THEIR MOST PRODUCTIVE YEARS: YOUNG PHYSICS FACULTY IN 1990

An APS survey reveals that many of our brightest young physicists are struggling in a research climate that they regard as dismal. A similar survey in 1977 found opposite results.

Roman Czujko, Daniel Kleppner and Stuart A. Rice

We live in a society shaped by science and technology. As our society evolves it will draw more and more upon science and technology to generate economic growth, to improve health and to enhance the quality of life. In order to provide adequate scientific and engineering personnel for our national needs and to sustain the knowledge base from which growth derives, careers in science and engineering must be attractive to our youth.

The generation of young physicists now on the faculties of US universities is a keystone of our scientific future. From this group we can expect many of the important scientific discoveries in the coming decades. These young professors will assume responsibility for training an increasing fraction of our graduate and undergraduate students; their career patterns will have a decisive influence on many students as they make their own career choices. In response to widespread concerns about the availability of support for the research of these young faculty, The American Physical Society undertook a study of their situation.

This article reports on the results of a survey of young physicists on the faculties of the 175 physics-PhD-granting universities in the United States. The 1990 Survey of Young Physics Faculty was initiated by and carried out under the supervision of the Physics Planning Committee of The American Physical Society.[1] The committee was particularly interested in learning how these young faculty fared in starting their research programs and how

Roman Czujko is a member of the staff in the Education and Employment Statistics Division of the American Institute of Physics. **Daniel Kleppner** is the Lester Wolfe Professor of Physics and associate director of the Research Laboratory of Electronics at MIT. **Stuart A. Rice** is the Frank P. Hixon Distinguished Service Professor of Chemistry and dean of the Division of Physical Sciences at the University of Chicago.

Comments by Young Physics Faculty

The following comments were volunteered by young physics faculty in response to an open-ended question about the current climate of research.

"The research is incredibly exciting. The funding situation is dismal."

"I am expected by the university to support graduate students, but NSF says I am too young to supervise graduate students and did not fund that portion of my proposal."

"I have seen the best minds of my generation driven from high-energy theory into mind-numbing jobs, their talents and training (and the public funds which helped pay for that training) gone to waste. How soon before I join them?"

"Being a woman in this business is too tough; in particular, I receive no support as an assistant professor with a baby. If money doesn't come from somewhere soon, I'll have to waitress in the summer."

"I have been quite fortunate with funding. However, most of what I see is bright young people full of ideas and energy, but without sufficient support to utilize all this."

"Grant agencies put young researchers into a Catch-22 situation: They expect a track record, which comes from previous grant support, but for many it is difficult or impossible to get that initial grant!"

"The fundamental aspects of 'basic' research seem to have changed dramatically in the last half-decade. There is the sense that all research worthy of funding must have direct and immediate applications."

"I'm doing fine; I know others are not. I succeeded by (a) collaborating with others, thus getting credibility in areas where I had no track record and (b) emphasizing applied aspects. I don't regret doing either, but some cannot. Funding for basic research is an absolute disaster."

"I was taken in 'under the wing' of an established guy. Without that I wouldn't know what to do."

"It is frustrating to be told by referees that your proposals are brilliant, by grant officers that they will not be funded and by the university that you should be supporting more students."

"One has to spend so much time begging for funding, keeping it flowing and figuring out how to pinch pennies that little time remains to think about research."

"No grant means no tenure. This means being kicked out of academia."

"The funding situation is a disaster. I am hanging on by a thread under an enormous amount of funding-related bureaucracy. And I am aware that I am one of the extraordinarily lucky ones."

"In order to carry out research, I've written a large number of proposals, each of which is for a fairly small amount of money. This takes a huge amount of time."

"Although I listed three grants, only one (Department of Defense) is a 'real' grant with salary support. If this had not materialized, I would not have gotten tenure and would not be here to answer this survey today."

"I do not presently advise young PhDs to go into academic lines. Many good people are withering on the vine due to extremely competitive funding."

they perceived their general opportunities for research in physics. Every faculty member who received his or her PhD degree since 1980 was polled. This group includes the majority of our best young physicists—those scientists who succeeded in winning coveted academic appointments in a period when positions were scarce. In the coming decade, as these young investigators advance professionally and their senior colleagues start to retire at an accelerating rate, they will assume increasing responsibility for this nation's research and advanced education in physics. The research these young scientists are pursuing today is forming the foundation for their careers and the foundation for our national capability in physics in the coming decades.

Our principal finding is that young physicists are experiencing serious difficulties in obtaining research support. For those who submitted proposals to launch their own research programs, only one proposal in three succeeded in attracting funding. Of the successful proposals, only two out of five were funded at the requested amount; the remainder were funded at about half that amount. When asked their view of the support situation, the majority of the young physics faculty characterize it as seriously inadequate. In an attempt to verify whether these concerns are realistic or merely the expression of a desire for essentially unlimited support, the results of this survey were compared with those of a similar survey in 1977. In both surveys the vast majority of young physicists reported that they felt they had made the right career choice in pursuing physics. However, the change in attitude about research support is striking: In 1977 two-thirds of the young physicists felt that support was adequate; today the same proportion say it is seriously *in*adequate. Written comments from the young physicists reinforce the picture of a system in disarray. (See the box on this page for a representative sampling of comments.)

In the sections below we describe the procedure of the survey and summarize the results; more detailed analyses of the survey are available upon request.[2] We have not formulated recommendations, nor have we drawn conclusions. Nevertheless, we believe that the findings of the survey demonstrate a critical need for reassessing our national goals in the sciences.

How the survey was carried out

The Education and Employment Statistics Division of the American Institute of Physics assisted in developing the questionnaire and designing the research and was responsible for data entry and analysis.

The primary source for the population of young

Table 1. Academic rank of young physics faculty by years since PhD, 1990

Rank	Years since PhD 1–2	3–4	5–6	7–8	9–10	Overall
Assoc. or full prof.	0%	0%	5%	24%	56%	22%
Assistant prof.	79	87	83	66	36	67
Research faculty	21	9	8	8	5	8
Other ranks	0	4	4	2	3	3
Number of respondents	19	123	186	165	174	667

Table 2. Dissertation subfields of young physics faculty, 1990

Dissertation subfield	Percentage of young faculty
Condensed matter physics*	35
Elementary particles	20
Nuclear physics	10
Atomic, molecular and optical physics	10
Astrophysics	8
Astronomy	4
Plasma physics	3
Other subfields	10
Total	100%
Number indicating subfield	584
Number not indicating subfield	83

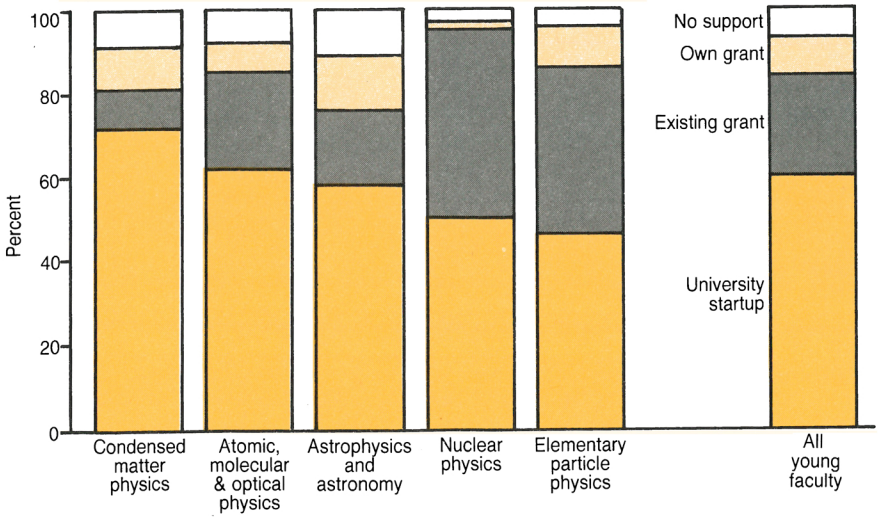
*Condensed matter includes surface science and low-temperature physics.

physics faculty was the 1989–90 *Graduate Programs Book* published by AIP, augmented by the *Directory of Physics and Astronomy Staff*. In addition, all 175 US physics departments were called to confirm that we had included every person on the faculty who had received a PhD degree in 1980 or later. Researchers holding postdoctoral appointments were not included in the survey. In total, 939 young faculty were identified and sent a four-page questionnaire designed to gather information on their work histories and efforts to secure research funding. Those surveyed were asked in particular about their first source of research support after receiving the PhD and what process they had used to secure startup support. An important element of the survey was a set of eight questions on job satisfaction and career direction that were similar to questions in a survey[3] carried out by APS and AIP in 1976–77.

The young physics faculty were mailed the questionnaire in the spring of the 1989–90 academic year. Two additional mailings and a telephone follow-up were needed to identify and contact every faculty member. In the end 667 of the young faculty—71%—returned usable questionnaires. Such a response rate is unusually high, reflecting the level of concern of the young physics faculty with the issues covered in the questionnaire.

Who the young faculty are

The first two tables provide a general description of the young physics faculty and where they work. Table 1 shows their academic rank as a function of the number of years since they received their doctorates. Although this table provides a snapshot at one particular time, one can see evidence of the typical academic career pattern. Academic physicists usually begin their careers as postdoctoral researchers; consequently, only a small number of those surveyed have had their doctorates for two years or less. Most young faculty start their careers as assistant professors. After four to six years, those who survive in academia are often promoted to associate professor. Thus the majority of those with nine or more years of experience are associate or full professors.



Research startup funds for young physics faculty came primarily from universities or existing grants. Only 9% managed to get their own grants, and 7% never received any funding. **Figure 1**

Table 2 provides a breakdown of the young faculty by their dissertation subfields. The distribution of subfields resembles the distribution for physicists of all ages on our university faculties,[4] with two exceptions: There are more condensed matter physicists and fewer plasma physicists among the young faculty.

Where they get their first support

Careers of young scientists are fundamentally affected by their initial success in obtaining funding. As shown in figure 1, the first source of research support for the majority of the young investigators (60%) was university startup funds. Physicists supported in this manner received on average approximately two-thirds of the amount needed to start their research programs. Most of the others got started on a group grant or by working under an existing grant. Only 9% were first supported as principal investigators on their own grants, and most faculty in this group required four or more years to obtain their first support. About 7% of the young physics faculty had never received research support.

Experimentalists were more likely than theorists to have received university startup support—65% versus 54%—and theorists were twice as likely as experimentalists to be among the "never supported" group—11% versus 5%.

Table 3. Startup proposals submitted by young physics faculty, 1990

Dissertation subfield	Submitted no proposals (%)	Average number submitted*	Average number funded*	Success rate (%)
Elementary particles	41	2.0	1.1	55
Nuclear physics	50	2.0	1.0	53
Astronomy and astrophysics	18	4.3	2.2	51
Atomic, molecular and optical	20	4.2	1.6	38
Condensed matter	15	5.2	1.3	25
All respondents	26	4.0	1.4	36

*Among those young faculty who submitted one or more proposals.

Table 4. Opinions of young physics faculty on career direction and job satisfaction, 1990

	Strongly agree (1)	Agree (2)	Neutral (3)	Disagree (4)	Strongly disagree (5)	Average rating
My present position is professionally challenging	66%	25%	5%	3%	1%	1.5
I would recommend physics as a field of study for a bright young person	41	37	15	5	2	1.9
My career has gone pretty much in the direction I intended	30	45	17	6	2	2.0
Arriving at where I am today has been much more difficult than I had anticipated	13	23	32	24	8	2.9
The job market after I received my PhD was worse than I had anticipated	14	17	25	29	15	3.1
Research support for young faculty is generally adequate for establishing a research track record	2	9	20	32	37	3.9
If I had to do it over again, I would go into a different subfield of physics	3	8	14	31	44	4.1
If I had to do it over again, I would go into an area other than physics	3	7	12	27	51	4.2

Table 5. Opinions of young physics faculty, 1977 and 1990

	Strongly agree (1)	Agree (2)	Neutral (3)	Disagree (4)	Strongly disagree (5)	Average rating
Research funding is adequate						
1977	22%	41%	14%	12%	11%	2.5
1990	2	9	20	32	37	3.9
Job market was worse than expected						
1977	34	27	8	9	22	2.6
1990	14	17	25	29	15	3.1
Arriving at where I am today has been much more difficult than I had anticipated						
1977	13	18	24	26	19	3.2
1990	13	23	32	24	8	2.9
Position professionally challenging						
1977	58	30	8	5	0	1.6
1990	66	25	5	3	1	1.5
Career has gone in intended direction						
1977	40	37	13	7	3	2.0
1990	30	45	17	6	2	2.0
Would recommend physics						
1977	38	24	21	10	7	2.2
1990	41	37	15	5	2	1.9
Would *not* choose physics again						
1977	4	15	24	25	32	3.7
1990	3	7	12	27	51	4.2
Would *not* choose same subfield again						
1977	1	10	21	22	46	4.0
1990	3	8	14	31	44	4.1

Young physicists in elementary-particle physics and nuclear physics were twice as likely as other young physics faculty to have started their careers on a group grant or someone else's grant, and were the least likely to have received university startup support (47% and 50% of them, respectively, had gotten such funding). Young physicists in condensed matter physics were the most likely to have received university startup funds: 72% had gotten their first support in this way.

Three-quarters of all the young physics faculty members had submitted at least one startup grant proposal; on average, the members of this group had submitted four proposals. Of these four proposals, 1.4 were funded on average. Of the funded proposals, 40% were funded at the requested amount, while the remainder were funded at about half the request. Thirty-seven percent of the young physicists who submitted proposals failed to obtain any startup funds after submitting three proposals.

It should be emphasized that these numbers represent averages. As shown in table 3, large variations exist among subfields in the numbers and success rates of startup proposals. Young physicists in nuclear physics and elementary-particle physics submitted the fewest startup proposals—50% of the nuclear physicists and 41% of the particle physicists had submitted no proposals—but those who did seek funding submitted two proposals on average, with a success rate of better than 50%. Those young physics faculty in condensed matter physics, astrophysics, and atomic, molecular and optical physics who did submit proposals submitted an average of more than four, but the success rates for these investigators varied substantially by discipline. Condensed matter physicists, with a success rate of only 25%, seemed to have the most difficult time getting startup grants.

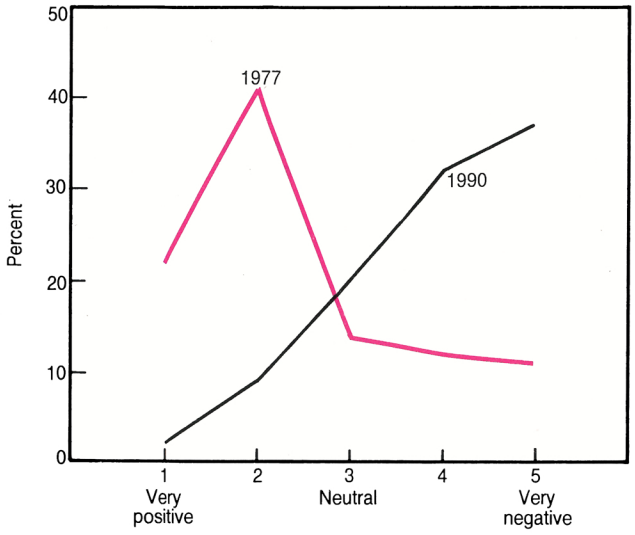
All the young physics faculty members who got funding—whether a startup or continuing grant—were asked where that funding came from. The National Science Foundation was the dominant external source of support, cited by 49% of the respondents. The Department of Energy was the second largest source of external funding, cited by 23%. The Department of Defense and NASA were also mentioned, by 14% and 13% of the respondents, respectively. Other sources included Sloan Fellowships, the Petroleum Research Fund administered by the American Chemical Society and grants from local industries, typically for equipment.

How they feel about their careers

To assess how young physics faculty feel about their careers, we asked them to respond to a set of statements covering satisfaction with physics as a career choice and perceptions of career directions, the job market and availability of funding. Table 4 presents the exact wording of these statements and tallies the responses.

As a group the young physicists say that their positions are professionally challenging, that their careers have gone pretty much in the direction they had intended and that they would recommend physics as a field for a bright young person. Few of the respondents say that if they had to do it over again they would go into a different subfield of physics (11%) or an area other than physics (10%).

The opinions, however, are not uniformly positive. In particular, there was a very strong negative response to the statement "Research support for young faculty is



Is research funding adequate? Yes, said young physics faculty in 1977. By contrast, young physicists in 1990 feel that the research support available to them is grossly *in*adequate. **Figure 2**

generally adequate for establishing a research track record." Fully 69% of the young physics faculty disagree with this statement, while only 11% agree. Because "establishing a track record" is synonymous with advancing professionally, such a response indicates a serious problem. The extent of the problem is suggested by the written comments from the young faculty (see the box on page 38).

To provide a baseline against which to evaluate the opinions of the young physics faculty, the responses were compared with those elicited from a similar group of young faculty in 1976–77. The results are shown in table 5. On six of the eight items, the two groups responded almost identically. But on two issues—the job market and availability of funding—they differed significantly.

The young faculty of 1977, many of whom had experienced firsthand the tight job market of the early 1970s, found the job market worse than they had expected. By comparison, the young faculty of 1990 report that the job market was about what they had expected.

The most dramatic difference in the opinions expressed by the two sets of faculty was on the availability of research support (see figure 2). In 1977 the young faculty had a generally positive view of the availability of support: Nearly two-thirds classified the research funding as satisfactory or very satisfactory. The 1990 results, on the other hand, reveal deep dissatisfaction: Over two-thirds disagree or strongly disagree with the notion that there is enough research funding. It should be emphasized that the questions asked in 1977 and 1990 were almost identical. The dramatic difference in response reveals a major change for the worse in the research climate.

What they have to say

The final question in the survey was an open-ended request for comments. Such open-ended questions are often included in surveys to allow the respondents to explain unusual circumstances or to give detailed comments; usually only a small fraction of respondents offer such comments. In the young physics faculty survey, the response was unusually high: Approximately 45% of the respondents offered their comments. Among condensed matter theorists, over 60% commented on the state of research funding.

The comments reveal a strong sense of frustration and dismay. A number of the physicists refer to the state of funding as "abysmal" or "disastrous." Even the comments from those who have succeeded in winning support strike a disquieting note: Quite a few refer to being "lucky" either in getting funding or in having found a mentor with a strong track record—as if these were random processes. These comments are particularly telling, coming as they do from a group of young investigators who were able to secure faculty positions in research departments during a time when competition for positions was fierce. A selection of their comments is presented in the box.

Several suggestions for APS recur in the comments. Many of the young faculty ask APS to serve as a conduit for information on how to obtain research support, for example, by publishing a booklet on sources and contacts within agencies, along with advice on how they should be approached, and by holding seminars on funding at society meetings. Others suggest developing a system that provides a more consistent and less onerous source of startup funds.

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References

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