

Physics Today and the spirit of the Forties

When the magazine emerged 25 years ago, it reflected the hopes for science in the postwar period and focused attention on the new opportunities and environment for research.

Charles Weiner

Great expectations were in the air for the future of physics when the first issue of *PHYSICS TODAY* appeared in May 1948. The applications of physics in World War II had created a new social environment for science in terms of public attitudes and government financial support. Among physicists themselves excitement was brewing over new experimental discoveries and theoretical interpretations in solid-state and particle phenomena. At the same time, new instruments of unprecedented power and size were offering high hopes for probing both the smallest particles of matter and the largest dimensions of the universe. The birth of *PHYSICS TODAY* as a communication link among physicists, and between them and the larger community, reflected these events of the postwar years. The emergence of the new magazine in May—like the dedication in June of the 200-inch Palomar telescope and the public announcement in July of the discovery of the transistor—was the culmination of a process that had been set in motion years earlier.

In the midst of the intense involvement of science in World War II, US physicists had started to explore what their postwar role might be. Despite their busy wartime activities, many leaders of the profession speculated about the new social environment that was sure to develop from their own and the government's "discovery" of the utility of the concepts and techniques of physics and the skills of physicists.

They began to plan for the future of physics and its financial support, within specific academic settings as well as on a national scale.¹ The time was also ripe for evaluating the effectiveness of the organizational structure of the physics community itself, especially because of the increasing specialization that had evolved during the prewar decade since the American Institute of Physics was founded in 1931.

Planning for postwar physics

These issues had been discussed at a small meeting on "Problems of Physics in the Postwar Period," held in Philadelphia in 1944 under the sponsorship of the National Research Council. One result of the meeting was a recommendation that the Institute should take steps to bring increased organizational unity to those whose primary scientific interest was in physics. By 3 January 1945 the Institute's Policy Committee presented a plan to accomplish this aim, noting that:

"A very significant change is that interest in the science of physics is now much more widespread than formerly. It is no longer so much concentrated in academic circles and extends into a host of industries and into the border ground of other sciences. The number of academic, institutional, and industrial workers who identify themselves with physics has approximately doubled in the past decade, and the postwar era promises a much greater expansion."²

The committee proposed a reorganization of the Institute and the publica-

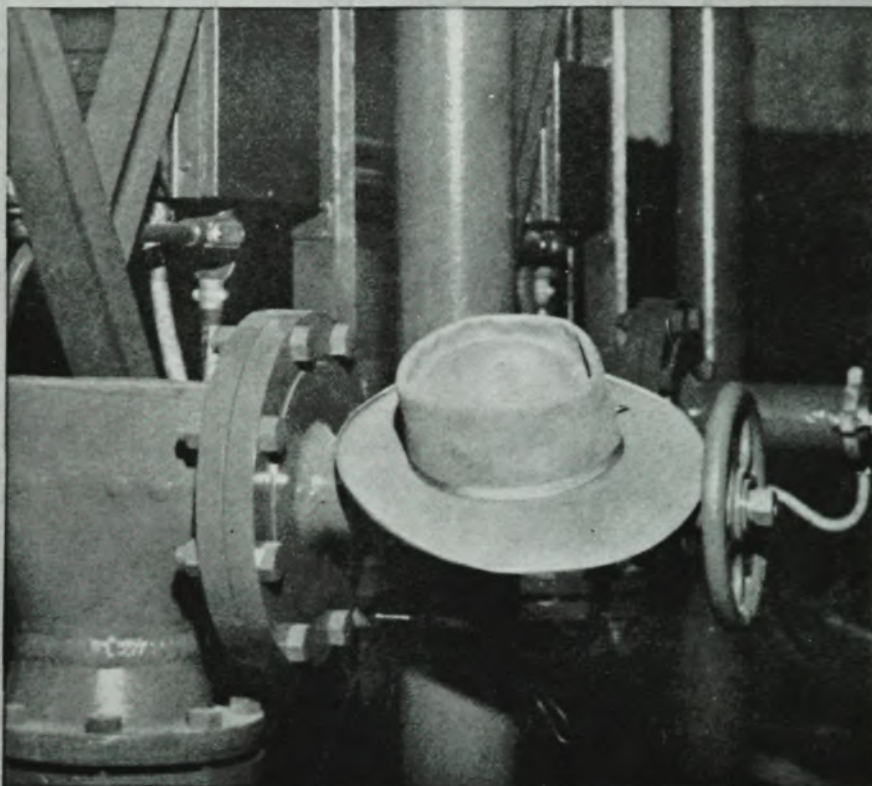
tion by AIP of a journal that would bring to the attention of all physicists "subjects of general interest or far-reaching importance. It should aid the specialist to keep in contact with the broad progress of the science. It should bring to individual physicists news about his colleagues and about events, announcements, and legislation of general interest to physicists. It should, in short, serve as a broad unifying influence."²

On the occasion of the 25th anniversary of that journal it seems appropriate to look back on some of the events covered in its first issues. Today's observers and participants will easily recognize that many of these events in the postwar transition period for science have had a profound impact on scientific work throughout the past quarter century.

The postwar trends were examined in the first issue by Vannevar Bush, who had been one of the major architects of the wartime scientific effort and of the subsequent steps to define new government-science relationships. Bush expressed pleasure and surprise that the new public interest in physical science—which stemmed from the dramatic practical applications in the form of radar, proximity fuses and the atom bomb—was not limited to its applied aspects but extended to basic science as well. He observed: "There are indications that this broadening of the approach also is having the effect of ensuring public interest, and hence eventual support, not only in the physical sciences from which most of the war implements were evolved, but also

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PHYSICS *today*



TRENDS IN AMERICAN SCIENCE by Vannevar Bush

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First cover of PHYSICS TODAY in May 1948. This photograph of Robert Oppenheimer's porkpie hat, tossed on the Berkeley synchrocyclotron, symbolizes the early postwar period, when theorists eagerly awaited experimental results from the new particle accelerators.

in science generally." Despite the relative lack of publicity for the medical advances applied during the war, he noted, "the interest of the public today seems to be fully as much in the biological sciences, which are the basic source of medical advances, as in physics or chemistry."³

Evidence of public interest and support included the Congressional discussions of legislation to establish a National Science Foundation. Bush's July 1945 report *Science, the Endless Frontier* called for extensive federal support of science and recommended the establishment of a government foundation for support of basic research. After legislative disputes about its administrative structure were resolved, the NSF was created in 1950. In 1948, Bush told the readers of the

first issue of PHYSICS TODAY:

"... If science legislation of this general type had been enacted in the middle thirties, I think ... it would have been heavily weighted in the direction of aid to inventors, pilot plants for new processes considered likely to provide an immediate public benefit in goods or materials, and applied affairs generally. The discussion in the last Congress, however, revolved almost entirely about the support of basic science, and there seem to be no dissenters from the thesis that this is the stage most suitable for federal support, leaving applied science to government laboratories and industry. It is devoutly to be hoped that this point of view will continue, and that a highly representative Foundation will soon be

established and actively on its way."⁴

New sources of funds

While the NSF legislation was tortuously evolving, the burden of federal support for basic research was taken up by the Office of Naval Research, as part of a program initiated in the fall of 1945. By November 1948 ONR was spending twenty million dollars annually to support about 500 unclassified basic research projects in the physical sciences at universities throughout the US. That month, the ONR program was described in the PHYSICS TODAY article "Investment in Basic Research" by Emanuel Piore, who directed the ONR Physical Sciences Division. Piore noted that "support of a broad, long range, basic research program by the federal government in laboratories outside the government, is in a sense a new venture." He explained that "ONR tries to stimulate creative scientific activity to insure the existence of a broad base for applied research and development. Thus, support is given to the traditional source of creative thinking—the universities—stimulating their normal function of research and graduate instruction."⁵

Nuclear physics received the largest amount of ONR support; it accounted for thirty percent of the Physical Sciences budget during the fiscal year 1947-1948. This support helped make possible the proliferation of a new generation of large accelerators that were under construction or coming into operation at a number of US universities. Electrostatic and linear accelerators, cyclotrons and synchrotrons were being dreamed up, tuned up or turned on in 1948, most of them paid for—and the bills were large—by ONR and the new Atomic Energy Commission.

These aspects of the rise of big physics stimulated the song "Take Away Your Billion Dollars," by Arthur Roberts, printed in that same November issue. According to Roberts, he wrote the song in 1946 "when it seemed as though every physicist was inventing, building, or projecting a new and larger machine, and while plans for the Brookhaven Laboratory were being formulated. The AEC was not yet in existence, and all financing for new machines was being thought of as from the Armed Forces. This appeared to many people a dangerous situation ..."⁶ His musical comment was:

"... Now in my lab we had our plans, but these we'll now expand. Research right now is useless, we have come to understand. We now propose constructing at an ancient Army base, The best electronuclear machine in any place,—Oh,

*It will cost a billion dollars, ten billion volts 'twill give.
It will take five thousand scholars seven years to make it live.
All the generals approve it, all the money's now in hand.
And to help advance our program, teaching students now we've banned...
This machine is just a model for a bigger one, of course,
That's the future road for physics, as I'm sure you'll all endorse.*

*And as the halls with cheers resound and praises fill the air,
One single man remains aloof and silent in his chair.
And when the room is quiet and the crowd has ceased to cheer,
He rises up and thunders forth an answer loud and clear:
'It seems that I'm a failure, just a piddling dilettante,
Within six months a mere ten thousand bucks is all I've spent.
With love and string and sealing wax was physics kept alive,
Let not the wealth of Midas hide the goal for which we strive.—Oh*

*Take away your billion dollars, take away your tainted gold,
You can keep your damn ten billion volts, my soul will not be sold...'*

Era of the big machines

What the newly completed machines "could and should do" was the focus of a conference of 150 accelerator specialists held at MIT in 1948. Most were experimentalists concerned with high-energy particle accelerators, but a number of theorists were also present. E. Alfred Burrill, reporting on the conference in the September 1948 issue of *PHYSICS TODAY*, observed a division between those physicists concerned with high energy and those concerned with higher energy: The greater precision obtainable in the relatively lower energy range was needed for studies of nuclear structure; the study of nuclear forces required ever increasing energies.⁷

A major stimulus to interest in high-energy machines had occurred in February 1948 when the Berkeley 184-inch synchrocyclotron produced the first artificially made mesons, from 380-MeV alpha particles. Meson physics had begun to take off in 1947, when C. F.

Powell and G. P. S. Occhialini discovered pions in cosmic rays. The production of mesons in the laboratory promised new research opportunities in a field that was providing fundamental challenges to the persistent attempts at formulating a theory of nuclear forces. Increased particle energies could also provide data relevant to the new theories of quantum electrodynamics. The accelerator specialists were aware of these theories, because, as Burrill pointed out in his report, "the theoretical physicists present at this conference were fresh from their sessions at the Pocono Conference in the early spring and essentially echoed its conclusions. There was hope of discovery and anticipation of what would happen when the particle energy is increased."⁸

The Pocono Conference, held in April 1948, involved 27 participants who spent four days in a Pennsylvania mountain environment talking about the theoretical implications of the discovery of new particles and of the precise measurement of atomic energy levels. With J. Robert Oppenheimer as chairman, the conference was spon-



The Shelter Island conferences brought together leading theorists—and an occasional experimentalist. Here we see (left to right) Willis Lamb, Abraham Pais, John Wheeler, Richard Feynman, Her-

man Feshbach and Julian Schwinger considering a problem at the first conference, which took place in 1947. The photo seen here, now at the AIP Niels Bohr Library, is from Abraham Pais.



Dedication of the 200-inch Hale telescope took place in June 1948, one month after the beginning of *PHYSICS TODAY*; planning had begun in 1928. Photo from reference 14.

sored by the National Academy of Sciences. It was a follow-through of a similar conference held the previous year at Shelter Island, New York, which Oppenheimer later described as "the first serious and intimate conference after the war."⁹ These conferences brought together leading theorists and, according to the participants, were of immense importance because they focused attention on the outstanding problems facing theoretical physics, and helped to solve some of them. One participant, Richard Feynman, described the Pocono conference in the second issue of *PHYSICS TODAY*: After discussing the discovery of pions (which were then called "heavy mesotrons") and their controlled production and use in experiments at Berkeley, he reported:

"Faced with all this wonderful confusion of new particles decaying into one another, the theoretical physicists admitted that they were unable

to bring appreciable order into the picture, and certainly not to predict what kind of particle would be discovered next, or any new properties for particles already discovered. The future of these problems lies almost completely in the hands of the experimenters."¹⁰

Feynman then gave an account of the past year's progress in understanding some observed discrepancies from theory. Willis Lamb had reported his work on precise energy levels of hydrogen at the Shelter Island Conference, and I. I. Rabi had reported on the magnetic moment of the electron at the same meeting. These results pointed up the difficulties in the theory of quantum electrodynamics. It was at the Pocono meeting that Julian Schwinger and Feynman each presented and defended his own ideas on the subject. Just after the meeting Oppenheimer received a letter from Sin-iti Tomonaga in Japan who described

his progress on these problems.¹¹ (In 1965, Schwinger, Feynman and Tomonaga shared the Nobel Prize for this work.) Feynman's summary of the 1948 conference symbolized the atmosphere of the late 1940s:

"The conference showed that just as we were apparently closing one door, that of the physics of electrons and photons, another was being opened wide by the experimenters, that of high-energy physics. The remarkable richness of new particles and phenomena presents a challenge and a promise that the problems of physics will not be all solved for a very long time to come."¹²

The cover of the first issue of *PHYSICS TODAY* was also an expression of the spirit of the time: a photograph snapped after Oppenheimer had tossed his familiar pork pie hat on a portion of the 184-inch synchrocyclotron at Berkeley. Construction of the machine had started in 1940 when The Rockefeller Foundation agreed to provide a grant of \$1 150 000. Private foundations had been the major source of financial support for physics research in the US before World War II. Cyclotrons, in particular, attracted foundation support because of their social potential through production of radioisotopes for use as tracers and for experiments in radiation therapy. But the Rockefeller Foundation support of the 184-inch machine in 1940 was a harbinger of the support accelerators were later to receive from government agencies. As Warren Weaver of the Foundation noted at the time, it was viewed as "the definitive instrument for the investigation of the nucleus—the infinitesimally small—just as the 200-inch telescope is viewed as the definitive instrument for the investigation of the universe—the infinitely great."¹³

The 200-inch telescope began its metamorphosis from dream to reality in 1928 when George Ellery Hale convinced the Rockefeller-supported International Education Board to provide \$6 000 000 for the project. After a long period of planning and construction of this optical instrument of unprecedented size, which was interrupted by the war, the 200-inch Hale telescope was dedicated atop Palomar Mountain on 3 June 1948.¹⁴ Hopes for the new instrument were expressed by Lyman Spitzer in his September 1948 *PHYSICS TODAY* article, "The Formation of Stars":

"Perhaps when the 200-inch telescope probes further into the secrets of space, and when further progress in experimental and theoretical physics increases our understanding of the processes at work between the stars, we may then outline with more assurance the detailed steps by

which supergiant stars may be forming almost before our very eyes.”¹⁵

Growth of solid state

A month after the Palomar dedication, an event in New York opened yet another era in physics. Although the 1 July press conference announcing the point-contact transistor rated only eight sentences in *The New York Times*, buried among programming changes in “The News of Radio” column, *PHYSICS TODAY* thought it was more newsworthy:

“A semi-conductor has been used for electronic amplification in the Bell Telephone Laboratories. For years the only flexible amplifier available, the vacuum tube, has been an important tool, not only in radio, telephony, and industrial control but in physical research as well. Now a fundamental study of certain problems of solid state physics has provided a new amplifier which seems suited for a variety of practical applications. Developed by John Bardeen and Walter H. Brattain under a general research program initiated and directed by William Shockley, the transistor, as it is called, is a semi-conductor triode which can be used as an amplifier, an oscillator, and in other ways in which vacuum tubes perform.”¹⁶

Like the 200-inch telescope, the transistor's origins went back to the late 1920's, when the new concepts of the quantum theory of matter were applied to the theory of metals. Wartime semiconductor studies, undertaken in connection with the development of radar, contributed importantly to greater understanding of the subject and to the availability of pure germanium and silicon. All of these developments helped set the stage for the Bell Labs project, which was launched late in 1945 and by December 1947 had produced the first transistor.¹⁷

At the time of the public announcement of the transistor, solid-state physics was flourishing on many fronts. A spring conference at Shelter Island on low temperatures “tried to interpret low temperature theory, and make some sense out of superconductivity and liquid helium,” according to John Slater who reported on the meeting in the August *PHYSICS TODAY*.¹⁸ Subsequent articles on the subject in 1948 included ones by Laszlo Tisza and by David Shoenberg. At the same time the newly formed Solid State Division of The American Physical Society was providing communication channels for the increasing number of physicists in the field.

Vannevar Bush, in his inaugural issue article, foresaw that the growth in research might create some problems for the scientific community:

“What a pickle this whole movement is getting us into in regard to publication of scientific results . . .”¹⁹

Readers of *PHYSICS TODAY* in 1948 also learned about “The Challenge of Industrial Physics” and about the needs and techniques for “popularizing science.” In each case they were reminded that the traditional academic approaches to research and teaching needed to be more flexible: “Industrial work requires a breadth of viewpoint and a necessity for cooperation which is sometimes considered unnecessary in a university,”²⁰ and, “If science wants a mass radio audience, it must compete for it using radio, not classroom techniques.”²¹ The latter statement introduced John Pfeiffer's article “Science on the Air” in July 1948 in which he expressed concern that the public's interest in science was due to the role of science in the war and that they “will continue to associate it with uniforms unless they learn to appreciate its peacetime meanings—and the power of the methods behind the discoveries.”²²

Growth and its consequences

These illustrations highlight the circumstances surrounding the emergence of *PHYSICS TODAY*. Now, 25 years later, we can appreciate well the spirit of Bush's concluding remarks in the inaugural issue. His expectations for the growth of research were coupled with concern for the nature of this growth and its effects on the scientific community and on the society in which it functions:

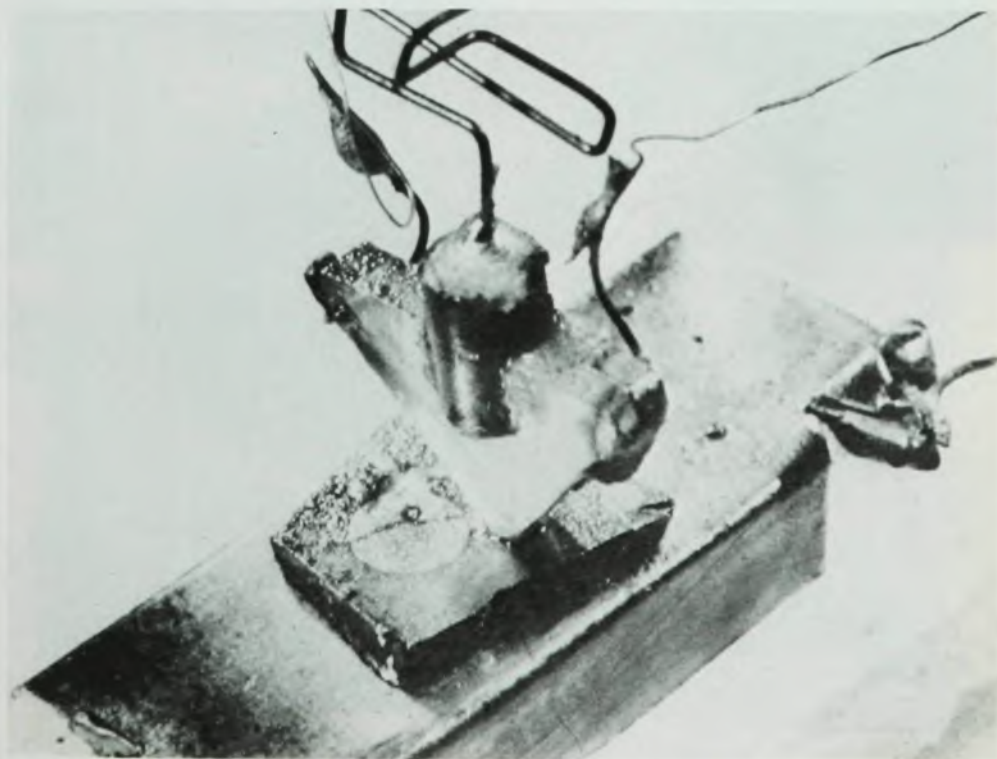
“It would be still more interesting, if

anyone could accomplish it, to examine what sort of a world all this is leading us into, quite apart from the nature of possible future war, with digital calculators expanding our mathematical power, and enzymes capable of all the chemical reactions that evolution ever found useful.”

Ending on an optimistic note, Bush observed:

“But it is sufficient for the moment to note that we are on our way, that public support of science apparently rests on a deep-rooted conviction that the public has apparently a sound conception of what science really is and what parts of it can best be furthered by public support, that the present expansion carries with it an emphasis also on advanced training, and that thus far at least the movement has proceeded reasonably soundly and free from regimentation of fundamental science. The results in a decade or two, if the trend continues, should be exciting.”¹⁹

The seeds that were taking root in 1948 have now borne their fruit. We do not need to be reminded of the wealth of knowledge and insight into the physical universe that has unfolded during the past 25 years, nor of the vast social impact of the applications of physics research during the same period. The changes in the social environment are also apparent. Now the expectations of increasing government support for basic research have given way to concern for establishing priorities, both within science and in relation to overall national needs. Amidst current expectations and concerns, it would be



Point-contact transistor. Bell Telephone Laboratories announced the new device at a press conference in July 1948, during a time of rapid growth for solid-state physics.

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interesting and useful to examine and attempt to understand what has happened in the past 25 years, while we ponder, as Bush did, about the future of science in the next decades.

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