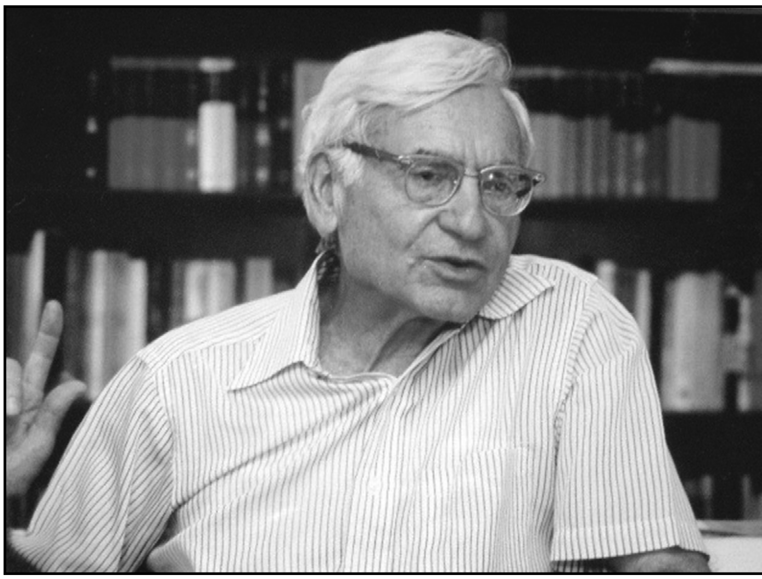
ALVIN M. WEINBERG



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ALVIN was all about questions. First as research director, and from 1955 to 1972 as director of the Oak Ridge National Laboratory (ORNL), he instituted the Information Meeting. Each research division, and there were about fifteen of them, held an Information Meeting annually, at which the work of the division was reviewed by a visiting committee of outside experts. Part of the review was a presentation of the work of the division by the scientists and engineers who actually did the work. Alvin sat in the front row, in the right-hand seat, and asked questions. Sometimes about the fine details, sometimes about the overall purpose of the research. The questions were always right to the point. Clearly, he understood the presentation in its details, he was interested in it, and by inference he was interested in the speaker. Research at ORNL included nuclear and atomic physics, chemistry, analytical chemistry, separation chemistry, chemical engineering, biology, ecology and environmental science, health physics, solid state physics, metallurgy, mathematics and statistics, reactor physics, reactor engineering, and radioactive and stable isotope production. Alvin understood it all!

The effect of Alvin's presence at the information meetings was electrifying. Each staff member was sure that the laboratory director knew what he was doing, that he cared, that he was interested, and that it mattered. Scientists lived in fear that Alvin might ask a question they could not answer, and also in fear that Alvin would not ask any questions, thus showing his lack of interest in the topic. It is not surprising that the Oak Ridge National Laboratory was regarded as Weinberg's laboratory, or that the staff felt that they were working directly for him. Alvin Weinberg personified the laboratory.

I don't believe that Alvin asked those questions only as a style of laboratory directorship. He asked them because he was intensely curious, because he wanted to know, because the material in question was important, and because he felt that as director he should know.

Alvin was born in Chicago and went to the University of Chicago, where, as a graduate student under Carl Eckart in molecular physics, he wrote a dissertation on the "Mathematical Foundations for a Theory of Biophysical Periodicity." The first of his 541 publications, an article on triatomic molecular spectra, appeared in 1937 in the *Journal of Chemical Physics*. After his Ph.D. he shifted his interests to the mechanism of nerve conduction. But when the Manhattan District established its laboratory at the University of Chicago Alvin was recruited into the atomic bomb project. He worked with Eugene Wigner, one of the truly great physicists of the last century, on the design of large reactors for the production of plutonium. Wigner was a hard taskmaster. He required a high order of physical intuition and mathematical skill in his collaborators. Alvin had both.

In 1943 Alvin was transferred to Oak Ridge, to work at what was then called the Clinton Laboratories, to design and construct the world's first real reactor. Not an experiment like Fermi's pile in Chicago, but a reactor to produce gram quantities of Pu for chemical research. It is illuminating to recapitulate the timing for the construction of what was eventually to be called the Graphite Reactor. On 1 February 1943 the Oak Ridge site was cleared; foundations for the reactor were laid in April; the reactor was completed by Halloween; loading of U slugs followed, and the reactor went critical on 4 November, with about half of its channels loaded. By the end of 1943 1.5 mg of Pu were extracted, and by early 1944 the power of what was then called the X-10 pile was increased to 1.8 MW. Alvin was responsible for the reactor physics. It was really his baby.

Four more research reactors were successively built at ORNL, culminating in the 100 MW High Flux Isotope Reactor, completed in 1965, and still the highest flux reactor in the world.

In the 1950s Alvin's career split into three channels. He was still laboratory director, intimately concerned with the development of ORNL, with its quality and its changing mission. At the same time he became a prophet for the nuclear age. He saw in nuclear energy a way to extricate mankind from the Malthusian curse. With plentiful and cheap energy Alvin saw ways to increase food production by desalting sea water and reducing oxidized nitrogen. "Cheap and abundant energy is no longer a luxury: it will eventually be a necessity for maintenance of the human condition," he wrote in 1966. Of course that energy would come from nuclear fission or, perhaps less likely, from fusion. Alvin was tireless in his advocacy of nuclear power. His vision imagined large agro-industrial complexes, for example, in India, that would bring water to arid soils and electricity to new industrial development. In the Middle East he envisioned plentiful water as a way to bring peace to the Israel-Arab conflict. For the future he envisioned a reactor-based hydrogen supply for the propulsion of cars and trucks. To supply this energy he proposed a mix of burner and breeder reactors, and an unlimited uranium and thorium supply from granite, "mining the rocks," and from the seawater, "mining the sea." Alvin was a master of the vivid phrase.

But Alvin was not a mindless booster of nuclear power. Perhaps before anyone else, he saw the danger of reactor accidents. A double-ended pipe break in the main cooling system of a water-cooled reactor would bring a catastrophic failure and melt-down of the reactor core. He saw that the Atomic Energy Commission at that time was both the advocate and the regulator of nuclear power. In 1970 he was a strong advocate for the establishment of the Nuclear Regulatory Commission, an independent agency that would assure safety for the burgeoning nuclear industry. This was the time when unfettered industrial development began to be questioned, when the impact of *Silent Spring* resulted in environmental legislation such as the Clean Air Act and the Clean Water Act, when the Cuyahoga River caught fire, and smog made people cry. In 1972 Alvin's eloquent concern for reactor safety cost him his job as director of the Oak Ridge National Laboratory. The accident at Three Mile Island in 1979 effectively stopped commercial reactor sales in the U.S. Alvin thought that the response to Three Mile Island had been excessive, and he spent the next decade inventing "technological fixes" that would revive nuclear energy in the U.S. Meanwhile, another problem arose to bedevil nuclear energy: storage of radioactive waste. Early on, Alvin had recognized that with a full complement of reactors we would have to do something extraordinary to store the waste. He first thought of storage in abandoned salt mines, but the people who lived in those areas objected to sprinkling waste repositories over their landscape. Next was the injection of radioactive grout in deep shale deposits. When some of the radioactivity escaped from experimental injection areas, that ended, too. Then there was reprocessing, but that, too, foundered. Finally we have been brought to a stalemate; no one now knows what to do with reactor waste, so we keep it isolated at the reactor sites. A few years ago, Alvin, recognizing the seriousness of the waste situation, said, "I should have put my best engineers on the waste problem at the time when nuclear energy was riding high, we could have had an acceptable solution." To the end, Alvin considered himself an "old nuke" and he continued to seek out ways to make nuclear energy efficient, safe, and acceptable. He, along with many others, thought it was safer than, and preferable to, coal with its sulfur and CO_2 problems.

Alvin's greatest renown stems from his role as an adviser in matters of public policy. He was a member of both the National Academy of Sciences and the National Academy of Engineering, a rare honor that placed him on committees at the center of many policy debates. He was appointed to the President's Science Advisory Committee (PSAC), the highest and most respected advisory body in the land. He not only gave advice, but also published articles on science policy questions in journals like *Daedalus*, *Minerva*, and *Proceedings of the American Philosophical Society*. He was a clear and graceful writer, and his arguments were persuasive and frequently influenced policy decisions by the executive and legislative branches of the federal government.

In scientific circles he is perhaps best known for his "Criteria for Scientific Choice," in which he examines how the government should decide how much support to give one scientific program, as compared with another program. How, for example, do you decide between funding high-energy physics on the one hand and space exploration on the other? Briefly put, Alvin distinguished internal criteria from external criteria in such funding dilemmas. In his view it was not sufficient to demonstrate that a science was fruitful and showed interesting results to justify funding; it also had to influence and enrich neighboring fields of science or technology to the benefit of mankind to merit exceptional support. Alvin wrote a good deal on this subject,[1] and his ideas still influence it.

He was a great inventor of language. "Technological fix," "Big Science," "Faustian bargain," referring to the proliferating nuclear power plants, all enriched the language and delineated the debate. Alvin incurred the ire of the high-energy physics community by his skepticism about the value of a science that operates at energies and time scales orders of magnitude removed from human experience. He thought that it failed on the basis of extrinsic criteria. Even the great successes of the standard model, and the other Weinberg, did not alter Alvin's judgment. He did, however, waver in recent years when high-energy physics and cosmology began to show fascinating connections

In his role as a science policy guru, Alvin again asked the penetrating questions, as he had at ORNL, only this time he asked them of the U.S. science establishment. He continued asking questions after he established the Institute for Energy Analysis in Oak Ridge in the seventies. Now he would question the fate of the earth threatened by the global climate change due to CO_2, while his most recent concerns had to do with the danger to the earth from the major impact of a solar system bolide. Again he raised questions: how probable is such a catastrophe, and is there something we can do about it?

Alvin was much honored in his lifetime. He received twenty-eight honorary degrees, the Atoms for Peace Prize, the Enrico Fermi Award, the E. O. Lawrence Award, and my favorite, the Young Man of the Year Award in 1951. He deserved all these honors, but was not ostentatious in displaying them. On a shelf in his home there was a collection of about twenty-five cups, statuettes, and plaques, testifying to his high achievements. Seven of those were for local tennis triumphs. He was a proud tennis player, well into his eighties. He was also an accomplished classical pianist, and gave several recitals in Oak Ridge. He played the piano every day, almost to the end of his life.

Alvin was married to two wonderful women. He married Margaret Despres in Chicago, after he was engaged by her family to tutor their daughter in mathematics so she could get her degree from the University

[1] *Reflections on Big Science* (Cambridge, Mass.: MIT Press, 1967).

of Chicago. She was a great lady, who helped him in many important ways during his transformation from a theoretical physicist to a major figure in U.S. science. Unfortunately she died young, in 1969. A few years later he married Genevieve DePersio, a stock broker. She and Alvin had a good life together, traveling and enjoying a fruitful retirement. She died in 2004. Alvin had two sons: David, now deceased, and Richard, a neurobiologist at the University of North Carolina. He is survived by his sister, Fay Goleman, and by three grandchildren.

Alvin will be greatly missed by his many friends and colleagues. He was a wonderful man to talk to, always brimming with new questions.

Elected 1977; Committee on Membership I 1997–2001

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