

Report Of The Committee On The Status Of Women American Astronomical Society

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Abstract

In accordance with its charge by the Council of the American Astronomical Society, the Committee reports on the status of women in astronomy and recommends steps for the Council to take that might improve this status. Of Society members, 8.2% are women. The status of women has changed very little since 1973. Although women are employed in proportion to their numbers, they are poorly represented in the highest-ranking jobs. On the average, women earn \$3500 less than men; the difference persists when salaries are compared within ranks. The difference is much smaller, however, if only unmarried women are considered. This comparison is only one indication that job-related problems are significant for married women astronomers. In current statistics on hiring, we find no evidence for reverse discrimination. The recognition of women's research productivity in areas other than employment has improved since 1973. Among women graduate students the attrition rate is apparently greater than among men. The major recommendations are that the Council pass resolutions on equal opportunity and on flexibility in hiring, and that the Council authorize the appointment of a standing Committee on the Status of Women.

I. INTRODUCTION

At the 152nd meeting of the American Astronomical Society in Madison, Wisconsin (June 1978), the Council voted to establish an *ad hoc* Committee on the Status of Women in Astronomy. This committee was charged with two tasks: (1) to update the Report to the Council of the AAS from the Working Group on the Status of Women in Astronomy—1973 (Cowley *et al.* 1974) and (2) to recommend to the Council specific actions that the AAS can take to improve the status of women in astronomy. The Executive Committee of the Council of the AAS appointed a five-member committee (three women and two men) and asked for a report in approximately one year's time. The following is our report.

The data used below have come from many sources, among which are: a questionnaire sent in December 1978 to all AAS members; AAS membership lists; employers listing job openings with the AAS; graduate departments of astronomy; editors of the major journals; directors of national observational facilities; Status of Women committees of other scientific societies; and 1977–1978 AIP Directory of Physics and Astronomy Staff Members (1977). Many of the following data came from the AAS questionnaire. From the approximately 3600 members, we received 1181 (33%) replies. Of the 1156 replies with sex specified, 8.6% were from women, a figure almost identical with the percentage (8.2%) of AAS members who are women. Of the respondents who are not graduate students, 89% hold the doctorate as their highest degree, 8% a master's, and 3% a bachelor's degree. Graduate students comprised 8% of the sample; however, of the women, 12.1% were graduate students as opposed to 7.6% of the men. When necessary, we will use data from the questionnaire in the absence of more complete information. Wherever possible, we will compare the current data with those from 1973, in order to determine whether the status of women in astronomy is improving.

The organization of our report is the same as that of the 1973 report. Section II concerns the American Astronomical Society and the International Astronomical Union. Section III discusses employment, including mobility, job satisfaction, and "reverse discrimination." Section IV deals with research-related matters, such as publication frequency and assignment of telescope time. Section V discusses graduate study, and Sec.

VI presents our conclusions and recommendations to the Council.

II. AMERICAN ASTRONOMICAL SOCIETY AND INTERNATIONAL ASTRONOMICAL UNION

From a count of members of the Society as listed in the Directory for 1979, we find that 8.2% of the members are women. This value is slightly greater than the 7.9% of 1972; possibly the fraction of astronomers who are women has begun to recover from its long decline from a maximum of about 17% in the early 1940's. The reason for the decline may have been related to larger cultural changes in the status of women. It was probably also partly due to the influx into the AAS of scientists from other disciplines, especially physics, in which there are even fewer women than in astronomy. Of the respondents to the AAS questionnaire, 92% of the women call themselves astronomers or astrophysicists (as primarily opposed to physicists) compared to only 77% of the men.

The age profile of the society as reflected in the information from the questionnaires largely contradicts the conventional wisdom that women astronomers are, on the average, younger than men. The median age for men is 36 and for women, 35.

TABLE I(a). Percentage of men and of women who received Ph.D.'s in given interval.^a

| Year | Men | Women |
|-----------|-----|-------|
| 1920–1929 | 1 | 1 |
| 1930–1939 | 2 | 2 |
| 1940–1949 | 2 | 7 |
| 1950–1959 | 11 | 11 |
| 1960–1969 | 34 | 29 |
| 1970–1979 | 50 | 50 |
| Totals | 100 | 100 |

^aData from AAS questionnaire. Sample: 843 men, 71 women.

TABLE I(b). Percentage of women as AAS officers, prize winners, invited speakers, and members.

| | | % who are women | | % who are women | |
|----------------------------|-------------|-----------------|--------------------|-----------------|---------|
| | | % | (No.) | % | (No.) |
| Officers elected | before 1973 | 6 | (16) | 1973 and after | 17 (6) |
| Prize winners ^a | before 1973 | 1 | (0.5) ^b | 1973 and after | 7 (1) |
| Invited papers | before 1973 | 1 | (1) | 1973 and after | 5 (4) |
| Membership | 1972 | 8 | (220) | 1979 | 8 (298) |

^aExcluding Cannon award, which is restricted to women.^bPrize was shared by G. and M. Burbidge in 1959.

Women are better represented among graduate students than among those with Ph.D.'s (see Sec. V), and fewer of the women respondents to the questionnaire have a Ph.D.: 82.8%, as opposed to 89.7% of the men.

Among those with Ph.D.'s, however, the age distributions are similar. Table I(a) shows the percentage of men and women AAS members with Ph.D.'s who earned their degrees during the time interval given. All that distinguishes women from men is a downward fluctuation during the 1960's and an upward one during World War II.

Table I(b) updates the statistics on women as officers, prize winners, and invited speakers for the AAS. Women are now well represented as officers in the Society, but have still only received 1.5% of the prizes (except for the Cannon award) and are still under-represented among the invited speakers at meetings.

The United States members of the International Astronomical Union number 1105, of which 63 (5.7%) are women. Out of the 299 accepted from the U.S. into the IAU in 1979, 19 (7.2%) are women. In 1972 women represented 6.6% of the U.S. members of the IAU. Thus although the percentage of women among members of the AAS has increased slightly in the last seven years, the percentage among U.S. members of the IAU has dropped somewhat and is still below that in the AAS.

III. EMPLOYMENT

A. General Employment

In the 1973 Report on the Status of Women in Astronomy,

job titles and salaries were found to differ substantially between men and women. The following paragraphs give the current (1979) status and the change, if any, over the past six years.

1. Place of Employment

Table II(a) shows the places of employment of the respondents to the 1973 and the 1979 AAS questionnaires. As was found in 1973, men and women are hired at various institutions in about the same distribution, with the bulk of positions being at universities. We note in 1979 a somewhat smaller-than-average representation of women on the staffs of observatories and other research institutes, but this difference may not be statistically significant.

2. Job Titles

Table II(b) lists the percentage of members of each sex who hold jobs in various categories, again based on the AAS questionnaire, together with the figures from the 1973 survey. In cases where a respondent listed two titles, only the first, or primary, title is included in the first group of figures in Table II(b). The second group of figures, which shows little change from the first except for the title Lecturer, also includes people who use a given title as a secondary title. The percentage of women who hold the rank of Associate Professor has increased since 1973, though at the level of Full Professor the percentage has not reached the value men enjoy. In both the 1973 and 1979 surveys, the percentage at the Assistant Profes-

TABLE II(a). Place of employment.^a

| Employer | Number of employed | | % who are women | | % of each sex having given employer | |
|------------------------------------|--------------------|-------|-----------------|------|-------------------------------------|-------|
| | Men | Women | 1979 | 1973 | Men | Women |
| University | 461 | 40 | 8 | 10 | 48 | 49 |
| Government | 161 | 14 | 8 | 5 | 17 | 17 |
| Observatory/ Research institute | 130 | 7 | 5 | 5 | 13 | 9 |
| Private industry | 77 | 6 | 7 | 3 | 8 | 7 |
| 4-year college | 84 | 8 | 9 | 12 | 9 | 10 |
| 2-year college | 11 | 1 | (8) | 27 | 1 | 1 |
| Planetarium | 10 | 1 | (9) | 0 | 1 | 1 |
| Other | 26 | 5 | 16 | 11 | 3 | 6 |
| Totals | 960 | 82 | — | — | 100 | 100 |

^aData from AAS questionnaire; graduate students and retired people omitted.

TABLE II(b). Distribution of job titles among men and women.

| Title | % of sex holding primary title | | | | % of sex using title as primary or secondary title 1979 | | % of those holding title who are women 1979 | Number of women holding title 1979 |
|---------------------|--------------------------------|------|-------|------|---|-------|---|------------------------------------|
| | Men | | Women | | Men | Women | | |
| | 1979 | 1973 | 1979 | 1973 | Men | Women | 1979 | 1979 |
| Chairman | 1 | 4 | 0 | 1 | 2 | 0 | 0 | 0 |
| Full Professor | 15 | 13 | 8 | 5 | 16 | 9 | 4 | 6 |
| Associate Professor | 14 | 9 | 13 | 5 | 14 | 12 | 8 | 10 |
| Assistant Professor | 10 | 18 | 10 | 17 | 10 | 10 | 8 | 8 |
| Instructor/Lecturer | 3 | 3 | 7 | 5 | 3 | 11 | 11-Instructor 39-Lecturer | 6 |
| Head/Director | 8 | 7 | 2 | 5 | 10 | 4 | 4 | 2 |
| Scientific Staff | 37 | 38 | 40 | 51 | 38 | 42 | 8 | 32 |
| Postdoctoral | 2 | 6 | 2 | 2 | 2 | 2 | 8 | 2 |
| Other | 10 | 2 | 18 | 9 | — | — | — | 14 |
| Totals | 100 | 100 | 100 | 100 | | | | 80 |

*Data all from AAS questionnaire; graduate students and retired people not included. Sample: 943 men, 80 women.

sor level was approximately the same for both sexes. We also find that a greater percentage of women now hold the less prestigious ranks of Instructor and (especially) Lecturer than before. Though some women have been promoted to higher academic ranks, a closer examination of the larger departments shows that these gains must have occurred primarily at the smaller institutions. Using the 1977–1978 AIP Directory of Physics and Astronomy Staff Members, we counted all of the departments in which four or more faculty members identify themselves as astronomers. The resulting distribution includes 66 departments with 769 individuals of whom 571 held professorial rank (Assistant, Associate, or Full Professor). Of all the astronomers listed, 5.5% were women, whereas only 3.9% (22) of the professorial positions were held by women. In 1973, 4.6% of all professorial positions in the larger departments were held by women. This decrease is not statistically very significant, but one can certainly conclude that women are not gaining in this area. Since the age distributions of women and men in the Society are very similar, the poor representation of women in the higher-ranking jobs cannot easily be ascribed to a lack of older people.

3. Salaries

We studied responses to the questionnaire from 942 men and 82 women, excluding graduate students and retired people, and we corrected all salaries to full-time equivalent. Figure 1 presents the current salary distribution. While the percentage of women having salaries between \$20,000 and \$30,000 is about the same as that of men, a greater percentage of women earn the lowest salaries and a far smaller percentage earn the highest salaries. A similar salary profile was found in 1973.

Table II(c) lists average salary by type of employer. As in 1973, men's mean salaries uniformly are higher than women's. The difference is especially noticeable at universities, and may be partially a reflection of women's low representation in professorial ranks. Since the percentage increase of women's salaries at universities is also largest, however, some improvement

has been made. Men enjoyed on average 39.6% increase in salary over the past six years, while women's salaries increased by only 31.3%. As a result, the mean salary difference between men and women in all jobs has widened from \$3,300 in 1973 to \$3,500 in 1979.

The distribution of salaries for men and women in academic ranks is given in Table II(d). Within each level, the mean salary for women is lower than for men. Table II(e) lists average salary, by sex, depending on highest earned degree. As was found in 1973, women earn less than men at the doctoral level.

The overall conclusion from Secs. III A 1–III A 3 is that, as in 1973, the major differences between men and women in astronomy lie in the jobs they hold rather than where they work.

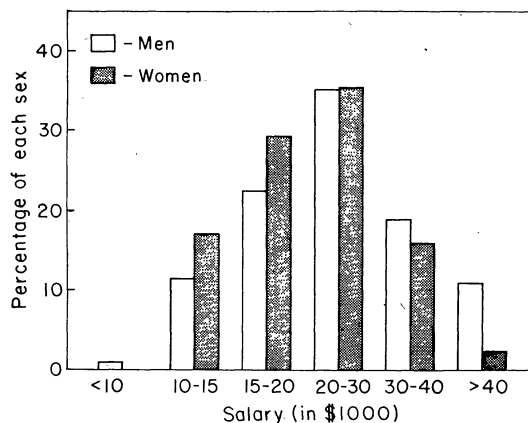


FIG. 1. Percentage of each sex having salary in a given interval. Figures are similar when only Ph.D's are considered. Data from AAS questionnaire; graduate students and retired people not included. Sample: 942 men, 82 women.

TABLE II(c). Mean salary by type of employer. ^a

| Employer | Mean ^b salary (in units of \$1,000) | | | | Percentage increase | |
|-------------------------|---|------|-------|------|------------------------|-------|
| | Men | | Women | | Men | Women |
| | 1979 | 1973 | 1979 | 1973 | | |
| Government | 31.6 | 22.5 | 31.1 | 29.0 | 40 | 7 |
| 4-year college | 20.3 | 15.0 | 18.1 | 16.7 | 35 | 8 |
| 2-year college | 23.9 | 16.6 | — | 14.2 | 44 | — |
| University | 24.3 | 17.2 | 20.6 | 12.4 | 41 | 66 |
| Obs./Research Institute | 25.3 | 19.5 | 25.0 | 21.2 | 30 | 18 |
| Private Industry | 29.5 | 20.3 | 23.8 | 17.5 | 45 | 35 |
| Planetarium | 24.0 | 19.4 | — | — | 24 | — |
| Other | 27.5 | 17.5 | 23.0 | 15.0 | 57 | 53 |

^aData from AAS questionnaire; graduate students and retired people not included. Sample: 941 men, 82 women.

range was multiplied by the salary of the middle of the range.

^bNot a true mean—the number of people in a given salary

TABLE II(d). Salary distribution for men and for women by academic rank. ^a

| Salary (\$1000) | Prof. | | Assoc. Prof. | | Asst. Prof. | | Inst. | |
|--------------------|-------|---------|--------------|---------|-------------|---------|-------|---------|
| | % men | % women | % men | % women | % men | % women | % men | % women |
| 10-15 | 1 | — | — | — | 23 | 37 | 31 | 100 |
| 15-20 | 3 | — | 30 | 50 | 53 | 50 | 25 | — |
| 20-30 | 35 | 57 | 64 | 50 | 22 | 12 | 37 | — |
| 30-40 | 34 | 43 | 6 | — | — | — | — | — |
| > 40 | 26 | — | — | — | — | — | — | — |
| Number | 150 | 7 | 125 | 10 | 94 | 8 | 16 | 2 |

^aData from AAS questionnaire; graduate students and retired people not included. Sample: 385 men, 27 women.

TABLE II(e). Mean salary by highest earned degree. ^a

| | Salary (Number) (\$1000) | | | |
|-----------|-----------------------------|------|-----------|------|
| | Men | | Women | |
| | 1979 | 1973 | 1979 | 1973 |
| Bachelor | 22.8 (28) | 16.6 | 25.6 (4) | 20.0 |
| Master | 24.3 (68) | 18.0 | 23.2 (10) | 17.5 |
| Doctorate | 26.0 (841) | 18.5 | 22.5 (68) | 15.2 |

^aData from AAS questionnaire; graduate students and retired people not included. Sample: 937 men, 82 women.

Means were calculated as in Table II(c).

4. Tenure

The results of the 1979 survey show that 46.4% of the men and 28.6% of the women have job tenure. Figure 2 gives a breakdown of percentages of those having tenure as a function of number of years since receipt of Ph.D. As was found in 1973, not only do fewer women enjoy tenure, but those women who eventually gain tenure are granted it later than their male counterparts. This trend is presumably related to the fact that roughly half of the women have been unemployed or underemployed for some part of their professional lives for family-related reasons (see Sec. III A 5). Of those people presently without tenure, 26.2% of the men and 21.8% of the women stated that the future possibility of tenure exists in their present positions.

5. Occupation of Spouse; "Astronomical Couples"

Tables II(f-1) and II(f-2) summarize the data on the occupation of the spouses of questionnaire respondents. Because we were examining the effect of the spouse's occupation on employment, we have not included graduate students or retired people in the following discussion. Of the male respondents, 75% are married; of the female, 73%. While only 59% of the men's spouses are employed outside the home, 95% of the women's are. It is interesting to note that 58% of the female partners reported having had problems finding jobs for both partners, whereas only 26% of the men did.

Table II(f-2) shows that a high percentage of married women in astronomy have spouses also working in astronomy or a

TABLE II(f-1). Percentage of married people with given status of spouse's employment outside home. ^a

| Status | Men | Women |
|-----------|-----|-------|
| Full-time | 31 | 87 |
| Part-time | 28 | 8 |
| None | 42 | 5 |
| Totals | 100 | 100 |

^aData from AAS questionnaire; graduate students and retired people not included. Sample: 704 men and 60 women.

TABLE II(f-2). Percentage of married people with spouse in given occupation. ^a

| Field of spouse's occupation | Men | | Women | |
|------------------------------|------|------|-------|------|
| | 1979 | 1973 | 1979 | 1973 |
| Astron/Physics | 7 | 4 | 68 | 48 |
| Other Sci/Math | 6 | 7 | 7 | 16 |
| Other Acad/Research | 6 | — | 0 | — |
| Non-Scientist professional | 2 | 44 | 8 | — |
| Homemaker | 19 | — | 0 | 0 |
| Var. other | 51 | — | 12 | — |
| Unspecified/Retired | 9 | — | 5 | — |
| Total | 100 | | 100 | |

^aData from AAS questionnaire; graduate students and retired people not included. Sample: 704 men and 60 women.

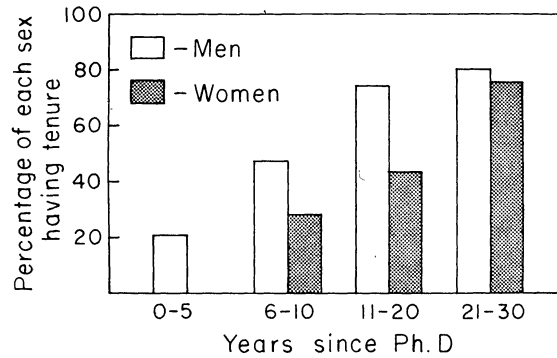


FIG. 2. Percentage of each sex having tenure as a function of years since receipt of Ph.D. Data from AAS questionnaire; graduate students and retired people not included. Sample: 925 men, 77 women.

closely related field. This figure has increased dramatically in the last six years (from 48% to 68%). Presumably some additional individuals are living together as couples and therefore experiencing many of the same job-related difficulties as married people, although they were not counted in this sample.

We compared the distribution of salaries and job titles among members of "astronomical couples" (spouse in astronomy or closely related field) with the distributions for all astronomers. Figure 3 shows the distribution of job titles among members of couples, and Table II(g) compares their salaries with those of single people. Although the data on job titles for the women in astronomical couples do not differ greatly from those for women astronomers in general, the difference between the women and the men in astronomical couples, especially in senior professorial ranks, is plain. Single women earn significantly better salaries than their counterparts who are members of astronomical couples; indeed, single women earn slightly more than single men.

The traditional pattern, in which women are in charge of the home and children, shows strongly in the responses to two questions. Of the married women, 44% stated that they had at some time worked part-time for family reasons, whereas only 7% of the married men answered the same way. Only 2% of

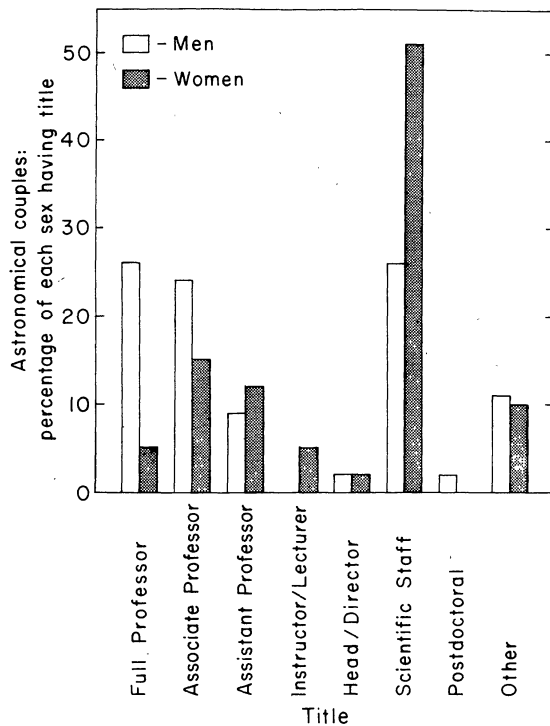


FIG. 3. For members of astronomical couples, percentage of each sex holding a given job title. Data from AAS questionnaire; graduate students and retired people not included. Sample: 44 men, 41 women.

the men, but 27% of the women, stated that they had at some time been unemployed for family reasons. Thus, it is preferentially the women who bears the family responsibilities, moves with her husband when he finds a better job, and accepts the lower-status, less well-paid position. And since, if one considers *all* women in astronomy, 50% have husbands in astronomy or closely related fields, the problem of finding an equitable compromise between the demands of two similar careers is critical for women.

TABLE II(h). Percentage of men and of women expressing a given degree of difficulty in changing job location by a large distance.^a

| Degree of difficulty | Men | Women |
|-------------------------|-----|-------|
| Not difficult | 44 | 28 |
| Somewhat difficult | 36 | 20 |
| Very difficult | 13 | 21 |
| Prohibitively difficult | 3 | 21 |
| Uncertain | 4 | 10 |
| Total | 100 | 100 |

^aData from AAS questionnaire; graduate students and retired people not included. Sample: 937 men, 80 women.

B. Mobility and Job Satisfaction

By "mobility" we mean the ease with which a person can move to a new location in order to accept a better job. Table II(h) presents the distribution among men and women of perceived degree of difficulty in accepting a job at a distant location. Clearly, women find their possibilities more restricted. In cases where a move was considered very difficult, prohibitively difficult, or of uncertain difficulty, 84% of the women listed employment of the spouse as the reason, whereas only 43% of the men gave this reason. Other family-related causes were the second most common reason for difficulty (14% of the women and 24% of the men). The women respondents feel much more constrained to obtain jobs in the location where their spouses work than do the men. In cases where the spouse works in astronomy or a related field, 67% of the men considered moving to be no more than somewhat difficult, as opposed to 38% of the women. And in cases where the reason for difficulty in moving was related to the employment of the spouse, 52% of the men responding considered moving to be no more than somewhat difficult, in comparison to 18% of the women. We conclude that, in most cases, the husband's job comes first, both in the husband's view and in the wife's, and therefore it is the wife who must take whatever employment she can find in the area she happens to be in.

In keeping with the discussion above are the data on job

TABLE II(g). Percentage of members of astronomical couples and of single people having given salary.^a

| Salary (in units of \$1000) | Member of astronomical couple | | Single | |
|-----------------------------------|-------------------------------|-------|--------|-------|
| | Men | Women | Men | Women |
| < 10 | 2 | 0 | 3 | 0 |
| 10-15 | 9 | 17 | 18 | 14 |
| 15-20 | 25 | 34 | 30 | 23 |
| 20-30 | 37 | 37 | 30 | 31 |
| 30-40 | 11 | 12 | 15 | 23 |
| > 40 | 16 | 0 | 4 | 9 |
| Totals | 100 | 100 | 100 | 100 |

^aData from AAS questionnaire; graduate students and retired people not included. Part-time salaries are corrected

to full-time equivalents. Samples: astronomical couple: 44 men, 41 women; single: 227 men, 22 women.

TABLE II(i). Percentage of men and of women expressing a given degree of job satisfaction. ^a

| Degree of satisfaction | Men | Women |
|------------------------|-----|-------|
| Very satisfied | 39 | 32 |
| Moderately satisfied | 42 | 42 |
| Somewhat dissatisfied | 15 | 15 |
| Very dissatisfied | 4 | 11 |

^aData from AAS questionnaire; graduate students and retired people not included. Sample: 909 men, 74 women.

satisfaction. The AAS questionnaire asked how satisfied the respondent is in his or her present job; in addition, many respondents commented on this point at the end of the questionnaire. Table II(i) gives the distribution of degree of job satisfaction among men and women. When we examined the relationship between job satisfaction and type of employer, we found that satisfaction for both sexes is at or above the average in research institutes, observatories, government, and private industries, but the women at universities are noticeably unhappier with their jobs than the men.

Finally, we summarize employment-related comments by respondents at the end of the AAS questionnaire. Of those who indicated their gender, 18% of the men and 41% of the women wrote comments. By far the single most common complaint from men concerned the possible existence of reverse discrimination (see Sec. III C). This feeling, however, seems to be part of the general frustration expressed by both sexes about the shortage of jobs and the paucity of funds for research. The most common complaint from women still concerns employers' nepotism practices, which cause married women to take "left-over" jobs and be treated as second-class citizens. Several women mentioned that an "old boy network," which is often less accessible to women than to men, is still the most effective way to get jobs. Several respondents have encountered hostility towards women in academia.

Some respondents to the questionnaire expressed distaste at the idea of distinguishing among astronomers on any basis other than merit. We agree. Given that society as a whole treats women very differently from men, however, a sex-blind attitude is probably not conducive to equal opportunity.

Recommendations included in the comments at the end of the questionnaires largely centered on making jobs more flexible: tenure for part-time positions, shared jobs, improvement of "off-ladder" positions by less exploitation and equal pay as

TABLE II(j). Positions filled in astronomy, 1977-1979.

| | Men | Women |
|--|------|-------|
| Number of applications | 2815 | 188 |
| Percentage of applications from each sex | 94 | 6 |
| Number of filled positions | 105 | 8 |
| Percentage of positions filled by each sex | 93 | 7 |
| Percentage of applications that resulted in filled positions, for each sex | 4 | 4 |

TABLE II(k). For recent hires, distribution of men and of women among type of position. ^a

| Type of position | % of men | % of women |
|----------------------------------|----------|------------|
| Postdoctorate/Research Associate | 41 | 17 |
| Temporary faculty | 12 | 50 |
| Tenure-track faculty | 35 | 33 |
| Nonacademic | 12 | 0 |
| Totals | 100 | 100 |

^aSample: 95 men, 6 women.

well as by ability to be Principal Investigator on federally funded research projects, and abandonment of nepotism practices. Several respondents underscored the importance of role models for both women and minorities.

C. Recent Filling of Positions

As part of our study of employment in astronomy, we sent questionnaires to 200 employers who had advertised positions in the AAS Quarterly Register of Job Opportunities in the past two years. The questionnaire asked whether the position was filled and, if so, whether by a woman or a man; whether the position was at any stage offered to a woman; and how many women applied. We wished to learn whether women apply for jobs in proportion to their numbers in the profession and whether the fraction of positions being filled by women has begun to change very recently. We received responses concerning 113 filled and 26 unfilled positions. Tables II(j) and II(k) show the results.

Since 6% of all applications came from women, we conclude that women are applying for jobs in approximate proportion to their numbers in the Society. Women applied for all types of jobs in about the same proportion. The percentage of applications that came from women was 5% for postdoctorates and 7% for all other jobs. Likewise, 7% of filled positions went to women, which is commensurate with the number who applied and with the number of women in the Society. This result belies the complaint, often repeated in the responses to our questionnaire, that women and minorities are preferred in hiring. This conclusion is one of our most important: in astronomy as a whole, rumors of discrimination in the form of preferential hiring of women are false.

Table II(k) shows that a much larger fraction of women than men was hired into temporary faculty positions. In spite of the uncertainty imposed by the small numbers, this difference appears significant. Longer-term monitoring of employment data would reveal whether this difference is real.

Perhaps the most significant datum in Table II(j) reveals that only one job application in 25 is successful, independent of the sex of the applicant.

IV. RESEARCH PRODUCTIVITY AND ITS RECOGNITION

In 1973 the Report of the working group concluded that, while the fraction of women astronomers who publish papers in *The Astrophysical Journal* is smaller than the fraction of men astronomers, the productivity of those who do publish is about the same. It went on to point out that this productivity is

TABLE III(a). Publication rates.^a

| Type of employer | Average number of papers per year | | | |
|------------------------------------|-----------------------------------|-------|------|--------------|
| | 1979 | | 1973 | |
| | Men | Women | Men | Women |
| All | 2.1 | 2.0 | 3.3 | 2.7 |
| University | 2.5 | 2.3 | 3.2 | 2.9 |
| Government | 2.0 | 1.9 | 2.7 | 4.0 |
| Research Institute/ Observatory | 2.6 | 4.2 | 3.8 | ^b |
| 4-year college | 1.5 | 0.9 | — | — |

^aData from AAS questionnaire; graduate students and retired people not included. Sample: 950 men, 80 women (1979); 475 men, 47 women (1973).

^bFewer than three individuals.

not proportionately recognized by membership on advisory panels and by participation in such community activities as refereeing. Although participation in these activities is sometimes regarded as a burden, it is a measure of status in the profession. We now compare the current levels of productivity and its recognition with those of 1973.

A. Productivity

1. Publications

Respondents to the current questionnaire gave the number of papers they had published during the last two years. Table III(a) presents these results in terms of the average number of papers per year for men and women, broken down by type of employer. In 1973 the data were presented in terms of the average number of papers per year since receipt of a Ph.D. Because the two numbers were computed differently, comparison of a given figure from one year to the other may not be valid. Comparison of a difference, as between two types of employers, should, however, be valid. Table III(b) presents the details of the results from the current questionnaire. The main conclusion to be drawn from these results is that, both now and in 1973, there is essentially no difference in rate of publication between women and men.

In issues of *The Astrophysical Journal* for September and October 1978, 4.5% of the papers were published by women,

to be compared with 3.3% in 1975 (figures supplied by H. A. Abt). In *Annual Reviews of Astronomy and Astrophysics*, on the average 7% of the authors in volumes 12 to 16 are women, to be compared with 4% for volumes 1 to 11. Since contributions to this series are invited, this increase represents an improvement in the recognition of the research output of women.

2. Usage of Telescope Time

The amount of telescope time assigned to Guest Investigators at national facilities is another measure of research activity. Table III(c) gives the fraction of all Guest Investigators who are women and the fraction of all Guest Investigator time that was used by women, as an average for the years 1977 and 1978. For Kitt Peak and Cerro Tololo, we obtained the information from those observatories' Annual Reports; for the other facilities, the information was supplied by the Director or Project Scientist. Astronomers unidentifiable by gender (a small fraction) were omitted from the counts, and telescope time assigned to teams was prorated according to the number of men and women on the team. In the case of IUE, the figures refer to Principal Investigators only.

In 1973, 10% of the Guest Investigators at Kitt Peak and 4% at NRAO were women. Thus, the current figures show an upward trend. In general, women use a greater share of the optical telescope time than their numbers in the Society would indicate. Since we have little information to indicate what fraction of women are theorists and what fraction observers, however, interpretation of these percentages is difficult.

B. Recognition

1. Refereeing

Since refereeing of papers for journals is the principal public service activity in which astronomers engage and confers considerable power on the referee, the extent to which women serve as referees is a good measure of women's status in astronomy. For the journals published by the AAS, Table III(d) gives the fraction of all manuscripts that were refereed by women. These values are lower limits, because the editors, who did the counting, assumed that the few individuals who are personally unknown to them are men.

Our figures show a significant improvement over 1973. To some extent, this improvement reflects efforts on the part of the editors of those journals to correct an injustice, and we commend these efforts.

TABLE III(b). Percentage of men and women publishing a given number of papers in the last two years, by employer.^a

| | Government | | 4-year college | | University | | Research Institute/ Observatory | |
|--------|------------|-------|----------------|-------|------------|-------|---------------------------------------|-------|
| | Men | Women | Men | Women | Men | Women | Men | Women |
| 0 | 10 | 14 | 28 | 25 | 5 | 5 | 5 | 0 |
| 1-2 | 32 | 22 | 28 | 50 | 22 | 26 | 16 | 0 |
| 3-5 | 34 | 43 | 27 | 25 | 36 | 38 | 40 | 14 |
| 6-10 | 18 | 21 | 9 | — | 28 | 23 | 29 | 43 |
| > 10 | 6 | — | 8 | — | 9 | 8 | 10 | 43 |
| Number | 159 | 14 | 82 | 8 | 457 | 39 | 129 | 7 |

^aData from AAS questionnaire; graduate students and retired people not included.

COMMITTEE REPORT

TABLE III(c). Telescope time assigned to guest investigators during 1977 and 1978.

| Facility | No. men | No. women | Women/total | Percentage of time used by women |
|----------------------|------------------|-----------------|-------------|----------------------------------|
| Kitt Peak | 240 | 35 | 13 | 15 |
| Cerro Tololo | 120 | 16 | 12 | 13 |
| Kitt Peak, solar | 33 | 2 | 6 | 1 |
| Sacramento Peak | a | 0 | 0 | 0 |
| NRAO | a | a | a | 5 |
| Arecibo | a | a | a | 13 |
| Einstein Observatory | a | a | a | 11 |
| Copernicus | a | a | a | 8 |
| IUE | 219 ^b | 23 ^b | 15 | 16 |

^aFigures not available.^b1978 only.

TABLE III(d). Percentage of manuscripts refereed by women.

| Journal | Time period | Percentage | Percentage, 1973 report |
|-------------------------------|-------------------|------------|-------------------------|
| Astronomical Journal | Sep 1977–Sep 1978 | 6 | — |
| Astrophysical Journal Letters | Jan 1977–Nov 1978 | 5 | 2 |
| Astrophysical Journal | Sep 1977–Sep 1978 | 4 | 3 |

TABLE III(e). Membership on advisory committees.

| Board or Committee | Percentage of members who are women | | Number of women | |
|---|-------------------------------------|------|-----------------|------|
| | 1979 | 1973 | 1979 | 1973 |
| AAS Publications Board | 16 | 0 | 1 | 0 |
| Associate Letters Editors, <i>Astrophys. J.</i> | 25 | 0 | 1 | 0 |
| Editorial Committee, Annual Reviews of Astronomy and Astrophysics | 0 | 0 | 0 | 0 |
| KPNO and CTIO Users' Committees | 12 | 14 | 4 | 4 |
| Ad hoc Instrumentation Committee (7 members) | 0 | 0 | 0 | 0 |
| Telescope Allocation Committee | 18 | a | 3 | a |
| Board of Directors, AURA | | | | |
| Appointed | 7 | 0 | 1 | 0 |
| At large | 0 | 20 | 0 | 1 |
| Visiting Committee, AURA | 11 | 11 | 1 | 1 |
| NRAO Users' Committee | 3 | 0 | 1 | 0 |

^aLumped with Users' Committee in 1973 report.

Though we have no figures from 1973 on referees of proposals for grant funding to the NSF, we used the published list of peer reviewers for the period October 1976–September 1978 to find that 6% of the reviewers in astronomy were women. We feel that the current level of participation of women in these activities is satisfactory.

2. Membership on Advisory Committees

Table III(e) gives the percentages of members of various advisory boards who are women. These figures show a slight improvement with respect to 1973. In general, we conclude that, though the employment situation of women is static, at least the nonemployment professional recognition of women is improving. Perhaps this recognition will have a favorable effect on the employment of women in the future.

V. GRADUATE STUDY

Table XVII in the 1973 Report summarized percentages of degrees awarded to women in physics and astronomy from 1947 to 1971. During that 24-year period, 8.2% of the Ph.D. degrees in astronomy went to women, as against 2.5% in physics. New figures are available for 1971 to 1975, and the comparable values are 8.2% and 4.0%. Thus, women entering astronomy are just holding their own, while the situation in physics appears to be improving.

We requested information from 66 departments of astronomy or astronomy and physics in the United States and Canada on how many graduate students are currently working primarily in astronomy or astrophysics and how many Ph.D.'s were awarded in the past five years. In 62 responding institutions, 13% of the 647 students currently enrolled in graduate school are women. From the same institutions, 8% of the 535 people receiving Ph.D.'s in the past five years are women. These data suggest that relatively more women than men drop out of graduate school. The cause of this apparent selective attrition is not known, and should be studied.

In the AAS questionnaire, we asked the members with Ph.D.'s how many years they spent in graduate school, and Table IV(a) shows the results. In spite of the attrition discussed above, the women who stay in school finish in the same time as men.

TABLE IV(a). Percentage of men and women taking a given number of years to earn a Ph.D.^a

| Number of years | Percentage of men | Percentage of women |
|-----------------|-------------------|---------------------|
| 2 | 1 | 1 |
| 3 | 7 | 7 |
| 4 | 19 | 23 |
| 5 | 27 | 21 |
| 6 | 19 | 24 |
| 7 | 11 | 11 |
| 8 | 6 | 6 |
| 9 | 4 | 0 |
| 10 | 3 | 0 |
| 11 | 1 | 1 |

^aData from AAS questionnaire. Sample: 848 men, 80 women.

VI. CONCLUSIONS AND RECOMMENDATIONS

In this section we carry out the second part of our charge: to recommend specific steps that the AAS can take to improve the status of women in astronomy. From the data above, we reach the following conclusions, which motivate the recommendations in Sec. VI B.

A. Conclusions

1. Overshadowing all other problems facing women astronomers is a problem for men also: the shortage of permanent jobs in astronomy. The existence of fierce competition for scarce jobs makes any improvement in the status of women difficult. Although we have little new to offer on this subject, our fourth recommendation addresses it in a limited way.

2. Because society does not encourage young women to pursue scientific careers in general, few women enter astronomy each year. Greater numbers would promote greater variety among astronomers and would diminish the isolation felt by women astronomers. While one should hesitate to encourage young people to enter a field in which employment opportunities are poor, a valid goal is that young women should not be discouraged more than young men.

3. In the responses to our survey of AAS members, the most frequent comment from men was that women today are preferred in hiring. Our survey of employers who had recently advertised positions, however, yielded no evidence of reverse discrimination. The widespread impression that reverse discrimination exists is not conducive to equal opportunity, but might be countered if more information were available on who is being hired.

4. Women who are married to physicists or to other astronomers must often take whatever work they can find near their husbands' place of employment. Usually, they are also the family member who must take time from a career to care for children. True, their situation is the result of conscious choice, and men also must assign priorities to career and to family. Still, these choices are presented to men far less starkly, and men can usually expect to have both a successful career and a family. It should be possible to make this double goal more accessible to women as well.

5. Although women seem to be able to find jobs in astronomy, more often than men they hold lower-ranking jobs, such as Lecturer and Scientific Staff Member. In universities, women are reasonably well represented at the levels of Assistant and Associate Professor, but poorly represented at the level of Full Professor. In university departments with four or more astronomers, only half as many women hold faculty rank as would be expected on the basis of numbers in the Society.

6. Because of their small numbers in the profession, women often feel isolated and are often perhaps unthinkingly overlooked or slighted. An informal structure within the Society, by which women could receive moral support from other women and from sympathetic men, could fortify them against these problems, alert them to opportunities for grants or employment, and assist them in setting goals.

7. On the average, women continue to be paid significantly less than men. This statement holds when only holders of the Ph.D. are considered, and when men and women are compared within the same academic rank. The difference is much smaller when only single women are considered. Apparently, married women are hurt financially by their lack of mobility.

8. Because the problems women astronomers face are partly

the result of deeply rooted social forces and longstanding tradition, we do not expect our recommendations to solve these problems completely, even if implemented. We expect the status of women to improve slowly, in bootstrap fashion. Therefore, we see a need for continued monitoring of the situation, so that it will be clear where improvements are occurring and where they are lacking.

9. Finally, we mention the respect in which the status of women has improved since 1973. Women are more often asked to referee manuscripts for journals, serve on advisory boards, and deliver invited lectures. Women who we think should have been honored long ago finally winning awards and serving as officers of the Society.

B. Recommendations

1. We request that the Council publish the full text of this Report in the *Bulletin of the American Astronomical Society* and send a copy of the abstract and major recommendations (which will occupy a single sheet of paper) to each member in the next mailing. We also ask that the President send a copy of this report, with a covering letter that urges attention and appropriate action, to the chairmen of departments of astronomy and physics/astronomy and to the appropriate officials of funding agencies.

2. We recommend that the Council pass two resolutions, one in favor of equal opportunity and one in favor of flexibility in the structuring of positions. We suggest the following wording*:

(a) Equal opportunity: "The Council of the American Astronomical Society believes that when able young people are discouraged from entering the discipline of astronomy or when astronomers have to combat discrimination, the resulting waste of talent and creativity is injurious to the health and welfare of the entire astronomical profession. Therefore, be it resolved that the Council will promote, and urges all members to promote, equality of opportunity within the astronomical profession without regard to race, age, handicap, or sex."

(b) Flexibility: "The Council of the American Astronomical Society considers that greater flexibility in hiring would benefit employers, astronomers, and the profession and wishes to do whatever is possible to promote such flexibility. It urges employers to provide tenurable part-time employment, including job sharing for those who wish it, and to seek other innovations of this kind. It also urges institutions to be flexible in allowing all competent scientists to become Principal Investigators."

3. In the longer term, we would like to see the Council investigate the possibility of establishing an endowed program of small grants to astronomers in the early stages of their research careers who are trying to establish themselves. We envision grants in the vicinity of \$5000 for stipend and/or research expenses. Though not sufficient to provide an astronomer's sole support, they would provide an opportunity for someone whose spouse accepts a job in a new location or someone who must work part-time outside of astronomy.

4. For the sake of readability, we combine the following minor recommendations into one section.

(a) We recommend that the Executive Office keep and update a list of women members of the Society and that it make

the list available to employers or other interested parties on request.

(b) We recommend that the Executive Office, in collaboration with the Committee on Manpower and Employment and the Education Committee, attempt to find ways of educating small colleges and other institutions that hire physicists in the advantages of hiring an astronomer. The Shapley Lectures are one possible vehicle for such an effort.

(c) We recommend that the Education Officer and the Task Group on Education in Astronomy direct their attention to any sex biases that may occur in educational materials. For example, are the contributions that women have made to present knowledge presented fairly? When astronomers doing astronomy are presented, are women shown realistically?

(d) We recommend that the Council commend the Center for Astrophysics for its successful career booklet *Space for Women* and we hope that the Center will continue to reprint it.

(e) We recommend that the Council change the restrictions on eligibility for the Cannon, Warner, and Pierce Prizes from a limit based on age to one based on the number of years of full-time postdoctoral experience. The present age limit discriminates unfairly against women who cease working in astronomy temporarily in order to raise children.

5. We recommend that the Council establish a standing Committee on the Status of Women, to consist of two men and three women chosen by the Council, preferably from among volunteers. At least one member of the present committee should serve initially. The members should serve staggered three-year terms and should elect a head from among themselves. This committee should continually monitor the status of women in astronomy and should first draw up its own charge, with particular attention to the problems we have described. Below, we list tasks the Committee should address, with shorter-term projects first.

(a) Draw up a yearly budget to be submitted to the AAS Council, to include at least funds to defray office and communications expenses for members whose institutions cannot or will not provide them. Participation in the Committee by unemployed or junior-level astronomers should not be limited by lack of funds.

(b) Work with the Executive Officer on compiling and disseminating information on current hiring of women.

(c) Every year, publish the figures from the *AIP Directory of Physics and Astronomy Staff Members* on the representation of women on the larger faculties.

(d) Remind prize committees and the Program Committees for meetings to give fair consideration to women in awarding prizes and inviting speakers. Qualified women are often overlooked in these situations.

(e) Take positive actions to make women feel at home in the Society, a necessity because of the small number of women. Such actions should include setting aside a time and place at each Society meeting so that women (and men interested in women's issues) can get to know one another.

(f) Contribute items of interest to and about women to the Society newsletter. Contributions should include (1) guidelines on helpful ways to write vitae (e.g., whether personal information such as marital status be included) and letters of reference (e.g., comments such as "She is emotionally very stable" should not be included); (2) case histories about innovative forms of employment, such as job sharing; (3) recommendations of astronomy texts that are especially successful in fairly presenting women astronomers; (4) an offer by the Com-

*These two resolutions were passed by the Council of the AAS at its meeting on 11 June 1979.

mittee to review new or existing texts for the purpose of eliminating any sex bias; and (5) periodic reminders to university departments to include women as colloquium speakers.

(g) Perform a study on why students leave graduate school, and especially why more women leave than men.

(h) Obtain and maintain in the Executive Office a file of information on grievance procedures. Included could be sources of legal help, case histories, names of interested people and government agencies, and government documents. (We are *not* suggesting that the Committee provide active help in such cases.)

(i) Contact new women graduate students to explain the aims of the Committee and to invite them to join the Society and attend its meetings.

(j) Work with planetarium directors to ensure that the history and current progress of astronomy are presented fairly. Possible projects include developing materials for shows, sending a representative to meetings of planetarium directors, and writing articles for planetarium journals.

(k) Work with analogous committees of other scientific societies on problems in the relationship between science and the public. Possible projects include persuading high school counselors and science teachers that girls should take a full mathematics curriculum, promoting junior high and high school science texts that are free of sex bias, developing materials for courses in the history of science and women's studies, promoting the fair presentation of women scientists in television programs such as *Nova*, developing unbiased audiovisual materials for education, and conducting or publicizing summer workshops on women in science.

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NOTE FROM THE SOCIETY PRESIDENT

This report was presented orally to the AAS Council in June 1979, and the formal written report was accepted in January 1980. Of the recommendations in Sec. VI B, the two resolutions in item 2 were adopted in June 1979, and I transmitted them to several dozen astronomy departments the following month. The first recommendation in item 5 (establishment of a standing committee) was also adopted at that time, and planning was begun for the changing of prize rules [item 4(e)].

At its January 1980 meeting the Council adopted the rest of the recommendations. The main part of recommendation 1 is largely implemented by the present publication. The remaining recommendations in parts 1 and 4 will be implemented as soon as possible. The Council will also work with the Committee on the Status of Women in investigating possible funding sources for the support that is suggested in item 3.

The Council adopted a resolution (under item 5) that the Committee on the Status of Women draw up a recommended charge for itself, to be submitted to the Council for approval; items 5(a)-5(k) are thus to be construed as examples of tasks that the charge might include rather than as portions of an accepted program.

The Council thanks the Committee on the Status of Women for a task well started.

IVAN KING