COMMITTEE ON THE STATUS OF MINORITIES IN ASTRONOMY

JANUARY 2007

# SPECTRUM

A report on underrepresented minorities in astronomy

INSIDE THIS ISSUE:



## Diversity in Physics

***by Shirley Malcom, American Association for the Advancement of Science***

***The underrepresentation of women and minorities among recipients of physics degrees is a manifestation of systemic educational problems. Corrective measures must begin in the primary grades and continue through university schooling and beyond.***

Physics stands out among the sciences for its inability to attract enough women or minorities that their representation in physics will, in the foreseeable future, be commensurate with their proportions in the general population. True, among the so-called hard sciences, physics has experienced over the past decade the most significant rate of increase in women PhDs. But the baseline number of women PhDs, say from the 1970s, is small. In 2003, women received only 22% of bachelor's degrees and 18% of PhDs awarded in physics by US colleges and universities; those numbers include degrees awarded to non-US citizens. In the same year, African Americans received 3.5% of bachelor's degrees and 2.3% of PhDs awarded in physics to US citizens. For Hispanic citizens, the numbers are 3.4% of bachelor's degrees and 2.5% of PhDs. In 2004, women received 184 of 1186 total physics doctorates, or 15.5%. African American students who were citizens or permanent residents accounted for 13 doctorates, about 1% of the total. Hispanic citizens and permanent residents also received 13 doctorates. A single PhD was awarded to an American Indian in 2004. For additional statistics, see Figure 1 and Tables 1-2.[1]

*(Continued on page 2)*

## Preparing Minority Scientists and Engineers

***by Michael F. Summers and Freeman A. Hrabowski III***

***An undergraduate program involving mentorship, summer and other workshops, and targeting high-achieving high school students improves participation of underrepresented minorities in science.***

As international participation in advanced science and engineering (S&E) increases, and as national populations become more diverse (*1-3*) it becomes even more important to provide quality science education to all children, including those from racially diverse groups (*2, 3*). Despite several decades of federally supported programs, Americans from these groups continue to be underrepresented among Ph.D. recipients and in the S&E workforce (*4-6*).

Contrary to popular belief (*7*), many well prepared underrepresented minority students (URMs)—including men and women of Latino, Native-American, Pacific Island, and African-American descent—are interested in pur-

*(Continued on page 3)*

HIGHLIGHTS:

- *Read a new AAAS report highlighting statistics and strategies on diversity in physics and astronomy.*
- *Learn about a model program at the University of Maryland, Baltimore County, that has significantly increased diversity in science and engineering fields.*
- *Read about demographic and education trends over the past century that are changing the face of science in the United States.*

# Diversity in Physics (cont'd)

*(Continued from page 1)*

Low though they are, the percentages of physics degree recipients who are women represent significant increases from 30 years ago. Those gains were achieved through the efforts of many in the science community to promote more diversity in physics, and they track the modern civil-rights movement for women that dates from the early 1970s. Intervention programs introduced girls and young women to the possibilities of nontraditional careers and encouraged them to take more mathematics and science courses. Underrepresented minorities (URMs), defined as African Americans, Hispanics, and American Indians, have received increasing numbers of bachelor's degrees in physics since the 1970s, except for a serious decrease in production for African Americans that began in the late 1990s and continues to this day, albeit with significant fluctuations. The statistics for PhDs paint a less optimistic picture: Both African Americans and Hispanics have earned stagnant or declining numbers of PhDs during the past decade.

Physicists need to be aware that the figures I have quoted compare rather unfavorably with those for chemistry. Chemistry doctorates awarded to women by US institutions grew from 6.4% of the total in the 1960s to 10.4% of the total in the 1970s to nearly 20% of the total in the 1980s. In 2004, women received almost 32% of all US chemistry doctorates awarded, a proportion that has been relatively stable since the mid-1990s. At the bachelor's level, women and men receive an approximately equal number of chemistry degrees.

Since the 1960s, URMs have increased their percentage of chemistry doctorates, albeit at a slower rate than women. In 2004, African American citizens and permanent residents received 2.3%, Hispanic citizens and permanent residents earned 2.2%, and American Indians received 0.2% of all doctorates awarded. Collectively, URMs accounted for 7.9%, or 93 of 1180 doctorates in chemistry awarded to US citizens and permanent residents. The 27 physics PhDs awarded to URMs in 2004 were 4.8% of physics doctorates awarded to all US citizens and permanent residents.

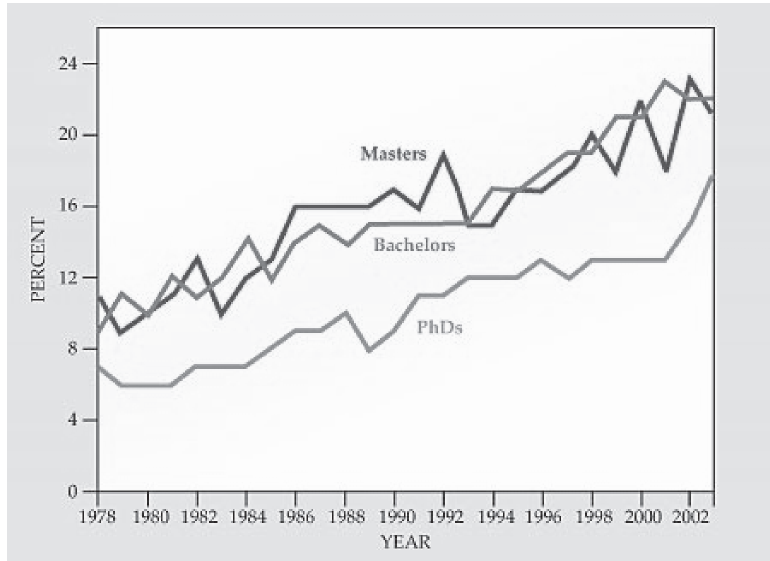


**Figure 1.** *Women received an increasing percentage of the physics degrees from US colleges and universities from 1978 to 2003. Still, in 2003, women received far less than one-fourth of the bachelor's, master's, and PhD degrees conferred in the US. (Chart adapted from the American Institute of Physics Statistical Research Center, Enrollments and Degrees Report, 2003.)*

## Institutions That Serve Minorities

Historically black colleges and universities and Hispanic-serving institutions have had a disproportionate impact in producing URM baccalaureate degree holders. Between 1992 and 2001, HBCUs granted 45–50% of bachelor's degrees in the physical sciences awarded to all African Americans and 48–56% of the degrees conferred on African American women. The 10 institutions awarding the most bachelor's degrees to African Americans in 2003–04 were all HBCUs. According to American Institute of Physics data, the eight departments that awarded an average of at least three physics bachelor's degrees to African Americans for the classes of 2001, 2002, and 2003 were all at HBCUs.[2]

> *"The 10 institutions awarding the most bachelor's degrees to African-Americans… were all Historically Black Colleges and Universities."*

*(Continued on page 10)*

# Preparing Minority Scientists and Engineers (cont'd)

*(Continued from page 1)*

suing scientific or engineering careers. In 2005, the same percentage (44%) of African-American and Caucasian college-bound high school students indicated their intent to major in S&E fields (*8*). Many students with strong SAT scores, impressive grades, and success in high school honors math and science courses leave the college science pipeline, but the loss is disproportionately among women and minorities (*9*, *10*). Thus, factors other than school preparation, science aptitude, and interest must be responsible for the low achievement and low persistence in these subgroups of undergraduate and graduate S&E students. Identifying these negative factors and retaining well-educated students with S&E interests would improve the United States' ability to compete in today's global scientific community.

Factors that keep URMs from persisting with science include academic and cultural isolation, motivation and performance vulnerability in the face of low expectations, peers who are not supportive of academic success, and discrimination, whether perceived or actual (*10*-*15*). These factors can have a stronger effect at institutions with predominantly majority populations. Such institutions award about 75% of all bachelor's degrees earned by African Americans (*16*). To address these particular factors, we developed the Meyerhoff Scholars Program in 1989 at the University of Maryland, Baltimore County (UMBC). At that time, the university was graduating fewer than 18 African-American S&E majors per year (see graph below). Typically, fewer than five of these students graduated with a grade point average above 3.0 (on a 1 to 4 scale), consistent with achievement levels observed at other institutions (*17*, *18*).

The Meyerhoff Scholars Program (named after Baltimore philanthropists Robert and Jane Meyerhoff) focuses on producing bachelor's degree recipients, particularly African Americans, who go on to doctoral programs in science and engineering. Since 2000, an average of 1900 candidates have been nominated each year by high school teachers and counselors. Of those nominated, the 80% who are from Maryland (~1500) represent about 2% of graduating high school students in Maryland. We typically invite about 180 students and their parents to UMBC for interviews, and offer 4-year scholarships to about 100 of them. About half accept. Most students who decline the Meyerhoff program accept other scholarships at UMBC or other institutions. Transfer students, typically not more than two per year, can join the program later.

The program has supported 768 students, 260 of whom are currently undergraduates. Most of the Meyerhoff graduates (435 of 508 students, 86%)

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SPECTRUM

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# NSF Report Reveals Century of Doctoral Education Trends in the United States

**In this article, we highlight the recent findings of the NSF Report *US Doctorates in the 20th Century*, with particular focus on the demographic results. The full report is available on the web at the URL http://www.nsf.gov/statistics/nsf06319**

A new report released by the National Science Foundation (NSF) documents trends and patterns that reveal the rapid growth and changing demographics of doctoral education during the 20th century, especially over the last 25 years.

*U.S. Doctorates in the 20th Century* reveals many factors about who is educated and where. It also describes the complex changes taking place in the pursuit of doctoral degrees, many in new interdisciplinary fields. For example, relatively small Oberlin College in Ohio provided the baccalaureate origins of more science and engineering doctorates over an 80-year period (nearly 2,800) than the University of Nebraska, Duke University, Johns Hopkins University, Virginia Tech and the University of Iowa. Another example is that five of the eight leading doctorate-granting universities from 1920-1999 were Midwest-based, Big Ten schools. Prior to that period, the majority of doctorate-granting institutions were East Coast institutions.

"The report shows how much has changed in doctoral education in just 25 years," says Susan T. Hill, director of the Doctorate Data Project in NSF's Division of Science Resources Statistics. "For one thing, nearly two-thirds of all doctorates awarded in this country occurred in the last 25 years of the 20th century. Second, the United States has become an educator of the world, expanding its role in providing doctorates to foreign-born and U.S. students. Third, the U.S. system reveals a great flexibility in opening varied pathways for Ph.D. recipients into career opportunities both in and outside their fields. This has increased U.S. innovation, competitiveness and leadership in many fields."

The report is based on the Survey of Earned Doctorates, which had a 95 percent response rate. Some of the report's major findings include:

### Changes in demographics

- Men received 73 percent of all doctorates awarded in the 20th century, but in the 1990s, women made significant gains, receiving over 40 percent of all doctorates.
- Foreign nationals held less than 10 percent of all doctorates before 1960 but received more than a third of all science and engineering (S&E) doctorates by 1999, and 17 percent of non-S&E doctorates.

### New pathways to doctoral degrees

- Two-year colleges vastly increased their role in educating those who go on to pursue a Ph.D. In the century's final 5 years, 1995-1999, one-fifth of all American Indians/Alaska Natives who received doctorates attended two-year colleges. One-sixth of all Hispanic Ph.D. recipients also reported having attended two-year colleges.
- From 1995-1999, almost a third of African-American Ph.D. recipients reported receiving an undergraduate degree from a Historically Black College or University (HBCU).

### Increasing Indebtedness

- In 1999, for the first time, more than half of all graduating doctorates reported debt from their undergraduate and graduate education.
- In non-S&E fields, doctorates owing more than $20,000 from education loans quadrupled between the late 1980s and late 1990s. The corresponding percentage for science and engineering doctorates owing more than $20,000 was also significant, more than doubling during the same period.

### Field Choices and Demographic Characteristics of Doctoral Recipients

**Fields of Study.** More than 1.35 million research doctorates were awarded in the United States during the last eight decades of the 20th century—62 percent in science and engineering (S&E) and 38 percent in non-S&E.

**Sex.** Men received about 73 percent of all doctor-

*(Continued on page 5)*

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ates awarded between 1920 and 1999. The rapid increase in the numbers of women earning doctorates, beginning in the 1960s, increased their share of doctorates from 15 percent in the early 1920s to 41 percent in the late 1990s.

**Citizenship Status.** In the late 1980s about one in four Ph.D.s was a foreign national; by the 1990s this proportion had increased to almost one in three. Most foreign doctorate recipients were on temporary visas, most were men, and most studied S&E fields.

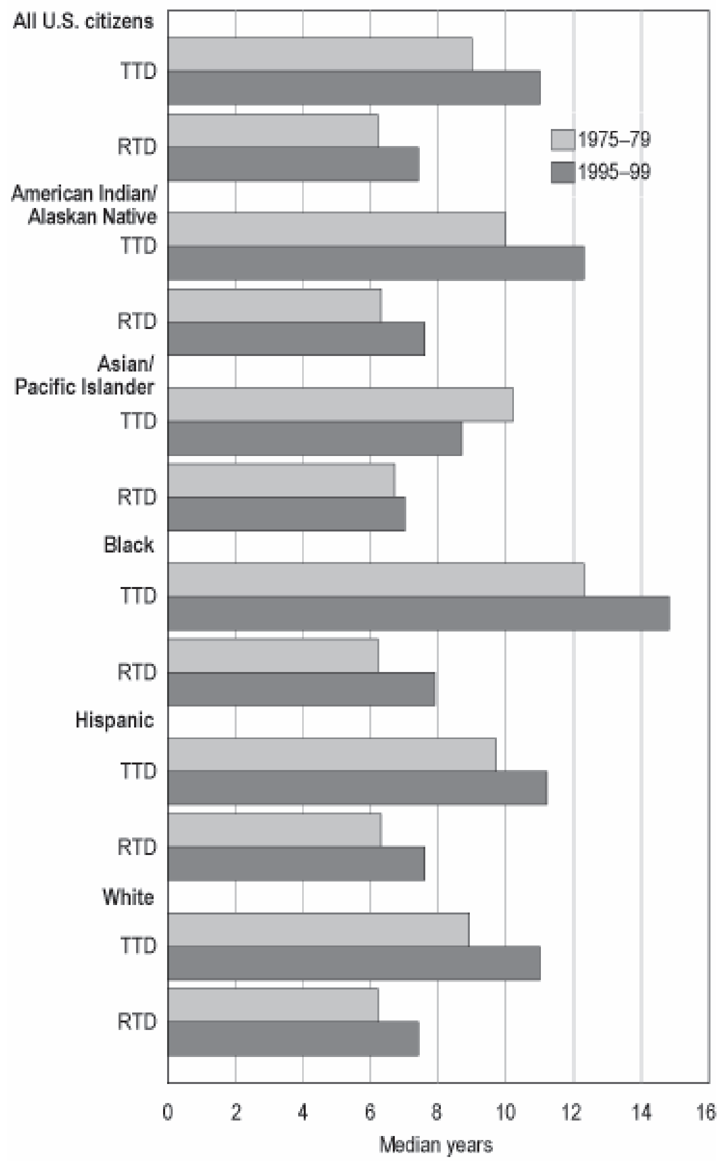
**Race/Ethnicity.** Minorities accounted for nearly 14 percent of all S&E doctorates awarded to U.S. citizens in 1995–99, compared with about 6 percent in 1975–79, when data on race/ethnicity were first collected in the SED. Among U.S. citizens, minorities also increased their share of non-S&E doctorates from less than 10 percent in 1975–79 to more than 14 percent in 1995–99.

**Parents' Education.** Rising educational attainment in the U.S. population as a whole is reflected in the Ph.D. population. Data on the educational attainment of the parents of Ph.D.s became available in 1965. On the whole, the level of educational attainment for families of doctorate recipients is higher than the national average. By 1995–99 more than one-third (nearly 35 percent) of new Ph.D.s came from families in which both the mother and the father had a college degree. Nearly half of doctorate recipients in 1999 had a parent who held a bachelor's or advanced degree, compared with less than one-fifth of parent equivalents (those 55 or older, the assumed age of Ph.D.s' parents) in the U.S. population. In contrast, 30 years earlier, almost half of new Ph.D.s came from families in which neither parent had attended college. Among doctorate recipients in general, the father's educational level was higher than the mother's.

## Path to the Doctorate: Time to Doctorate

Many factors, including domestic and international conditions, influence the time it takes graduate students to earn the doctorate. Furthermore, fields differ in terms of the availability of financial support for full-time graduate study, and

FIGURE 4-18. U.S. citizens' total time to doctorate and registered time to doctorate, by race/ethnicity: 1975–79 and 1995–99




NOTE: RTD is registered time to doctorate; TTD is total time to doctorate.

SOURCE: NSF/NIH/USED/NEH/USDA/NASA, Survey of Earned Doctorates and Doctorate Records File.

members of the various demographic groups tend to favor some fields over others. The interactions of all these elements are ultimately reflected in measures of the elapsed time it takes to complete the doctorate.

Generally, time-to-doctorate, as measured by both total time to doctorate (TTD) and time registered at colleges or universities between receipt of bachelor's degree to doctorate (RTD), has been con-

*(Continued on page 8)*

# Diversity Blueprint: A Planning Manual for Colleges and Universities

***from DiversityWeb.org, reprinted with permission.***

**Diversity Blueprint** is a "how-to" planning resource for administrators, faculty and staff working to create campus diversity policies based on the following priorities:

- Leadership and systemic change
- Recruitment, retention, and affirmative action
- Curriculum Transformation
- Campus/community connections
- Faculty, staff involvement

For ordering information visit the Association of American Colleges and Universities website: www.aacu.org.

## Concept

To create a diversity plan, each college or university must first define its culture and then use those findings to set the tone to conduct needed research, determine institutional priorities, and take action. For the University of Maryland, five diversity planning principles have provided the structure and process to guarantee that diversity would become and remain an institutional priority. The five principles – accountability, inclusiveness, shared responsibility, institutionalization, and evaluation – not only helped set the structural development for diversity planning, but enabled the university to successfully engage with the campus community, the Maryland community, and the nation in addressing issues of diversity.

Setting priorities can also help an institution identify specific programs and actions needed to achieve change. The five priorities usually considered by an institution undergoing diversity reform are: leadership and systemic change; recruitment, retention and affirmative action; curriculum transformation; campus-community connections; and faculty, staff, and student involvement. Initial research at the University of Maryland revealed a comprehensive list of priority areas to include in the change process, and signaled the need for an institutionalized structure to address the priorities. Born out of the numerous internal struggles and external pressures to change with the times, the Diversity Initiative grew from this need.

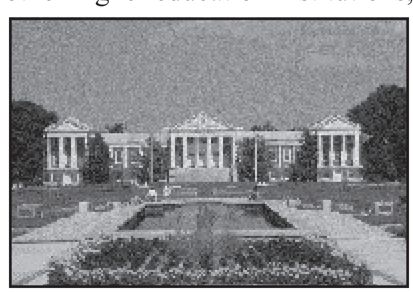
The Diversity Initiative is the University of Maryland's innovative and comprehensive approach to educating the campus about multicultural issues. It "explores and enhances common values that emphasize interdependence, equality, justice, human rights, and the sanctity of each individual's dignity." The goal is to make the university a more welcoming and inclusive community for all. Setting priorities and using the diversity planning principles maximize our efforts to achieve this success.

## Chapters

**Chapter One: Introduction: Why Diversity? Can it be Achieved?**

Despite controversial views about the value of diversity efforts, the impact of successful campus diversity programs nationwide are both visible and measurable. Discover why the institutional success of colleges and universities can no longer be separated from diversity programming.

**Chapter Two: The University of Maryland, an Overview**



Typical of many other higher education institutions, the University of Maryland possessed no traditions, history, programs or practices of diversity. Yet despite its segregated past, diversity initiatives now flourish on the campus. Look at Maryland's diversity history to learn why diversity planning efforts have succeeded here, and what you can learn from Maryland's "trial and error."

(Continued on page 7)

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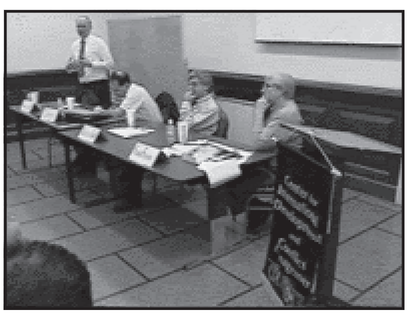
**Chapter Three: Principles of Change**

While there is no single formula that guarantees success for each institution's unique circumstances, there are strategic, organizational planning principles and institutional priorities that have successfully guided the efforts of the University of Maryland and other institutions. These planning principles can help any campus, regardless of type or size, create a successful diversity plan. The five major diversity principles are accountability, inclusiveness, evaluation, shared responsibility and institutionalization. Find out how attention to these fundamental aspects will guide you on the path to campus-wide, systemic change.

**Chapter Four: Additional Leadership Efforts and Change**

Vision, commitment and leadership are essential for systemic change in higher education. An inclusive institutional vision encourages a nurturing and challenging intellectual and social climate for all members of the campus community. What are the challenges and benefits of institutional vision and systemic change when embracing diversity as an essential part of the institutional mission? Look at some of the commissions, committees, and campus offices to get at their innovative visions, goals, strategies, policies, assessment tools, research and resources for success.



**Chapter Five: Recruitment, Retention, and Affirmative Action**

Current controversy over the value and meaning of affirmative action for higher education sometimes forgets the historical (and continuing) struggles of people seeking equal opportunity in our society, which is still segregated by race, class, gender, disability, religion and sexual orientation. Recruitment and retention of underrepresented groups ultimately enhances the educational experience for all. Pinpoint the continuing challenges and successes for those interested in and committed to access, equity and excellence in higher education by looking at some of Maryland's practices, legislation, resources and assessment tools related to this area.

**Chapter Six: Curriculum and Community**

Campuses are changing their curricula to address issues of diversity, and University of Maryland administrators define the educated person as one who has a grounding in non-Western as well as Western cultural traditions. Examine revised general education models and courses, new interdisciplinary programs, along with traditional disciplinary majors that have systematically addressed diversity in their course offerings or requirements. Also see how centralized programs continue to work on classroom changes with unique community outreach projects.

**Chapter Seven: Involving Faculty, Staff, and Students**

Active commitment to support services for both student as well as faculty and staff has proven to be an effective part of educational success. This priority is manifest in the many campus programs aimed at improving the overall climate. There are several offices at the University of Maryland which have added strong diversity components to their struc-

*(Continued on page 19)*

# Century of U.S. Doctoral Education Trends… (cont'd)

*(Continued from page 5)*

| 1975-99 Baccalaureate Institutions | PhDs | 1995-99 Baccalaureate Institutions | PhDs |
|---|---|---|---|
| All U.S. institutions | 2,635 | All U.S. institutions | 842 |
| Oklahoma State U. | 62 | U. Oklahoma | 20 |
| U. Oklahoma | 58 | U. California-Berkeley | 18 |
| Northeastern State U. | 50 | Northeastern State U. | 17 |
| U. California-Berkeley | 40 | Oklahoma State U. | 17 |
| U. North Carolina-Pembroke | 33 | Auburn U. | 10 |
| Top 5 as percentage of total | 9.2 | Top 5 as percentage of total | 9.7 |

| 1975-99 Baccalaureate Institutions | PhDs | 1995-99 Baccalaureate Institutions | PhDs |
|---|---|---|---|
| All U.S. institutions | 25,872 | All U.S. institutions | 842 |
| Howard U. | 752 | Howard U. | 20 |
| Southern U. | 419 | Spelman College | 18 |
| Hampton U. | 386 | Hampton U. | 17 |
| Florida A&M U. | 382 | Florida A&M U. | 17 |
| Tuskegee U. | 361 | Jackson State U. | 10 |
| | | Southern U. | 71 |
| Top 5 as percentage of total | 8.9 | Top 6 as percentage of total | 8.7 |

| 1975-99 Baccalaureate Institutions | PhDs | 1995-99 Baccalaureate Institutions | PhDs |
|---|---|---|---|
| All U.S. institutions | 15,574 | All U.S. institutions | 4,745 |
| U. Puerto Rico-Rio Piedras | 1,835 | U. Oklahoma | 478 |
| U. Puerto Rico-Mayaguez | 440 | U. California-Berkeley | 182 |
| U. Texas-Austin | 333 | Northeastern State U. | 115 |
| U. California-Berkeley | 289 | Oklahoma State U. | 110 |
| U. California-Los Angeles | 252 | Auburn U. | 90 |
| Top 5 as percentage of total | 20.2 | Top 5 as percentage of total | 20.5 |

**Top:** *Top 5 baccalaureate institutions of American Indian/Native American U.S. citizen PhDs: 1975-99 and 1995-99.* **Middle***: Top 6 baccalaureate institutions of black, US citizen PhDs: 1975-99 and 1995-99. All schools are historically black colleges/universities.* **Bottom***: Top 5 baccalaureate institutions of Hispanic, US citizen PhDs: 1975-99 and 1995-99.*

siderably shorter for men than for women, shorter for temporary residents than for permanent residents and U.S. citizens, and among U.S. citizens, shorter for Asians/Pacific Islanders than for other racial/ethnic groups.

*(Continued on page 9)*

# Century of U.S. Doctoral Education Trends… (cont'd)

*(Continued from page 8)*

Reliable race/ethnicity data first became available in 1975. Since then, among U.S. citizens the median RTD has increased for every racial/ethnic group, and the median TTD has increased for every group but Asians/Pacific Islanders (see Figure 4-18 at right). Among racial/ethnic groups in 1995–99, Asians/Pacific Islanders—highly concentrated in S&E fields—had the shortest median TTD (9 years) and the shortest median RTD (7 years). Blacks, with their heavy concentration in the field of education, had the longest times to degree completion.

## Top Institutions of Racial and Ethnic Groups

### *Baccalaureate Institutions*

The collection of data on race/ethnicity did not begin until 1975, but data since then have shown that the characteristics of baccalaureate institutions differ among U.S. citizen racial/ethnic groups (see the tables on page 8).

Research-intensive institutions played a less prominent role in the undergraduate education of blacks, Hispanics, and American Indians/Alaskan Natives than in the undergraduate education of whites and Asians/Pacific Islanders. Location, on the other hand, seems to have played a significant role for underrepresented minorities.

**Top Institutions of U.S. Citizen American Indians/Alaskan Natives.** Many of the top baccalaureate institutions of U.S. American Indian/Alaskan Native Ph.D.s were in the southwestern, southeastern, and midwestern regions of the United States.

**Top Institutions of U.S. Citizen Asians/Pacific Islanders.** Among U.S. Asians/Pacific Islanders who earned doctorates between 1975 and 1999, 62 percent received baccalaureates from the top 50 institutions for this demographic group.

**Top Institutions of U.S. Citizen Blacks.** More than 42 percent of all U.S. blacks who received doctorates between 1975 and 1999 earned bachelor's degrees at historically black colleges and universities (HBCUs).

**Top Institutions of U.S. Citizen Hispanics.** Forty-three of the top 50 institutions of U.S. Hispanics who earned doctorates between 1975 and 1999 were in states or territories with large Hispanic populations—Arizona, California, Florida, New Mexico, New York, Puerto Rico, and Texas.

### *Doctoral Institutions*

**Top Institutions of U.S. Citizen American Indians/Alaskan Natives.** U.S. American Indians/Alaskan Natives received doctorates from 274 institutions in the 1975–99 period. Their top 50 institutions were dispersed across 30 states.

**Top Institutions of U.S. Citizen Asians/Pacific Islanders.** About 65 percent of U.S. Asians/Pacific Islanders received doctorates from this demographic group's top 50 institutions between 1975 and 1999, and nearly 18 percent received doctorates from the top 5 institutions.

**Top Institutions of U.S. Citizen Blacks.** Three of the top 50 doctoral institutions of U.S. blacks were HBCUs—Howard University, Clark Atlanta University, and Texas Southern University. Although HBCUs primarily serve the black U.S. citizen population, the focus is shifting. In 1975–79, black foreign citizens constituted the second largest group to receive doctorates from HBCUs (24 percent), following black U.S. citizens (56 percent). There was greater diversity in the citizenship status and race/ethnicity of HBCU graduates at the end of the century. By 1995–99, black U.S. citizens earned 60 percent, and black foreign citizens 12 percent, of the doctorates earned at HBCUs. White U.S. citizens were the second largest group in 1995–99, receiving about one-sixth (18 percent) of all HBCU doctorates.

**Top Institutions of U.S. Citizen Hispanics.** Between 1975 and 1999, more than three in five U.S. Hispanic Ph.D.s earned doctorates at their top 50 institutions.

*U.S. Doctorates in the 20th Century was produced under an NSF contract with SRI International and authored by Lori Thurgood, Mary J. Golladay (NSF), and Susan T. Hill (NSF). NSF provided funding for the report, along with the National Institutes of Health, National Endowment for the Humanities, NASA, the Department of Education and the Department of Agriculture.*

For the full report 'US Doctorates in the 20th Century', see http://www.nsf.gov/statistics/nsf06319/

# Diversity in Physics… (cont'd)

(Continued from page 2)

**Table 1. Doctorates by field, sex, and race, class of 2004**

| Field | All | US* | Women | American Indian* | Asian* | African American* | Hispanic* |
|---|---|---|---|---|---|---|---|
| Physics | 1186 | 559 | 184 | 1 | 44 | 13 | 13 |
| Chemistry | 1987 | 1180 | 629 | 4 | 110 | 46 | 43 |
| Mathematics | 1075 | 510 | 305 | 0 | 54 | 10 | 26 |
| Computer & Information Science | 949 | 448 | 195 | 2 | 72 | 17 | 13 |
| Engineering | 5776 | 2182 | 1014 | 6 | 354 | 94 | 88 |

Source: T. B. Hoffer et al., ref. 1
*US citizens and permanent residents

**Table 2. Physics degrees granted to US citizens by race and ethnicity, class of 2003**

| | Bachelor's | | Exiting Master's | | PhD | |
|---|---|---|---|---|---|---|
| | Number | Percent | Number | Percent | Number | Percent |
| African American | 152 | 4 | 15 | 4 | 12 | 2 |
| Hispanic | 144 | 3 | 14 | 4 | 13 | 2 |
| White | 3711 | 87 | 332 | 83 | 465 | 88 |
| Asian | 171 | 4 | 20 | 5 | 29 | 6 |
| Other | 110 | 3 | 18 | 4 | 11 | 2 |
| Total US Citizens | 4288 | 100 | 399 | 100 | 530 | 100 |

Source: American Institute of Physics Statistical Research Center, *Enrollments and Degrees Report, 2003*

Of the 10 colleges and universities awarding the most bachelor's degrees in the physical sciences to Hispanics in 2003–04, most were Hispanic-serving institutions. The exceptions are all research universities: University of Texas at Austin; University of California, Santa Cruz and San Diego campuses; and MIT. An institution could appear on *Diverse* magazine's top-50 lists for African American and Hispanic physical sciences baccalaureates by awarding 5 and 4 degrees, respectively.[3]

It is not reasonable to expect growth in the URM PhD population without first addressing the small number of physics bachelor's degrees awarded. And perhaps it is not reasonable to expect an increased number of bachelor's degrees in light of experiences in K–12 schools, uneven career guidance, small numbers of visible role models, and few institutions with significant degree output. Those factors combine to decrease the pool of interested and well-prepared students who can consider advanced study in physics.

Among those graduating high school in 2000, only 26% of African Americans and 26% of Hispanics took any physics classes. In comparison, 62% of African Americans and 56% of Hispanics took chemistry courses.[4] Behind those numbers is the issue of the nature and quality of science education at elementary- and middle-school levels, including the extent to which physics concepts are being taught. Research suggests that K–12 schools largely attended by minority students have higher proportions of instructors teaching subjects they were not trained to teach.[5] The problems related to the nation's overall scarcity of certified physics teachers are likely magnified for schools with significant African American, Hispanic, and American Indian enrollment.

The gap between males and females taking at least some physics classes in high school is closing; 36% of males in the class of 2000 reported taking some physics, as did 32% of females. But both overall numbers remain unacceptably low. Compare them with the 58% of males and 67% of females who took chemistry. Clearly, most students graduate high school with no formal instruction in physics. That means low levels of physics literacy among the adult population. Or does it?

(Continued on page 11)

# Diversity in Physics (cont'd)

*(Continued from page 10)*

## A human activity

Opportunities exist for adults to develop a physics sense, even if they have not been exposed to a significant number of physics concepts. A trip to the local science museum can be enlightening, but one can also learn a good deal just by paying attention to everyday events—how a car responds during a drive around town, the forces at play when one assembles something, the trajectory of a ball from bat to glove. In observing everyday physics, adults are doing what some cognitive scientists argue is a natural component of child development. As children experience the physical, living, and social worlds, they develop assumptions about how those worlds work. Consider, for example, the following discussion of how babies reflect on issues of cause and effect, from *The Scientist in the Crib* by Alison Gopnik, Andrew Meltzoff, and Patricia Kuhl:

> *There are other reasons to think that, at about a year, babies understand how objects can influence each other. You can show babies a classic case of "billiard ball" causality: a toy car rolling along and bumping into another toy car, which then moves off. Or you can show them almost the same sequence, with just a slight difference—the first car gets close to the second car, and the second car rolls away, but the two cars don't actually touch. Although this is very similar to the first sequence, it violates a basic causal principle. Usually, at least, objects can't act on each other at a distance. Ten-month-olds look longer at the second scene than the first one. This suggests that they recognize just how peculiar it really is. And this, in turn, suggests that they know something about how objects can causally influence each other, quite independent of their own actions.*[6]

The book cites other examples, including toddlers providing appropriate explanations about what caused what and making predictions about how simple mechanical systems will work.

Young children explore, try things out, and try to make sense of the world. Their natural experiments are coupled with social interactions that reinforce their proclivity for sense making. On the topic of how babies learn about the external world, Gopnik and coauthors note: "They start out with some crucial assumptions, assumptions that seem to be built in. But, just as important, they are endowed with powerful abilities to learn, and even more powerful motivations."[7]

How do children move from behaving in ways that are so clearly consistent with learning about the physical world to avoiding courses that can support their understanding of it? Put a different way, how does physics move from being an inclusive domain for learning to an exclusive or exclusionary one?

## Fixing the System

Sixty-five percent of undergraduate students are female or URMs. Clearly, their reduced interest in physics and the barriers to their entering the field do not bode well for the long-term health of the discipline. It is important to consider how the current patterns of participation might be changed. The problems that have led from physics as a part of what it means to be human to physics as a community lacking diversity can be fixed. But, I contend, the issue is a systems problem, and it can respond only to a thoughtful suite of interventions that begins at the earliest grade level and moves through the professional life span. Those interventions would include at least the following components:

- Education and professional development so that those who teach physics are confident and comfortable teaching physics *concepts*.
- High-quality, hands-on, inquiry-based science for the primary grades.
- Development and dissemination of high-quality, research-based curricula for the middle grades.
- Experimentation with curriculum and instructional models, including such strategies as "physics first," to increase the number and diversity of students taking physics in high school (see ref. 6 and the Reference Frame column by Leon Lederman, Sept. 2001). Such experimentation may be especially valuable in schools that serve a significant number of URMs.
- Recruitment of minority students at all levels to take physics classes and to engage in informal

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# Meet Marcel Agüeros, NSF Postdoctoral Fellow at Columbia University

***by Keivan G. Stassun***

"For a long time I was an aspiring astronomer because it was different career choice and I liked that, even as I wondered if I could really make it my profession. It's only fairly recently that I've become comfortable with calling myself an astronomer."

Marcel Agüeros, a born-and-bred New Yorker, is now back in his hometown as an NSF Astronomy and Astrophysics Postdoctoral Fellow at Columbia University (his alma mater), but his path from downtown to uptown Manhattan has been full of detours. The son of a Nuyorican father and French mother, Marcel went to French school first in Manhattan and then in Brussels, Belgium, where he moved in 1989, after his parents divorced. A good student in New York, Marcel found adjusting to life in Brussels very difficult, and stayed back his junior year before escaping with a Baccalauréat (the French high school degree) in 1992. "Ultimately I found the French educational system suffocating, and I just didn't deal with the authoritarian side of my high school very well, to say the least. My experiences there had some rather unforeseen consequences. It took me a couple of years of college before I believed that any professor actually was interested in my opinion; in high school the emphasis was on thesis antithesis synthesis, and no one asked what you thought."

In 1992 there was no prom, no graduation ceremony, no yearbook—none of the fuss associated with senior year in an American high school. "It's funny, actually. There's now an alumni association that is planning a special reunion for the school's 100th birthday next May. I guess Americanization is inevitable wherever you look!" Marcel has yet to decide whether he will attend the reunion... "I'd like to see my biology teacher again. On the first day of my second junior year, she did the roll-call, and then asked if any of us were repeating the year. I dutifully raised my hand, and she said: 'Ah... Agüeros! but for you it will be as though this is the first time!' I never did do very well in her class."

If graduating from high school in the summer of 1992 was a small miracle, entering Columbia College that fall was another. The French school in Brussels had no real college advising. The best students were encouraged to apply to so-called preparatory schools, where they would suffer for two years while training for the entrance exams to the "grandes écoles," the best French university programs. Every graduate was automatically eligible for a spot at one of the French public universities. Marcel signed up to attend a university in Paris, but was much more interested in returning to the U.S. Advice on how to get into an American college was almost non-existent.

"We had a few American friends who helped me figure out which tests to take, etc., but it was all very improvised. My teachers didn't speak English, and anyway French universities really don't care about recommendations, so they overstated my qualifications ('one of the ten best students I've ever had!') and had me translate their letters. I arranged to have at least one of my admission interviews in a bar... I could go on, but I don't want to have my B.A. taken away." Columbia was one of a handful of colleges that admitted Marcel, perhaps in part because he had very good test scores and perhaps in part because they thought more highly of the French educational system than he did.

His first semester at Columbia, Marcel decided to take classes in the areas that interested him when he was 12: astronomy, archeology, and judo. A couple of research experiences helped him decide to major in astronomy, and an REU at the Arecibo Observatory in Puerto Rico made the prospect of a life in astronomy both concrete and attractive. "I loved being at Arecibo. For one, it was only an hour or so (depending on how fast you drove) from my abuela's home in Quebradillas. For another, I really liked the research atmosphere and the astronomers there. I started being able to see myself living and working among these people, and I liked the idea." He also started developing an interest in

*(Continued on page 18)*

# Diversity in Physics (cont'd)

(Continued from page 11)

**Figure 2.** *Packard scholars exchange ideas during their July 2005 annual meeting held in Monterey, California. In the foreground, with his back to the camera, is James Stith of the American Institute of Physics.*

physics experiences such as those offered in science and technology centers, after-school programs, and camps.

- Support of physics programs in institutions that serve URMs.
- Increased recruitment of bachelor's-level URM and women students for summer internships and research opportunities.
- Transfer of effective models from high-production to low-production institutions.
- Exploration of the efficacy of mentoring or a community of colleagues to improve the retention of women and URMs in graduate school.
- Understanding of the departmental climate as a factor in increasing student diversity.
- Awards and recognition for individuals and departments that effectively mentor URMs.
- Support, through professional organizations, for the professional development of women, URMs, and persons with disabilities as well as for those who teach and advise them.
- Equal opportunities for employment and advancement.
- Focused attention on the needs of female URMs in physics at all levels.

Some of the interventions are general and would have a positive impact on the study of physics for all students; ensuring that teachers are comfortable with physics concepts is one example. Other proposals, including focused attention on the needs of female URMs, are targeted. In many instances, people's ability or willingness to implement targeted programming has been dampened by concerns about legal challenges.[7] Rather than seek ways to legally and effectively serve populations most in need, institutions have tended to cancel their efforts or make them "for all," a move that neither increases the number being served nor addresses the special needs faced by those in the minority. Legally responding to the concerns of women and URMs is an issue that deserves more discussion in the physics community.

It is crucial that science educators work to maintain the early excitement, interest, and curiosity that children bring with them when they begin school. Nonexistent or poor early science instruction can affect students' attitudes toward science and their future willingness to take elective courses in science. Professional development that allows teachers to learn in the same way they should teach is demonstrably effective. Programs such as the Teachers Academy of Math and Science in Chicago and La Main à la Pâte, begun in France but now operating worldwide, focus on enhancing the interactions between scientists and educators and encourage the use of hands-on, inquiry-based strategies that move from phenomena to concepts. Many of the topics they recommend are from physics. Wherever the projects are in use, their results are universally engaging for children.

> *"In many instances, ability or willingness to implement targeted programming has been dampened by concerns about legal challenges."*

Lederman's physics-first concept, in which physics is a required first course rather than an elective capstone course, changes how the student relates to the disciplines of physics, chemistry, and biology. When he proposed the idea in the mid-1990s, I asked Lederman to look at the patterns of course-taking for different demographic groups in the schools that reordered their sequence. He found

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# Preparing Minority Scientists and Engineers (cont'd)

*(Continued from page 3)*

earned science or engineering bachelor's degrees (students in good academic standing who leave S&E fields before graduation become supported by other UMBC scholarship programs). Most of the S&E graduates (379 students, 87%) went on to graduate or professional programs (41% to Ph.D. or M.D.-Ph.D., 22% to master's, 24% to medical or other professional programs, and 13% employed). Meyerhoff students with completed advanced degrees now number 44 with Ph.D.'s or M.D.-Ph.D.'s (most earned in the past 2 years), 72 with master's degrees, and 32 with medical degrees.

The effectiveness of the Meyerhoff program is highlighted by comparing students who entered the Meyerhoff program with those who were invited but declined and attended other institutions (*9*, *19*, *20*). Both groups earned similar grades and graduated at similar rates. But students who entered the Meyerhoff program were twice as likely to earn a science or engineering bachelor's degree (*9*) and 5.3 times more likely to enroll in post-college graduate study (*19*, *20*). In addition, Meyerhoff students were about twice as likely to earn S&E B.S. degrees as Asian, Caucasian, and non-Meyerhoff African-American students with similar preparation and interests (*9*).

The Meyerhoff model has four overarching objectives: (a) academic and social integration, (b) knowledge and skill development, (c) support and motivation, and (d) monitoring and advising (*9*, *19*, *20*). Our ongoing evaluation of outcomes leads us to identify five elements as most important for achieving these objectives: (i) recruiting a substantial pool of high-achieving minority students with interests in math and science who are most likely to be retained in the scientific pipeline, (ii) offering merit-based financial support, (iii) providing an orientation program for incoming freshmen, (iv) recruiting the most active research faculty to work with the students (our philosophy is that it takes a scientist to train a scientist), and (v) involving the students in scientific research projects as early as possible, so that they can engage in the excitement of discovery. Encouraging high academic performance in the first 2 years is critical. Students are encouraged to retake courses in which they earn a C in order to strengthen foundation knowledge before advancing to other courses.

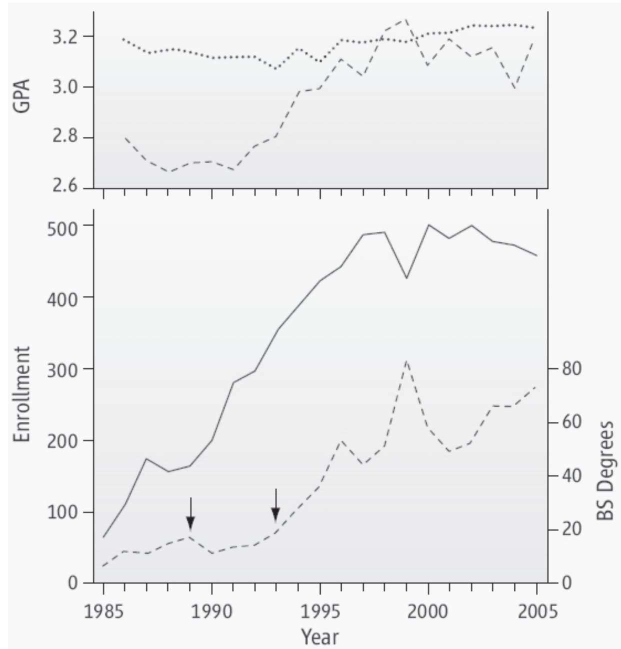


***Figure 1: Effect of the Meyerhoff program on undergraduate studies*****.** ***(Top)*** *Average grades of Caucasian (dotted line) and African-American (dashed line) students at graduation in S&E fields (biology, biochemistry, chemistry, computer science, engineering, mathematics, and physics).* ***(Bottom)*** *African-American enrollment (solid line) and graduations (dashed line) at UMBC for S&E undergraduates. The Meyerhoff undergraduate program was initiated in 1989 and began graduating students in 1993 (arrows).*

The program encourages students to pursue academic goals, earn top grades, and prepare for graduate school. Students participate in study groups and use university resources for tutoring and counseling. Students also mentor and tutor other students on campus as well as children in inner city schools. Group activities such as monthly focus groups to discuss class and research experiences, receptions with mentors and parents, competitive team building events, and group participation at scientific conferences encourage a sense of community among the students, faculty, and staff.

As participation in the Meyerhoff program has grown, we have observed a simultaneous increase in S&E participation among UMBC minority students who are not in the Meyerhoff program. The number of African-American undergraduates majoring in science and engineering has increased

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# Preparing Minority Scientists and Engineers (cont'd)

(Continued from page 14)

more than sevenfold since 1985 (see Figure 1) whereas overall African-American enrollment increased 1.4-fold. Overall and S&E enrollments among Latino students have also grown (three- and fivefold, respectively) since 1985. The number of Caucasian S&E majors also increased during this time period (from 710 to 1287 students, 1.8-fold) at a rate greater than that of total undergraduate enrollment (from 7914 to 9406 students, 1.2-fold). The average GPA of all African-American S&E graduates has increased from 2.70 in 1989 to 3.21 in 2005, due primarily to the high achievement of the Meyerhoff Scholars (average graduating GPA = 3.42 ± 0.12). The average GPA of Caucasian S&E graduates has remained relatively unchanged (3.17 ± 0.05) (see Figure 1).

In the 1990s, participation of URMs in graduate studies at UMBC continued to reflect low national averages (Meyerhoff undergraduates are encouraged to pursue graduate studies elsewhere). To address this, we began the Meyerhoff Graduate Biomedical Fellows Program in 1996. The program includes (i) a prematriculation orientation program; (ii) group social activities, including annual weekend retreats and picnics (with white-water rafting and hiking); (iii) monthly student seminars; (iv) instruction on technical writing and grantsmanship; and (v) financial support for student travel and minority scientist seminars. Efforts to encourage student applications focused on predominantly minority serving campuses. Research opportunities for summer students and undergraduate research symposia were available. Applications from African-American and Latino students went from about 2 per year in 1998 to about 50 per year since 2002, and URM participation has increased by an average of 18% (see Figure 2).

Sustaining interest in a scientific career is every bit as important in producing the scientific workforce as is generating the interest and knowledge in the first place. Retention of both undergraduate and graduate students can focus on specific populations. Success depends on addressing both academic and community issues. At the undergraduate level, administrative efforts and resources are needed to attract high-achieving minority S&E students and prepare them for the rigors of college courses. Research faculty are usually eager to mentor minority students who are academically successful. At the graduate level, departmental leadership is critical, since this is where admissions, mentoring, and candidacy decisions are made.

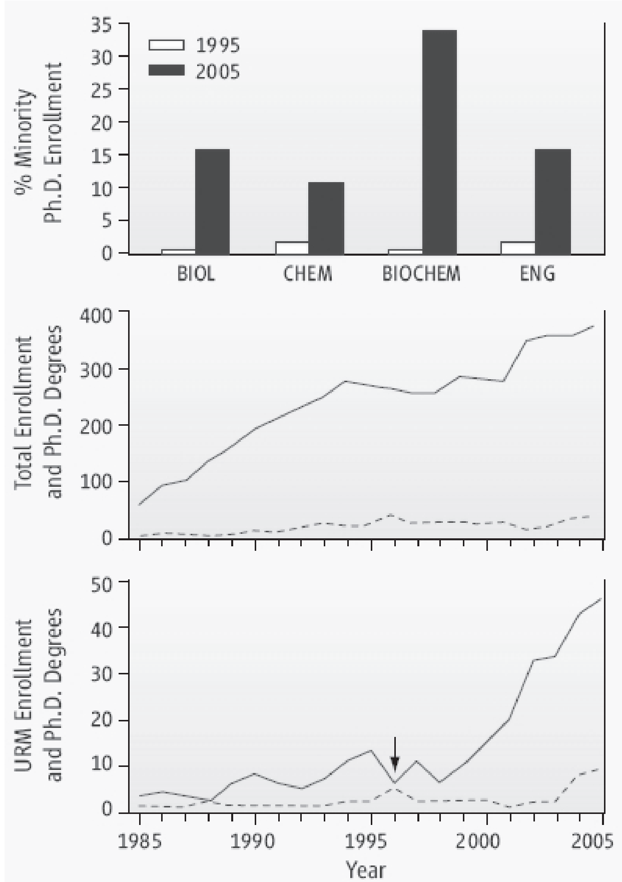


***Figure 2: Effect of the Meyerhoff program on graduate studies.*** *(**Top**) Effect of diversity efforts on minority S&E Ph.D. enrollment. (**Middle**) Total S&E Ph.D. enrollment (solid line) and degrees awarded (dashed line) at UMBC. (**Bottom**) Total African-American and Latino S&E Ph.D. enrollment (solid line) and degrees awarded (dashed line). The Meyerhoff graduate program was initiated in 1996 (arrow).*

*Michael F. Summers, Howard Hughes Medical Institute (HHMI) and Department of Chemistry and Biochemistry; Freeman A. Hrabowski, III, Office of the President, University of Maryland, Baltimore County, 1000 Hilltop Circle, Baltimore, MD 21250, USA.* *This article is reprinted by permission from the from the 31 March 2006 issue of Science, the magazine of the American Association for the Advancement of Science.*

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# Diversity in Physics (cont'd)

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more students, and a more diverse group of students, were taking more science classes.

### After the Degree

Why are some institutions effective in recruiting, retaining, and graduating physics students from diverse populations while others are not? Student potential, the reality of student capacity, the learning environment, the curriculum, and expectations all play a role. But the fact is URM baccalaureate degree recipients in physics come disproportionately from minority-serving institutions.

A 2005 talk-back session with newly minted African American PhDs who participated in the Packard graduate scholars program provided insights into the success of minority-serving institutions. The program supported the graduate-level education of science and engineering students who had received their undergraduate degrees from HBCUs. In the talk-back session, scholars contrasted the communities of the black colleges with those of their graduate schools and noted that the HBCUs gave them confidence, encouragement, and tangible proof that African Americans could succeed in science. In a February 2006 *Inside Higher Education* editorial, Daryl Chubin, who moderated the talk-back session, summarized the students' messages and their implications.[8] Gender and race bias, the students found, is a graduate-school reality that has to be managed, and even though successful students devise their own ways to cope, institutions need to consider formal systems to address discrimination. In particular, institutions need to reward outreach and work to develop student diversity. The Packard scholars also noted that they must stay focused on completing the requirements for their doctorate.

*"...any prospect for success in increasing diversity is predicated on leadership—having it and nurturing it."*

One important comment Chubin made was that any institution of higher education can effectively serve minorities. A recent article by Michael Summers and Freeman Hrabowski in the journal *Science* gives an example of a predominantly majority institution, the University of Maryland, Baltimore County, that aspired to and became a minority-serving school.[9] I must note, though, that any prospect for success in increasing diversity is predicated on leadership—having it and nurturing it.

In 1876 Edward Bouchet received the first PhD awarded to an African American from a US university.[10] His degree, from Yale University, was in physics. Little in Bouchet's background would have led one to predict that outcome. The son of former slaves, he was able to demonstrate his capacity to achieve in physics by being given the opportunities for education up to the highest levels. And yet, when he completed his doctorate, he found no employment opportunities appropriate to his level of preparation.

Subsequent African American doctorates, at least through the civil-rights years of the 1960s, worked in HBCUs or in government. But until employment opportunities opened more broadly in the 1970s, one could not have reasonably expected a significant influx of African Americans into the study of physics. A feedback loop exists between the opportunities for employment and advancement in a field and the ability to attract and retain people. At least for women in physics, appointments to faculty positions seem to track with the number of women in the overall pool. That is not the case for women in chemistry, at least at the major research universities. Industry has done a better job at offering women with chemistry degrees employment in proportion to their numbers.

It will not be easy to change the system of education and career opportunities in physics to one that is fully supportive of diversity. But failing to consider change is unacceptable to the health of the field.

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# Diversity in Physics (cont'd)

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the end points of stellar evolution, and in particular in neutron stars, the area of research he has spent most of his time exploring.

Back from Puerto Rico, Marcel got to know David Helfand, who has been his most important mentor ever since. "Joe Patterson, a great teacher, was my first Columbia adviser, and I didn't really meet David until my senior year. Nothing in our early interactions suggested how important David's friendship and advice would become to me, but as it turns out there hasn't been a professional decision I've made over the last ten years where I haven't consulted him. I'm incredibly grateful for everything he's done for me."

While majoring in astronomy, Marcel also completed the requirements to be certified to teach high school physics, which included a semester student-teaching at Frederick Douglass Academy in Harlem. "I love working with high school students, and I was planning to teach in the public school system for a couple of years after graduation, while I had the energy. Instead I went to England." Marcel had received the Euretta J. Kellett Fellowship, through which Columbia funds students for two years of study at either Cambridge or that other place. In the fall of 1996, Marcel moved to England to enter Emmanuel College, and was soon working on an M.Phil. at the Cavendish Laboratory under the supervision of Dave Green—a supervisor suggested by David Helfand. "An M.Phil. is a research degree, and so I spent a year working with data taken with one of our observatory's radio interferometers to measure the expansion of supernova remnant Cassiopeia A. It was a very useful experience for gauging my interest in obtaining a Ph.D., and I loved working with Dave, but when I was done I decided I wasn't quite ready yet."

It took a few years of wandering (including six months in South Asia and a year in Paris) before Marcel decided to come back to the U.S. for a Ph.D. "David and I sat on a bench outside of the old Observatory in Cambridge and he listed the places he thought I'd be happy. The University of Washington was one of the places he mentioned, and if he hadn't, there's no way I would've thought of applying." A visit in 1999 to the U.W. was enough to convince Marcel, and in the fall of 2000 he moved to Seattle. The transition was not the smoothest, but Marcel was lucky to find a great adviser, mentor, and friend in Scott Anderson, who eventually headed his thesis committee. He also relied on fellow graduate students to help him through the tough times, and credits classmates Anil Seth and Kevin Covey (both now at the CfA) in particular with making graduate school life easier.

Marcel's research as a graduate student focused on using correlations of the Sloan Digital Sky Survey (SDSS) with surveys at other wavelengths to characterize large numbers of "ordinary" objects, while simultaneously searching for rarer ones. His dissertation, titled "Candidate Isolated Neutron Stars and Other Stellar X-ray Sources from the ROSAT All-Sky and Sloan Digital Sky Surveys," used SDSS and 2MASS, along with spectroscopy from the ARC 3.5-m telescope at Apache Point, New Mexico, to construct a catalog of X-ray-emitting stars while looking for those much more elusive isolated neutron stars. "My thesis title is unwieldy but does describe what happens when one works with large surveys. Typically one is more excited about the needles, but still has to spend lots of time describing the haystack..."

SDSS cannot identify isolated neutron stars directly, since these are typically much fainter than the survey's 22 or 23 mag limit, but it can be used to identify more common X-ray emitters (including main sequence stars) and thereby produce, by elimination, a list of possible neutron star candidates. Follow-up observations of these candidates are on-going, and Marcel is hopeful that these may turn out to be useful for constraining the neutron star equation of state. "There are only seven isolated neutron stars currently known, and while in theory these objects represent one of our best opportunities to examine the neutron star EOS, in practice we really could use a few more to study."

While at the U.W., Marcel also worked on addressing the historic underrepresentation of women and minorities in astronomy. Along with two other then graduate students, Andrew West and Kevin Covey, he wrote a diversity plan for the department, and later submitted a proposal to the university's administration to fund a new program for

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# Meet Marcel Agüeros… (cont'd)

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entering freshmen, dubbed the Pre-Major in Astronomy Program (Pre-MAP). "Pre-MAP came out of discussions Kevin and I had about how we might move from talk about diversity to action. We were very pleased when our proposal was accepted, but we never expected it to become as big a part of the department's life as it has." Now in its second year, Pre-MAP is directed by Eric Agol and is run by a team of roughly a dozen graduate students.

Underrepresented students are recruited into Pre-MAP the summer before they enter the U.W. Once on campus, they take an introductory astronomy course designed for science-interested students along with the special Pre-MAP seminar. In the seminar, the students acquire basic computing skills required to work on research projects (e.g., IDL). They also practice data manipulation and visualization, reading scientific journals and science writing, and are introduced to basic statistical analysis. A few weeks into the quarter, members of the department present available research projects. The students then work on their chosen research projects in small groups supervised by the seminar leader and the project scientist. "While it's too early to say whether we'll meet our goal of eventually doubling the number of underrepresented students graduating from the U.W. with degrees in astronomy, Pre-MAP has definitely been very successful. Last year, for example, at the U.W.'s showcase for undergraduate research, only 11 of the 505 participants were freshmen—and five of them were Pre-MAP students." Similar programs have been shown to increase persistence within a major, student performance, and academic self-esteem. [Editor's note: To learn more about Pre-MAP, visit : http://www.astro.washington.edu/premap/]

Having finished his Ph.D. and moved to New York, Marcel is looking forward to exploring new research directions, and to becoming re-acquainted with some of his old haunts. "Recently I was talking to Héctor Arce, a fellow NSF fellow who is at the Museum of Natural History, about helping out with one of his outreach projects—which happens to be with students at Frederick Douglass Academy! Needless to say, I signed up." And why did he decide on a return to New York, anyway? "When I was applying for post-docs, I came to an event at Columbia. Over wine and cheese afterwards, one of the astronomers asked me where I was going. I mentioned I might return to New York and he said 'Come back! All is forgiven!' So here I am."

# Diversity Blueprint… (cont'd)

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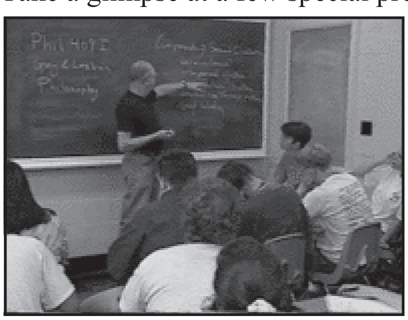
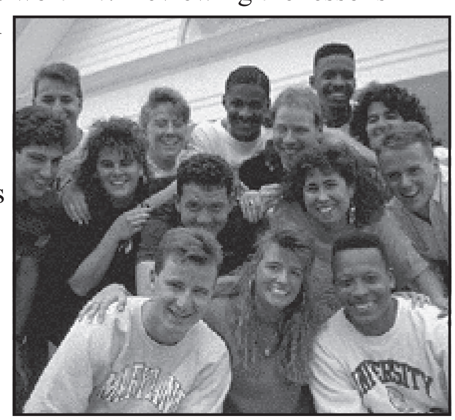
tures to better meet student, faculty and staff needs. Take a glimpse at a few special programming efforts, and get helpful hints about such things as the incentives, resources, and constraints involved with them.



**Chapter Eight: Summing Up: Diversity is at the Heart of Education**

Those who support the aims and principles of diversity, as well as those who decry them, agree that campuses face a variety of challenges in their efforts to make education a truly inclusive option. But are these threats worth it? Reviewing the lessons learned through the university's experience and analysis, along with their general suggestions about how to begin, expand, or alter your institution's diversity program and policies, ultimately lend an urgency to transform our campuses into communities that welcome and support all our citizens in the education enterprise.



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