# Diversifying the next generation of Astronomers One institution at a time 

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#### Abstract

Executive Summary: The limited representation of women and especially minorities in astronomy is of serious concern. This issue must be addressed immediately to avoid a negative impact on the future scientific and technological leadership of the country. We recommend setting the ambitious goal of increasing the percentage representation of women and minorities in the astronomical workforce by a factor of two for women, and by a factor of five for minorities, over the next 10 years. We advocate for a plan that involves universities, as well as centers, national laboratories and funding agencies, working together to design and implement a coordinated strategy to achieve this goal. We invite collaboration among all STEM fields in these goals and efforts.


## Background

It is well established that the key to success for any institution, whether its goals are profit, increased productivity or academic achievement [1,2] is to attract and retain a diverse workforce. People of different gender and ethnic background contribute different perspectives and approaches. This variety creates an environment that is inclusive, receptive and tolerant, and that stimulates creative thinking and innovation. These factors are key to institutional achievement and success. The projection is that in a few decades, the population in the US will be much more diverse than it is today. Hence, a plan to diversify the workforce today is essential to maintain American scientific and technological leadership in the future.

## The current situation in science: US astronomy is white and predominantly male

The US population has an increasingly diverse profile. It is approximately split in half according to gender. African American and Hispanic individuals account for $12.8 \%$ and $15.1 \%$ of the population, respectively (Table 1).

|  | Total | Female | African <br> American | Hispanic |
| :--- | :---: | :---: | :---: | :---: |
| US Population (2007) | 301.601 .157 | 152.962 .259 | 38.756 .452 | 152.962 .259 |
|  |  | $50.7 \%$ | $12.8 \%$ | $15.1 \%$ |
| Space Telescope Science Institute Staff | 366 | 145 | 21 | 5 |
|  |  | $40 \%$ | $5.7 \%$ | $1.3 \%$ |
| \# PhDs in Physical Sciences (2006)* | 1993 | 578 | 48 | 79 |
|  |  | $29 \%$ | $2 \%$ | $4 \%$ |
| STScI Astronomers | 72 | 9 | 0 | 0 |
|  |  | $13 \%$ | $0 \%$ | $0 \%$ |

Table 1: Demographic data for the US Population [3], the Physical Sciences workforce [4,5], and a typical astronomical institution, STScI. *Note: These data reflect the nature of current data available, that include Physics, Astronomy and Chemistry.
A typical American scientific institution often does not reflect that profile. For example, the Space Telescope Science Institute (STScl) by nature of its mission must employ staff with a very diverse skill mix, including research staff as well as engineers, technical support personnel and administrators, and has a staff predominantly composed of white males. The situation is even more extreme when considering the astronomer research staff, where the number of female astronomers falls into the single digits, and African American and Hispanic astronomers are completely absent. STScI has made a concerted effort to improve the demographics mix of its staff and some success has already been achieved. However, these numbers are far from atypical when one considers the small numbers of PhDs awarded in 2006 to women and minorities in Physical Sciences, which includes Astronomy, Physics \& Chemistry (Table 1). Advancement in Astronomy in the future, as for all sciences, will require a broader participation of diverse populations to ensure continued discovery, innovative solutions to unique and novel problems as well as adequate representation of the evolving composition and nature of the American population.

How can this unacceptable situation be turned around? In this position paper, we attempt to describe the current representation of women and minorities in US astronomy, and offer a coordinated plan to rectify the current situation that, especially for minority astronomers, is unsatisfactory and requires immediate and strong action.

## Aggressive hiring is only a part of the solution

In an ideal economic situation, where scientific hiring can be carried out aggressively, some improvement in representation can be achieved on a relatively short time scale. Even in a tight economy, institutions must make improved representation in hiring a priority. This requires that recruitment best practices be successfully implemented, for example proactive recruitment of targeted groups and bias-aware selection; that attention be paid to the organizational requirements of a diverse employee base; and that policies facilitate the retention of the individuals targeted and successfully hired [6]. It is also critical for the institution to develop a climate that welcomes a diverse staff, where tolerance and inclusion are set as a strategic goal, and a priority, at the highest institutional levels.

As an interesting case study, STScI was successful in increasing the number of female astronomers from $3 \%$ of the research staff in 2005, to the current improved fraction of $13 \%$. The number of female astronomer departures has reached an all-time low in the last three years and was reduced to zero in 2008 due to a dedicated and collective effort to create a more open and hospitable work environment. This included addressing tolerance and cultural issues, as well as implementing a suite of family friendly policies. Still, there is more that can be done.

## Representation of Women in Astronomy: there is national-scale progress

The number of PhDs in Astronomy awarded to women has dramatically increased over the years. As reported by the American Institute of Physics [4], 30\% of the total number of Astronomy PhDs were awarded to women in 2006, compared to less than $10 \%$ in 1977.

The percentage of Bachelor's Degrees awarded to women is higher, hovering around $40 \%$ in 2002-06. This indication that significant losses of women still occur during the graduate years is of concern.


The marginal success in Astronomy has not been realized to the same extent in Physics. Although some growth has been observed over the years, only $15 \%$ of Physics PhDs awarded in 2006 were to women.

For women scientists, the challenge remains in advancement through academic career ranks.
In Figure 2, the percentage of female astronomers is plotted as a function of rank. Although the numbers have been increasing in recent years at the entry level (Assistant), drops are still recorded in promotion to Associate; and a significant drop ( $>50 \%$ ) is observed in
Figure 1: Percentage of Bachelor Degrees and PhDs in Astronomy awarded to women from 1977 to 2006.
promotion to Full Astronomer, where women ultimately make up only $10 \%$ of the total. This number has not changed in recent years, and is an indication that a glass ceiling for women in academia is still "alive and well".

Figure 2: Percentage of female astronomers as a function of rank in 2003-2006.

## Minority Representation in Astronomy: aggressive hiring is only a small part of the solution

The current situation for minority astronomers is worse than what was observed for women in the 1970's. This is clearly exemplified by the difficulty finding reliable data tracking the
progress in education for minority astronomers. Major funding agencies such as the National Science Foundation (NSF) [5] have only very recently started to track comprehensive and detailed demographics data on minorities.
As can be seen in Figure 3, adapted from Stassun [8], the percentage of Astronomy PhDs awarded to African American and Hispanic astronomers remains in the low single digits. It is encouraging that the number has roughly doubled in the last five years, demonstrating the tangible national-scale results of dedicated initiatives, such as the Fisk-Vanderbilt Bridge Program.

However, from the point of view of an institution such as STScI, where we have established diversity in the workforce as a high
 priority objective, these numbers are not sufficient to enable us to meet our goal. Even in a situation where every single minority astronomer is hired, the representation numbers are too low to make a difference on a global scale; and they do not reflect, by far, the composition of the US population.

Figure 3: Percentage of PhD's in Astronomy awarded to African American and Hispanic in the timeframe 1996-2004[8].

We will not attempt to outline, discuss or interpret the complex causes for this limited representation. We do want to state the obvious: in order to make a difference in representation, it is necessary to create a much larger pool of minority astronomers.

## The goal over the next 10 years

We would like to recommend an ambitious goal: that the representation of women and minorities in professional astronomy must increase in percentage by a factor of two for women, and by a factor of five for minorities over the next 10 years.

This major goal can only be accomplished if universities, centers, national laboratories, and funding agencies work together to develop a coordinated plan that addresses different facets of the issue as a part of a unified strategy. We identify two major areas of emphasis:

1) The creation of the diverse workforce. This area of strategic emphasis will target issues associated with undergraduate enrollment in astronomy (as well as physics and other STEM disciplines) programs through the attainment of a PhD ;
2) The employment and career advancement of the diverse workforce. This area of emphasis targets the period from the attainment of PhD through the individual's transition to the workforce, and commitment to a career in astronomy.

## 1) Phase 1: The creation of a diverse workforce

Universities must take the lead in this phase.

- Encourage active enrollment of women and minorities, especially for STEM disciplines. Modify the perception within society that "mathematics and physics are hard".
- Understand and confront pipeline issues. Set realistic, but ambitious, university-wide goals at each milestone in the education process, from undergraduate to graduate. Especially for minority students, small losses have great impact on the outcome, given the extremely low numbers in play.
- Create programs that supplement the sometimes limited scientific education that especially minority students might have experienced in their previous curricula. Design and implement strategies to level the educational playing field. Set the goal to enable minority students to become as competitive as white students who may have benefited from greater education opportunities and resources throughout their scholastic careers. Pioneering partnerships with Historically Black Colleges and Universities (HBCUs), such as the Fisk/Vanderbilt Bridge program, shepherded by K. Stassun, have already produced noticeable results in a relatively short time frame. These types of programs should be explored and potentially expanded on a national scale.
- Additionally, HBCU's traditionally have suffered from insufficient funding resources to enable them to provide access to opportunities and resources generally available in many historically white colleges and universities. HCBU's could benefit from improved research funding sources, as well as supported access to expanded educational and instructional resources in order to attract and retain students in these disciplines.

2) Phase 2: The employment and the career advancement of the diverse workforce.

Centers, observatories and national laboratories must lead the way in this phase.

- When recruitment is possible, recruit in a proactive and targeted fashion, by reaching out to special groups. Post position notices broadly. Compose the search committee with the strategic goals of enhancing diversity in mind. Selection bias should be discussed and addressed. Address possible two-body issues proactively and constructively.
- Take deliberate steps to create a hospitable and tolerant work environment. Cultural and behavioral issues should be addressed with high priority, to create a respectful environment, where every single individual feels appreciated for his/her contribution to the institution. Inclusion should be the preferred and reinforced style for conducting work interactions.
- Implement family-friendly policies to alleviate some of the demands of family life.
- Implement mentoring programs to ensure that the newly recruited scientists experience a successful transition to the workplace, and the foundations are set for a fruitful career.
- Ensure clarity on the requirements for major career milestones (such as tenure) and
ensure that career review processes are fair and transparent.
- Set some realistic but ambitious goals to advance female and minority astronomers to the highest career steps as expeditiously as their white male colleagues.

The funding agencies have oversight of both phases. They have the ability to:

- Hold universities accountable for their ability to generate a diverse workforce.
- Create incentives for universities, centers, observatories, and national laboratories to be successful at creating, recruiting and advancing a diverse workforce.
- Fund programs dedicated to address specific issues, such as the competitiveness of minority students at undergraduate and graduate enrollment level.

The most significant point is that no one group can solve this issue on its own. We strongly believe that only a coordinated and collaborative effort among all STEM fields will enable the type of significant change on a national scale required to respond to the needs of the astronomical community of the future.

## Conclusions

The issue of limited representation of women and minorities in STEM disciplines, and in astronomy in particular, is serious and must be addressed immediately. We recommend setting an ambitious goal: increase the percentage representation of women and minorities in astronomy by a factor of two for women, and by a factor of five for minorities over the next 10 years. We advocate a plan that involves a collaborative and integrated effort involving universities, as well as centers, national laboratories and funding agencies, to design and implement a coordinated strategy to achieve this goal.

We will have achieved success - in equalizing opportunities in education, minimizing bias in hiring and promotion, and creating fair and equal workplaces - only when women and minorities are represented in the workforce in proportion to their representation in the general population. We invite collaboration among all STEM fields in these goals and efforts.

Action must be taken now if we hope to achieve any significant change over the next ten years, and implement President Barack Obama's vision, " $[t]$ o give (ALL) our children the chance to live out their dreams in a world that's never been more competitive...[and] provide new computers, new technology, and new training for teachers so that students in Chicago and Boston can compete with kids in Beijing for the high-tech, high-wage jobs of the future," and to continue American leadership in science and technology in the future.

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