works on quantum theory by Fritz Reiche and by the founder of that theory, Max Planck.

Hideki Yukawa receiving the Nobel Prize, 1949. [Courtesy of Michiji Konuma; from *"Tabibito" (The Traveler)*]

These scholarly inclinations of Yukawa's were encouraged by a favorable home environment. Both parents had intellectual interests. The father was a university professor and the children were encouraged to study. It is also notable that intellectual interests in the family happened to straddle the "old" and the "new." Yukawa's paternal grandfather had been official Confucian lecturer to a *daimyo* (feudal lord) before the Meiji Restoration (1868). His father, whose specialty was geology, actively pursued side interests in Chinese archeology and culture. Yukawa's oldest brother became professor of Chinese history. A second brother became professor of metallurgical engineering, and a third served as professor of Chinese literature. The constellation of Yukawa's interests is scarcely surprising in view of this family environment. As readers of his book *Creativity and Intuition*, published in English in 1973 (*2*), are aware, Yukawa retained a lifelong interest in Taoism and other classical philosophies of China, as well as in physics, mathematics, literature, and various schools of Western philosophy.

This investigator of particle physics, by his own telling, had a personality that was more than a little introverted. As a youth he was easily upset, never had many close friends, and tried to minimize contact with other people. In high school he found he lacked the "brashness" required to sell tickets to the school festival and says his thoughts centered almost exclusively on his reading in literature, philosophy, and science. Relations with his family were also standoffish at times. He was close to his mother and youngest brother—the future Chinese literature scholar—but he fought constantly with his other brothers and tried to avoid most dealings with his father. Yukawa married happily at the age of 25, but he did so by the common Japanese pattern of family arrangement. We are not surprised when he tells us he found scholarly activities an escape from reality. He believed he chose theoretical physics in part to transcend the "problems and contradictions" of human society and as a university student would spend whole days reading scientific journals without ever talking with anyone.

Yukawa's account, in fact, underscores his marked intellectual self-suffi-