

REPORT TO THE COUNCIL OF THE AAS FROM THE WORKING GROUP ON THE STATUS OF WOMEN IN ASTRONOMY—1973*

INTRODUCTION

At the 138th meeting of the AAS in Lansing, Michigan (August 1972) the Special Committee on the Cannon Prize recommended to the Council that a group be formed to review the status of women in astronomy. The council approved the formation of a Working Group which would report their findings in approximately one year's time. The membership was based on volunteers from the AAS, who then elected a chairperson and steering committee. The aim of the committee was to gather pertinent facts and to let them speak for themselves. This report is the result of a year of volunteer work by many individuals, the most active of whom are listed at the end of this survey.

Our data have come from a variety of sources, which include:

- (1) A questionnaire distributed in April 1973 to all AAS members.
- (2) AAS membership lists (published in PAAS up to 1945 and distributed to members since that time).
- (3) Individual astronomy departments responding to direct requests from members of the Working Group.
- (4) A canvass of all women astronomers in the country.
- (5) NSF records on scholarships, fellowships, contracts, and grants.
- (6) Miscellaneous sources such as statistics of authors and titles in journal indices; personal letters to individuals to obtain various data on women's representation on committees, panels, etc.

A large amount of the data came from the AAS questionnaire. Of the approximately 2800 members to whom it was sent (in the preliminary announcement for the 140th Columbus AAS meeting) 737 (or about 27%) were filled out and returned. Of those replying about 12% were women, slightly higher than the 7.9% in the Society as a whole. Graduate students comprised 10% of the total responding sample. Ph.D. degrees are held by 79% of those responding; MA's by 11%; and BA's by 7%. Although this is a sampling of only about one-fourth of the AAS membership, we use it in the absence of more complete information when necessary.

This report consists of four main parts. Part I covers the American Astronomical Society, summarizing membership, officers, prizes, historical change, field of members and individual recognition. Part II covers employment, including place of employment, job titles, satisfaction, salary, part-time and volunteer work, tenure, hiring practices and nepotism. Part III discusses productivity in research, including publications, grants, and guest investigators. Part IV reviews various aspects

of graduate study including earned degrees, percentage and reasons for dropping out of graduate school, and financial support. Appendices consisting of several self-contained reports written by members of the Working Group are included after the tables.

I. AMERICAN ASTRONOMICAL SOCIETY (MEMBERSHIP, OFFICERS, PRIZES, HISTORICAL CHANGE, FIELD OF MEMBERS, INDIVIDUAL RECOGNITION)

Since the Society's formation in 1899, the membership has steadily increased, with an especially rapid rate of growth in the post-Sputnik era. Figure 1 compares the total AAS membership to the number and percentage of women members as a function of time. We note that while the number of women continued to increase, the percentage of women in the AAS has been steadily decreasing since 1945. We can speculate that this decreasing percentage of women may be due in part to the large influx of male engineers and physicists (two professional fields with even lower percentages of women). Responses to our questionnaire indicate that 74% of the 1973 AAS members with Ph.D.'s received their degrees in astronomy, 22% received Ph.D.'s in physics, and 4% listed other fields. (Total number in sample: 578). Table I shows the percentage of Ph.D. degrees awarded in astronomy, physics, or other fields to present members of the AAS tabulated by year of awarded degree. The percentage of recent Ph.D.'s in physics or other fields is not large enough to account for the decreasing trend in the percentage of women in the AAS.

Figure 2 presents the age profile for the responding AAS members as a whole and separately for the women. The average age for men is 37 yrs and for women it is 38 yrs; the median age for both is 33 yrs.

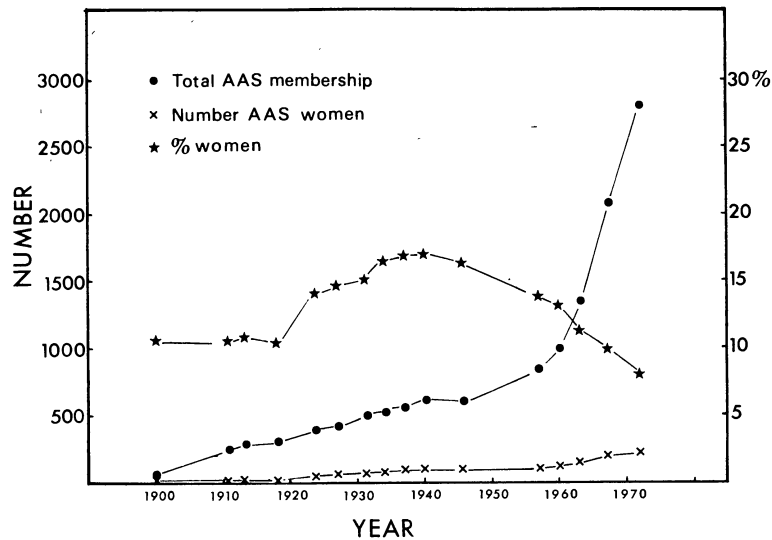
In Table II we list statistics on the representation of

TABLE I. 1973 AAS membership by major field of Ph.D. degree^a.

Year of degree award	No. respondents in sample	% in Astronomy, (No.)	% in Physics (No.)	% in other fields (No.)
before 1930	5	60% (3)	20% (1)	20% (1)
1930-1939	26	81% (21)	15% (4)	4% (1)
1940-1949	26	77% (20)	19% (5)	4% (1)
1950-1954	31	61% (19)	32% (10)	6% (2)
1955-1959	41	63% (26)	29% (12)	7% (3)
1960-1964	90	59% (53)	35% (32)	6% (5)
1965-1969	193	74% (143)	22% (42)	4% (8)
1970-1973	166	79% (132)	17% (29)	3% (5)

^aData from AAS questionnaire.

FIG. 1. Change in the AAS membership since the formation of the Society in 1899. Closed circles show the total number of AAS members; the crosses represent the number of women in the Society. The dramatic change in the slope of the membership curve near 1960 is not seen in the women's curve. The stars show the percentage of women in the AAS (read from scale on right). The Society now has the smallest percentage of women it has ever had. All figures are taken from AAS membership lists.



women in the various functions of the Society, namely as officers, prize winners, members of various committees, and invited speakers at AAS meetings. In summary, women have not been as well represented in the official activities of the Society as their numbers would warrant. It should be noted, however, that in this year's Visiting Professor Program which the Society sponsors, five (12%) of the 42 astronomers are women.

We can compare the membership of the AAS with that of the IAU. The percentage of IAU women members for the U.S.A. is slightly lower than the percentage of women in the AAS (6.6% vs 8.9%). In 1973, 210 new IAU members from the U.S.A. were elected; 12 (5.7%) of these are women. Table III lists comparative data for some of the larger member countries in the IAU. A more complete summary for the IAU is attached as an appendix.

II. EMPLOYMENT

Place of Employment: Table IV shows the distribution among our respondents of men and women employed at various kinds of institutions. Universities and the government account for the bulk of astronomical positions for both sexes, although 27% of the astronomers at junior colleges are women, compared to a 12% figure for the four-year colleges. The principal difference seems to lie in the type of position held rather than the place of employment.

Job Titles: Figure 3 is a histogram showing the percentage of each sex holding positions with various titles. Most government and national laboratory positions are included under "scientist" with no provision for grades since that information was not generally available from the respondents.

A higher percentage of men hold prestige and/or permanent (tenured) positions than do women. The bulk of women are research associates, assistant professors, instructors and lecturers, and "other" which included such things as "volunteer research assistant" and other similar positions.

Similar data were gathered in a survey of university astronomy departments based on departmental records 1962–1972. Table V shows the distribution of positions

TABLE II. AAS officers, prize winners, committee members, invited speakers, and members.

Officers	Total no.	No. men	No. women	% women
President	28	28	0	0%
Vice-President	60	58	2	3%
Secretary	12	12	0	0%
Treasurer	7	6	1	14%
Executive Officer	2	2	0	0%
Councilor ^a	175	162	13	7%
Prize Winners				
Russell Lectureship	24	24	0	0%
Warner Prize	19	18½ ^c	½ ^c	3%
Cannon Prize ^b	12	0	12	100%
Committees				
Nominating	119	109	10	8%
Russell Lectureship	22	21	1	4%
Warner Prize	25	23	2	8%
Cannon Prize ^d	10	5	5	50%
Invited Speakers at AAS Meetings				
Symposia (1948–1963)	155	150	5	3%
Invited papers (1964–1972)	80	79	1	1%
Session chairmen at AAS meetings^a (since 1962)				
	321	308	13	4%
Total 1972 AAS Membership				
	2598	2478	220	8%

^aSome of these individuals have served more than once.

^bRestricted to women.

^cPrize was shared by G.&M. Burbidge in 1959.

^dCannon Prize Committee has generally included at least one former recipient.

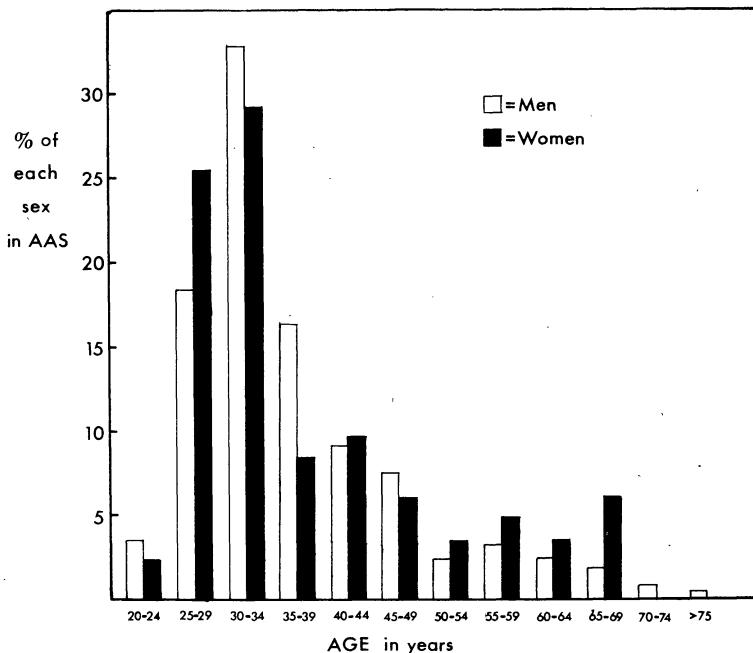


FIG. 2. Age profiles for men and women members of the AAS. The percentages of each sex are computed separately and are *not* given as percentages of the total (men plus women) membership. For example, 25% of all women in the AAS are between 25 and 29 years, while 18% of all men are in that same age group. Information is taken from the AAS questionnaire. The total number of men and women used in getting the "age profile" are M=721, W=82.

held by both men and women with Ph.D. degrees. It should be noted that 52% of the women hold nonfaculty positions, and only 25% of them have tenured appointments. This is to be compared with 35% of the men who held nonfaculty positions, and 41% of the men who have tenured positions.

The "Directory of Physics and Astronomy Faculties 1972-1973" was used as a source of statistics on the distribution of faculty appointments among men and women during that academic year (see Table VI).

TABLE III. Statistics on IAU membership for 1972^a.

Country	No. members	% of total IAU membership	No. women	% of members from each country who are women	% of all IAU women
All combined	2602	100%	198	7.6%	100%
France	168	6.5%	34	20.2%	17.2%
U.S.A.	728	28.0%	48	6.6	24.2
U.S.S.R.	362	13.9	55	15.2	27.8
U.K.	237	9.1	12	5.1	6.1
Australia	54	2.1	0	0	0
Belgium	52	2.0	3	5.8	1.5
Canada	89	3.4	6	6.7	3.0
Czechoslovakia	49	1.9	6	12.2	3.0
Italy	77	3.0	5	6.5	2.5
Japan	105	4.0	0	0	0
Poland	42	1.6	3	7.1	1.5
Sweden	42	1.6	4	9.5	2.0

^aThe twelve countries with largest IAU membership are included.

Briefly, women comprise 3.4%–5.7% of all faculty appointments at all levels. The lower percentage is for the "top five" graduate schools as ranked by the Commission on Graduate Education; the higher percentage is for all institutions awarding degrees in astronomy (97). At each faculty level, the percentage of women increases as the faculty level decreases. In the "top five" institutions there are no women in the levels of full professor, associate professor, or assistant professor, although these institutions awarded 8% of their total number of Ph.D. degrees to women. The distribution of appointments among women is also heavily weighted to the lowest level.

There are other ways of categorizing opportunities for advancement in astronomy; one alternative suggested to this Committee was to consider the percentage of women on staffs or faculties having access to the largest optical telescopes. Of the institutions having telescopes of aperture 90 inches or larger, about 5% of the staff scientists are women.

Degree of Satisfaction: Table VII lists the most common sources of satisfactions and dissatisfactions for both men and women. The dissatisfactions are: (1) cuts in or lack of funds, (2) lack of job security, and (3) low salary. Women also list these as common dissatisfactions, but with equal frequency they also mention: (4) dead-end job with no advancement possibility, and (5) isolation. The lower-status jobs that women hold in universities and four-year colleges (see Table VI) may lead to these feelings of dissatisfaction with advancement possibilities.

Salary: Directly related to the questions of job titles and promotion is salary information which we present in several forms in Tables VIII–X and Fig. 4. All information is taken from the AAS questionnaire. Note

TABLE IV. Place of employment (Ph.D.'s only)^a.

Employer	Number employed			% of total in each category		% of each sex having given employer		Total M&F
	Male	Female	Total					
				M	F	M	F	
Universities	286	32	318	90	10	56	65	57
Government	94	5	99	95	5	18	10	18
Nat'l, Obs. or Lab	42	2	44	95	5	8	4	8
Private Industry	29	1	30	97	3	6	2	5
Four-Year College	22	3	25	88	12	4	6	5
Jr. College	8	3	11	73	27	2	6	2
Planetarium	4	0	4	100	0	≤ 1	0	≤ 1
Other	25	3	28	89	11	5	6	5
Totals	510	49	559	100	100	100

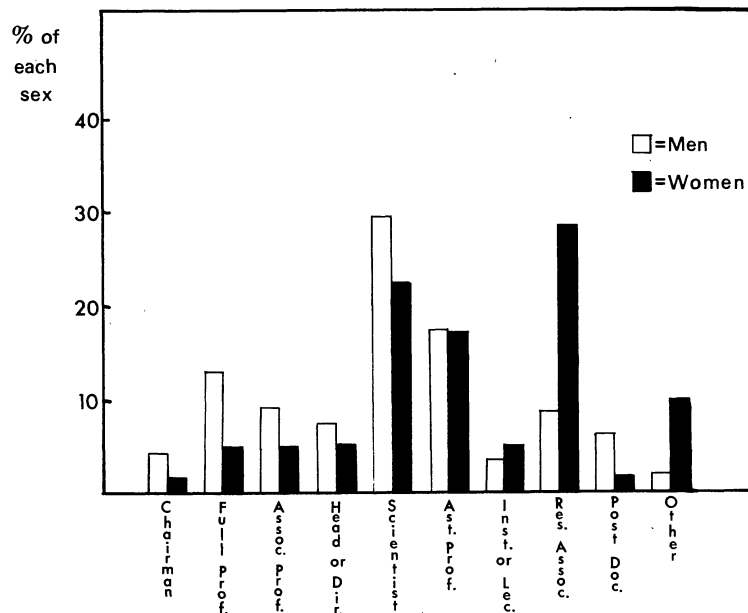
^aFrom AAS survey.

that all salaries have been corrected to a full time equivalent. For example, if someone indicated a half-time appointment at \$8000/yr, an annual salary of \$16000 was tabulated. The only exception to this was that academic year appointments were taken as full-time salaries, since we had no way of knowing if summer supplements were possible or if they had been included in the salary figure. Because of the small number of women in some of the samples, not all averages are significant and these are indicated by square brackets around the figure. Some selection effects might change the distribution in Table VIII (salary vs institution). However, the large number of data points used for the mean Ph.D. salaries makes the \$3300 difference between men and women quite convincing. This trend in salary differences is confirmed by a number of recent nationwide studies for which sufficient data were available to compare salaries for the same job titles.

It has been suggested that we should also break the sample by married and single respondents, since often a lower salary for a women is justified by the reasoning that since her husband works she doesn't really need the money. However, the majority of single men are young and therefore their salaries are expected to be lower than average. The mean age for single women is higher. A much higher percentage of the single women are over 40 than the percentage of men above the age, but there are not enough in each sample to further subdivide by age. We note in passing that in spite of the different age distribution for single men and women which should favor a higher mean salary for single women, their mean salaries are very similar (\$15300 for single men, \$16000 for single women).

Part-time and Volunteer Work: In the survey only 14 people identified themselves as part-time employees

FIG. 3. Distribution of job titles for each sex. Greater percentages of men hold "prestige" and/or "tenured" positions (left of diagram) while the greatest percentage of women are Research Associates (generally a "dead-end" position with no advancement possible). Information is taken from the AAS questionnaire.



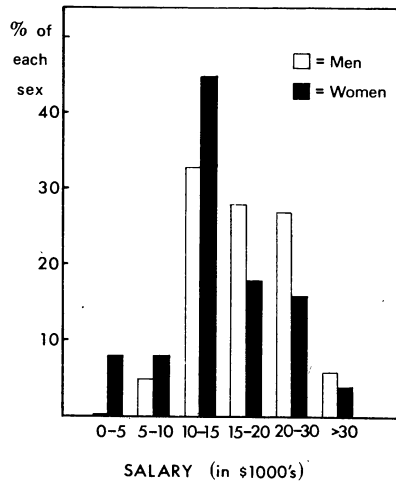


FIG. 4. Salary distribution for AAS members holding Ph.D. degrees. All graduate students, members working in foreign countries, unemployed, and retired members have been excluded. Part-time workers' salaries have been corrected to a full-time equivalent salary. The percent of each sex having salaries in a given range is plotted separately. Note the trend for a higher percentage of women to have salaries less than \$15 000, while a substantially greater percentage of men have salaries in excess of \$15 000. Data are from the AAS questionnaire.

(see Table XI). All graduate students were eliminated from this sample. Of these, 78% were women. It is commonly believed that women accept part-time positions while their children are young. In our small sample, 1/3 of the women employed part-time have no children, although all are married. All but three of these women are married to astronomers or physicists. It is possible that many of these part-time positions for women are tied to nepotism problems rather than the more traditional view that women take part-time jobs out of choice.

Four people indicated that they worked full-time, but without pay, with titles like Volunteer Research Associate. All four are women, all with husbands in astronomy (3), or another science (1). None is volunteer by choice, according to her remarks.

TABLE V. Distribution of positions in 28 graduate departments among astronomers with Ph.D. degrees.

Position	Men	Women ^a
Professor	25%	11%
Assoc. Prof.	16%	14%
Assist. Prof.	20%	11%
Lect. or Instructor	4%	11%
Research Assoc.	31%	50%
Research Assist.	4%	2%
Total No. Ph.D.	485	44

Men: 25%, 16%, 20%, 4%, 31%, 4% → 61%
 Women: 11%, 14%, 11%, 11%, 50%, 2% → 36%, 52%

^aFurther data is available for only women from 18 other departments. The distribution of positions stays the same when these 48 additional women are included in the sample.

TABLE VI. Faculty appointments in astronomy 1972-1973.

Percent women at all faculty levels	
Institutions	Percent
All ^a	4.6
Top 5 ^b	3.4
Top 15 ^c	5.7

Percent women at each faculty level			
Level	Institution		
	All	Top 5	Top 15
Full Prof.	2.4	0	4.1
Assoc. Prof.	5.0	0	4.8
Assist. Prof.	1.9	0	0
Other	14.7	3.4	20.0

Percent distribution by sex						
Level	All		Top 5		Top 15	
	Women	Men	Women	Men	Women	Men
Full Prof.	19.4	39.0	0	47.6	28.6	40.4
Assoc. Prof.	22.6	21.8	0	13.1	14.3	18.3
Assist. Prof.	9.7	25.1	0	10.7	0	17.4
Other	48.3	14.1	100	28.6	57.1	23.9

^aInstitutions in AIP Directory that award Ph.D., M.A., or B.A. in astronomy. There are 97 institutions with a total of 647 faculty members.

^bCalTech, Princeton, Berkeley, Chicago, and Harvard.

^cCal Tech, Princeton, Berkeley, Chicago, Harvard, Wisconsin, Arizona, Cornell, Maryland, UCLA, Columbia, Texas, Michigan, Washington, Yale, (MIT not included because astronomy faculty not easily identified).

TABLE VII. Most common source of job satisfaction and dissatisfaction for AAS members^a.

Source of satisfaction	% of each sex ranking item highest			(Total No.)
	Male	Female	All	
Freedom to make own choices about teaching, research, etc.	19%	14%	18%	(139)
Work itself	16%	22%	17%	(128)
Colleagues	13%	22%	14%	(107)
Facilities	10%	8%	10%	(74)
Good Students	7%	8%	8%	(57)
Stimulating Atmosphere	8%	3%	7%	(55)

Source of dissatisfaction	% of each sex ranking item highest			(Total No.)
	Male	Female	All	
Cuts in, or lack of, funds	10%	12%	10%	(72)
Lack of job security	9%	10%	9%	(67)
Low Salary	9%	7%	9%	(65)
Isolation	5%	10%	6%	(40)
Dead-end job; no advancements	2%	11%	3%	(21)

^aInformation from AAS questionnaire.

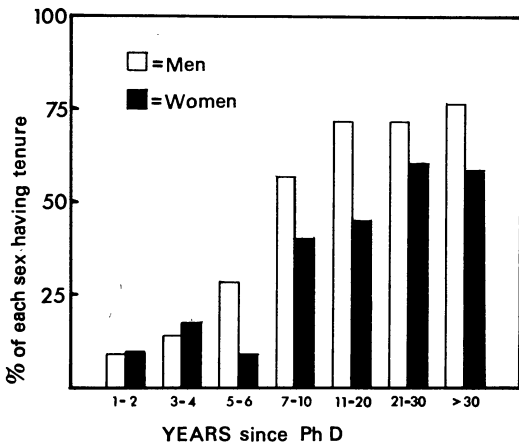


FIG. 5. Distribution of tenured jobs within each sex as a function of length of experience. At nearly every time interval a greater percentage of men have tenure than do women. After ten years of experience most men who are going to attain tenure (about 75%) have it. A smaller percentage of women ultimately attain tenure, and the trend is for women to reach tenure later (curve doesn't level off until about 20 yrs of experience). Data is taken from the AAS questionnaire.

Tenure: One of the questions asked on the questionnaire was whether or not the respondent had job tenure. For completeness we present a histogram (Fig. 5) of the percent of men and women who have tenure as a function of the years since his or her highest degree. During their professional lifetimes, a lower percentage of women have job tenure.

TABLE VIII. Mean salaries at various institutions^a.

Institution	Salary ^b (No. Respondents)	
	Male	Female
Government	\$22470 (90)	[\$29000 (5)] ^c
Industry	20260 (29)	[17500 (1)]
Nat'l. Obs. and Labs	19460 (42)	[21250 (2)]
Planetariums	[19380 (4)]	
Other	17500 (20)	[15000 (3)]
University	17170 (263)	12400(32)
Jr. College	[16560 (8)]	[14170 (3)]
Four-year College	15000 (22)	[16670 (3)]

^aPh.D.'s only; all salaries corrected to full-time. No retired, unemployed, or graduate student. Information from AAS questionnaire.

^bSalaries in brackets are based on too few respondents to be significant.

^cThe Committee on Women in Physics (APS) found that at government installations women's salaries were significantly higher than men's. Upon examination this turned out to be because high administrative positions did NOT go to women so they remained in scientific jobs for many years with continually increasing salaries. Beyond a certain level men became administrators, so male scientists in government jobs tended to be younger and, therefore, have lower salaries than the women scientists.

TABLE IX. Mean salary for AAS members^{a,b}.

Degree	Men	No.	Women	No.
Ph.D.	\$18470	477	\$15194	49
M.A.	\$18030	33	\$17500	8
B.A.	\$16620	17	[\$20000]	3
All	\$18395	531	\$15742	60

^aInformation from AAS questionnaire.

^bValues in brackets are based on too few individuals to be significant.

Hiring Practices: One of the comments which has been made to us is that "inverse discrimination" is now operating, and most astronomical jobs are going to women. As a test of this all prospective employers who listed their job(s) in the AAS Quarterly Register of Job Opportunities for the first quarter of 1972 were queried. In that particular issue 52 positions at 34 institutions were listed. The replies show that 38 positions were filled by men (one full professor, two associate professors, 14 assistant professors, one instructor, five staff scientists, 14 postdoctorals and two research associates). Three positions were not filled, and eight institutions (with a total of eight available positions) did not respond. Therefore, 8% of the positions filled were taken by women, which is nearly the same percentage as women in the field as a whole. However, these positions were at the lowest ranks.

Similarly, of those individuals in the AAS Candidates Register now seeking employment, out of a total of 134, 9% are women. Ninety-seven percent of the men seeking positions have obtained their degrees within the last ten years whereas only 86% of the women have been awarded their degrees since 1963.

Hiring decisions often include making assumptions about what the applicant and his or her family really wants. It is frequently said that "her husband would not want to come here" or "her husband has an offer from another place." This attitude works largely against women, but it also affects men. It is not often operative in the initial screening of applicants from their resumes. Hiring committees should make an effort to avoid judging the desires and preferences of candidates, and try to make their decision solely on merit. Where feasible personal information such as marital status, number of children, etc., should be deleted from standard resume and application forms.

Nepotism: It is clear from the numerous remarks on the questionnaire that nepotism considerations are operating in the astronomical community. Table XII gives some statistics concerning the frequency of married and single individuals in each sex group as well as information about their respective spouses.

Nearly half of all married women astronomers have husbands who are also astronomers or physicists. Another 16% listed their husbands as in another scientific field. On the other hand, only 4% of the married male astronomers have wives who are in the same field and 7% have wives who are in another scientific field.

TABLE X. Mean salary vs year of Ph.D.^{a,b}.

Year of degree	Male		Female	
	Mean salary (No.)	% in sample	Mean salary (No.)	% in sample
1970-1973	\$13 360 (144)	30	\$10 710 (12)	27
1965-1969	17 300 (166)	34	13 000 (18)	41
1960-1964	21 800 (84)	17	[16 000 (5)]	11
1955-1959	24 600 (31)	6		
1945-1954	26 900 (35)	7	[26 500 (5)]	11
1930-1944	27 000 (23)	5	[16 400 (4)]	9

^aInformation from AAS questionnaire.^bValues in brackets are based on too few individuals to be significant.

Individual Remarks: At the end of the AAS questionnaire, comments were invited. One hundred and twenty-seven (17%) of those returning the questionnaire wrote remarks, some quite extensive. Twenty-eight percent of those who wrote remarks were women. Although it is difficult to deal with these remarks in a statistical or objective way, they do reflect astronomers' concerns and therefore are summarized here. Examples are given, but it is important to note that there were remarks on both sides of every issue.

The largest single category (27 people) dealt with personal nepotism problems. In the majority of cases difficulties were encountered even though there were no formal antinepotism rules. Sample remark by a woman in her thirties: "not considered for faculty status... although they had recently formally discontinued nepotism policies, and although nepotism was the original basis for denial." Sometimes the salary or funding discrimination category blends into that of antinepotism. In an extreme case a woman "was told that since the university was paying my husband, it was not necessary that I also receive a salary" (woman in her thirties, currently working without pay).

The lack of a question on discrimination, an unfortunate oversight, was pointed out by several people. Personal and general comments on this subject were made by 23 people. Example: "I notice a subjective discrimination against women here in terms of job expectations and 'pecking order'—i.e., who is assigned the 'diddy' tasks, whose voice is listened to, etc." In addition to discrimination by sex, discrimination

TABLE XI. Distribution of AAS members not working full time in astronomy^a.

Status	% of each sex	
	Men	Women
Unemployed	1%	9
Working part-time	<1	13
Volunteer	0	4
In other fields	17	17

^aData from the AAS questionnaire.TABLE XII. Marriage and "Astronomical Couples" in AAS^{a,b}.

Marital status	Percent of each sex	
	Male	Female
Married	80	70
Single	15	20
Widowed or Divorced	5	10

Occupation of spouse	Percent of married men	
	Percent of married men	Percent of married women
Astronomer or physicist	4	48
Other scientist	7	16
Homemaker	44	0

^aInformation from AAS questionnaire.^b"Astronomical Couples" designates those married couples in which both partners are either astronomers or physicists.

on the basis of age, race (Oriental), nationality, and marital status was reported.

The largest group of categories involves employment and unemployment, which was discussed by 37 people. Many reflected worry, concern, disappointment, pessimism, frustration, bitterness or anger about the present job situation in astronomy, including both the lack of jobs and job insecurity if employed. There were a few positive suggestions, as well as personal tales of woe. These categories of remarks are only marginally related to the subject of this report, although, of course, of utmost importance to the whole astronomical community.

Many interesting remarks didn't fit well into the above categories. For example, by a woman in her

TABLE XIII. Job titles for individuals in "Astronomical Couples"^{a,b}.

Job titles	No. males	No. females
Chairman, Director, Head	2	0
Full or Assoc. Prof.	8	1
Full Astronomer, Senior Scientist	2	7
Assistant Professor	5	3
Scientist or Astronomer	3	2
½-time Assistant Prof.	0	2
Lecturer or Visiting Assistant Prof.	0	2
Postdoctoral Fellowship	1	0
Research Associate	0	3
Volunteer Research Associate	0	3
Scientific Assistant	0	1
Graduate Student	0	4
Other	1	3
Total	22	31

^aData taken from AAS questionnaire.^b"Astronomical Couples" are married couples with both husband and wife either an astronomer or a physicist.

TABLE XIV. Publications of AAS members (January–June 1972)^a.

	Women	Men
AAS membership	220	2578
No. of members publishing	62	1062
Percent of each sex who published	28.2%	41.2%
Average no. publ./author	1.9	2.3

^aInformation taken from *Physics Abstracts*.

thirties: "In retrospect, my main difficulty was in not taking myself seriously enough until it was nearly too late."

III. PRODUCTIVITY IN RESEARCH

Publications: The productivity of women relative to men in astronomical research can be estimated on the basis of the number of references compiled in *Physics Abstracts*. A count of these references for each AAS member during a six-month period (January–June 1972) is given in Table XIV. While the percentage of women publishing papers is less than that for men, the number of papers per author is about the same for men and women.

American women astronomers were contacted individually in an attempt to develop a roster of them. Of the 300 letters sent soliciting responses, 59 women supplied their bibliographies. From this sample, an average publication rate of two research papers per year was found. The roster of 59 women astronomers included several who are unemployed or hold only part-time jobs or who are employed full-time to teach in small liberal arts colleges.

Similarly, data on productivity in research were gleaned from the questionnaire and are summarized in Table XV. Overall figures as well as a breakdown

TABLE XV. Research productivity^a.

Job Location	Average no. of papers/year since award of Ph.D.		No. of respondents	
	Male	Female	Male	Female
All	3.3	2.7	475	47
University	3.2	2.9	268	33
Government	2.7	4.0	90	4
National Obs.	3.8	b	41	•••
Industry	3.8	b	27	•••
Four-Year College	2.4	b	19	•••
Junior College	3.2	2.7	9	3
Other	3.6	b	21	•••

^aInformation taken from AAS questionnaire. The information is not necessarily homogeneous since some respondents may have included abstracts and unrefereed papers, while others don't. Also, higher apparent productivity is found for recent Ph.D.'s since total number of papers is divided by years since degree, although some publications were probably written before degree completion.

^bLess than three individuals per sample.

by place of employment are given. In the mean, women in astronomy publish slightly less than men. However, a greater percentage of women hold part-time, volunteer, or purely teaching positions.

Grants: Out of a total of 158 grants funded by the National Science Foundation in the fiscal year 1973, nine were awarded to women as principal investigator. (Two of these women hold two grants each.) An additional 13 grants were awarded to support women research associates, although the principal investigator is not the woman herself. (Two of these grants support two women astronomers apiece.) It is very difficult to determine the percentage of support from NSF going to women since some scientists are partially funded. However, using a round number of approximately two astronomers supported per grant, we find that about 8% of the NSF grant money supports women astronomers. This figure is near the percentage of women in the field. (Information supplied by J. Wright.)

TABLE XVI. Data on Ph.D. graduates^a.

Data	Women	Men
Median age at Ph.D.	26	27
Average no. years enrolled in graduate school	5.2	4.8
Average no. years from entry to degree	6.0	5.5
% of AAS questionnaire respondents holding a Ph.D.	69%	79%
% of AAS questionnaire respondents currently graduate students	14%	10%

^aInformation from AAS questionnaire.

Advisory Panels and Editorial Boards: It is pertinent to investigate the extent to which women participate in the general activities and responsibilities of the astronomical community, such as the work of various advisory panels and editorial boards.

Among the 930 members of the U.S. National Academy of Sciences, there are some 40–50 astronomers, none of whom are women. The "Greenstein" report, "Astronomy and Astrophysics for the 1970's," was produced for the NAS by the Astronomy Survey Committee. This committee consisted of 23 astronomers, plus about 100 additional astronomers, who served as panel members or contributors. One was a woman.

The report, "Priorities for Space Research 1971–1980," undertaken at the request of NASA and published by the NAS, was the result of a summer study convened by the Space Science Board (SSB) of the NAS. Some 90 scientists, including consultants from abroad, were involved in the study. None were women. The present SSB (18 members) has one woman member; the Space Astronomy Committee of the SSB has two women members.

The *Astrophysical Journal* has no women as editors or on its editorial board. The *Astronomical Journal*

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TABLE XVII. Percentage of degrees awarded to women^a (and total no. of degrees awarded to men and women).

Time interval	BA/BS		MA/MS		Ph.D.	
	Astronomy	Physics	Astronomy	Physics	Astronomy	Physics
1947–1951	19.4% (98)	5.3% (11156)	17.9% (56)	4.6% (3442)	14.0% (50)	2.1% (1265)
1951–1955	17.5% (80)	4.2% (8200)	14.1% (64)	4.2% (3052)	11.1% (63)	1.7% (1959)
1955–1959	22.5% (89)	4.2% (12075)	8.8% (68)	3.2% (3277)	11.4% (70)	2.1% (1869)
1959–1963	18.1% (182)	4.5% (18257)	14.7% (129)	4.2% (5336)	3.8% (78)	1.5% (2470)
1963–1967	12.8% (328)	5.1% (19221)	12.6% (269)	4.1% (7814)	7.0% (185)	2.1% (3876)
1967–1971	12.7% (474)	6.1% (20964)	10.6% (379)	6.0% (8732)	8.2% (329)	2.5% (5444)

^aData taken from "Earned Degrees Conferred by Year-Institutions Data" Department of Health, Education, and Welfare.

has one woman associate editor, compared to seven men. The editorial committee for the *Annual Review of Astronomy and Astrophysics* contains 11 men. For comparison, in the *Annual Review of Astronomy and Astrophysics*, volumes 1–11, nine of the 218 contributors are women. The Astronomical Society of the Pacific has one woman and ten men on the Board of Directors.

Fourteen percent of the members of committees of KPNO (Users and Telescope Allocation Committee) are women astronomers. The 12 universities comprising AURA each appoint two Board members; all 24 of these members are men. Of the five members-at-large of the AURA Board (the only Board members the Corporation is free to select), one is a woman, as is one of the nine Visiting Committee members.

Guest Investigators at National Observatories: Of the guest investigators at Kitt Peak, last year 10% were women. Only about 4% of guest observers at NRAO are women; this small percentage may reflect the low percentage of women in radio astronomy, because the women's applications for time are filled in this same proportion as are those of the men. (Information supplied by W.E. Howard.)

IV. GRADUATE STUDY

Table XVI shows comparative statistics on men and women graduate students. Data on the percentage of degrees awarded to women in physics and astronomy are given in Table XVII. These figures were taken from the annual publication of the Department of Health, Education and Welfare, "Earned Degrees Conferred by Year—Institutional Data," and represent a complete sampling. The percentage of women receiving the Ph.D. degree in astronomy has decreased from 14% during 1947–1951 to 8.2% during 1967–1971. In contrast, physics shows a smaller percentage of Ph.D. degrees awarded to women, but the percentage has not changed with time.

Graduate departments offering the Ph.D. in astronomy have been polled to find out how many and why students drop out of graduate school. Data in Table XVIII indicate that 52% of the men finish with a Ph.D. while 33% of the women receive the Ph.D. The difference is due to the fact that more women leave with a Master's degree. The number of students leaving with no degree is the same for both sexes.

In Table XIX we have summarized the reasons given for terminating before completing the degree. For women the most frequent reason given for terminating studies is marriage, while for men it is academic or unknown.

Data on financial support for graduate students are presented in an appendix (data for NSF). In summary, these data show that women represent approximately 10% of students in astronomy departments and 6% in combined physics and astronomy departments. Table XX shows the level of support for these students is similar for both men and women. In a published study of graduate students in all fields at Harvard it was found that the attrition rate for graduate students was similar for women and men who were given equal financial support. Furthermore, after the doctorate, 91% of the women Ph.D.'s continued working, 80% without interruption. Hence, it appears imperative that to produce productive women Ph.D.'s women graduate students must be supported at levels equal to their male counterparts.

SUMMARY

I. AMERICAN ASTRONOMICAL SOCIETY

Membership: The percentage of women in the AAS is now the lowest that it has been in the history of the Society. There is a marked decrease in the percentage

TABLE XVIII. Survey of graduate students between 1962 and 1972.

	Women	Men
Number admitted	236	803
Received Ph.D.	58	319
Current students	62	185
Number terminating		
before Ph.D.	116	299
(a) with MA/MS degree	59	88
(b) no degree	51	159
(c) not accounted for	6	52
Percentage receiving		
(a) Ph.D.	33%	52%
(b) MA/MS	34%	14%
(c) no degrees	29%	26%
(d) not accounted for	3%	8%
Number institutions reporting	46	29

TABLE XIX. Reported reasons graduate students terminate before Ph.D.^a

Reason	Percentage (numbers) of each sex					
	Women	Men	Women	Men	Women	Men
Marriage	31% (12)	0% (0)	26% (11)	0% (0)	28% (23)	0% (0)
Other employment	18% (7)	17% (11)	7% (3)	8% (10)	12% (10)	11% (21)
Personal	10% (4)	1% (1)	12% (5)	3% (4)	11% (9)	2% (5)
Academic	13% (5)	30% (20)	21% (9)	38% (30)	17% (14)	35% (70)
Change field	10% (4)	6% (4)	12% (5)	9% (12)	11% (9)	8% (16)
Change universities	5% (2)	15% (10)	12% (5)	14% (18)	9% (7)	14% (28)
Highest degree desired	0% (0)	11% (7)	0% (0)	0% (0)	0% (0)	4% (7)
Unknown	13% (5)	20% (13)	12% (5)	28% (37)	12% (10)	25% (50)
Death	0% (0)	0% (0)	0% (0)	1% (1)	0% (0)	<1% (1)
Totals	100% (39)	100% (66)	100% (43)	100% (132)	100% (32)	100% (198)

^aFrom information supplied by 29 graduate departments for period 1962–1972.

of women members since 1940 (17%) to the present (8%). Are we encouraging enough women to enter astronomy?

Membership on Committees: Women have generally been under-represented as Society officers, committee members, prize recipients, invited speakers, session chairmen, and journal editors. Are women overlooked simply because they are not visible enough? Will the recent elimination of a sex-restricted prize increase the probability of women being considered for other awards?

The IAU: The U.S.A. ranks seventh in the percentage of IAU members who are women (6.6%), far behind France (20%), and USSR (15%). One could infer from these numbers that other countries have a higher percentage of women in the sciences. Does this reflect a different attitude towards women in the professions?

II. EMPLOYMENT

Job Titles and Salary: Most of the women Ph.D.'s have the less prestigious, untenured positions. In academia, the percentage of women decreases as the faculty level increases. At 28 universities, the ratio of faculty to research positions for men is 61% to 35%, while for women the ratio is nearly reversed (36% to 52%). The data upon which this study is based indicate that "inverse discrimination" in hiring was not operating in favor of women in 1973. Many more women than men comment about isolation and no possibility of advancement in their jobs. What factors are operating to keep the women in these less prestigious positions?

We believe that several factors keep women in the lower level positions. Hiring and promotion policies of universities and departments (i.e., sex discrimination) and antinepotism policies have been responsible in many cases. Today no one will admit to sexual discrimination in hiring, although in the past employers have readily stated that women were poor risks because of the likelihood that they would marry. This is not to imply that attitudes are not changing. Women may now observe with the largest telescopes and attend certain graduate schools where they were previously excluded because of their sex.

Although one can point to two examples of women in highly responsible posts in NASA-oriented astronomical

activities, women generally receive lower salaries than men, even for the same position and same length of experience. What justification can reasonably be given for this salary difference? Since more women are in lower positions and apparently are not promoted at the same rate as men, they of course receive less pay.

Hiring Practices and Nepotism: Antinepotism practices are working against women and are partly responsible for keeping women in nonfaculty positions. Even though many universities have recently rescinded their restrictions in hiring husbands and wives together, the woman must sometimes wage a lengthy battle with her department and university to have her position improved, even after many years of service.

III. PRODUCTIVITY IN RESEARCH

The percentage of women (28%) who publish papers in the *Astrophysical Journal* is less than the percentage of men (41%) in the AAS, but the numbers of papers per author is about the same (two papers/six months). Thus, women are nearly as productive as the men which is remarkable since they can look forward to fewer "rewards" for their work. Is it not the astronomical community as a whole which has the most to lose for not fully utilizing the talents of its women members?

IV. GRADUATE STUDY

The percentage of Ph.D.'s in astronomy granted to women has been declining since 1947 (14%) to the present (8%), while in physics the percentage is lower (2%), but has remained constant during the same period.

Fifty-two percent of men entering astronomy graduate programs receive the Ph.D. while 33% of the women get a Ph.D. This may not reflect academic pressure so much as social pressures. The most frequent reason given by women for quitting graduate school is marriage, while for men it is scholastic problems.

Every graduate student has periods of self doubt and a women student who marries during graduate school may find it actually more acceptable to quit. Are her advisors and other faculty members encouraging her to continue instead of writing her off as a lost cause when she marries?

TABLE XX. Financial support for graduate students 1972-1973^a.

Departments	No. of Depts.	Full-time students			% of each sex with support > \$1 200	
		Men	Women	% Women	Men	Women
Astronomy, Astrophys., Astr.&Space Sciences	30	523	52	9.0%	87%	86%
Physics&Astron.	18	875	54	5.8%	89%	83%
Physics	220	8822	571	6.1%	91%	88%
Chemistry	216	10092	1842	15.4%	94%	93%
Physical Sciences	683	25787	3161	10.9%	89%	88%
Math. Science	320	10595	2383	18.4%	76%	73%

^aFrom NSF records based on their own questionnaire to various graduate schools.

The current enrollment in graduate astronomy departments is about 10% women. The level of financial support is similar for men and women.

RECOMMENDATIONS

From our study, we believe that women astronomers face greater obstacles in almost all aspects of their professional careers than do their male counterparts. While we recognize that there may be problems peculiar to the education and employment of women, we believe that the astronomical community can only be enriched by the employment and acceptance of women as colleagues.

Specifically, we ask the Council of the AAS to accept the following recommendations of the Working Group on the Status of Women in Astronomy.

(1) The Council of the American Astronomical Society strives for the goal of equal encouragement, equal acceptance, equal recognition, equal employment, and equal salary for astronomers of equal ability and achievement, without regard to sex. Within the Society, every attempt will be made to utilize women in positions of responsibility consistent with the numbers of qualified women. As one step in identifying women astronomers, the roster of women astronomers will be made available to all officers of the Society and of its divisions, the Nominating Committee, the prize and lectureship committees, and to the editors of its publications. This list can be used to identify women astronomers for the following purposes:

- (a) nomination for Society offices,
- (b) appointment to committee memberships,
- (c) nomination for prizes and lectureships,
- (d) presenting invited papers,
- (e) chairing sessions at meetings,
- (f) appointment to journal editorships,
- (g) refereeing journal manuscripts.

The Council urges all astronomers to work toward these goals.

(2) To the academic community, the Council recommends the encouragement of women astronomy stu-

dents at the undergraduate and graduate levels. Such encouragement can take many forms: financial assistance on the basis of ability; equal opportunities for informal scientific contacts; minimizing restrictions on transferring credits, part-time study or returning to studies following an interruption; but especially, strong moral support for the student and her ability to do the job. Often, such encouragement can play a fundamental role in producing a valuable member of the astronomical community.

Secondly, the Council encourages all employers to adopt the following guidelines:

(a) to support and to implement Affirmative Action Programs at their place of employment,

(b) to give equal consideration to women of equal ability and achievement,

(c) to consider making available senior appointments on a part-time or reduced-load basis,

(d) to replace written or unwritten antinepotism rules by conflict of interest rules,

(e) to invite women astronomers outside the local academic community to participate in the scientific activities of the department by attending seminars, by presenting lectures, by serving on visiting committees, and by counseling students.

We feel that these actions will enhance the value of women astronomers to the astronomical community as a whole.

(3) To implement the goal of (1), the Working Group on the Status of Women in Astronomy asks:

(a) that the Council sponsor the publication of this Report in the BAAS or other suitable journal,

(b) that the Council authorize a member of the Society to maintain an up-to-date roster of women astronomers,

(c) that the Executive Officer of the Society be authorized to make available copies of the Report and the Roster to all who request it,

(d) that the President of the AAS send a letter to all department chairpersons, observatory directors, and major employers of astronomers outlining the conclu-

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sions of the study of the Working Group, referring to the publication of the Report and including Recommendations (1) and (2) in their entirety. The letter should ask their support in the implementation of the recommendations.

ACKNOWLEDGMENTS

We would especially like to thank several people who have been most cooperative and helpful, namely B.J. Bok, H.M. Gurin, and C. Tolbert. We are indebted to Kitt Peak National Observatory for assistance in the preparation of the manuscript, and we are most appreciative of the assistance the Society has given in the printing and distributing of the questionnaire to the membership, supplying us with funds for data reduction, and printing our notices in the Preliminary Announcement brochures for forthcoming meetings.

Members of the Working Group who are primarily responsible for this Report are A. Cowley, K. Garmany,

N. Houk, R. Humphreys, J. Lutz, B. Lynds, H. Malitson, M. Risley, V. Rubin, and L. Willson. Other contributors include L. Bautz, C. Cowley, K. Docken, A. Dupree, J. Goad, H. Gurin, S. Heap, J. Karpen, S. Maran, I. Marinen-Little, J. Rubin, S. Simkin, and R.E. White.

Respectfully submitted by the American Astronomical Society's Working Group on the Status of Women in Astronomy.

[*Note Added in Proof:* On 3 December 1973 in Tucson, Arizona, the AAS Council unanimously accepted the Report and adopted the recommendations of the Working Group on the Status of Women in Astronomy.]

A. COWLEY

R. HUMPHREYS

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* This report was received by the Council at the 142nd Meeting of the AAS and the recommendations contained therein are under consideration.

ANNUAL REPORT FOR THE ASTROPHYSICAL JOURNAL: MARCH 1974

LETTERS TO THE EDITOR

The transition to a new Letters Editor was made smoothly in September 1973. Dr. A. Dalgarno has assumed the position from Dr. John Mathis and is assisted by Associate Letters Editors Dr. Eugene H. Avrett, Dr. John N. Bahcall, Dr. Hale V.D. Bradt, Dr. Michael B. McElroy, and by Secretary Mrs. Barbara Plakans. We are grateful to them for their generous help, good judgment, and efficient management of the Letters section of the *Journal*.

The optimum length of papers in the Letters section has been four pages, allowing for the publication of about a dozen papers per issue. Despite the 40% increase in page content with the new *Journal* format, it did not seem reasonable to reduce the paper length to two or three pages. Therefore, we are retaining the four-page optimum size and have arranged with the University of Chicago Press for an expansion to 50 pages per issue in the new format at no increase in subscription costs.

JOURNAL CHANGES

The *Journal* converted to the larger 8 X 10½ in. size with the 1 January 1974 issue. The new format saves considerable expense in production and allows greater flexibility in the sizes of figures, tables, illustrations, and equations. We trust that the options to the authors of one- or two-column format will satisfy their needs. I congratulate the *Journal* staff at the University of Chicago Press for their good taste in the *Journal* composition.

A microfiche edition of the *Journal* was also started with the 1 January 1974 issue. Subscribers may sub-

scribe to either the paper or microfiche editions at the same rates or to both at a reduced rate for the second. Microfiche issues are sent by airmail to foreign subscribers. The paper edition tables of contents list the location of papers in both the paper and microfiche editions.

A tentative Table of Contents is now being published in each issue of Part 1 of the *Journal* for the issue to be published 2½ months later. These tables of contents are not indexed because it is anticipated that they will be removed in binding.

We are starting to add at the end of each paper the authors' postal addresses; the title pages will give only the authors' affiliations.

PAPERS AND REFEREES

Statistics for calendar year 1973 follow; these do not include errata or abstracts of Supplement papers:

	Part 1 + Supplements	Part 2
Papers received	890	475
Papers published	759	269
Number of different referees consulted	555	213

For Part 1, the publication time is about 4½ months following acceptance. For Part 2 the average publication time is 75 days following receipt for the 54% of the papers that are not revised, and 95 days for the revised papers.