STATUS

A REPORT ON WOMEN IN ASTRONOMY

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Katy Garmany, Editor

Women in Astronomy; Meeting the Challenges of an Increasingly Diverse Workforce

Dr. Anne Kinney, Director, Solar System Exploration Division, GSFC
Chair of Women and Minorities in Astronomy III, 2009 Organizing Committee

Here are my opening comments from the meeting on Women in Astronomy held from October 21 to 23, 2009 at the University of Maryland Conference Center, along with a brief description of the contents of our proceedings, and recommendations on next steps.

The proceedings are available on the web site (http://wia2009.gsfc.nasa.gov/). Note also there were two thoughtful articles on the meeting published in the January 2010 issue of the American Astronomical Societies newsletter SPECTRUM, published by the Committee on the Status of Minorities in Astronomy (http://csma.aas.org/Home.html); *"Women in Astronomy 2009; Lessons and Outcomes Relevant to Underrepresented Minorities"*, by Laura Lopez, and *"Did WIA2009 Really Address the Challenges of Increasing Racial Diversity?"* by Jarita Holbrook.

We were excited by the response to our meeting, and were thrilled with the attendance of over 300 people that included an energized cadre of early career scientists as well as mid career and senior scientists from 57 different universities. We were especially pleased to have in attendance managers and mentors of the scientific workforce representing: Carnegie Observatories, Gemini Observatory, Harvard Smithsonian Center for Astrophysics, Jet Propulsion Lab, National Optical Astronomical Observatory, National Radio Astronomy Observatory, National Science Foundation, NASA Headquarters, NASA Ames, NASA Goddard, NASA Langley, and NASA Marshall, Massachusetts Institute of Technology, Planetary Science Institute, Search for Extraterrestrial Intelligence, Space Telescope Science Institute, Spitzer Science Center, and Yale. Societies that represent scientists were also in attendance; the American Astronomical Society, American Institute of Physics, and American Physical Society were all well represented.

The topics of this meeting focused on the senior scientists who mentor and manage the workforce, the mid-career scientists who face the full range of challenges, including balancing home and work, and the early career scientists who represent the future of the field. Our workforce now spans six generations, where the youngest scientists make up the most diverse group. The generational gap is simultaneously a cultural gap.

In the 16 years since the first Women in Astronomy meeting, we have seen vast changes in the field, some of which are summarized in papers by Rachel Ivie, Catherine Cesarsky, and Claude Canizares. Women now make up a much larger fraction of the field than they did 16 years ago, when American Astronomical Society membership for those under the age of thirty was less than 20% female, compared to today's 40%. Meanwhile, there have been few changes in the presence of minorities in the field.

I believe that the rapid progress of women in the field is due in part to the sharing of lessons learned within what was for years a disenfranchised cadre of female scientists, and by the ability of these scientists to mentor each other in a field where true mentoring is rare. As the field struggles to increase its diversity to underrepresented minorities, these lessons for success may be very valuable. One of the aims of this meeting was to capture some of these successful practices in the hope of applying them towards the success of minorities in astronomy and space science.

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Editor's Comment – Staffing Changes at STATUS

Pat Knezek

After 5 years of dedicated service, Fran Bagenal decided to step down as the editor of STATUS. Fran's first issue was the June 2004 edition. Not only did she do an exemplary job of soliciting contributions and overseeing the production of each issue but she also wrote many of the articles herself during her term as editor.

In her letter of resignation, Fran told us that she was ready to move on to other things. She is a professor in Astrophysical and Planetary Sciences at the University of Colorado and specializes in the synthesis of data analysis and theory in the study of space plasmas.

On behalf of the CSWA, as well as continuing associate editor, Joannah Hinz, and myself, I wish to thank Fran for her service and wish her all the best in her future pursuits. We have definitely benefited from her guidance and dedication, and appreciate the work she has done to promote women in astronomy.

Stepping into such big shoes will be a challenge. Thus, I'm delighted to introduce Catharine (Katy) Garmany as the new editor of STATUS. I've known and worked with Katy for a number of years, and I know she will do an excellent job in her role as editor, and very much look forward to the opportunity to work with her in this venue.

In addition to bringing Katy on board, Arti Garg has joined Joannah Hinz and myself as an associate editor. Given the staff changes, and the fact that it has been a year since our last issue, I thought it would be appropriate for us to (re)introduce ourselves, so below are brief biographies for each of us (in alphabetical order!).

Dr. Arti Garg: Arti recently joined the Office of Research and Graduate Studies at the University of California Office of the President (UCOP). She is working in the Research Accountability and Coordination Unit, where her responsibilities include analyzing and reviewing system-wide research investments. Prior to joining UCOP, she served as an legislative science fellow in the House Foreign Affairs Committee. Following her PhD, she was a post-doctoral research at Lawrence Livermore National Laboratory. Her astronomy research focuses on time-varying astrophysical phenomena. She is married to a physicist who now works in the semi-conductor industry.

Dr. Catharine Garmany: Katy is part of the Education and Public Outreach (EPO) group at the National Optical Astronomy Observatory (NOAO). She is the Editor of the NOAO/NSO Newsletter, and serves as NOAO Diversity Advocate, along with Dara Norman. Prior to coming to NOAO, she was the Director of an astronomy program at Biosphere 2, and before that spent many years at the University of Colorado, both as a researcher with a special interest in hot stars, and later director of the planetarium and observatory on the campus. She is married to astronomer John Glaspey, and proud that her 4 year old grandson can find Jupiter for his father!

Dr. Joannah Hinz: Joannah is an assistant astronomer at the University of Arizona working on infrared observations of nearby galaxies using the Spitzer and Herschel telescopes, with interests in dust content and outer disk evolution. She is a former member of the CSWA and has been an associate editor of STATUS since 2002.

Dr. Patricia Knezek: Pat is an associate scientist at the National Optical Astronomy Observatory (NOAO), and is currently serving as the Acting Director of WIYN Observatory. Her varied career path since finishing her Ph.D. has taken her to U. Michigan, Las Campanas Observatory, Johns Hopkins, STScI, and now NOAO/WIYN. Her research focuses on the interplay of star formation and galaxy evolution. She is a former member of the CSWA, and has been an associate editor of STATUS since 2004. She is currently active in the working group developing the AAS/AIP Longitudinal Study of the career paths of astronomers. She and her partner, a mechanical engineer who designs astronomical instruments, are currently struggling first hand with balancing work/life and the needs of aging parents.

Women in Astronomy *continued*

THE CHANGING SCIENTIFIC WORKFORCE

As a microcosm of this world, let me share with you the numbers for the Solar System Exploration Division at Goddard Space Flight Center, which I now lead. There are 100 Civil Servant scientists in the division, with approximately 60% senior, 20% mid-career, and 20% early career scientists.

Of the early career scientists, 50% are female, 10% are African American, 10% Asian/Pacific Islander, none Hispanic, and an unknown percentage LGBT, reflecting the "don't ask, don't tell" policy of today's workplace.

In comparison, the senior scientists are 10% female, with 1% minority. Mid-careers are approximately one-third female, 5% African American, and 15% Asian/Pacific Islander. Again, percentages of LGBT are unknown.

Meanwhile, at NASA, the highest status positions are those of Principal Investigator, Project Scientist, and Instrument Scientist. Of the twenty scientists playing these roles in Solar System Exploration Division, none are women, and one is Asian/Pacific Islander.

The precise status of this microcosm of the scientific workplace? One challenge has been overcome, with the pipeline for women up and running and producing highly competitive scientists, who are getting hired at a rate approaching 50%.

But several other challenges remain: the pipeline for minorities, the success of these women in the workforce, and the need to increase awareness of LGBT issues such that scientists are comfortable bringing up workplace problems of real concern to this multiple-minority.

Here also is the concise location of the wave of women in the science workforce; women are present in large numbers at the junior level, which creates the impression that they have been fully accepted. Yet no female scientists have made it into the highest status positions of this particular workplace microcosm, the Solar System Exploration Division at Goddard Space Flight Center.

CONTENTS OF PROCEEDINGS

The topics of our conference encompass these concerns. In the proceedings there are several papers capturing the statistics for women in the field from Dr. Rachel Ivie of the American Institute of Physics, Dr. Claude Canizares on the National Research Council study, and finally from Dr. Catherine Cesarsky with international statistics for women in astronomy. Our proceedings contains papers concerning issues of bias, papers concerning the building the next generation of scientists, a discussion on how institutions and professional societies can aid in retention and recruitment, and a discussion on paths to non-academic careers. Additionally there are papers addressing best practices of proposal submission, gender imbalance and diversity, career choices and work/life balance, previous Women in Astronomy meetings, and progress within Historically Black Colleges and Universities.

In addition, there are numerous papers focused on everything from how to become a Project Scientist, to interacting with the media, marketing your science, how to set up a lactation facility, and a brief section on history.

CONCLUSIONS

1. Creating an Atmosphere of Engaged Interaction

There were several important "ah-ha" moments for me at this meeting. First, we were able to create an atmosphere of engaged discussion, especially involving cross-generational interactions between scientists. For a field dominated by scientists who have better scientific skills than social skills, this was an accomplishment that served our purpose of transfer of best practices. We created this atmosphere by the conference starting each day with a "networking breakfast," where early career scientists signed up to sit at tables populated with various senior scientists. These breakfasts, held between seven and eight AM, served to kick off the day with interactions between junior and senior scientists, and they set the tone for the whole meeting. We thank the senior scientists who agreed to show up at the un-scientific hour of seven AM, ready to engage our early career scientists in active discussion; Dr. Meg Urry, Dr. Debbie Elmegreen, Dr. Coleen Hartman, Dr. Ed Weiler, Dr. Mark Sykes, Dr. Kathie Olsen, Dr. Keivan Stassun, Dr. Barbara Williams, Dr. Fran Bagenal, and Dr. Laurie Leshin.

This activity is well worth imitating in any organization where sharing of lessons learned is important. Here at Goddard Space Flight Center we are imitating it by setting up "networking breakfasts" between Emeritus Scientists and new hires, and by organizing lunches to facilitate communication between mentors and mentees. We aim to create an atmosphere where early career scientists communicate often and openly with senior scientists who can serve as both official and unofficial mentors.

2. Early Career Scientists in an Increasingly Challenging Environment

Dr. Canizares closes his paper discussing the nature of the field that we have created. Scientists earn PhDs anywhere in the range from the age of 25 to 35. They are then expected to have one to two post doctoral positions lasting approximately three years each. Then, at the ages of 31 to 41 they will "graduate" to a job at a salary level beyond that of an apprentice. If that job is a tenure track position, there could be an additional six years before achieving tenure. This challenging career track, where there is

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little stability or security for raising a family until a person is well into their 40's, may be discouraging not only for women and men, but also for a diverse population of scientists.

There is a need to reach out to early career scientists and give them the tools to survive the ever-expanding obstacle course of our field. A good example of such an outreach program is the "Next Generation Lunar Scientists and Engineers Program," headed by PI's Dr. Noah Petro and Lora Bleacher, a three-year program funded from the NASA EPO for Earth and Space Science. The Next Gen Program goal is to enable members to become better equipped to contribute to the lunar program. The program organizes workshops for early career scientists prior to major meetings in Lunar Science. The program provides 24/7 communications and networking opportunities via the web as well as networking opportunities between junior and senior level lunar scientists with an emphasis on the cross over between science and engineering. Their approach is one that could be readily adapted to help early career scientists be aware of and develop the survival tools needed in astronomy and planetary science.

3. Increasing Diversity

The final "ah-ha" moment for me concerned the situation with minority scientists. We had excellent presentations about the programs of Spelman College, the University of Maryland in Baltimore County (i.e. the Meyerhoff Program), and the Fisk Vanderbilt University Bridge Program. These programs are producing high quality minority students who are continuing into graduate school and into successful careers in science. This is a pipeline to which the field must pay attention. I suggest that the next meeting in the WIA series concentrate on the pipeline for minorities in Astronomy and Planetary science, with an emphasis on intern programs and workshops for early career scientists. I hope that NASA and NSF will be interested in supporting such an important effort.

Women and the Imposter Syndrome in Astronomy

Rachel Ivie and Arnell Ephraim
Statistical Research Center, American Institute of Physics

It's likely that at one time or another, almost anyone who has been to graduate school may have experienced what some psychological researchers call the "imposter syndrome." The imposter syndrome has been defined as the belief that you don't really belong in your chosen field or occupation. This can happen when we doubt ourselves and wonder if we made the right choice to come to graduate school, take a postdoc, or work at a particular university or research institute.

The imposter syndrome was first used by psychologists Pauline Clance and Suzanne Imes in 1978 to describe highly successful women who nevertheless had difficulty internally recognizing their own achievements and continued to feel as though they were imposters in their careers. Since that time, further research has demonstrated that men can also exhibit characteristics of the imposter syndrome. In further describing the imposter syndrome, Langford and Clance (1993) wrote that the syndrome is defined by "believing that one's accomplishments came about not through genuine ability, but as a result of having been lucky, having worked harder than others, and having manipulated other people's impressions." One key aspect of the imposter syndrome is the attribution of your own success to factors beyond your control, such as luck, while attributing the success of others to skill or knowledge. But it is not just external factors to which those with the imposter syndrome attribute their successes. People with the imposter syndrome can also discount their successes by attributing them to hard work, while believing that others sail through based on natural talent. Another version of the imposter syndrome is to feel that you have in some way, probably not consciously, tricked or fooled your colleagues into believing that you are much smarter than you really are. Perhaps you studied really hard and made a high score, but secretly you "know" that these achievements don't reflect your true "inadequate" self.

The issue of the imposter syndrome was interesting to the working group charged with surveying astronomy graduate students as part of a longitudinal study. The working group hypothesized that the imposter syndrome would exist for astronomy graduate students and might even explain why some people eventually drop out of astronomy. Would the imposter syndrome manifest itself more strongly in women, thus contributing to a higher drop-out rate among women than men? The working group set out to answer these questions and others.

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Women and the Imposter Syndrome in Astronomy *continued*

Background of the longitudinal study

In 2003, the Pasadena conference on Women in Astronomy adopted a resolution (later adopted by the AAS Council) which expressed their interest in conducting a longitudinal study of women in astronomy using sound statistical methods. In response to this recommendation, the Committee for the Status of Women in Astronomy convened a working group to design a study to track graduate students in astronomy over several years. The working group members were Patricia Knezek, Audra Baleisis, Susana Deustua, Stefanie Wachter, Jennifer Neakrase and Rachel Ivie.

The longitudinal study was designed to:

- collect data on people who obtain graduate degrees in astronomy,
- compare attrition rates, starting in graduate school, for men and women,
- collect data on people who leave the field of astronomy, and
- collect data on astronomers who work outside the traditional employment sectors of academe and the observatories.

The first survey in the study:

- examines whether or not the "imposter syndrome" exists among astronomy graduate students.
- was funded by the AAS Council and the American Institute of Physics (AIP). The AIP Statistical Research Center (SRC) collected the data.
- can't be used to draw conclusions on employment outcomes or attrition because we have only collected data at one point in time.

How we collected the data

The target group for this study was U.S. astronomy and astrophysics graduate students during the 2006-2007 academic year. To survey these students, the SRC gathered contact information from the following: (1) the AAS junior membership list; (2) lists of graduate students supplied to the SRC by physics and astronomy departments; and (3) announcements in the AAS newsletter that invited students to contact the SRC if they wanted to participate in the study. The final contact list included 2,056 names.

The questionnaire was available on paper and on a secure website hosted by AIP. Initially, all students were contacted electronically. The SRC sent a notice describing the study, an invitation to complete the questionnaire on a secure website, follow-up email requests to complete the survey, and a special email to the students who started the survey on the web but did not complete it. Paper versions of the questionnaire were mailed to contacts who had not responded after four months of contacting them electronically.

Survey Questions

The questionnaire asks for demographic information and includes questions about variables thought to influence attrition, including perception of mentorship, feelings of isolation, the imposter syndrome, and self-perception about potential to develop into good researchers or teachers. Because of space constraints, only results explaining the imposter syndrome are presented in this article.

Demographic Variables

Demographic variables include questions about sex, year of birth, number of years in program, part-time v. full-time student classification, citizenship status, source of graduate school funding, educational goals, and parents' education. Details about some of the measures used in the multivariate analysis include:

- Number of years in program was measured by asking the students the month and year they entered the program they attended during 2006-07, and calculating the number of years between entry and academic year 2006-07.
- Citizenship status was measured by asking students to classify themselves into three categories: US citizen, permanent US resident, or temporary visa. US citizens and permanent residents were combined for this analysis, following the system used by the NSF.
- Source of graduate student funding was measured by asking respondents to indicate their primary source of graduate study support during 2006-07. There were nine choices given. The three most common answers were teaching assistantship (21%), research assistantship (57%) and fellowship (16%). The remaining responses were combined into "other funding" for this analysis and include: family, savings, loans, tuition reimbursement from outside employment, students' income from outside employment, foreign government support, and military assistance. The analysis compares research assistants, people who have fellowships, and people who had other funding to teaching assistants.

Mentoring

Mentoring was measured by a simple yes/no question: "Did you feel you were mentored in the astronomy or astrophysics graduate program that you attended during the 2006-2007 academic year?" 72% reported that they felt mentored. This question doesn't allow us to determine what the source of mentoring was for the student. Mentoring could have been received from a faculty member, from another student, or from some other person. We will follow-up on mentoring in the second survey to find out more about the respondents' mentoring experiences.

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Imposter Syndrome Measures

Questions from the Clance Imposter Scale (1988) and Harvey Imposter Scale (1981) were used to measure the imposter syndrome but were modified for use with astronomy students. Using a five-point scale (strongly agree to strongly disagree), students were asked to rate the level to which they agreed with the statements below. The tendency to agree with items one through four below is indicative of the imposter syndrome. The tendency to disagree with items five through seven below also is indicative of the imposter syndrome.

1. In general, people tend to believe I am more competent than I really am.
2. Sometimes, I am afraid others will discover how much knowledge or ability I lack.
3. At times, I feel I am in my current career position though some kind of mistake.
4. When I succeed, it is because I work much harder than others.
5. The major cause of success in my life is my high ability.
6. I feel highly confident that I will succeed in my future career.
7. I am at least as smart as my peers.

For this analysis, "strongly agree" and "agree" responses were combined to indicate agreement, and the other responses (neither agree nor disagree, disagree, and strongly disagree) were combined for those who did not agree.

Hypotheses and Methodology

The hypotheses that we tested include:

- The imposter syndrome would be more likely to occur among women than among men. Women are under-represented in astronomy, so we thought that this could contribute to a feeling of not belonging in the field.
- Feeling mentored in graduate school will decrease the likelihood of the imposter syndrome.
- The longer a student stays in graduate school, the less likely they are to experience the imposter syndrome (Although the results related to this finding are not discussed in this article due to space limitations, it is worth noting that this hypothesis was not confirmed).
- Students who have traditional types of funding (research assistantships, teaching assistantships, and fellowships) are less likely to experience the imposter syndrome than those who rely mostly on less traditional funding (family, savings, loans, tuition reimbursement from outside employment, students' income from outside employment, foreign government support, and military assistance).
- Citizenship will make a difference in the imposter syndrome, but we were not sure in which direction.
- Full-time students will be less likely to feel like imposters than part-time students.

We were mostly concerned with discovering sex differences in the imposter syndrome, if they exist. But we knew that what appears to be a sex difference could really be the effect of some other variable, so we included potentially important independent variables in multivariate logit models. If sex differences in these models were shown, we would know that the differences exist independently of the effects of other independent variables. In all, we ran seven different logit models. In each model, one of the seven imposter syndrome measures was the dependent variable, and the independent variables were: sex, feeling mentored, length of time in graduate school, source of funding, citizenship, and full-time status. Each dependent variable had two categories: "agree" and "do not agree."

Results

Due to space constraints, only the effects of mentorship and sex on the imposter syndrome will be discussed in this article. Other results will be published at http://www.aip.org/statistics or are available from the authors.

Responses

We received 1,576 responses to the survey. Of that number, 1,348 respondents identified themselves as graduate students in astronomy or astrophysics. Of these, 1,143 identified themselves as male or female and were therefore included in the analysis.

Demographics

Approximately 40 percent of the respondents identified themselves as women. Most of the respondents' parents have college degrees. The majority of the respondents were U.S. citizens. Twenty-three percent of the respondents reported having temporary student visas.

Table 1. Demographics

Variable Description	Frequency
Female	39%
Mothers have college degrees	64%
Fathers have college degrees	71%
U.S. Citizen	77%
Planning to obtain a PhD	91%
Full-Time status	97%
Median Age	27 years
Median Length of Time in Program	3 years
# Analyzable responses	**1,143**

Mentoring Matters

Feelings of mentorship are linked to positive outcomes for both men and women. Students who reported feeling mentored appear to be less likely than others to exhibit characteristics of the imposter syndrome. Mentored students were more likely than others to report that the major cause of success in their life was due to high ability and that they are at least as smart as their peers. Students who reported feeling mentored were also less likely to report that they felt they were in their current career position through some kind of mistake (Table 2).

Women are more likely than men to show characteristics associated with the imposter syndrome. For example, women were more likely than men to say that they were afraid others would discover how much knowledge or ability they lack. Women were also less likely to attribute their success to high ability and less likely to report feeling confident in their ability to succeed in their future careers (Table 2). Furthermore, women may be more likely than men to report feeling that they had to work much harder than others to succeed (Table 2, $0.05<p<0.10$). The statistical results from Table 2 are summarized on Table 3.

A note about statistical significance levels: On Table 2, results that are considered statistically significant are denoted as either $p<.01$ or $p<.05$. This refers to the probability that the results would have occurred by chance alone. If $p<.01$, the results would have occurred by chance alone less than 1% of the time, and for $p<.05$, the results would have occurred by chance less than 5% of the time.

Conclusion

Our hypothesis that women astronomy graduate students would be more likely than men to feel like imposters was confirmed. Women in graduate school in astronomy or astrophysics do tend to feel more like imposters than men, at least on three of our measures of the imposter syndrome and probably on a fourth. We also found that if students, both male and female, are mentored, they are less likely to feel like imposters in astronomy. Mentoring is often cited as a mechanism for improving retention of students in science, but mentoring has not often been linked in research to outcomes such as graduation rates and employment (George and Neale, 2006). George and Neale also write that "more . . . mentoring studies that follow cohorts of students or scientists

Table 2. Logit Analysis Odds Ratios for Imposter Syndrome Variables[1]

Independent Variables	Dependent Variables						
	People believe I am more competent than I really am.	Others discover I lack ability or know-ledge.	Succeed in my future career.	In my current career by mistake.	The major cause of success in my life is my high ability.	I work much harder than others.	I believe I am at least as smart as my peers.
Feeling mentored	0.86	0.81	1.68**	.50**	1.18	.88	1.34*
# of years in program	0.99	1.04	0.83**	1.06	0.95	1.0	0.97
Not full-time student	1.21	1.20	2.03	0.67	0.77	1.75	1.16
Research Assistantship[2]	1.08	1.02	1.03	1.24	1.08	1.03	1.21
Fellowship[2]	0.86	0.89	1.01	1.26	1.04	1.27	1.14
Other financial support[2,3]	0.40*	0.52*	2.18*	0.61	1.13	0.78	2.44*
Temporary visa	0.83	0.38**	0.65**	0.89	1.08	1.59**	1.49*
Sex: female	0.92	1.60**	0.64**	1.16	0.76*	1.27	0.83

**p<.01

*p<.05

[1]A result <1 indicates that the respondents who fall into the defined group are less likely to agree with the statement than their counterparts, while a result >1 indicates that they are more likely to agree with the statement.

[2]Teaching Assistantship is the comparison group.

[3]Other financial support includes family, savings, loans, tuition reimbursement from outside employment, students' income from outside employment, foreign government support, and military assistance. Teaching assistantship is the comparison group.

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and engineers are needed." We plan to continue our focus on mentoring in the follow-up surveys of this cohort of astronomy graduate students. Although we now know that mentoring reduces the imposter syndrome among these students, we still don't know if mentoring will decrease attrition out of astronomy for them or whether the imposter syndrome itself will predict the likelihood of leaving astronomy. We also plan to do further research on whether the effects of mentoring are different for women than they are for men. Our hope is that this longitudinal study will advance our understanding of what helps to keep women and men in astronomy and that this knowledge will be used to implement effective programs that allow access to careers in astronomy for all talented students.

Table 3. Interpretation of Imposter Syndrome Measures for Women

Imposter Syndrome Measure	Women generally	Response Indicates ...
Sometimes, I am afraid others will discover how much knowledge or ability I lack.**	Agree	Imposter syndrome
The major cause of success in my life is my high ability.*	Disagree	Imposter syndrome
I feel highly confident that I will succeed in my future career.**	Disagree	Imposter syndrome

*p<.05
**p<.01

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Do you think that's appropriate? A survey of perceptions of behavior in student-advisor relationships

Adam J. Burgasser is an Assistant Professor in the Department of Physics at the University of California, San Diego in La Jolla, CA.

Last summer, my graduate student, Jacqueline Faherty, and I were discussing the behaviors of our research advisors, past and present, trying to come up with a list of the ten most inappropriate things they – or we – had said or done. After batting around some colorful stories, we realized that we didn't always agree on what constituted "clearly inappropriate" behavior. An act that seemed fairly innocuous to one of us, such as buying a gift on a birthday, was outlandish to the other, and vice-versa. Finding that our perceptions differed somewhat, we began to wonder whether some of the behaviors we agreed were appropriate, such as late-night socializing or paying for meals, might be considered grossly inappropriate by other students and advisors. We also wondered what role our respective genders played in our perceptions of appropriate behaviors.

We expanded our coffee table conversation to encompass as much of the astronomy community as we could reach, through an online survey conducted last year to coincide with the 2009 Women in Astronomy and Space Sciences (WIA3) conference. Our aim was to explore how perceptions of appropriate behavior between students and advisors vary according to factors such as gender, age and professional status. We focused on ten

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Do you think that's appropriate? *continued*

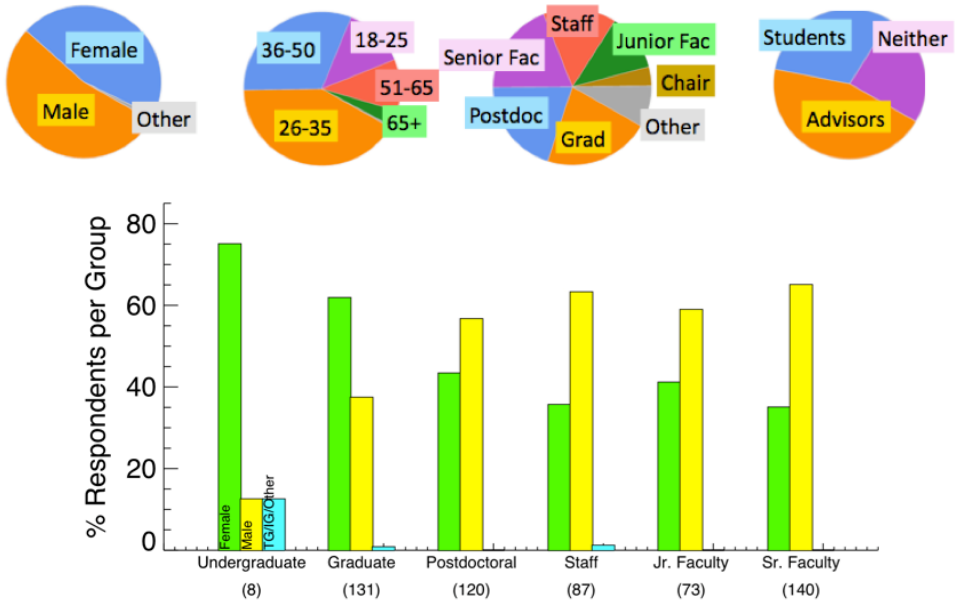

Figure 1: (Top) Demographics of survey respondents, broken down by gender, age, professional position and students/advisors. (Bottom) Gender fraction of respondents by professional status (female = green, male = yellow, transgender/intergender/other = blue); note the transition at the postdoctoral level.

"grey-area" situations we had encountered in our own student-advisor interactions, situations in which we didn't necessarily see eye-to-eye (see **Box**). For each of these scenarios, we asked respondents to assess the level of appropriateness on a scale of "appropriate", "slightly appropriate", "slightly inappropriate", "inappropriate" and "not sure" for four pairs of gender roles (female/male advisor, female/male student). We also queried on variations of these scenarios and allowed respondents to comment freely on how each might be clarified or changed to make them "more appropriate".

We conducted the survey during a two-week period in October 2009, and advertised through the CSWA, CSMA and AAS mailing lists; Facebook; and our own web pages and blog sites. A total of 579 respondents participated in the survey. **Figure 1** shows their demographic distribution. We had roughly equal numbers of female and male respondents (46% versus 53%), although males were increasingly overrepresented in more senior academic positions, in line with current demographic trends (Bagenal 2004; Hoffman & Urry 2004; Ivie & Ephraim 2006). Most respondents were in the 26-35 (42%) or 36-50 (31%) age brackets, with even representation at all professional levels, albeit primarily from academic institutions (76%). Slightly fewer than half of the respondents reported that they were currently an advisor (45%); nearly a third reported that they were currently a student (31%).

Highlights of the survey

The results of our survey are detailed on our website.[1] I summarize here the highlights of our analysis.

The clearest outcome of our survey was that perceptions of appropriateness for these grey-area scenarios vary considerably within the astronomy community, more so than even we had anticipated. Most of the scenarios had roughly equal numbers of responses in the four appropriateness levels. More importantly, the comments reflected strong, polarized differences of opinion. For example, in Scenario 3 (see Fig. 2), socializing with an advisor after hours, respondents commented: *"After hours socializing is inappropriate in a professional non-peer relationship"*; *"Networking is an essential component of astronomy, and facilitating this is a major component of many conferences"*; *"It's always going to be at least slightly creepy for the advisor hanging out with his/her students"*; and *"I find nothing inherently problematic with socializing between students and advisors."* Even scenarios which the majority of respondents judged to be inappropriate (e.g., Scenario 4, late-night calling) there remained a broad range of tolerance as evidenced by the

[1]http://www.browndwarfs.org/wia2009

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Do you think that's appropriate? *continued*

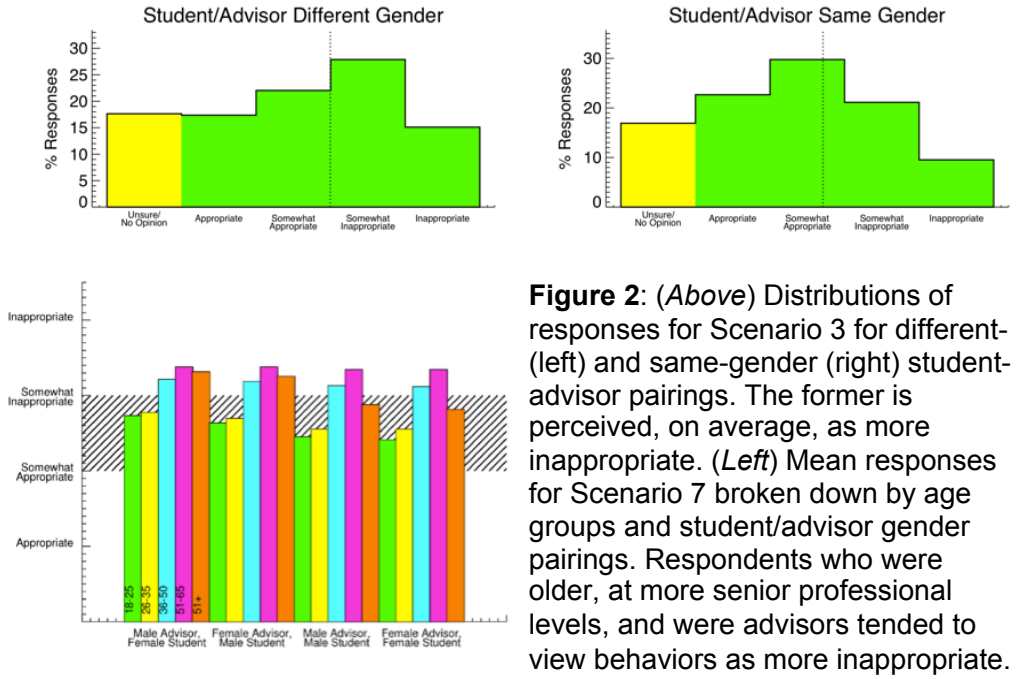

Figure 2: (*Above*) Distributions of responses for Scenario 3 for different- (left) and same-gender (right) student-advisor pairings. The former is perceived, on average, as more inappropriate. (*Left*) Mean responses for Scenario 7 broken down by age groups and student/advisor gender pairings. Respondents who were older, at more senior professional levels, and were advisors tended to view behaviors as more inappropriate.

comments (*"This might be appropriate if this were near the end of a critical project"*). This indicates that even behavior deemed "obviously inappropriate" by many is not obvious to all.

We analyzed the response data to look for trends in perception linked to the respondents' gender, age or professional status. No significant variations were seen with respect to gender; men and women ranked the ten scenarios with essentially the same distribution of appropriateness. However, there were notable differences based on age and professional status. Younger astronomers and those at earlier stages in their careers (e.g., students, postdoctoral researchers) typically viewed the scenarios as more appropriate than their older and/or more senior colleagues. These trends may reflect greater sensitivity among more experienced advisors to potentially inappropriate situations, and possibly more "conservative" values among older generations (*"Speaking as a professional in their late thirties, I see an increasing trend towards blurring the line between faculty and students"*). Concurrently, there were measurable differences between students and advisors in perceptions of appropriateness, confirming the experience of Jackie and I that students and advisors do not always see eye-to-eye on appropriate behavior.

While the gender of the respondents does not seem to make measurable differences in perception, the genders of the student-advisor pairs in the scenarios did make a difference. On average, scenarios were seen as more inappropriate for opposite-gender student-advisor pairs than for same-gender pairs. The specific genders themselves were unimportant—male advisors with female students were viewed identically as female advisors with male students. Since perceptions of inappropriateness are commonly linked to romantic/sexual relationships, such a perceptional shift might be expected for the majority of our (heterosexual) respondents.

Who is advising our students?

While the differing perceptions between opposite-gender and same-gender student-advisor pairs are not explicitly gender specific, current demographics in astronomy indicate that these differences are more of an issue for female students than male students. This conclusion is based on biographical data provided by respondents who were advisors, who reported the number and gender of the students and postdoctoral researchers they had advised over the past 5 years. Breaking those numbers down by student education level, student gender and advisor gender, we see the trends illustrated in **Figure 3**. As students progress through academic stages toward becoming a professional astronomer, the fraction of female students advised by female advisors drops dramatically, from 44% in high school to 26% at the postdoctoral level. The latter fraction matches current demographics for female representation in faculty positions (although not among our survey sample; see Figure 1). In contrast, 65-74% of male (and female) students have male advisors at these educational levels. Hence, female students are far more often in student-advisor relationships with someone of the opposite gender. As the results of our survey indicate, behaviors tend to be viewed as more inappropriate in opposite-gender pairings. Female students are

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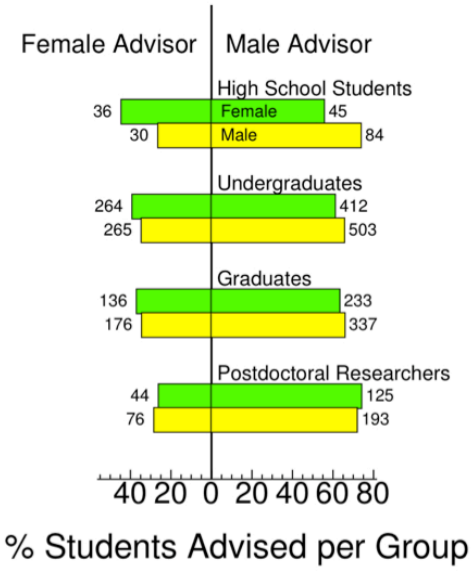

Figure 3: Genders of advisors and their students in our survey. These numbers are based on the 2,959 students that 252 respondents reported they had advised over the past 5 years. The students are separated by education level (high school through postdoctoral) and gender (green for female, yellow for male), while the bar graphs indicate the fraction of students in each subgroup advised by a male or female advisor (total numbers of students in each subgroup are listed outside each bar).

The ten scenarios examined in the survey are listed below, and were based on situations that Jackie and I have experienced in our roles as students and advisors. I invite the reader to discuss these scenarios with your students and/or advisors as a way to initiate a dialog on expectations and perceptions of appropriate behavior.

(1) An advisor tells a research student that s/he will have to stay at work late in order to complete a funding proposal that ultimately supports the student's tuition and salary.
(2) An advisor occasionally gives a student gifts on her/his birthday or holidays.
(3) After a conference dinner, an advisor wants to hang out with a research student and her/his friends because they seem like fun people.
(4) An advisor, assuming that a student works at home in the evening, calls her/him on their personal phone after 10pm to discuss work-related or class-related issues.
(5) An advisor observes that a student has noticeably lost or gained weight, and makes a comment to her/him about it.
(6) An advisor insists on being seated next to a student during a long plane flight.
(7) An advisor, trying to connect with a student on a personal level, asks about her/his current relationship or marital status.
(8) An advisor friends her/his student on a social networking site, and comments routinely on personal pictures, posts, etc.
(9) An advisor asks a research student to come over to her/his home or hotel room to discuss a research project.
(10) An advisor routinely asks a student to join her/him for an informal lunch (just the two of them), and pays for the meal.

thus more likely to find themselves in situations that are perceived to be inappropriate—by themselves and others.

Limitations of the survey

One of our goals for this survey was to put our own perceptions of appropriateness in the student-advisor relationship into context with the rest of the community and explore how perceptions vary more broadly. Many of the trends we see are intriguing. Yet it is important to acknowledge the survey's limitations and potential biases. The most common concern by respondents was that the scenarios were without context (*"the appropriateness of different behaviors depends on the details of the situation."*). That is an unfortunate limitation of an online survey, which provides no effective means to encompass the myriad of complex social relationships with their attendant historical and community contexts. It is nevertheless important to remember that ambiguity is inherent in many situations – e.g., the early stages of a student/advisor relationship, or third-party views of these relationships. In terms of bias, our respondent sample may reflect a skewed perspective of the astronomy community at large, given the greater fraction of female respondents as compared to the demographics in the field. Also, we did not obtain sexual orientation data from our respondents, so we were unable to gauge its relevance in perceptions of appropriateness, particularly in regards to trends in same- versus opposite-gender student-advisor pairings. Finally, we made no assessment of the role of cultural background, a prominent factor in the moral compass of most individuals. This is regionally important within the US, as reflected by one of our favorite survey quotes: *"Hugging is a borderline issue. Californians are huggers but this can be misinterpreted."*

The author thanks the 579 members of the community who participated in the survey for their time and insightful remarks, and G. Bjorn for assistance in editing.

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Hoffman & Urry (2004), *STATUS*, p. 1
Ivie & Ephraim (2006), AIP Academic Workforce Survey

STATUS Spotlight : Prof. Kelsey Johnson

Joannah Hinz & Katy Garmany

Kelsey E. Johnson is an assistant professor of astronomy at the University of Virginia. She was a 2006 recipient of the NSF's Faculty Early Career Development (CAREER) Program and in 2007 of the Fund for Excellence in Science and Technology (FEST) Distinguished Young Investigator award. And she is currently a David & Lucille Packard Foundation Fellow: this five-year, $875,000 grant is awarded to 20 top young researchers nationwide from a variety of scientific fields.

Despite all of this, Kelsey does not actually see herself as "successful", but rather "just very lucky". How has she achieved all this? Is it simply being in the right place at the right time, or is there more to it? And is there a lesson, perhaps, for young women wondering if they too can excel in astronomy? The authors of this spotlight have both known Kelsey for some years, and we talked with Kelsey about her career.

Kelsey has a very interesting perspective on what it takes to succeed in our field. She described the astronomy career track as "two orthogonal polarizing filters, both of which must be navigated successfully. The first filter, the one needed to be accepted in graduate school, requires one to be a good test taker, to keep lots of material in memory: everything useful for GRE's and qualifying exams. But the second filter, equally important but completely perpendicular to the first filter, involves creativity, developing good communication skills, writing ability and the social skills necessary to work with people." Kelsey admits that she struggled more with the first filter, but that she feels her strength is with the second one. This second filter isn't always necessarily obvious to scientists, who are often apt to lie somewhere on the other end of the spectrum!

She received her undergraduate degree from Carleton College, a liberal arts college, where she majored in physics and honed a lifelong love of tutoring and teaching. This was no doubt instrumental in developing her ability to pass through that second filter. "The beginning of my academic life was pretty rough", Kelsey says. "I started college with a lack of `cultural capital', and I still feel like I'm playing catch-up". However, she says she now feels that being a first-generation college student growing up with a single mother under the poverty line has given her characteristics that she deeply values.

She went on to earn her PhD with Peter Conti at the University of Colorado, Boulder, where one of us (KG) first met her. Mentorship can appear in many shapes: Kelsey describes KG as her mentor during those years in graduate school (her astronomy "godmother"), but it wasn't until we had this conversation that I recognized this. The message here is that if you have a mentor in your life, you may want to tell them that they are, or were, important to you at a critical time! But it also illustrates that mentoring needn't be a formal, time consuming job as some people fear when such programs are discussed. Kelsey says that her informal mentorship with KG kept her from dropping off the career track on numerous occasions.

REU Summer Group at Northern Arizona University: names and current affiliations. Top row: Erika Gibb (U. Missouri, St Louis), Kelsey Johnson (U. Virginia), Siobhan Sackey (Glendale Community College), Danielle Boyd (now Harlow, UC Santa Barbara), Ben Laaksonen (TruTouch Technologies), Joannah Smith (now Hinz, U. Arizona), Kartik Sheth (NRAO). Bottom Row: DJ Pisano (UWV/NRAO), Ben Weiss (MIT), Roger Valencia, Dave Norman

We talked about the importance of a support structure to keep you on trajectory as you navigate the bumps and wiggles in your life. This includes a supportive spouse or significant other: Kelsey is married to astronomer Remy Indebetouw. They met the summer of 1995 in Tucson when Kelsey was an REU student at NSO, and Remy an REU student at NOAO. They have two children, a daughter who was born during Kelsey's postdoctoral years and a son who was born while she was an assistant professor.

Kelsey notes that she came closer than ever to quitting after her first child was born, only a few months before her own mother died of cancer. "I was overwhelmed, and drained to the core. My husband, friends, and colleagues were an absolutely invaluable support network that kept me afloat."

Kelsey describes her current situation as the only woman on her faculty, but in a very family friendly department where about half the grad students are women. She and Remy manage a large group – but only 30% are men! Kelsey commented, "This isn't deliberate: there is a good reason why each student or post doc is working in our group, but the result is weighted heavily toward women", which suggests more subtle social dynamics in play.

Kelsey is known for her work on the properties of super star clusters in starburst galaxies, becoming one of the first to combine optical images with those in the infrared and radio as those technologies developed, initially through HST/NICMOS and the VLA, and later stretching to Spitzer. She has probed extragalactic star formation in unusual environments, in objects with extremely low metallicities and in objects undergoing mergers. Her future work rests on the possibilities between combining these wavelengths with the upcoming ALMA and EVLA projects.

Recently Kelsey started an astronomy club called "Dark Skies, Bright Kids" (http://www.astronomy.virginia.edu/dsbk/) at local elementary schools. Given her own background, Kelsey is passionate about the need to expose kids, especially from underserved demographic populations, to basic reasoning skills. This NSF grant-backed club, which relies on help from the grad students and post docs in the UVA astronomy department, is designed to expose rural elementary school students to science through learning about their clear dark nighttime skies.

One of her motives in implementing the club was the rural school's high percentage of low-income families. Kelsey believes that this program is having an impact on both the students and their families. In the words of one of the elementary school principals, "The astronomy club has brought the community together. Students and their families are intrigued, excited and involved."

Book Review

Gerrit Verschuur, University of Memphis

Under the Radar: The first woman in radio astronomy
by W.M. Goss and Richard X. McGee
Springer, 2010. ISBN 978-3-642-03240-3

Ruby Payne-Scott (1912 – 1981) was the world's first woman radio astronomer. She lived in an era when women fought against great odds to do what was regarded as something of a birthright for men: the freedom to pursue one's love for science.

World War II provided an opportunity for Payne-Scott to enter a field that would otherwise have been closed to her. As a physicist/engineer she played a key role in the development of radar used in the Pacific campaign. This gave her a great deal of experience that served her well when as she entered the nascent field of radio astronomy after the war. Her first observations of the sun actually occurred by accident in 1944 while using radar equipment that detected solar radio waves.

Payne-Scott's radio astronomical career unfortunately lasted only from 1945 to 1951 and therein lies the drama that underlines her story in **Under the Radar**. During that time she "became a driving force in the early radio astronomy efforts in Australia." She discovered several types of solar radio bursts, used the famous cliff-top interferometer, and helped develop a swept-lobe interferometer that tracked the source of the bursts through the solar atmosphere. She is also credited with contributing to the theory of aperture synthesis.

The tragedy of her story is that in the late 1940s she came into serious conflict with one of her colleagues, John Bolton, and then around 1950 with the bureaucracy at the Council for Scientific and Industrial Research (CSIR) where she worked. Back then a female government employee who became married had to forego a pension plan and would be demoted to a lesser position, if she could even stay employed. To avoid this Payne-Scott had kept her marriage in 1944 a secret. When the fact of her marriage became widely known she was severely berated by those who controlled her state of employment. Even if she had been able to keep her job, the fact that there was no such thing as maternity leave forced her to resign when she became pregnant.

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Book Review *continued*

She always fought discrimination against women in Australian society at the time and proving that she was as competent as her male colleagues must have been draining. But Payne-Scott had a personality that allowed her to push on regardless of the slings and arrows of outrageous fortune. She managed to keep her balance by retreating to the wilderness where she would hike for days (called bush walking).

After leaving CSIR she spent ten years raising her children and by then the rapid growth of radio astronomy had left her behind. She spent the next decade, from 1963-74, as a teacher at an all-girl's school until the insidious onset of Alzheimers forced her to resign.

Scientists are passionate about their research. That is why they are willing to suffer certain hardships, such as relatively low pay for endless hours of work. Then there is the ominous presence of discrimination in many forms that confronts women who dare venture into what is still largely a male realm. In Under the Radar the dedicated search for knowledge is manifested in two ways. The story of Payne-Scott forms the context for the passion displayed by the two authors (Miller Goss and Richard McGee, both radio astronomers) whose meticulous research into all of the science-related aspects of her life is quite stunning in its completeness.

I would have liked more editorializing about Payne-Scott's motives and likely feelings in order to obtain a clearer image of the circumstances in which she worked. But the authors of Under the Radar have compiled an objective report, much like a well-crafted research paper. They do include a chapter rationalizing why they wrote the book in which they admit that "... the ironic fact is that this book would not have been written had John Bolton not changed his view of Payne-Scott in the 1970s."

I am not a dispassionate reviewer of this book, since my Master's degree was on solar radio bursts at a time when the bursts had only recently been discovered. I built equipment and used it in ways not unlike those reported in Under the Radar. At the time I was aware of Payne-Scott's work but had no idea about what was behind the discoveries she made. From my point of view, therefore, the many detailed accounts of solar radio bursts were especially intriguing. The authors do suggest that those who are more interested in Payne-Scott's personal story will do well to skip these chapters.

Payne-Scott clearly was highly respected by most of her colleagues. Records of meetings at the lab where she worked reveal that not many decisions were made in regard to research programs without Ruby's imprimatur. She was a stickler for getting at the truth of any issue and was not hesitant to question authority figures if they held an opinion at odds with what she saw as the facts. As one of her colleagues is quoted as saying, "We were timid compared with the forceful Payne-Scott." It emerges that she did not suffer fools lightly.

Under the Radar is really two books in one. There is the early history of solar radio astronomy and it is also a review of the life of Payne-Scott. In this regard the tone of the book is perfectly objective, and perhaps too polite. Consider that the aforementioned Bolton is quoted as saying in 1970, when Payne-Scott was essentially lost to radio astronomy, that he considered her as "one of the best physicists in Australia." So on the one hand Bolton helped create a hostile working environment for Payne-Scott and years later, when she was out of the picture, he praised her and actually stimulated the authors to write her biography. Perhaps this book is in essence a posthumous apology. Just imagine what the "best physicist in Australia" could have accomplished if she had worked in a supportive environment and had a career lasting decades.

Given that the authors of Under the Radar clearly went out of their way not to be judgmental, the book is an enormously valuable resource. As regards Ruby Payne-Scott's life, it may yet serve to inspire women who have to deal with prejudices that threaten their career, prejudices that have nothing whatsoever to do with their natural abilities.

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