The state of the APS and of physics in 1978

The retiring president reviews an eventful and critical year, with ERA and tax-status problems in the foreground and employment prospects a continuing concern.

Norman F. Ramsey

It has been a great honor to serve as President of The American Physical Society during the past year, but the honor is not an empty one. There are numerous duties attached, one of the last of them being to give this report on The American Physical Society, the physics profession, and physics.

I will begin with a look at two of the problems the Society faced during this eventful and critical year—one problem relating to the Equal Rights Amendment and the other to a possibility of a change in the Society's tax status. The APS journal-publishing and scientific-meeting programs continue to show progress, and, thanks to dedicated and largely voluntary management, the Society's services to its members have increased while dues have remained constant. On the other hand analysis of physics employment prospects in the academic area shows a bleak picture for the next fifteen or twenty years. By the turn of the century the situation should improve, but we should be aware of the danger of undamped oscillations in academic-employment statistics. The APS and the American Institute of Physics are making efforts to upgrade the image on the campuses of non-academic physics careers.

When I turn to my summary of advances in physics itself, I have a selection problem because the subject has rarely been as fruitful as it is at present. I will therefore limit my examples to a handful of recently published research results that I have personally found particularly interesting.

Equal Rights Amendment

Let me turn first to the most divisive and controversial issue that has been faced by the APS Council. More than a year ago it became apparent that during this year the Council would have to reach a decision that would offend many APS members whatever the Council action or inaction might be. Should the APS join a number of other scientific societies in a boycott by cancelling meetings already scheduled in those states that had not ratified the Equal Rights Amendment? What made this issue particularly divisive was not merely the fact that the Council was close to equally divided on the subject, but also that most of the advocates of opposite views felt strongly that their views were clearly valid and that those of the opposition were quite wrong. The Council referred the question to its Panel on Public Affairs, which was also divided on the issue, but POPA performed a valuable service in the preparation of alternative motions and summaries of the principal relevant arguments. The primary issues were not the merits of ERA but the appropriateness of the APS taking the proposed action—or, for that matter, any action whatsoever on this issue. From the point of view of the proponents of cancelling scheduled meetings, the low number of women in physics was in part due to the absence of an Equal Rights Amendment, physics was retarded by this inhibition on the contribution of women and the Council should therefore act under Article II of the APS Constitution: "The object of the Society shall be the advancement and diffusion of the knowledge of physics." The opposition, on the other hand, interpreted the same phrase in the APS Constitution to preclude action on this issue by the APS and considered that the APS should be concerned with "the advancement and diffusion of the knowledge of physics" in a direct and limited sense. Exerting pressure on State Legislatures exercising their Constitutional duty of amendment ratification was considered from this point of view to be a political action with too little specific relevancy to physics to be justified under Article II of the APS Constitution.

It was quite apparent that whatever action the Council took or did not take on this issue would give substantial offense to large numbers of APS members. After extensive discussion at its November meeting, the Council adopted a resolution that was a partial compromise between the two extremes: it rejected the boycott proposal of cancelling meetings already scheduled, but it did vote to "schedule general and divisional meetings, beyond those already scheduled, only in states that have ratified the Equal Rights Amendment." This restriction is not applicable to the regional meetings, which may be held anywhere. Discussion of this issue continues with vigor, and the Council continues to receive overwhelmingly more letters on both sides of this issue than on all other subjects combined.

Internal Revenue Service

Another difficult problem during the past year has pertained to the Internal Revenue Service. A few weeks before my term as President of the APS was to begin, the APS received a Christmas gift from the Internal Revenue Service in the form of a letter stating that the IRS Examiner had concluded that the APS was not a scientific society as described in section 501(c)(3) of the Internal Revenue Code, but was "a business league . . . of

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persons having a common business interest" as described in section 501(c)(6). Similar letters were received by most other scientific societies at about the same time.

This letter from IRS opened a new dimension in my life and exposed me to a whole new world of tax lawyers, IRS Examiners, Conferees, District Directors, Regional Commissioners, and Revenue Codes. Joseph Burton, William Havens and I, as the APS officers most concerned, agreed that we should take our appeal very seriously and devote a major effort to retaining our 501(c)(3) tax status. We were convinced that APS reclassification was based on a complete misunderstanding of the APS operations by the original IRS Examiner. For example, he levelled the strongest criticism against the participation by the APS in the Physics Placement Service operated by the American Institute of Physics. Apparently the IRS Examiner confused the Physics Placement Service with a typical union hiring hall in which a union assigns jobs to its members. Instead, we could validly point out in the Appeal Conference that the Placement Service was open to all physicists—whether members of the APS or not—and that the APS merely provided the opportunity for potential employers to meet interested physicists with the APS having no say in the determination of who received a job offer. We could also point out that even if all the objections of the original examiner were valid—and we argued in fact that none of them were—the total expenditures for the criticized activities came to only 1.6% of the APS budget, whereas the normal IRS guidelines permit up to 5% expenditures on such activities.

I am happy to report that the Appeals Conferee was completely convinced by our arguments; he and the District Director came out resoundingly in favor of the APS and concluded "Based on all facts, law and argument in the case file, the exemption granted the American Physical Society under section 501(c)(3) of the Code should not be disturbed." Those of us who participated in the Appeals Conference like to believe it was the persuasiveness of our arguments that provided this favorable conclusion, but there remains the lingering suspicion that our success may have been due to our obvious incompetence—not our brilliance; it was perhaps the view of the IRS Conference that no organization with such unbusinesslike officers could possibly be a league of business men. In any case the judgment was totally in our favor.

I wish that I could report that all worries about the IRS are fully ended. Alas, despite the favorable IRS ruling for the APS, the appeal of the American Institute of Physics was denied; unless the AIP ruling is overturned at a still higher IRS level or in the courts, the AIP will lose its tax-exempt status. As President of APS I have written a strong letter in support of the renewed AIP appeal at a higher IRS level, and I sincerely hope that AIP regains its proper tax-exempt status. [See the editorial by Philip M. Morse and H. William Koch in this issue.]

Other APS activities

The primary activities of the APS in arranging scientific meetings and in publishing scientific journals are going well, with some complaints but with continuing efforts toward improvements. The delay in the publishing of articles—particularly those by authors who do not honor the page charges—has been markedly reduced. Robert Adair has accepted the appointment as Editor of *Physical Review Letters* and Benjamin Bederson has done likewise for *Physical Review A*. The Annual Meeting appears to be shrinking in size, but other meetings—especially the Divisional and Topical meetings—are thriving. Under the guidance of our Treasurer, Joseph Burton, the financial condition of our Society is sound. The number of APS physics prizes has increased and they continue to be awarded to outstanding physicists with splendid achievements. The program of Congressional Fellowships has continued to provide excellent opportunities for talented individuals to work on important Congressional problems. Appreciation for the program continues to be expressed by the recipients and by members of Congress. The newer program of Industrial Fellowships seems to be having the intended effect of increasing the openings for physicists in industry and of enabling some physicists to enter new industrial careers.

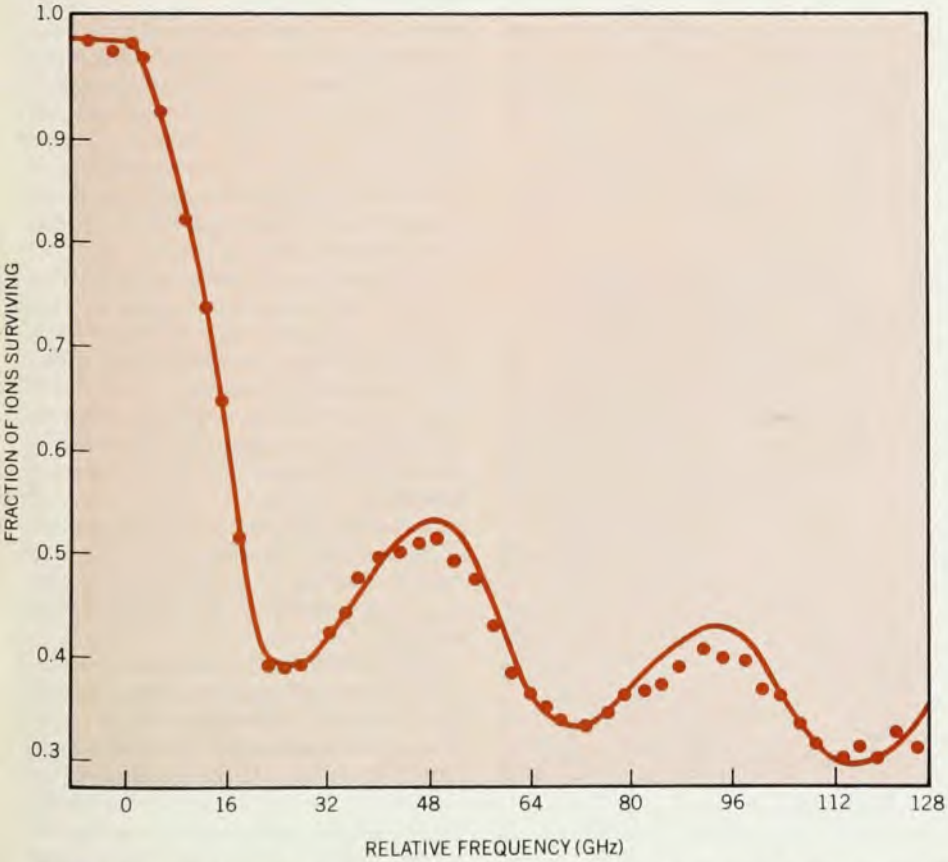
My immediate predecessors as President of The American Physical Society have expressed great appreciation for the existence of the Panel on Public Affairs. Now that I have completed my term, I fully understand the great value of the service performed by this Panel in making recommendations to the President and Council on public-affairs activities of the Society. POPA and its chairman, Richard Garwin, have been of immense value in helping prepare letters on matters of public affairs to which the President needs to respond. These letters range from responses to questions asked by Congressional Committees to letters written in support of foreign physicists whose freedom has been unduly restricted. Although it often appears that letters for such purposes will be to no avail, I have been pleasantly surprised on several occasions this year to receive letters of appreciation from physicists who had regained some of their freedom and believed that the letters from the President of the APS had been of real help in enabling them to do so. Alas, despite oc-

Dipole hyperfine frequency of rubidium-85 at magnetic fields ranging from 2 to 75 kG. The frequency shift can be interpreted as due to the shrinking of the electron orbits in an intense magnetic field. The shift varies linearly with the square of the applied magnetic field (slope = 1.65 ± 0.16 Hz/G^2), as expected with such an interpretation. (From reference 3.) Figure 1 casional individual successes, the problems of freedom for physicists in many countries remain several.

POPA has continued its effective role in organizing valuable studies of physics issues affecting the general public. An excellent example is the Solar Photovoltaic Study undertaken at the request of the President's Science Adviser, Frank Press. In accordance with the general guidelines governing such studies, the Summary Report of the Study was released to the public at the January meeting. Incidentally, the adoption of general guidelines for the release of Reports from POPA-sponsored studies was an important accomplishment of the APS Council during the past year.

I continue to be impressed by the dedication and effectiveness of the Society's officers, editors and staff and of the many physicists who serve voluntarily on the Council and the committees of the Society. It is only through these many dedicated individuals that the Society has been able to increase its services to its members and to the public while its dues have remained constant for 15 years despite the cost of living having more than doubled. In fact, by recent vote of the Council, the dues will in effect be lowered next year for most members of the Society. Burton called attention to the fact that a significant fraction of the extra $2 dues for membership in an APS division is expended in collecting and recording these dues, so the Council voted as an experiment for one year to cancel the dues associated with Divisional Membership.

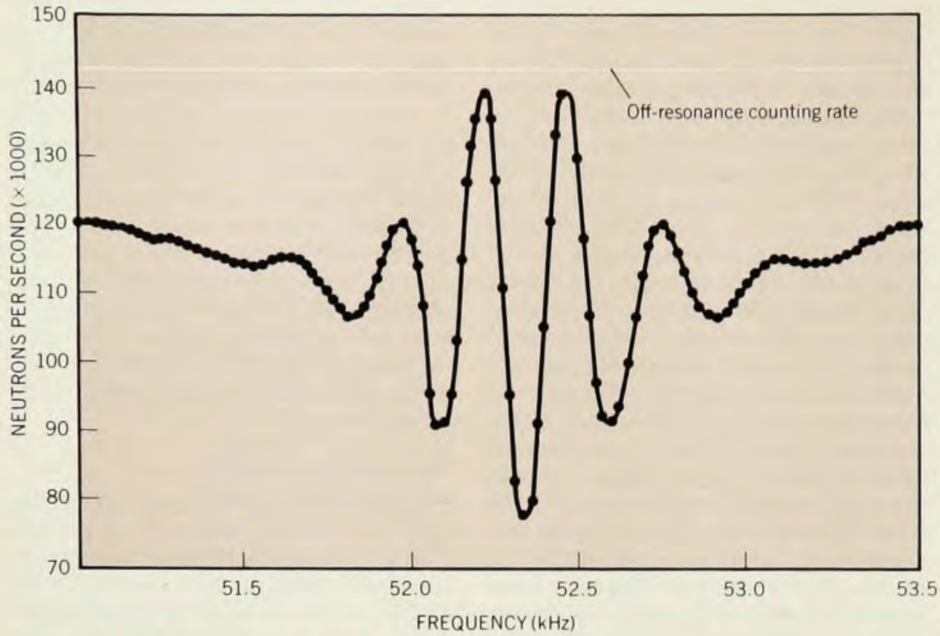
The Society continues its character of being managed primarily by scientists who have voluntarily accepted the responsibilities of managing most of the Society's activities. I have been surprised and delighted to find that essentially all of the many physicists who have been asked during the past year to serve on APS committees have freely accepted without even the necessity for any significant arm twisting; this willingness to serve the Society is a tribute both to the members of the APS and to their regard for the Society. I am convinced not only that such voluntary management is the least costly but also that it makes the Society most responsive to the needs and desires of its members. However, I feel a word of caution is in order. As the activities and responsibilities of the Society have increased during recent decades, they are beginning to approach the limit that can be effectively managed by predominantly part-time volunteers. The new President of the APS, for example, is now faced each year with the task of appointing new members to each of 34 APS Committees. Even though these committees perform valuable functions, and many have the relatively simple task of selecting a prize winner in a single field of physics, the totality of 34 APS Committees is rather awe inspiring. It is my personal view that the APS should be very cautious about undertaking new tasks and accepting new responsibilities lest it reach a degree of complexity calling for professional management, say with a continuing Executive Vice-President and a markedly increased permanent staff. The equilibrium between the two forms of management tends to be rather unstable, and once an organization is forced to a professional management the overhead tends to grow rapidly and the gulf between the membership and the management often does likewise.



Electron photodetachment. The graph shows the fraction of trapped negative sulfur ions surviving illumination as a function of the light frequency; the oscillations can be interpreted as due to the quantized cyclotron orbits of the final state electron. This is the first demonstration of the effect of cyclotron final states on photodetachment. (From reference 4.) Figure 2

The physics profession

Traditionally colleges and universities have been major employers of physics PhD's, and, even in the most recent year analyzed,[1] 31% of the new PhD's in physics were employed by colleges and universities. However, the employment prospects, especially at the tenure level, in colleges and universities in the next decade or so are rather dismal for all academic disciplines. The spectacular growth of colleges and universities during the 1950's and 1960's was based both on an increasing fraction of young people electing to go to college and on a rapid growth in the college-age population. This growth has now ended; it is unlikely that there will be a significant increase in the fraction going to college, and we know the size of the college age group will decline from 1981 to 1995 because these people have already been born. The situation is made even more grim by the present age distribution of most college and university faculties; most faculty members were hired during the rapid expansions of the 1950's and 1960's, so relatively few professors will reach even a retiring age of 65 until the end of the critical 1981–95 period. This bleak outlook for new PhD's seeking academic employment will become even worse if the recently adopted national legislation prohibiting mandatory retirement on the basis of age prior to age 70 leads many professors to postpone their retirements significantly. Dean Rosovsky of Harvard in his most recent annual report[2] has pointed out that reasonable projections for the period 1980 through 1995 suggest that the demand for new faculty members throughout the United States and in all academic areas could be met by the current output of *any single one* of our larger graduate schools. Following the turn of the century this situation should markedly improve. In fact there is a real danger that academic employment may enter a series of boom–bust cycles. In the sciences there are discussions of programs supported by the National Science Foundation and others to alleviate the prospective 1980–95 crisis and to damp the boom–bust oscillations. But even with the best of success of these efforts the



Measuring the neutron's magnetic moment. This neutron magnetic resonance was obtained during the determination of the value $\mu_n/\mu_p = -0.684\ 979\ 35\ (17)$. (From reference 5.) Figure 3

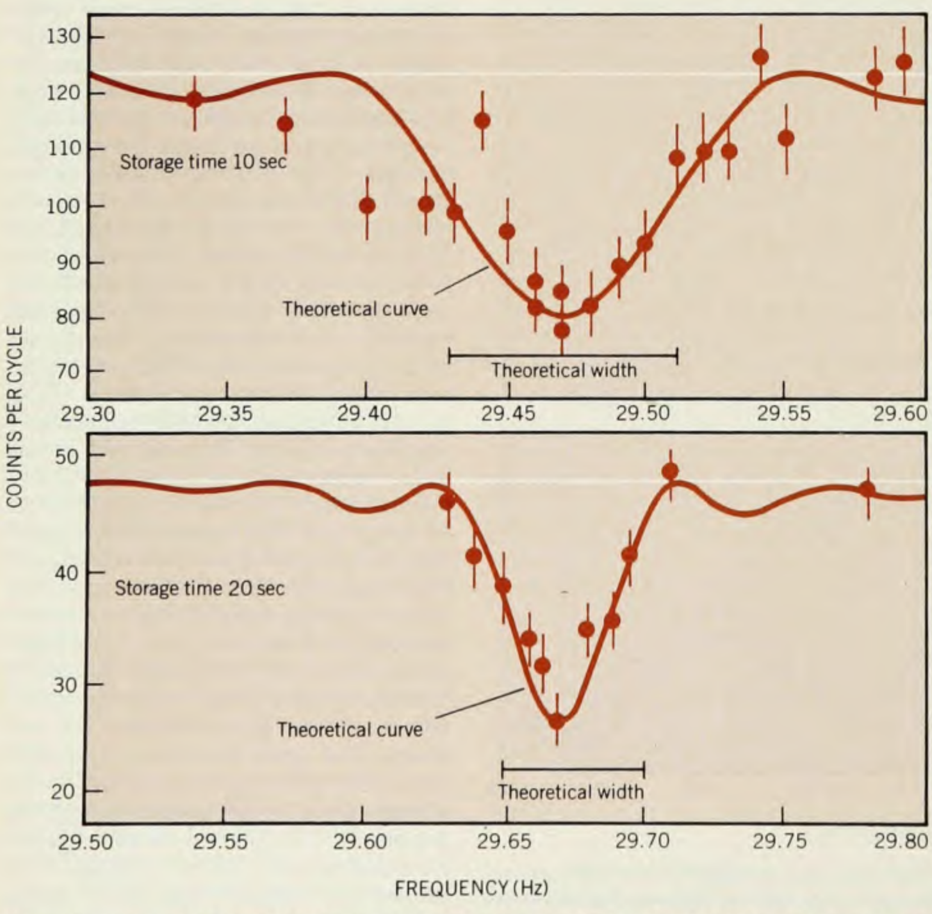
outlook for academic careers in virtually all disciplines appears grim for the next decade or two, except of course for a few individuals with great and easily recognized talents.

The hardships caused by the scarcity of new tenured positions in colleges and universities during the coming decades will be particularly acute in those academic disciplines for which there are relatively few employment opportunities other than academic. Fortunately for us, physics is not such a discipline. Less than a third of the last group of new PhD's were employed in colleges and universities, and the number choosing industrial careers increased to 46% from the 36% of one year earlier. In part through the efforts of The American Physical Society and the American Institute of Physics, most physics faculties and graduate students are fortunately also aware of these problems; this awareness is largely responsible for only two-thirds as many students receiving physics PhD's currently as in the peak year of 1969. Fortunately for physicists, it is also becoming increasingly apparent that many of the major problems facing our country—production of useful energy, energy conservation, energy transmission, environmental problems, transportation, communications and so on—require major scientific and technical innovations of the kind to which physicists can contribute importantly. The needs of these fields will, I hope, keep the employment situation of physicists in moderate balance.

Those of us on physics faculties, in my opinion, have several obligations with the changing employment prospects:

- We should keep our students well informed as to their prospects so they do not base their plans on excessively invalid assumptions.
- We should encourage student interests in directions other than academic and try to compensate for the natural tendency of a graduate student to want to follow only a career similar to that of his professor.
- We encourage most students to enjoy, appreciate and be well motivated by research and development of an industrial nature. In my opinion, the nature of the academic training even in the pure fundamental physics is ordinarily excellent preparation for an industrial research career, provided the student later is able to be well motivated for industrial research. Even a brilliant physicist is unlikely to do good industrial research if he is not really interested.
- In planning graduate course offerings, we should keep in mind the nature of the final employment of most of our students, though it is my personal opinion that a good basic physics training, excellent research experience and good motivation are even more important than studies specifically designed for anticipated applications.
- We should increase the employment opportunities wherever possible and support well conceived programs to alleviate this problem in the critical period ahead.

Despite efforts to attract more members of minority groups and more women into physics, the profession continues to be somewhat unattractive to both groups and there have not been marked improvements in the fractional representation of either group. I suspect that the problems in academic employment may contribute to the reluctance of students in these groups to enter a field, such as physics, in which the entrance fee in time and effort is so large.



Magnetic resonance curves obtained with bottled neutrons. This work should lead to a new lower limit for the electric dipole moment of the neutron. (From reference 6.) Figure 4

The state of the physics profession greatly depends upon the availability of funds to support research, since most research unfortunately costs money. Much of the research support in this country comes from the Federal Government, which in many ways has been generous; we should be and are grateful. However, a few years ago most research budgets fell well behind inflation, and those years established a lower rate of support from which many research fields have not yet recovered. In many individual research projects, the financial problems are severe and attractive research opportunities must often be missed for lack of funds.

Advances in physics

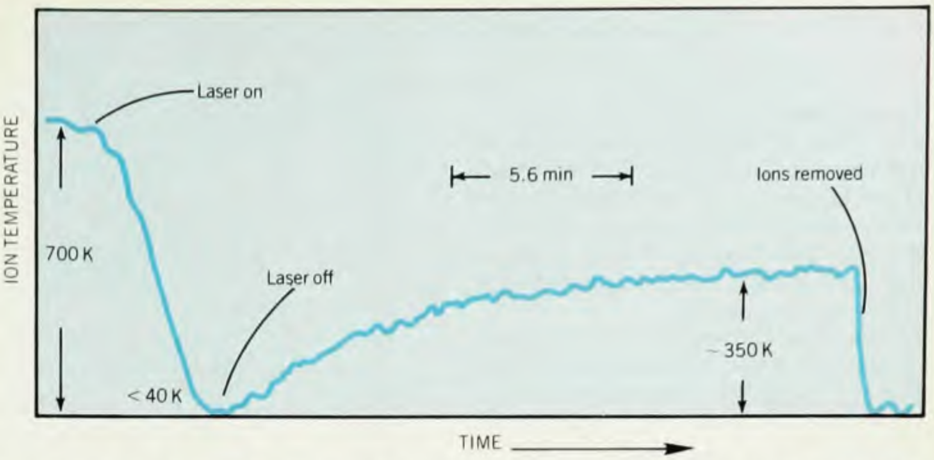
The physics profession has serious problems, as we have seen, but the subject of physics itself is thriving. Rarely has the subject been more fruitful and exciting than at present.

In fields where much of the interest stems from practical applications, the advances are coming at a rapid rate. For example, there have been dramatic advances in both the science and the technology of lasers; with these advances and with similar advances in related fields, such as fiber optics, useful applications of lasers are emerging in all directions from laser communications to industrial fabrication.

Physics continues to be a strong component of many fruitful interdisciplinary fields, as illustrated by this year's Richtmyer Lecture, which, by happy coincidence, is being given by my first PhD student, William Nierenberg, who is now the Director of Scripps Oceanographic Institute. His subject is "Physics and Oceanography." Likewise, I can skip examples of progress in condensed matter physics since Charles Kittel is this year's Oersted Medalist and can represent that field far better than I. [Texts of these two lectures are to be published by AAPT in *American Journal of Physics*.]

To illustrate progress in other areas of experimental physics I had initially thought of listing the most significant advances of the past year, but the list proved to be far too long. So I decided instead to show a few of my favorite pictures of the last year or so. The curves shown in these figures not only indicate past progress but also suggest even more interesting future prospects.

The first curves come from my own laboratory and for that reason have a special appeal to me. The first one is shown in figure 1 and was recorded in our laboratory at Harvard by my associates Nicholas Economou, Daniel Larson and Stephen Lipson.[3] It shows for the first time the increase in the magnetic interaction between an atomic nucleus and the atomic electrons as the electron orbit shrinks with the application of a very strong external magnetic field. All previous data would correspond to low-field points with such large error bars as to hide any indication of slope. The sensitivity of the observations and the strength of the magnetic field are sufficiently great that Larson hopes eventually to observe diamagnetic effects within the nucleus itself.

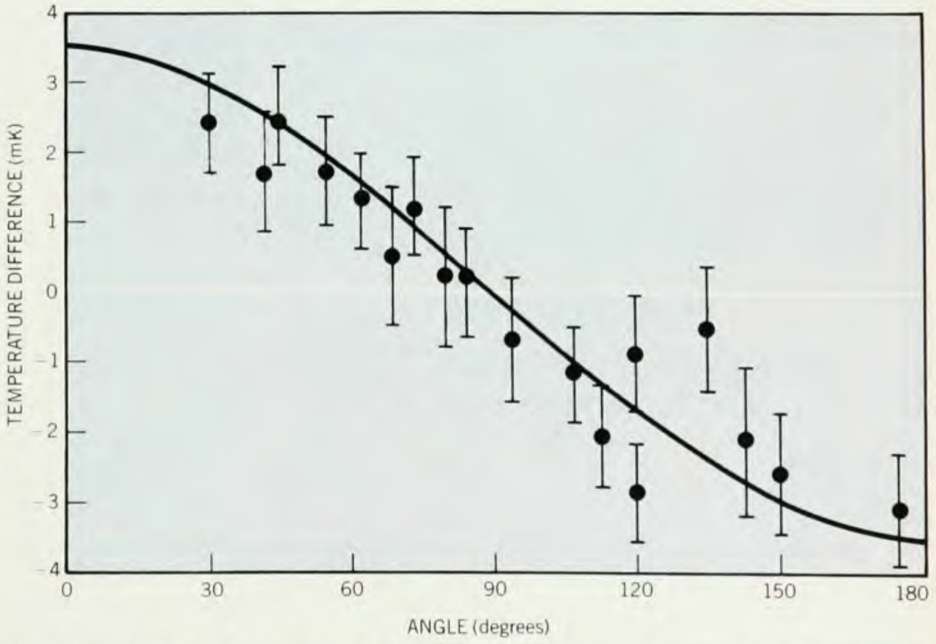


Laser cooling of trapped ions. From the initial temperature of 700 K, the curve shows cooling to a temperature approaching zero kelvins. (From reference 7.) Figure 5

The second curve, shown in figure 2, was obtained in our laboratory by William Blumberg, Larson and Robert Jopson[4] and shows for the first time the effect of the cyclotron final states in the electron photodetachment of a trapped negative ion.

The resonance curve shown in figure 3 is one obtained by Geoffrey Greene[5] and others in our group at Grenoble as we were measuring the magnetic moment of the neutron. The curve was used to obtain our recent much improved value $\mu_n/\mu_p = -0.684\,979\,35\,(17)$ for the neutron magnetic moment and is similar to the curves obtained in our past measurements setting a low limit on the neutron electric dipole moment. The 500-Hz width of the resonance can be contrasted with the 0.04-Hz width of the resonance in figure 4 obtained even more recently with our latest Grenoble apparatus by my colleague Kenneth Smith.[6] In this apparatus the neutrons are trapped for about 20 seconds utilizing the total reflection that occurs for neutrons slower than about 6 meters/sec. This much narrowed width should give a markedly lower limit in the next phase of our measurement on the electric dipole moment of the neutron.

The next curve, figure 5, was obtained at the National Bureau of Standards in Boulder, Colorado by one of my former graduate students, David Wineland and his associates.[7] It demonstrates the laser cooling of electromagnetically trapped ions. The laser is tuned to a value below an optical resonance of the trapped ions but within the Doppler broadened width. Since the energy is then absorbed at less

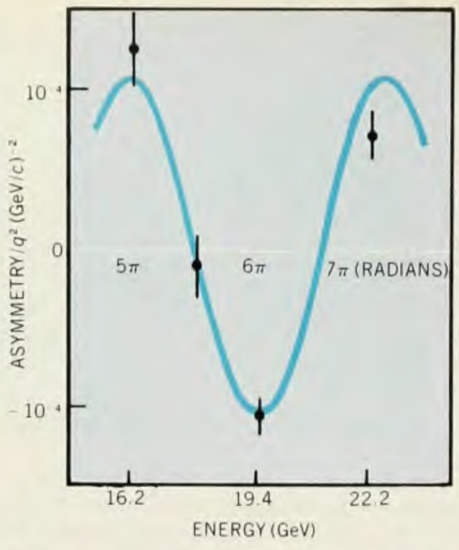


Temperature variation of background 3K radiation as a function of the angle from the maximum temperature (which is in the direction of the constellation Leo). The curve corresponds to a velocity of the Earth toward Leo of 390 ± 60 km/sec. (From reference 8.) Figure 6 than the resonance frequency but emitted on the average at the resonance frequency, the trapped ions (by conservation of energy) lose kinetic energy and are thereby cooled. In figure 5 the cooling is from 700K to below 40K, but there is every reason to hope that with this technique the ions may be cooled to low enough temperatures (much less than 1K) to reduce even the second-order Doppler shifts, which up to now have limited high precision spectroscopy.

Figure 6 is the beautiful curve obtained by George Smoot, Marc Gorenstein and Richard Muller[8] showing the anisotropy of the 3K cosmic black-body radiation left over from the original explosion at the beginning of the universe. From this anisotropy the authors infer that relative to the cosmic background the Earth is moving with a velocity of 390 ± 60 km/sec toward Leo.

My next chosen curve, in figure 7, is a beautiful confirmation from high-energy physics of one of the predictions of the unified gauge theory of weak and electromagnetic interactions. The data was obtained at the Stanford Linear Accelerator by Charles Prescott and a large group of associates.[9] The curve demonstrates parity non-conservation in electron inelastic scattering. Polarized electrons were scattered inelastically from deuterium, and the figure shows the change in the electron scattering asymmetry as the polarization of the electrons is changed. If there were no parity-violating forces there would be no variation in this curve; the amount of variation observed is in excellent accord with the predictions of the standard gauge theory of weak and electromagnetic interactions.

My final curve, shown in figure 8, is that obtained by Leon Lederman[10] and his associates at Fermilab showing the discovery of the upsilon including the confirming results from DESY (DORIS).[11] These curves not only represent a great discovery but they also show how the work of two different laboratories can complement each other. Had the upsilon not been discovered at Fermilab the scientists at DESY would not have pushed their accelerator to a high enough energy limit to detect the upsilon. But with the accurate location of the upsilon peak in the DESY experiment it became even more convincing that the upsilon prime peak in the Fermilab data was real. This encouraged the DESY scientists in turn to push the energy even further to confirm the upsilon prime. Now with these determinations of both the upsilon and upsilon prime masses, the Fermilab curve provides more convincing evidence for a third particle, the upsilon double prime.



Parity non-conservation in electron inelastic scattering. The curve shows an experimental asymmetry in the inelastic scattering of polarized electrons by deuterium and its variation with beam helicity as modified by changing the beam energy. (From reference 9.) Figure 7

In theoretical physics the progress during the past year or so has been dramatic and the prospects for future advances are bright. Through the work of Steven Weinberg, Abdus Salam, Gerard 't Hooft, Sheldon Glashow and others there have been great advances in unifying the theories of electromagnetic and weak forces, and through the developing theories of quantum chromodynamics there is now real hope that a single unified theory may one day encompass the electromagnetic, weak and strong forces and perhaps eventually even the force of gravity.

Experimental and theoretical physics advances such as these convince me that physics will continue as a fruitful and rewarding research field for many years to come. The profession of physics may have serious problems but the science of physics is wonderful.

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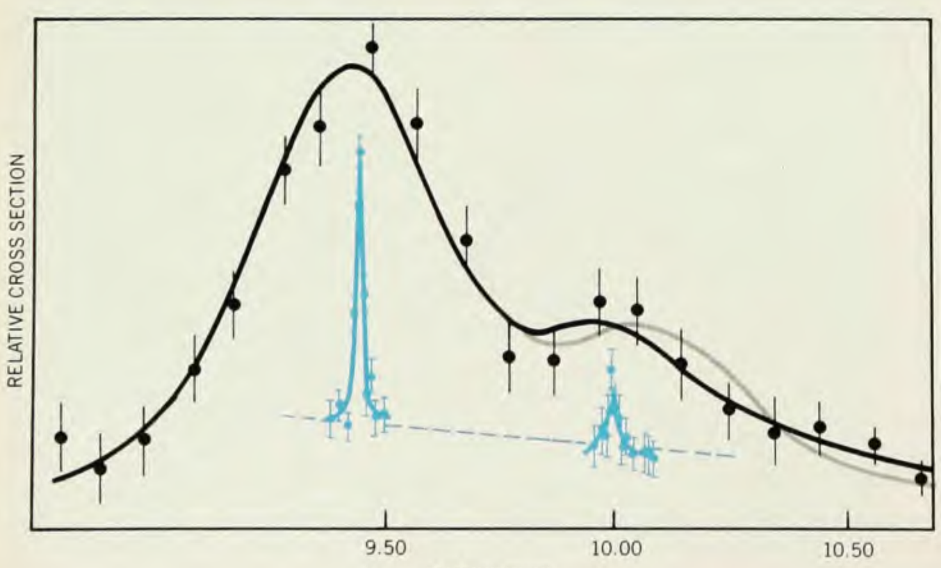
This article is an adaptation of the author's address as the retiring president of the APS, delivered at the joint APS–AAPT meeting in New York, 30 January.



Upsilon and upsilon prime as observed at Fermilab (black data, reference 10) and confirmed at DESY (colored data, from reference 11). The solid curve on the Fermilab data is the result of a numerical fit assuming a third peak at about 10.4 GeV; the gray part of this curve assumes the two lower peaks, at 9.45 GeV (the upsilon) and 10.02 GeV (upsilon prime) only. Figure 8

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