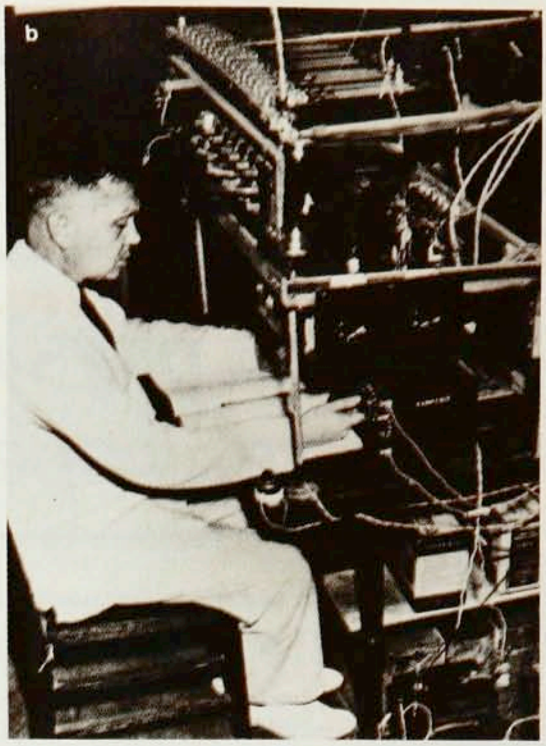
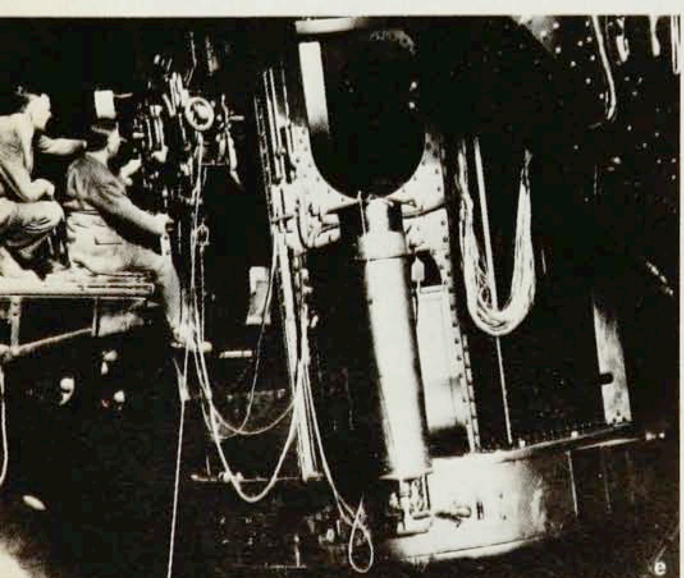
1931-1941



(a) *Alfred Landé, I. I. Rabi and Hans Bethe at a summer school seminar in Michigan.*
(b) *Harold Urey with his isotope separator at Columbia.*

(c) *A nuclear emulsion plate showing a μ-meson decay: the muon was the first of many surprising new particles.*
(d) *Laboratory of H. W. Kellogg at G. E.* **(e)** *Edwin Hubble and an unidentified astronomer at the 100-inch telescope.* **(f)** *Albert A. Michelson, in 1929, at the observing telescope of his 1-mile tube for measuring the speed of light.*



American physics comes of age.

Before the 1930s, physics was mostly a European enterprise. To be sure, there were many substantial contributions from this side of the Atlantic, but most of these came from a few isolated contributors, such as Joseph Henry, Josiah Willard Gibbs and Henry Rowland. Albert Michelson, one of the last of this breed of American physicists, died in 1931. Beginning in the 1930s, American physics began to rival—and in later decades to dominate—European physics. To illustrate the growth, we have selected a few photographs for each of the past five decades. Our selection, clearly, cannot be complete or objective. We merely mean to appeal to the collective nostalgia of physicists and to suggest how things have changed.

One of the reasons for founding the AIP was to ensure communication between academic and industrial physicists. Bell Laboratories and General Electric, for example, both had commitments to do research in physics.

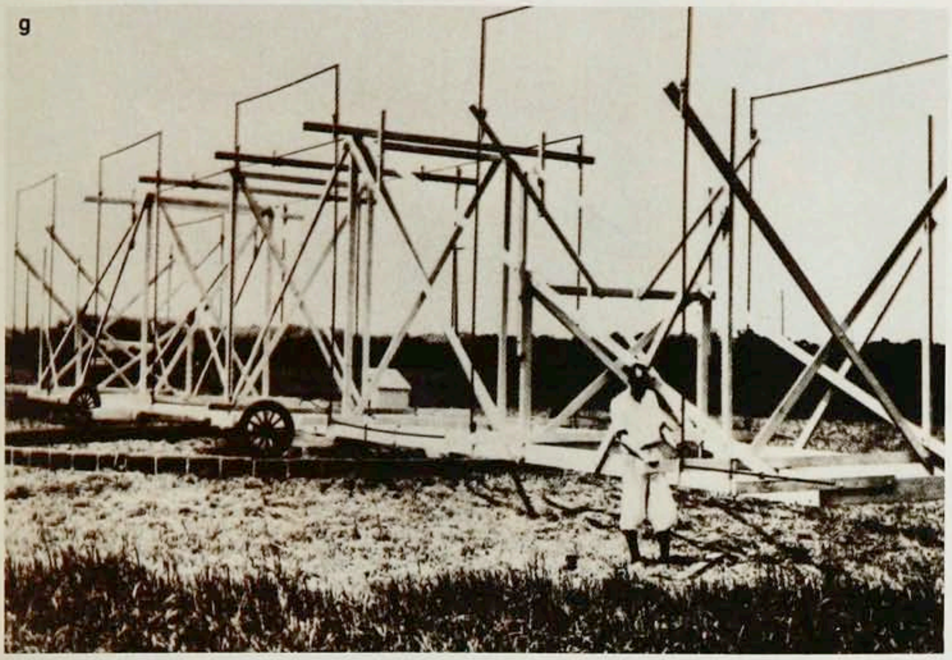
Instrumentation in the 1930s was generally put together by individual researchers. Ernest O. Lawrence's first cyclotron fits into the palm of his hand. Both Harold Urey's isotope-separation machine and I. I. Rabi's molecular-beam apparatus, began as one-man operations. Both, incidentally, were at Columbia University, where many of the initial discussions that led to the founding of AIP took place.

As anti-semitism, anti-intellectualism and, later, war ravaged Europe, many prominent physicists sought refuge in America. Both Alfred Landé and Hans Bethe were part of this massive transfer of intellectual capital across the Atlantic.

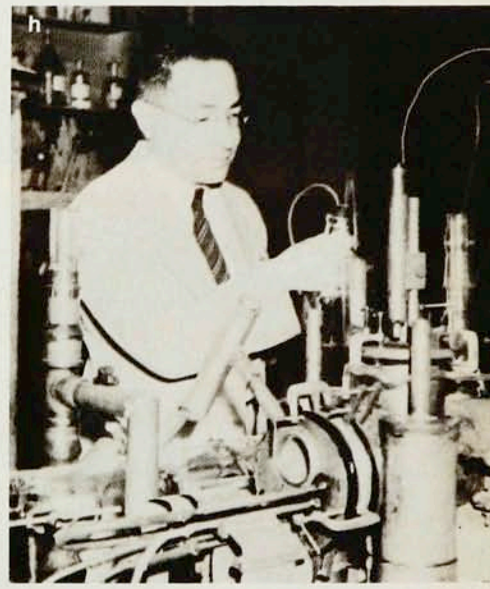
* * *

The photographs on these ten pages were selected with the generous assistance of Amy Weiner of the AIP Center for History of Physics.

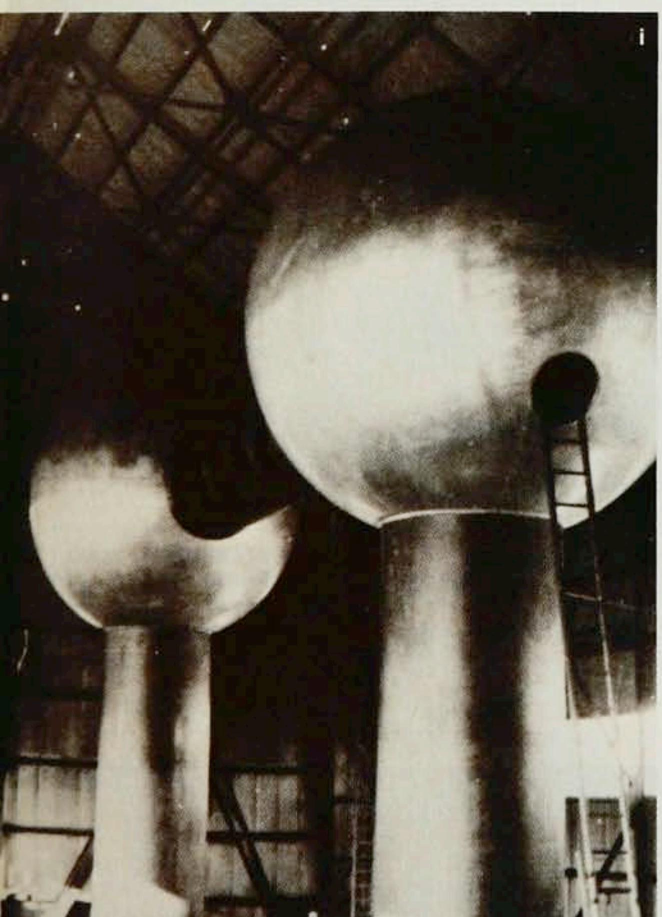
For photocredits, see page 7.



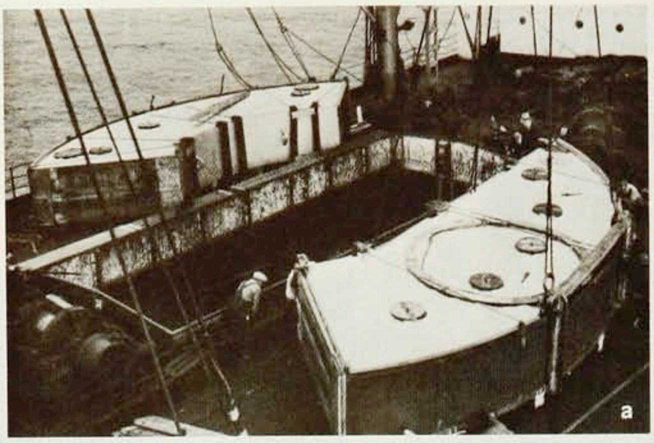
(g) *Karl Jansky with his radio telescope at Bell Labs in Holmdel, New Jersey.* **(h)** *I. I. Rabi with his molecular-beam apparatus at Columbia in 1939.*

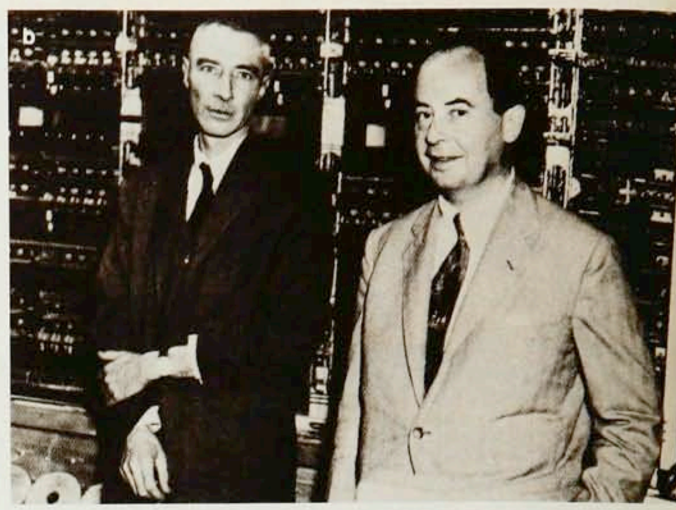


(i) *Van de Graaff accelerator and* **(j)** *Robert Van de Graaff, L. C. van Atta, J. P. Cockcroft and Curry Street.* **(k)** *Ernest O. Lawrence with his first cyclotron.*



1941-1951





(a) *The horseshoe support for the 200-inch mirror of the Mt. Palomar telescope.* **(b)** *J. Robert Oppenheimer and John von Neumann in front of the Institute for Advanced Study's EDVAC computer.*

(c) *The first radio sextant.* **(d)** *The staff of Theory Group 43 at the MIT Radiation Laboratory.* **(e)** *Gerard Kuiper and his wife.* **(f)** *Ernest O. Lawrence, Arthur H. Compton, Vannevar Bush, James B. Conant, Karl T. Compton and Alfred Loomis (left to right) at a meeting in April 1940 to discuss plans for a 184-inch cyclotron at Berkeley.*

The war and post-war years.

Among the major events for physics during this period were the development of radar, atomic weapons, computers and transistors. All of these owed something to the Second World War.

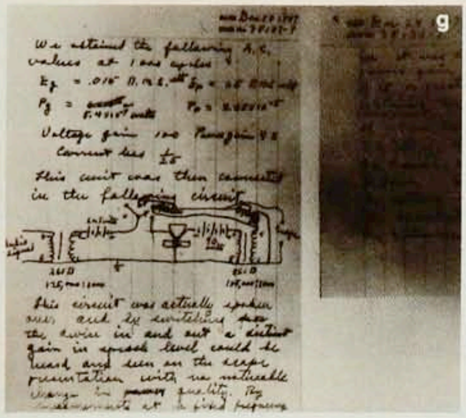
Radar, pioneered by the British, became one of the major tools of the War; in the US the "Rad Lab" at MIT produced not only new technology, but also much fundamental physical insight into the propagation of electromagnetic radiation.

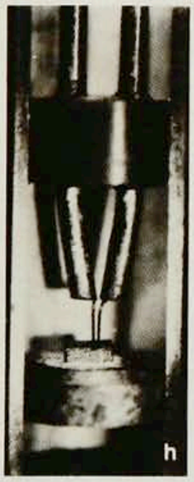
The most remembered experience during this period was the work at Los Alamos. Our photos show one aspect of the living conditions there—with the odd mix of small-town life and war-time security—and an aspect of the work—examination of ground zero after the test blast. Perhaps, as much as anything else, the war-time experiences in the large laboratories changed the way of doing physics: Although many physicists continued to work by themselves, or in small groups, large collaborative efforts later came to dominate many fields of physics.

The demand on computing speed and complexity for ballistics calculations soon outpaced the electromechanical devices developed before the War; to meet the need, an "Electronic Numerical Integrator And Computer" was developed; it became operational in 1945.

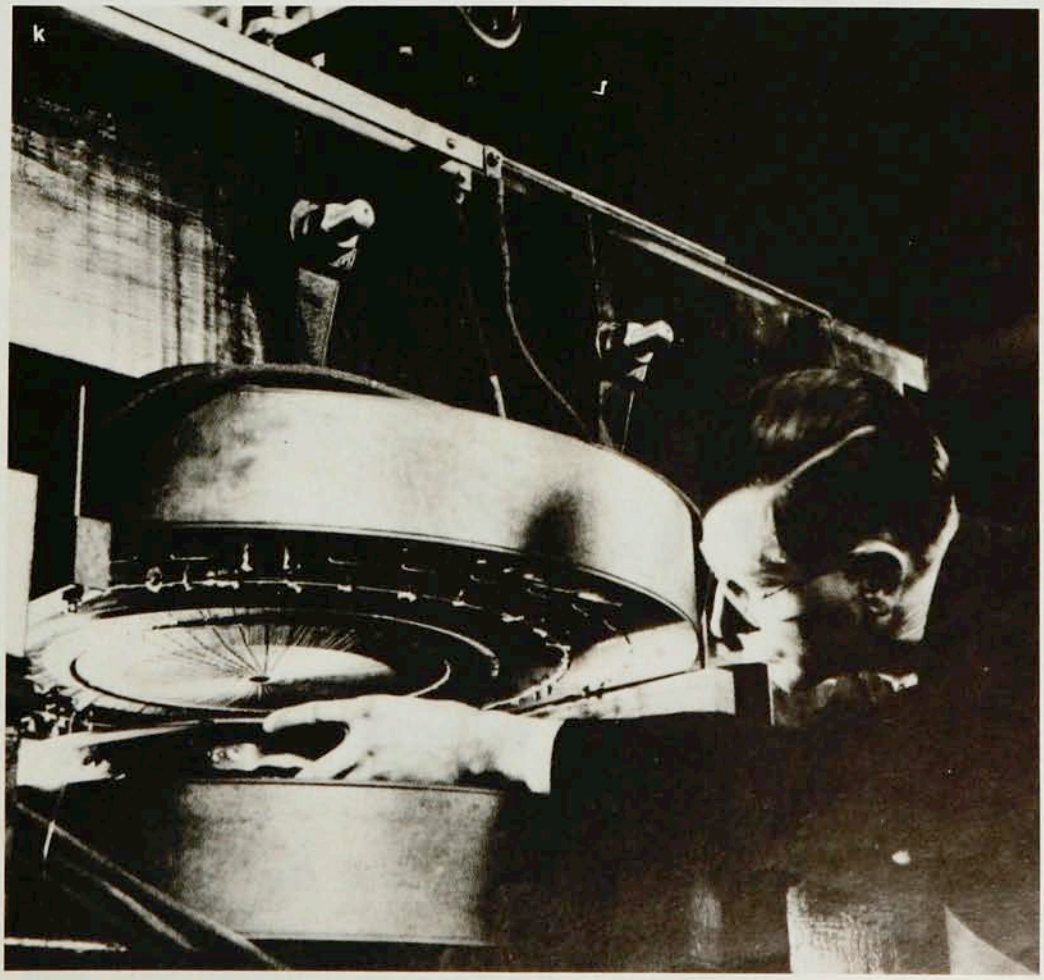
The modern pervasiveness of the computer—and of electronics in general—would not be possible without another invention, the transistor. We show a page from Walter Brattain's lab notebook and a photo of one of the first transistors.

To illustrate the return to normalcy after the war, we show a photo of Gerard Kuiper, who discovered the moons of Uranus in 1948, at his home in Williams Bay, Wisconsin. And to illustrate the increasing size and complexity of physics and astronomy we show the horseshoe for the 200-inch telescope on Mt. Palomar on its way through the Panama Canal and a betatron built by Donald Kerst—the second generation of particle accelerators.

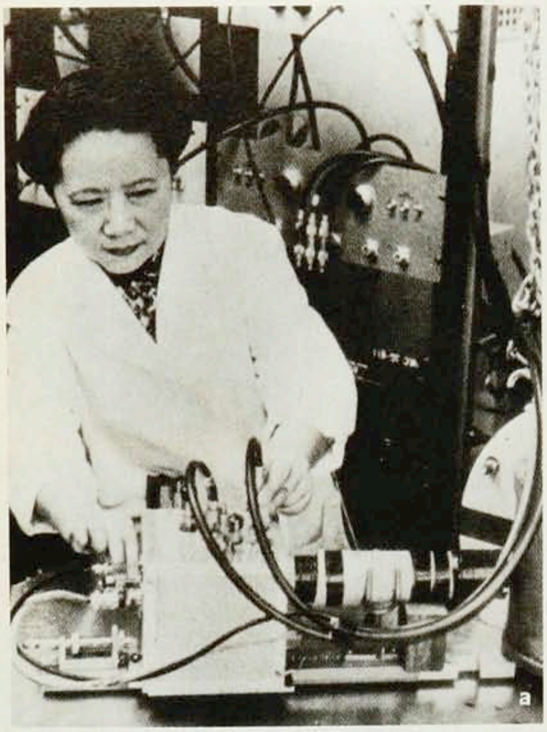




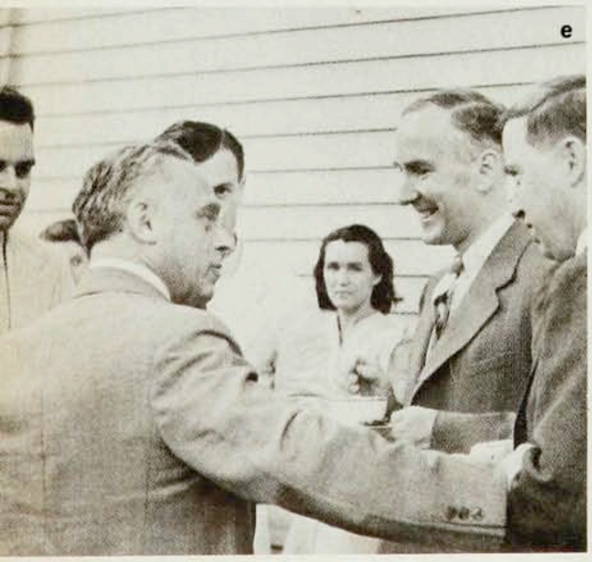
(g) *Walter Brattain's laboratory notebook and* (h) *one of the first transistors.*
(i) *Inspection team at ground zero after the first atomic bomb explosion.* (j) *Los Alamos.* (k) *Donald Kerst and his second betatron (1942).*

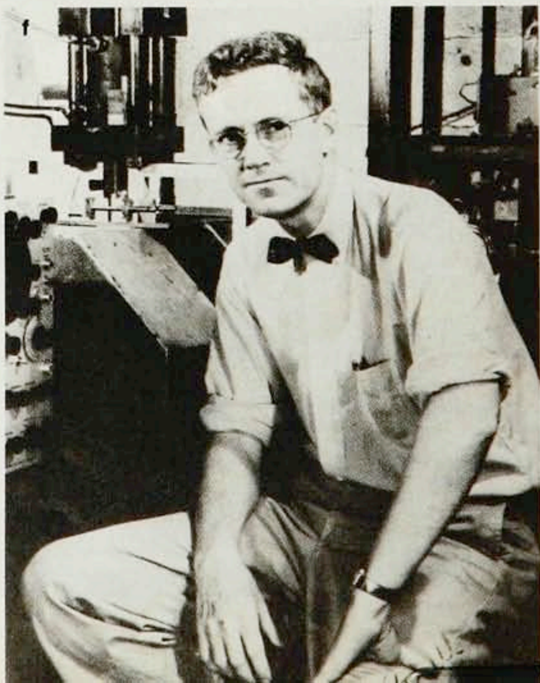


1951-1961



(a) *C. S. Wu in her laboratory at Columbia.* **(b)** *Richard Feynman and C. N. Yang.* **(c)** *Donald Glaser.* **(d)** *Charles H. Townes with a maser.* **(e)** *Bart J. Bok, Jan Schilt, Jan Oort and Harlow Shapley at a conference.* **(f)** *Edward Purcell.*





Big physics and little physics.

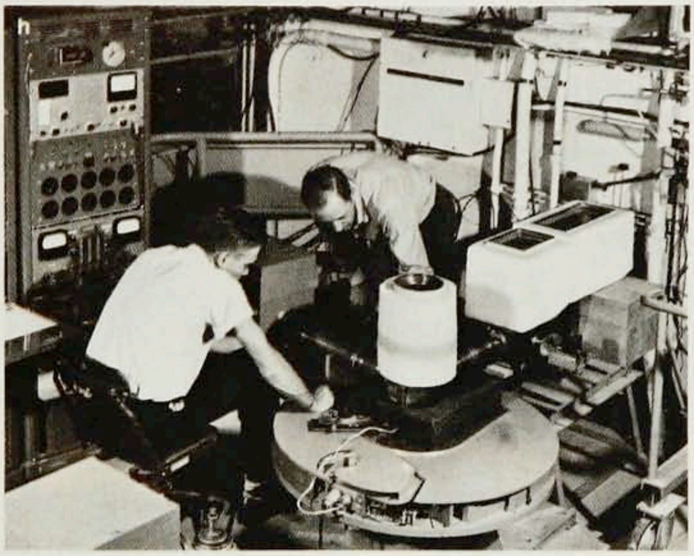
The US government, very satisfied with the results of government-funded science, continued to support basic research. As the science community relied more and more on government funding, the government also began to rely on scientists for advice. President Dwight D. Eisenhower established a formal Science Advisory Committee. Our photo shows Eisenhower, near the end of his Presidency, with many of the people instrumental in the activities of PSAC; nearly all of them are physicists.

The atomic bomb and its even more awesome successor, the hydrogen bomb, always made (and still do make) for good news copy. Edward Teller, called "the father of the H bomb," became a controversial figure both in the scientific community and for the public at large.

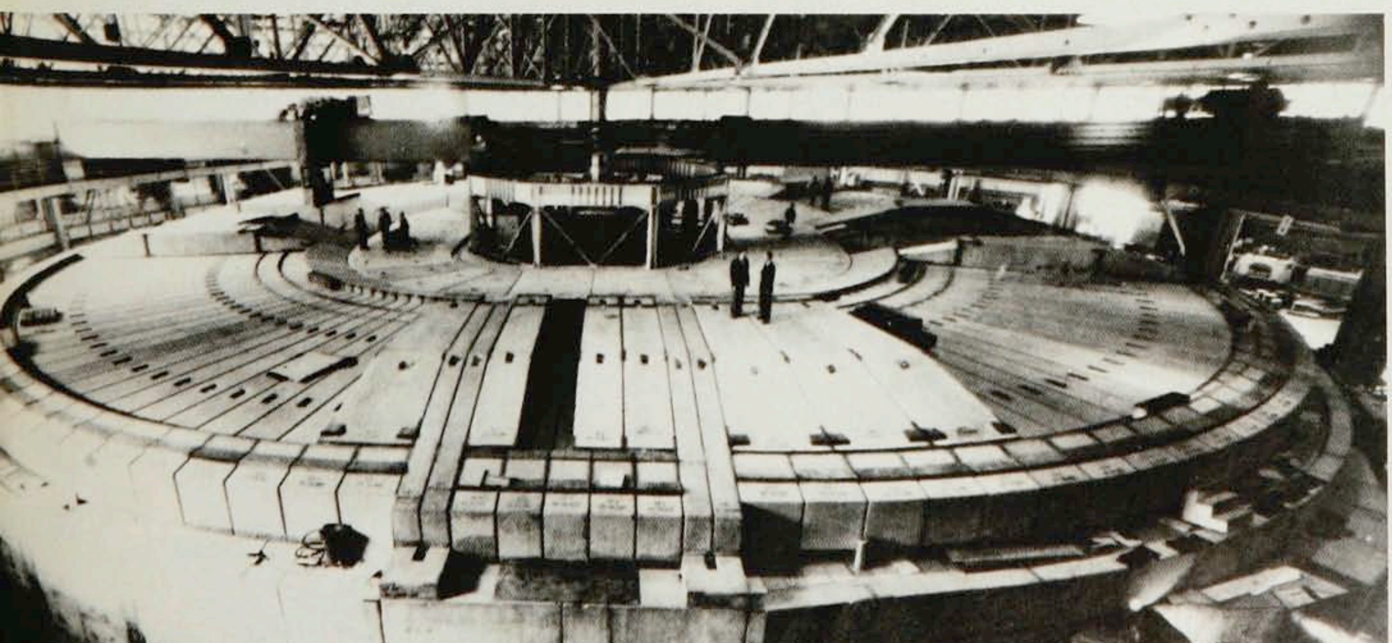
The equipment for high-energy physics became considerably larger: Accelerators could no longer be one-person operations. Our photos show the Bevatron in Berkeley and some of the ancillary equipment for the Cosmotron at Brookhaven National Lab. Donald Glaser's bubble chamber, invented in 1953, allowed for a greatly improved precision in measuring particle tracks.

In many other fields of physics, however, the scale of endeavors remained as it had been in the 1930s and earlier. Our photos illustrate a few of the interesting developments during this decade: the discovery of parity nonconservation by T. D. Lee and C. N. Yang, and C. S. Wu's experimental confirmation; the triumph of relativistic quantum field theory, after Julian Schwinger, Richard P. Feynman and Sin-Itiro Tomonoga discovered how to renormalize it; the invention of the maser by Charles H. Townes; the theory of superconductivity put forth by John Bardeen, Leon Cooper and J. Robert Schrieffer; the work on classification of galaxies by Harlow Shapley and others; and the discovery by Edward Purcell and Felix Bloch of the 21-cm radiation from interstellar hydrogen.

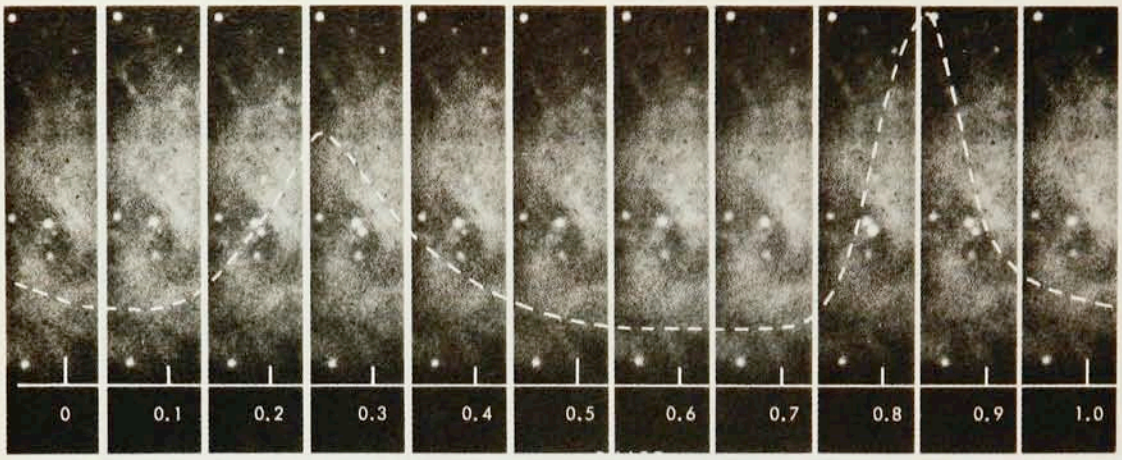
(g) *A bar magnet floating above a superconducting plate, repelled by the magnetic field set up by the plate (the Meissner effect).*



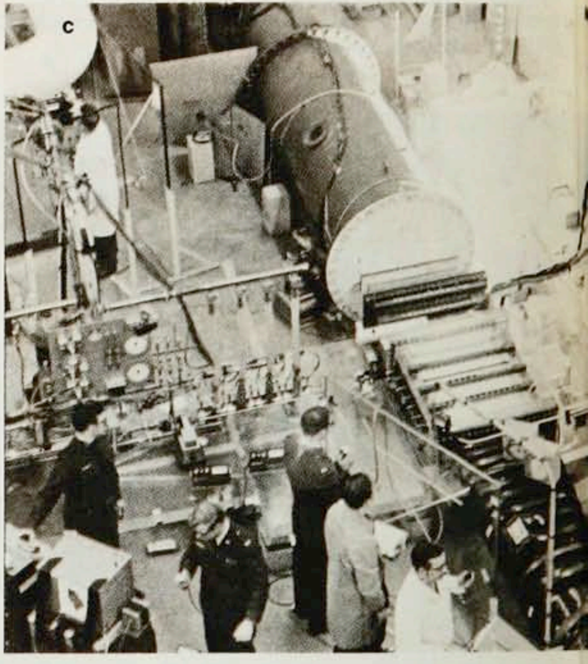
(h) *Counters and associated equipment at Brookhaven National Laboratory.* **(i)** *The last meeting of President Eisenhower's Science Advisory Committee; next to Eisenhower are James R. Killian and I. I. Rabi, behind are George Kistiakowski, Harvey Brooks, Alvin Weinberg, Glenn T. Seaborg, (unidentified), Emmanuel Piore and Wolfgang Panofksy.* **(j)** *Edward Teller at a breakfast press conference.* **(k)** *the Bevatron at Berkeley.*

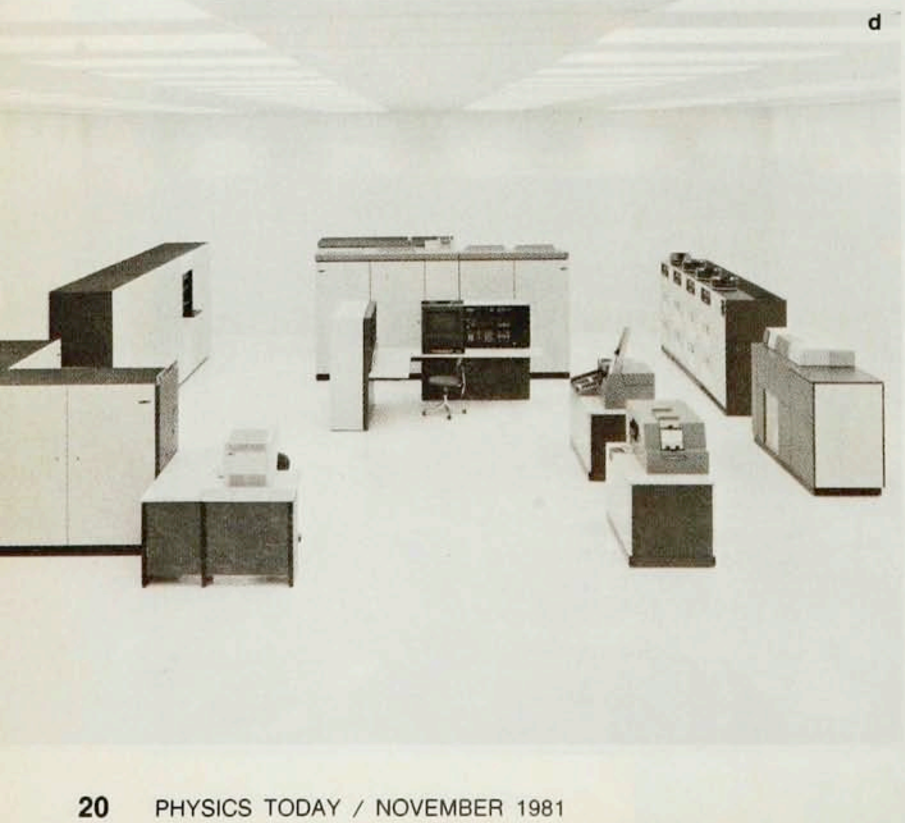


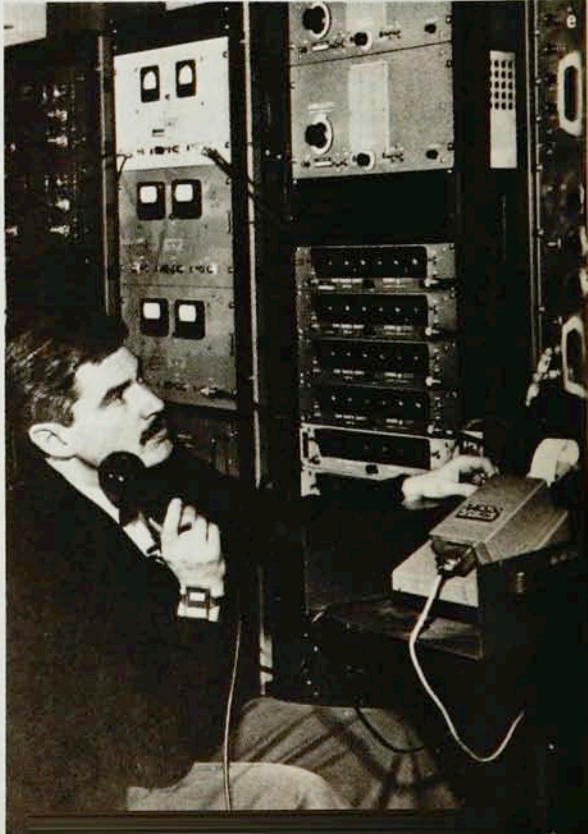
1961-1971



(a) *Pulsar in the Crab Nebula; the light curve is superposed on a sequence of stroboscopic photos of the central region of the nebula.* **(b)** *The Red Sea photographed from space.* **(c)** *High-power CO_2 laser at Wright-Patterson AFB.* **(d)** *IBM model 360/168 computer.* **(e)** *Robert V. Pound at Harvard.*







New frontiers

In retrospect the 1960s seem a golden age for American science: There seemed then to be no end to the growth in new knowledge, in sophisticated equipment, in government funding, in numbers of students—and faculty needed to teach them.

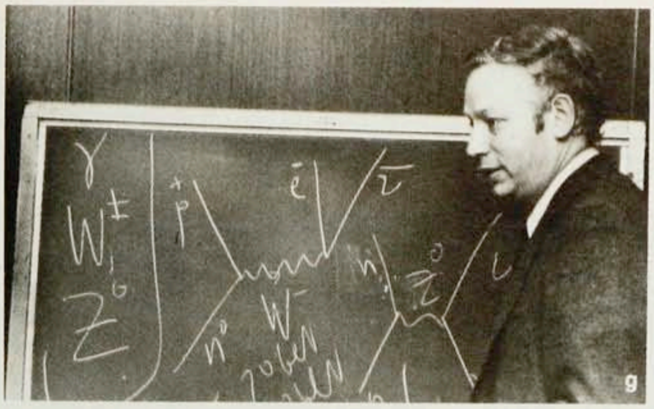
The space program, given a boost by Sputnik in 1957, was one of the first results of the East–West competition in science and one of the most inspiring. Satellite probes have gone to Venus (in 1962), to Mars (in 1965) and now to other planets; men have walked on the Moon.

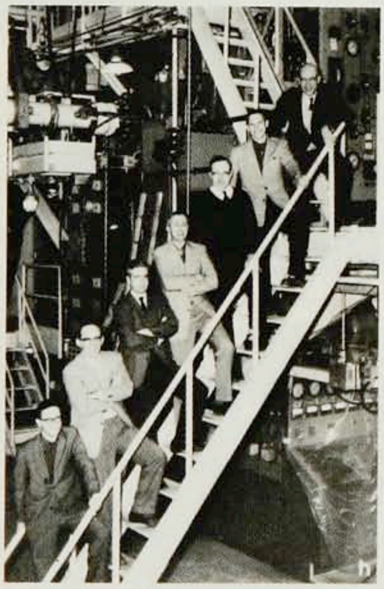
To illustrate the progress in technology during this decade, we show Robert Pound's 1961 electronics for measuring the gravitational red shift of γ rays (emitted in a transition whose linewidth is narrowed by the Mössbauer effect) and an IBM model 360 computer from the end of the decade. The CO_2 laser, capable of producing tens of kilowatts of continuous power, followed a little over a decade after Theodore Maiman's first ruby laser.

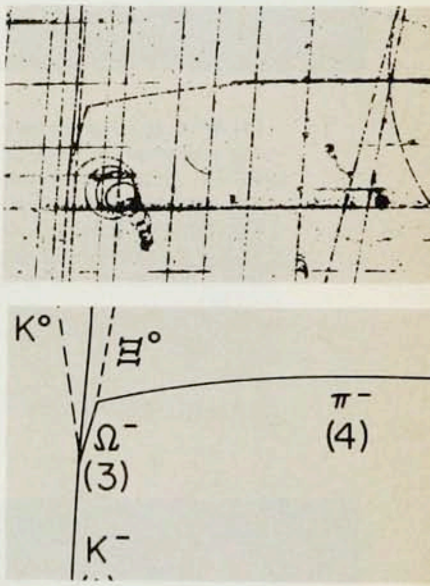
Developments in cryogenics allowed the discovery of superfluid phases of helium-3.

The alternating-gradient synchrotron at Brookhaven opened in 1961. Its 33-GeV proton beam allowed access to a whole range of new elementary particles. Among them was the Ω^-, whose discovery (in 1964) confirmed an elegant symmetry scheme. During this time the seeds were also sown for the unified theories that are currently generating considerable excitement: Steven Weinberg, Sheldon Glashow and Abdus Salam developed a unified theory of electromagnetic and weak interactions.

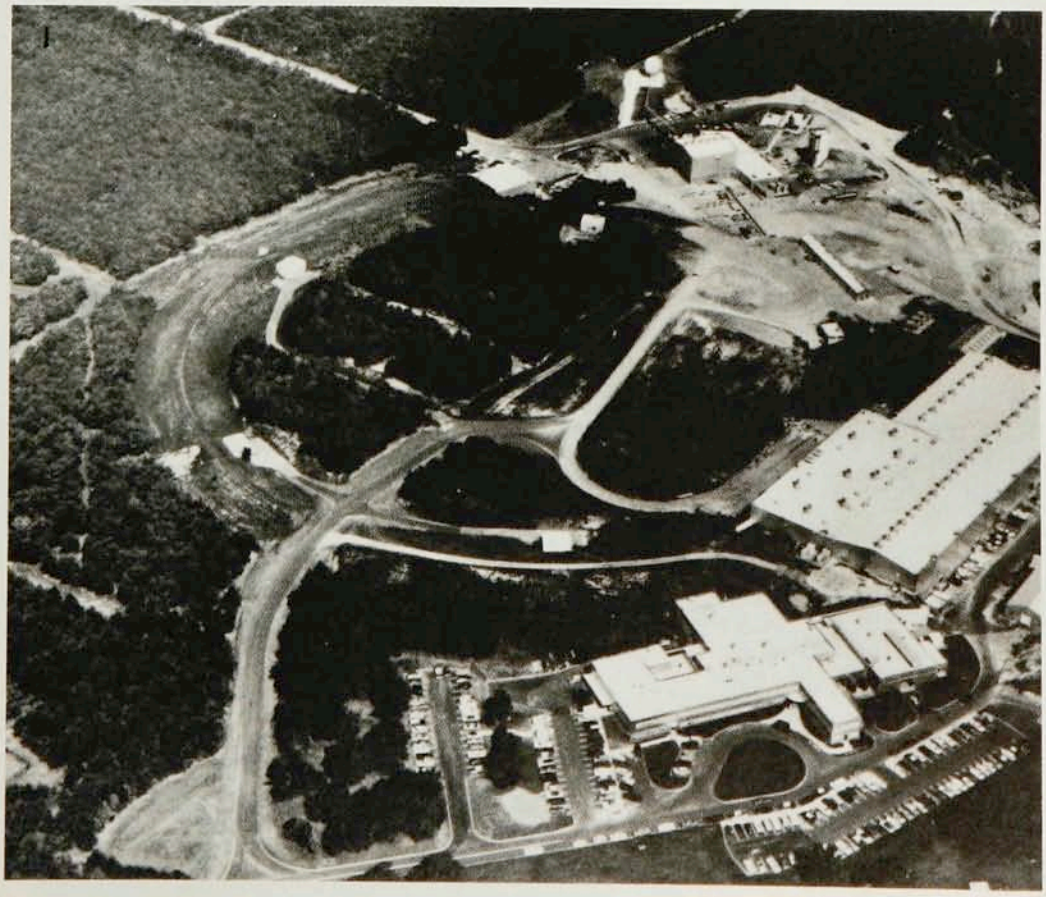
In astrophysics new discoveries appeared to challenge all known laws of physics. Quasars were discovered in 1963. Pulsars, discovered in 1968, were first jokingly identified as communications from "little green men"; they are now believed to be rotating neutron stars.



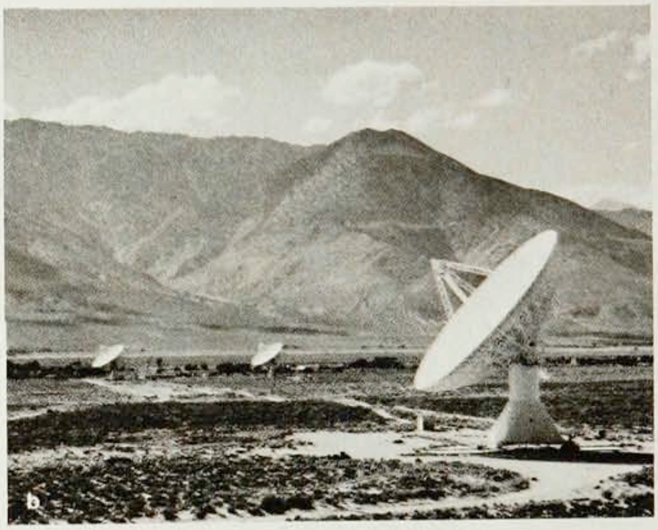




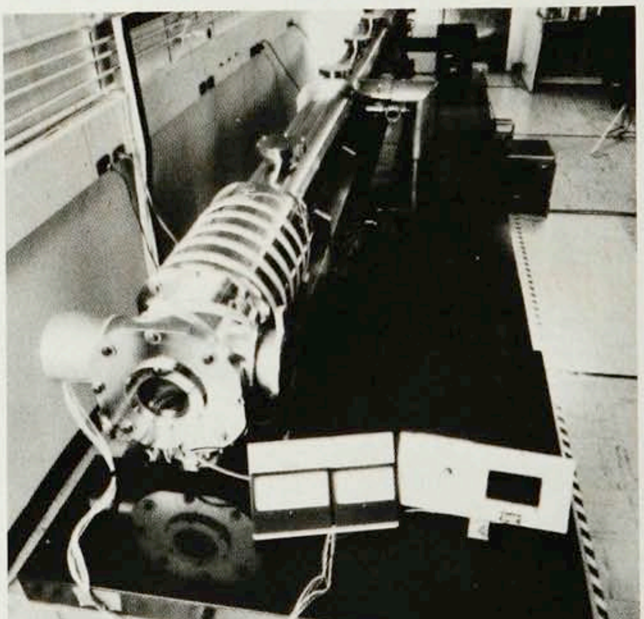
(f) *Fountain effect in superfluid helium-4.* **(g)** *Steven Weinberg.* **(h)** *Bubble-chamber group at Brookhaven in front of the 80-inch bubble chamber.* **(i)** *The first recorded event involving an Ω^- particle, photographed in the 80-inch bubble chamber at Brookhaven; the existence of the Ω^- was predicted from symmetry considerations before its discovery.*
(j) *The AGS at Brookhaven in 1962; the bubble chamber building is under construction.*

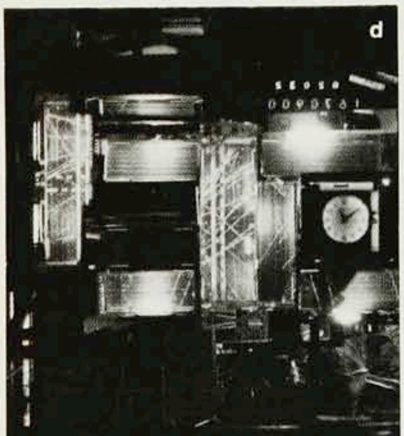


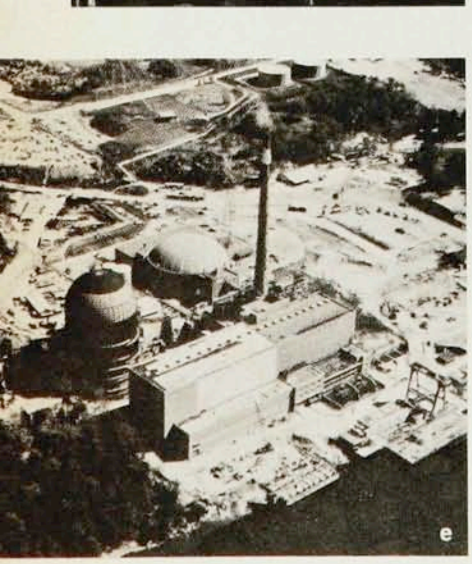
1971-1981

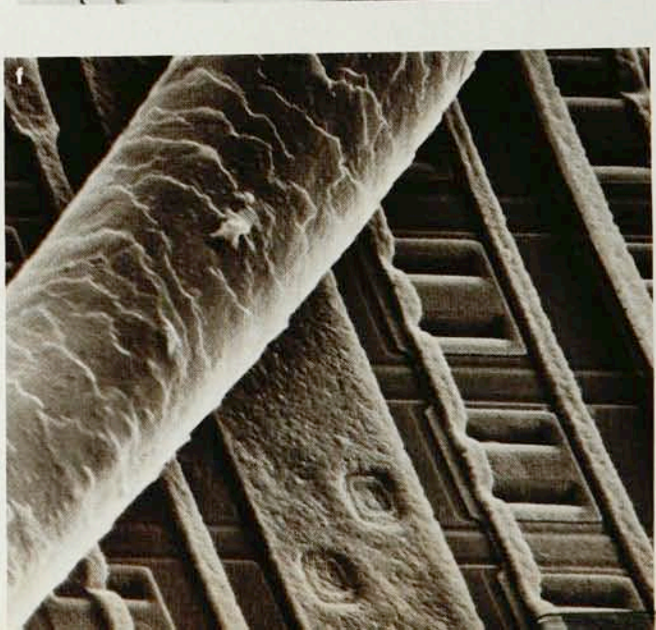


(a) *Geoffrey Burbridge, one of the astrophysicists involved in, among other questions, the controversy over quasar red shifts.* (b) *The Owens Valley radiotelescopes, which can be used together to synthesize an effective aperture as large as their separation.* (c) *The US primary standard of time, a cesium atomic-beam maser.*









(d) *An early spark chamber at the Lawrence Berkeley Lab.* (e) *The Indian Point nuclear power plant of New York's Consolidated Edison Co.* (f) *A VMOS memory chip, together with a human hair (enlarged 5000 times)*

The recent past

The boom of the 1960s could not last. The baby boom ended in the mid 1950s; the student boom therefore ended in the 1970s. The war in Viet Nam began to lead first to antiwar sentiment and then to economic difficulties. Research budgets were weighed against other claims on the government purse, and were cut back with increasing severity.

Prominent among the public-policy issues that confronted physicists were those involving nuclear weapons—issues to which physicists have had a special relation ever since their primary role in the Manhattan Project.

Perhaps in part because nuclear war seems too remote and too awful to contemplate, the general public directed its attention more to nuclear power than to the increasingly ominous buildup of strategic nuclear weapons. Public protest and increasing regulatory stringency coupled with less than advertised performance severely reduced the growth of nuclear power in the 1970s.

Elementary-particle physics during the decade was strengthened by Fermilab, the 200-GeV accelerator at Batavia, Illinois, which produced its first beam in 1972. As particle energies continued to increase, bubble chambers were slowly replaced by other counters, such as the spark chamber shown at left.

Atomic physics is undergoing a renaissance, sparked by new technologies—most notably the laser and maser—that permit experiments orders of magnitude more sensitive or precise than before.

With interferometric techniques (made possible by atomic clocks) the resolution of radioastronomy has come to rival that of optical astronomy.

We are now only beginning to see the impact of large-scale-integration of solid-state circuits, the "computer on a chip." These tiny silicon chips promise to be the building blocks of an "informational revolution" to rival the "industrial revolution." □