

Henriette Faraggi, president-elect of the French Physical Society, says you need an understanding husband to help your career.



Women in physics

Do we really need more women in physics?
If so, what are their special problems, and what
can society do to help them?

Gloria B. Lubkin

Women physicists are a rare breed, but most of us agree that we need more of them. They have many problems in common with other professional women, but some are peculiar to physics. Many would like to work part time while raising families. Some feel that the system should have a bias built in to help women get into science and stay there. Others caution against lowering our standards. How do we provide models for young girls to identify with? Is the situation different abroad? Can the federal government help? Can genuine discrimination be observed?

These and many other topics were addressed at a lively panel discussion held at the New York American Physical Society meeting on 3 February. It was standing room only as 600 men and women participated in the session. The panel discussion was moderated by Fay Ajzenberg-Selove (University of Pennsylvania). With me on the panel

were Charles Townes (University of California at Berkeley), Enid Sichel (Rutgers University), Betsy Ancker-Johnson (Boeing Scientific Research Laboratories and University of Washington), Chien-Shiung Wu (Columbia University), D. Allan Bromley (Yale University) and Henriette Faraggi (Saclay). After the panel's formal presentations, comments flew thick and fast among the audience and the panel.

Need for women

Why do we need women in physics? The reasons are many. Ajzenberg-Selove said, "I believe that most of us want for everyone, of whatever race, religion or sex, a full flowering of each individual's personality and attainment to the limit of that person's ability and commitment." She also quoted Wu as saying, "If in this human society, women are endowed with just as much intellectual capability as men, why then should they be deprived of such aspiration and fulfillment? Why should they not share the responsibilities of the progress of science with men?"

Townes observed that physics should have as large a group of talented people as possible to choose from. "We find in physics a very wide variety of personalities and approaches to physics that are successful." Physics has a multitude of types of problems, and its people have a variety of styles, attitudes and approaches that have been very successful and serve to complement each other. "We need this variety badly," Townes concluded.

Wu queried, "Would there be beneficial effects to society as well as to science if more women were encouraged to go into sciences? Men have always dominated the fields of science and technology. Look what an environmental mess we are in. They have brought us to the gigantic brink of environmental ruin. The air is polluted; lakes, rivers, seas and oceans are contaminated. Women's vision and humane concern may be exactly what is needed in our society. If there were more women like Rachel Carson to warn us of chemical pollution, Dr Alice Hamilton to call attention to occupational

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health hazards and more women like the young woman doctor who helped to safeguard us from drugs like thalidomide, the world would be a more pleasant and safer place in which to live."

How many women?

The number of physicists who happen to be women is small indeed. In the 1970 National Register of Scientific and Technical Personnel there are 36 300 physicists, of which 1354 are women; that is, 3.7% of the physicists are women. The percentage has remained roughly 3% since 1956.

In 1969 women received 5.3% of the master's degrees and 2.5% of the doctorates. The trend in women's doctorates is upwards, but not very fast; in 1961 women earned 1.1% of the doctorates. But the numbers are so small that each woman PhD is significant—in 1961 six women received the PhD, and in 1969, 33.

The typical woman physicist has only a master's; the typical male physicist has a doctorate. In 1968 there were 290 women with PhD's, 519 with master's and 343 with bachelor's degrees, for a total of 1156 women.

If a girl is interested in science, she generally doesn't turn to physics. Of all the women in the natural and mathematical sciences who are listed in the 1968 National Register, 8% are in physics (see table).

Such a small group of physicists clearly doesn't have much influence, I told the meeting. "Just look at the salary recognition they receive." Their median annual salary in 1970 was \$12 000. The median annual salary for men that year was \$16 000. That is, women earned only 75% as much as men. Although it may appear that the salary disparity occurs because so many more men have the PhD, proportionately, in 1968 women PhD's earned 75% as much as men PhD's, and the same percentage applied to the master's and bachelor's levels as well. "Does that mean a woman is worth only three-quarters as much as a man?"

I said, "I think the answer is 'No.' To get as far as she has, a woman physicist must probably be better than the men physicists she meets along the way.

Women in Natural and Mathematical Sciences

Field	Percentage
Chemistry	39
Mathematics and statistics	21
Biology	26
Earth sciences and meteorology	6
Physics	8
Total women	100

A girl has to have an unusually strong motivation to become a physicist." And she encounters prejudice all along the road. Ancker-Johnson agreed: "A woman in physics needs to be at least twice as determined as a man with the same competence to achieve as much."

Discrimination indicators

What kind of evidence for discrimination exists? Consider the 15 leading physics departments in the US as determined by the recent survey of the American Council on Education. The number of physicists with the rank of assistant professor or higher (not counting those who are adjunct professors, lecturers or research professors) is 760 men and six women. A similar count for all the physics departments in the

women constitute two or three per cent of the total graduate-student group. In the Berkeley zoology department, on the other hand, about one-third of the graduate students are women and more than 80% of the full-time research assistants for professors are women. "In a sense the women have been very successful in zoology. They're doing important research. But there are no professors."

Problems peculiar to physics

Although women physicists share many difficulties with other women professionals, some problems are peculiar to physics, Ajzenberg-Selove said. The field has moved very fast so that under the old approach it was very difficult for a woman to get a degree, leave the field completely for a few



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nation would show a larger proportion of women. "But the really top ranking departments have hardly any women at all," I said. Ajzenberg-Selove feels that one could easily double or triple the number of women in these departments, without lowering the quality.

One mark of achievement is to be a fellow of the APS. Ten percent of the APS membership are fellows, but only 0.8% of the fellows are women (even though 3.7% of the physicists are women). In the National Academy of Sciences there are 107 male physicists and two female physicists. For all fields of science there are 855 men and eight women.

Citing the Berkeley physics department as an example, Townes said that it has ten women graduate students, four postdoctorates and no professors;

years while raising a family and then to start again at a professional level, she said. Physics has always had very few women; so girls have not had enough models to observe. The field has had an aura of being composed entirely of brilliant people; so women, restrained by society from appearing to be very bright, have been reluctant to attempt joining the top elite of the scientists. Physics requires either a very good understanding of experimental techniques (generally not part of a girl's early education) or great ability to think abstractly (and there are few very good abstract thinkers, male or female). Physics often requires the ability and interest to lead people. "And a male-dominated society frowns on women who display the kinds of initiative, strength and pleasure in competition

which is, to a first approximation, involved in leading groups," she said.

It is in some cases tougher for a woman to get into graduate school, Sichel said, and I noted that it is probably tougher for her to get financial support, too. Once there, Ancker-Johnson said, she will encounter certain conceited men (fortunately a minority) who think she is there because she is husband hunting. Another problem she noted is that "I was never involved in the informal study groups that students spontaneously form and find so very helpful in the learning process. By the time I made friends with fellow students who accepted me for what I was, another student, I was past that stage. Being so completely alone during the early days was excruciatingly difficult; I doubt if many in the majority can

the earliest stages of life, it was generally agreed. In the discussion Walter Michels (Bryn Mawr) noted that early childhood training often handicaps girls with electrical circuits, motors and so on. In his experience, however, this is only a temporary handicap. Gideon Hirsch, a high-school science teacher, created a furore by saying that girls are not good in mechanics; so one should perhaps emphasize other topics in physics, such as optics.

In elementary and secondary schools young girls need real models of what they might aspire to, Bromley noted. I remarked that as a young girl I was greatly inspired by Madame Curie, but never met a real woman physicist until I went to graduate school. Valentine Telegdi (University of Chicago) said that he thinks the image of Madame

years after Pierre's death."

Bromley pointed out that other women have also been great contributors to science, such as Ada Augusta Lovelace (Lord Byron's daughter), who made major initial contributions to computing, in collaboration with Charles Babbage. He feels that more research on such women should be done, and the information made available to young people.

Sichel noted that until recently it was generally believed that a woman had to be superhumanly energetic to combine the responsibilities of a career and a family. "Admiring interviews in newspapers and magazines suggested that every successful woman scientist had five lovely children, was a terrific cook and housekeeper and had a myriad of other talents. In fact, this may be true, but it certainly discourages most women from seeking an active scientific career." Many younger women tend to reject the "superwoman" ideal, she said.

One reason for adding women to university faculties is to solve the problem of shrinking departments, according to Ajzenberg-Selove. These women would tend to attract women students into taking physics courses.

Girl students are particularly in need of good counseling. Bromley quoted studies showing that 75% of the physicists had made their decision to become physicists at an early stage of secondary education or earlier. Michels remarked that high-school and college counselors are likely to be drawn from the non-scientific, even antiscientific group of the country. He feels that if some of the women with interest in the sciences could exert more influence in the counseling of girls, it would be very effective.

Attitudes abroad

Are attitudes about women scientists different abroad? Faraggi, who is the new president-elect of the French Physical Society, said she thinks that there are more women at work in laboratories in France and perhaps all Europe than in the US. She believes this is because of the easier availability of people to care for children. Although there are a large number of women scientists in French research laboratories, they are not numerous nor in positions of responsibility in industry.

Townes commented that among the eight women members of the National Academy, five were educated at least to college level, in countries abroad. "It's very clear that somehow countries abroad are doing a substantially better job than we are in the US."

Wu noted that "even in the USSR where the frequent official boast is that women have equality under Communism, women grumble these days about



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understand the magnitude of this problem. The solution is so simple: treat them all alike. Then superficial, unimportant differences don't exist, whereas the inherent individuality of each flourishes."

The worst prejudice Ancker-Johnson encountered was in job hunting, she said. Although many openings existed then, the jobs she was offered were second rate. "Those of you who have recently obtained your PhD or been laid off and can't find suitable jobs understand something of my frustration. Except I wasn't being treated like everyone else in my set. I was in a special subset that employers had decided was not dependable: a woman will marry and what is invested in her goes down the drain."

Woman's role is defined for her from

Curie is overdone. "If I had been married to Pierre Curie, I would have been Madame Curie, too." He went on to suggest that the image of an inspired high-school science teacher might be less romantic, but in actuality be a greater inspiration than Madame Curie.

Replying to Telegdi, Wu said, "Pierre Curie's genius was known to all of us through his original work before their collaboration. But Marie Curie's genius and perseverance were undeniable in her first discovery, which was a brilliant success. It seems that many people do not know that it was Marie Curie's husband who left his own research to join his wife in hers, rather than vice versa. Furthermore, Marie Curie, after the death of Pierre Curie, unflinchingly carried on their work and was awarded a second Nobel prize five

male chauvinism, job discrimination and lack of concern by Soviet authorities. In an interview published in a recent issue of *The New York Times*, a middle-aged woman was quoted saying, "The revolution freed us, so that we can work harder than men."

Part-time versus full-time

Should there be more opportunities for part-time work? Bromley thinks so, although with reservations. "There're certain things one can't do as well part time," such as supervision. On the average it will be more difficult to compete for advancement, he feels. Part-time work should be available to men, too. "If we're really going to do much about mid-career retraining, one way of doing it is making part-time employment possible for both men and women. Then any possible stigma would be diluted."

Wu was very dubious on the question of whether or not part-time employment or retraining programs could work in physics. She considers these devices only temporary remedies that are more or less false panaceas, allowing one to avoid a more basic social readjustment. Ancker-Johnson said that part-time jobs have a place, but they should not be used as a way to relegate women to second-class positions.

Townes believes in a wide variety of career patterns for women, pointing out that men have similar problems. "For example, a person doing administration has much the same kind of problem as the woman temporarily taking care of her family." Such a man is taken out of direct personal research to a considerable extent. Townes has always insisted that along with his administrative duties he be allowed one day each week in which to do physics. "I think this helps a great deal in maintaining oneself at least partially alive as a physicist."

He noted that years ago at Bell Telephone Laboratories men who were hired at the bachelor's level in the 1920's and early 1930's were encouraged to continue their education on a part-time basis and gradually get their PhD's over a period of ten or 15 years. Some of these men have been outstanding leaders at Bell. Townes feels we must allow this and other flexible types of approaches for everybody.

"What is full time; what is part time?" Conyers Herring (Bell Labs) asked. "A great many physicists I know put in a 60-hour week. I happen to put in a 40-hour week." He noted that he had other interests, such as his children. He feels that society should provide opportunities for those women who want to spend time with their children when they are small to keep in intellectual contact with their field. "I have known women who have been

out of regular employment for a number of years and have gone back to a high level in their professional productivity."

"One of the hardest things in physics is the time rate of change of the field," Bromley observed. "It does mean that loss of time in physics, interruption, can have rather serious consequences. Attainment of success in any profession inevitably comes as a result of a highly competitive selection process; in general those who succeed most notably are those in a position to devote themselves to the profession for essentially 24 hours a day with single-minded aplomb."

Faraggi believes that you can go back to physics after a few years—she did it herself. "I discovered that coming back to physics after a gap of ten years, before the war and after the war, things

When times get hard and jobs get tight, as they are now, I said, women scientists are hit harder than men. The 1970 National Register contained 125 000 PhD scientists, of whom 1160 were unemployed. Among the unemployed PhD's 20% were women, even though the register has only 9%.

Employment opportunities

One factor affecting future employment for women is Executive Orders 11246 and 11375 and the subsequent legal actions instituted by the Women's Equity Action League (WEAL). (Copies of the hearings before the special Sub-Committee on Education, headed by Congresswoman Edith Green, on "Discrimination Against Women" are available by writing to one's own congressman.) These two executive



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were completely different, and I had to start over from the lowest level. But I was able to learn a little more quickly than the young people." She feels that the part-time job is not a good idea because it keeps one at a low level, that the better approach is to "Wait a few years and then come back. If you come back full time with a fresh spirit, you will do better."

Townes agreed that it's not impossible for a person in later life, say age 35, "to get back into science after a break. We generally say that after you stop for a while, one loses out. That's true, but there's no real reason that I can see why a person at 35 can not act like a student, take three years of courses if necessary to learn physics again, catch up on things they have not known, and perhaps be more perceptive than at 24."

orders forbid discrimination by all federal contractors because of race, color, religion, national origin—and sex. The orders are being applied to many universities, which are now being required, if they are to receive federal funds, to take affirmative action wherever necessary to remedy the effects of past discrimination and to counteract discriminatory barriers to equal opportunity for employment.

At the APS business meeting, Deborah Wallace (Columbia) announced, the council was asked to consider the following resolution: "That the APS charge its members with the duty of racial and sexual integration of their institutions, that the APS file an *amicus curiae* to support WEAL's suit in federal court to bar federal funds from institutions found to discriminate against women in hiring, promotion or

salary, that a committee to set up to research and publish the facts about the problems in graduate students and employment of women and nonwhites."

Do we need a bias?

The federal government can play a very powerful role in establishing an incentive structure, Paul Donovan (National Science Foundation) noted. He pointed to the NSF program to improve science curricula at black colleges as an example of the kind of swift and direct action that can be taken. He then asked Bromley if he would favor building a bias into the research-grant structure. Bromley is opposed to such a bias, he said, feeling that changing the standards of the profession would unloose a whole new set of problems. "I fully believe that women

in the past, Brian Schwartz (MIT) said; so there will be much fewer opportunities for women. He suggested a way of opening jobs to everybody: by eliminating tenure. Then if a woman were available who was better than the man in an existing post, he would be bumped by the woman. Another possibility, he said, is early retirement for men.

In the present poor job market, Sichel noted, anyone who is not extremely mobile will have difficulties. And married women generally do not choose the location in which they live. Another problem is the nepotism regulations at many universities, which prevent husbands and wives from working in the same department or school. Bromley suggested that the question of mobility can be beaten if we have husband and wife teams.

their chosen field? Why shouldn't educational institutions lead the nation in such bold social improvements?" She said that husbands need to be "man enough to respect their wives' interests and considerate enough to willingly lighten the burdens and cares of their wives. The social scientists and psychiatrists tell us that the most balanced and normal rearing of children is under the parental care of both father and mother, yet no assertion was ever made that men should make more room in their lives for the responsibilities of fatherhood so that the mother could also have time to devote to her interest. Why shouldn't husbands and wives share the work as well as the parental joy? However, I must say male physicists seem to make very good husbands. There are no lack of good examples."

Faraggi remarked, "You must be lucky to have a good husband who is able to understand and help you, even with the children. And let you go and spend the night at the machine. If this is not achieved, I don't think you can do good work."

Ancker-Johnson over the years has employed young German girls to join her family for two-year periods. "Without the assurance that my children were being competently and lovingly cared for in my absence from home, sometimes weeks at a time, I could never have had an untroubled mind to explore the ways of my friends, the electrons. Alas, this method of child care is no longer possible because of a new immigration law. I have no idea how I would solve the child-care problem if I still had pre-schoolers. In my opinion this is the single most difficult barrier to serious careers for women. No one should ever be put in the position of having to choose between children and career."

Ajzenberg-Selove said that she feels the present child-care deductions permitted by the Federal Government are scandalous. At most you can deduct \$600 per year for one child and \$900 per year for two or more. The deduction is allowable only if the woman's salary is less than \$6600 per year or if the total salary of husband and wife is less than \$6900 per year. She feels that the government should at least double the child-care deduction and increase the income level to a reasonable amount.

In adjourning the session Ajzenberg-Selove said, "We mustn't forget the fact that physics is beautiful, that it's a great privilege to be a physicist. And now we can get back to work in the laboratories and do some physics again. Of course we should also do some pushing to ensure that more women will be able to share the interesting lives we lead." □



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will be prepared to compete on any grounds we care to name."

Townes remarked that we already have many biases in the system, such as helping small colleges and initiating programs in some universities to seed a substantial effort. He would favor seeing that science programs are well established in those schools that train many women. But he opposes the kind of bias where one adds three points extra to a proposal because Professor X is a woman.

Erwin Marquit (University of Minnesota) said that it isn't enough to admit guilt in the past and say we won't do it anymore. "This question has arisen with blacks, and we do accept the fact that society has to at least appropriate funds to make amends."

A system has been developed that will no longer be expanding as it has

Raising a family

Ancker-Johnson reminisced about the prejudice she encountered during her pregnancies. "Having my first baby as an industrial research physicist was unnecessarily unpleasant. I was interviewed by half a dozen executives and told, perhaps in jest, that the decision to lay me off over my protest went all the way to the Board of Directors. I wasn't even allowed to enter the building for three months before the birth to hear a talk or get a book out of my private collection without special permission of the lab director."

Once they are born, who cares for the children? Wu said, "Is it too much to provide excellent professional child-care centers during the day so that mothers can get away from the monotonous household chores and work in