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Untapped Talent:

The African American Presence in Physics and the Geosciences

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Cover Photo

Attendees at the 2007 Joint Annual Conference of the National Society of Black Physicists and the National Society of Hispanic Physicists. Used with permission of NSBP. Photography by Rodney Choice.

Untapped Talent:
The African American Presence in Physics and the Geosciences

By Roman Czujko, Rachel Ivie, and James H. Stith

Executive Summary

This report provides a wealth of data on the presence of African Americans in physics and the geosciences. The data show trends over time, as well as comparisons with related disciplines. Compared to other scientific disciplines, physics and the geosciences consistently come out near the bottom in terms of their ability to attract and retain African Americans.

The data show that there are numerous African American students who have adequate high school preparation to succeed in physics. Yet these prepared students are more likely to choose math or sciences other than physics and geosciences. In higher education, the picture that emerges is consistent and clear: African Americans are under-represented in physics and geosciences. In addition, under-representation worsens with each step up the academic ladder.

While African American women earn physics and geosciences degrees in higher percentages than white women, the number of African American women in these fields is very small. Similarly, the number of African American faculty members is very small, and these faculty members tend to work in the Historically Black Colleges and Universities (HBCUs).

There are a few success stories in physics and the geosciences. Successful departments have several features in common, including unique recruitment efforts and a history of educating African American students. We list departments that have been successful in attracting and retaining African American students so that they might be used as role models by departments wishing to increase their numbers of African American students.

Highlights

- There are many African American high school students who achieve high scores on standardized tests in mathematics. However, these students are less likely to graduate from college than white students **(Figure 2)**.

- African Americans are under-represented among college graduates relative to their proportion among the college-age population. Still, more than 120,000 African Americans earn bachelor's degrees each year, and their representation differs dramatically by field of degree. Among the sciences, geosciences and physics have the lowest representation of African Americans **(Table 1)**.

- Historically Black Colleges and Universities (HBCUs) produce a large proportion of African American bachelors in science, math and engineering **(Table 5)**. Conversely, almost all physics and geoscience departments at majority-serving institutions have thus far played virtually no role in the education of African American physicists **(Table 2)**.

- Fifty-seven percent of all bachelor's degrees are earned by women. Among African American college students, women play an even bigger role, earning about 65% of all bachelor's degrees **(Table 9)**.

- Remarkably few African Americans have earned PhDs in physics or the geosciences over the last three decades, but the number is increasing **(Figure 4 and Figure 5).**

- Departments successful in graduating African American physicists and geoscientists are listed in this report as examples for those wishing to improve their numbers of African American students **(Table 3, Table 4, Table 15, and Table 16)**.

- There are fewer than 200 African American physics faculty members in almost 800 departments **(Table 17)**. Furthermore, most African American physics faculty members work in the 35 HBCUs that grant physics degrees.

Introduction

The national debate about the production of scientists, engineers, and the technically skilled workforce has reached record levels. The argument generally centers around the low production of domestic science and engineering graduates and the perceived shortage of personnel to meet the needs of the country. Whether one agrees with the position that the nation is facing an impending shortage, most agree that the nation needs to increase the percentage of those from under-represented groups who earn degrees in science, technology, engineering, and mathematics. In general, the physical sciences have difficulty attracting and retaining members of under-represented groups. Despite years of study, however, there is little agreement as to the reasons for this lack of representation.

This paper presents data covering the representation of African Americans among physics and geoscience degree recipients at each stage of the educational system. The data were collected by a number of statistical agencies and are here provided in far more detail than has ever been available before. By placing all the data in one place, we present a snapshot of the supply side of physics and the geosciences. These data can provide a factual framework to assist those engaged in the debate about the future of the scientific workforce.

In addition to compiling the data from disparate sources into one document, this report also places the education of African American physicists and geoscientists within the larger context of the educational system and social structure. The lack of adequate representation of African American physicists and geoscientists cannot be understood without a thorough examination of the role of African Americans in the educational system as a whole, beginning with high school preparation and extending to the relationship between geographical location and higher education. Then, it is essential that we examine the structural barriers some students must circumvent. We identify institutions that have been able to remove or reduce some of these barriers so that we know where we might find solutions to help students overcome these obstacles.

This report highlights the striking contributions of Historically Black Colleges and Universities (HBCUs) in supplying the scientific workforce of African Americans. While HBCUs educate more than one-fifth of African Americans who earn bachelor's degrees, they produce around fifty percent of the African American bachelor's degrees in physics and show similar numbers in the other sciences. Similarly, a few (certainly far too few) universities that are not Minority Serving Institutions (MSIs) also make significant contributions to the scientific education of African Americans. The report raises questions such as: What is unique about Xavier University in New Orleans that results in it being the leader in the production of African American bachelors in physics? What are the lessons to be learned from the select group of institutions that are the leading producers?

The authors acknowledge the generous support of the David and Lucile Packard Foundation in completing this study. Clearly, without it, we could not have completed this work.

How the Study was Conducted

Most of the analyses for this study were based on data collected and made available by the Science Resources Statistics Division (SRS) of the National Science Foundation, the National Center for Education Statistics (NCES) of the US Department of Education, the Bureau of the Census of the US Department of Commerce, and the Bureau of Labor Statistics of the US Department of Labor.

NCES was the source for all data on high school students, bachelor's and master's degrees. Analyses on high school students were conducted on the National Education Longitudinal Study (NELS), available on CD. We conducted the analyses of bachelor's and master's degrees using the Integrated Postsecondary Education Data System (IPEDS) which was downloaded from the web.

PhD level data were analyzed on-line using a database system designed and maintained by the National Science Foundation, called WebCASPAR (Web-Based Computer Aided Science Policy Analysis and Research). This database system provides access to a wide range of statistical data focusing on U.S. universities and colleges and their science and engineering resources. The WebCASPAR database includes data from several surveys conducted by the NSF Division of Science Resource Statistics (SRS), plus data from surveys conducted by the National Center for Education Statistics (NCES) of the US Department of Education, and data from a variety of other sources. The web-based system provides access to data in far more detail than could reasonably be published in print. For example, we were able to pull together several years of information about individual fields of science and engineering at individual academic institutions.

There are important differences in how the data were collected. The PhD data cited in this study were collected by the NSF from individual degree recipients. The bachelor's and master's data were collected by the NCES from academic institutions. Thus, students earning PhDs each indicated their own degree field; yet, the fields for bachelor's and master's degree recipients were entered by representatives from the universities and colleges providing the data. It is possible that individuals at the two lower levels might have indicated a different field based on nuances in their academic careers that were not readily apparent to the institutional representative. However, any discrepancies are small and have little impact on the overall findings.

Data on physics faculty members were collected by the Statistical Research Center of the American Institute of Physics. These data come from surveys sent to all degree-granting physics departments in the US. The surveys asking for numbers of minority faculty are conducted every four years. The last several surveys have had response rates of over 90%, which suggests the data are quite reliable.

The salary data were collected by the Current Population Survey and are published on the web site of the Bureau of the Census. For more information on income organized by education, gender and race, readers can visit http://www.census.gov/cps/.

While the field of physics is typically readily defined within a university, the geosciences include a broad range of fields. Most institutions have only one physics department, but many institutions have more than one geoscience department. At the undergraduate level, geoscience includes fields such as geology,

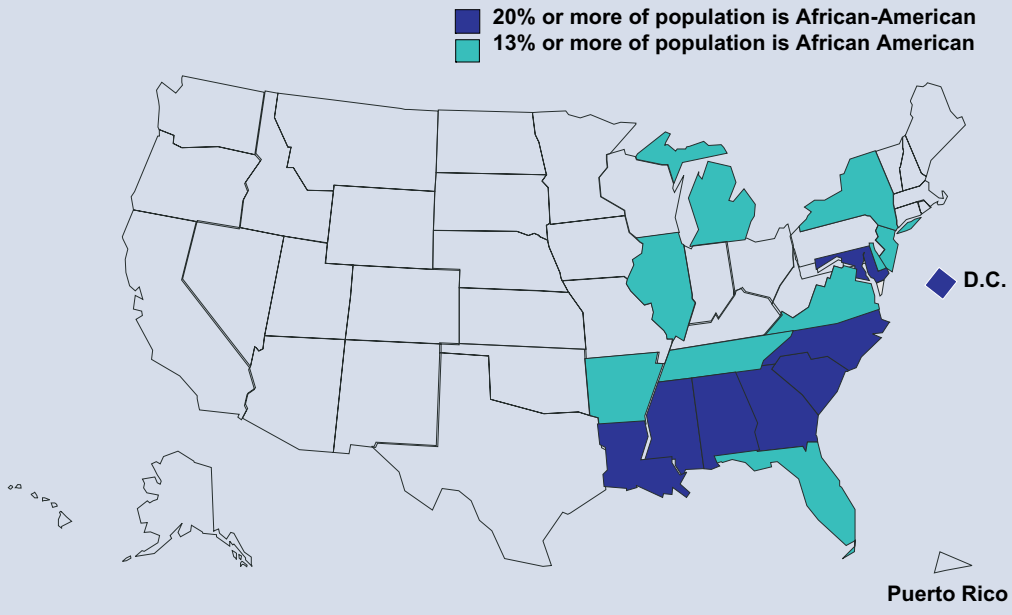
atmospheric science, and ocean sciences. At the graduate level, geosciences diversify even further and may include geology, hydrology and water resources, geophysics and seismology, stratigraphy and sedimentation, oceanography and marine sciences, and meteorology and atmospheric sciences. In this report, data that show number of degrees awarded include all the geoscience degree-granting departments at a university.

Readers are cautioned that there is some uncertainty in the geosciences data. In part this is due to typical data collection problems, but also it is due to taxonomy issues surrounding the field. This is especially problematic when examining data on small groups, such as African Americans in the geosciences. However, the field categorizations appear to have been applied consistently over time. Thus, even if the number of degrees earned changes slightly, we have very high confidence in the overall trend of the data.

Geography and Regional Differences

Prior to the in-depth analysis of the trends in physics and the geosciences, it is important to step back and establish the foundation for a few general trends. One of these involves where people live. African Americans represent 13% of the population of the U.S., but are more likely to live in some parts of the country than in others. As ***Figure 1*** reveals, African Americans are most heavily concentrated in the southern

Figure 1. States with highest concentration of African-Americans, 2000.



Source: AIP Statistical Research Center compiled from data collected by the US Census Bureau.

U.S. The states that are dark blue in ***Figure 1*** are those states with the highest concentrations of African Americans (at least 20% of the state's population). Those states that are light blue have the next highest concentrations of African Americans (less than 20%, but more than 13% of the state's population).

Geography has important implications in the college attendance patterns of African American students. Across all racial and ethnic groups, students who attend college often do so close to home. African American undergraduates are even more likely than other college students to attend schools close to where they grew up. In fact, half of African American undergraduates attend colleges within 10 miles of their homes (*The Journal of Blacks in Higher Education*, Number 36, Summer 2002, page 38). As this report will show, *where* African Americans attend college is related to the likelihood of participating in physics or the geosciences.

Secondary School and the Transition to College

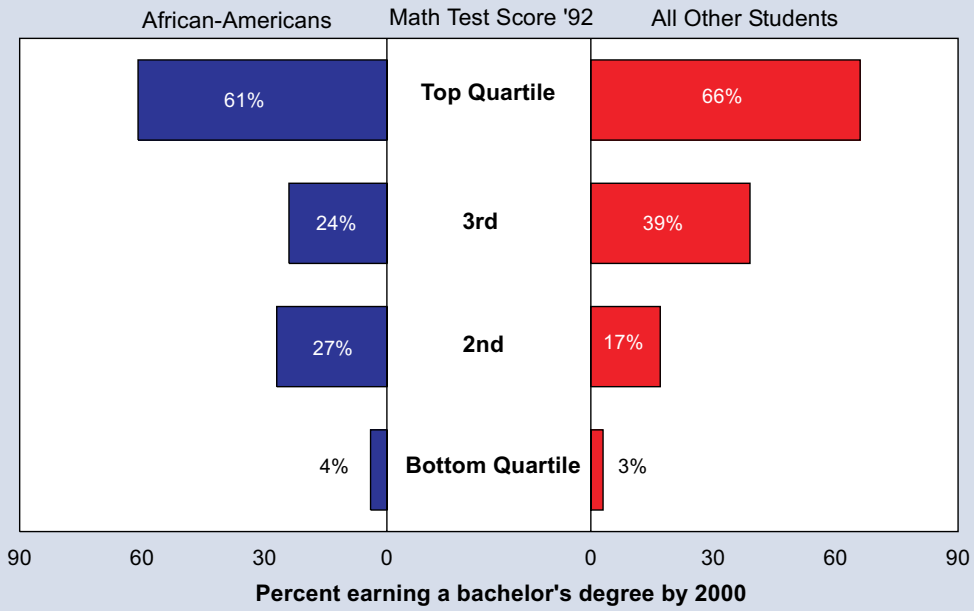
One often hears physics faculty members assert that African American students are generally not ready for physics because of inadequate preparation--particularly in math--at the high school level. However, this belief could not be further from the truth. Each year, there are thousands of African Americans who have adequate mathematics preparation but face many barriers to academic success in college. These barriers have nothing to do with the students themselves, but are solely products of the inequality experienced by African Americans.

These assertions are based on data from a longitudinal study conducted by the National Center for Education Statistics (NCES) of eighth graders. The study began in 1988 and had follow-up surveys in 1990, 1992, 1994 and 2000. Specifically, we will present some data on this national sample from the surveys in 1992 and 2000, when the respondents were approximately 17 and 25 years old, respectively.

African American students who graduate from high school with strong mathematics skills do not succeed in college at the same rates as other students. As ***Figure 2*** shows, African Americans who score in the top 25% of all test takers were less likely than other students with similar scores to earn a bachelor's degree. A similar disparity in academic success occurs for African Americans who score in the next highest quartile on the standardized mathematics test. African American students who succeed in high school face barriers to academic success in college. These barriers, which have nothing to do with the preparation of the students, require serious consideration by faculty members and university administrators. What is happening during college education that is so discouraging to well-prepared African American students?

In addition, well-prepared African American students are less likely to go into physics than into other sciences or math. Physics faculty members should work to remedy this imbalance. The next section will document that there are plenty of African Americans who have adequate math preparation, but these students are instead choosing math, engineering, and other sciences.

Figure 2. Mathematics test scores in high school and success in college, African-Americans and all other students.



Source: AIP Statistical Research Center analyzed data collected by the U.S. Dept. of Education (NELS:88).

African Americans among Bachelor's Degree Recipients

The science and engineering (S&E) workforce plays an essential role in fundamentally important areas such as economic growth, the standard of living, the quality of health care, and national defense. However, joining the S&E workforce typically requires at least a bachelor's degree. This section of the report will describe the current trends in the participation of African Americans at the undergraduate level.

Compared to their numbers among college-aged students, African Americans are under-represented among bachelor's degree recipients. African Americans make up 13% of the nation's population, but earn only 9% of all bachelor's degrees. About 1.4 million people in the U.S. earn bachelor's degrees each year. Slightly more than 120,000 of them are African Americans, which is well below the 182,000 we would expect if the demographics of bachelor's degree recipients mirrored those of the nation as a whole.

Table 1 shows the representation of African Americans among bachelor's degree recipients. While it varies considerably by field, nowhere is it lower than in the geosciences and in physics. While African Americans earn 9% of all bachelor's degrees, they only earn about 2% and about 4% of the bachelor's degrees awarded in the geosciences and physics, respectively.

Table 1. Percentage of Bachelor's Degrees Earned by African Americans, 2004.

	African American Bachelors %	All Bachelors N
Computer Science	10	59,968
Psychology	10	82,606
Business & Management	10	318,601
Chemistry	8	9,300
Biological Sciences	8	64,750
Mathematics & Statistics	6	13,735
Engineering	6	80,021
Education	6	123,174
Physics	4	4,140
Geosciences	2	3,903
TOTAL	9	1,417,421

Note: Engineering includes Engineering Technologies. Percentages are rounded.

Source: AIP Statistical Research Center compiled from data collected by U.S. Department of Education.

Physics and the geosciences are both comparatively small fields. For every 1,000 bachelor's awarded across all fields each year, about 3.0 are in physics and about 2.8 are in the geosciences. However, size alone does not adequately explain why so few African Americans earn bachelor's degrees in these disciplines. Over 120,000 African Americans earned bachelor's degrees in the academic year 2003-2004. However, only 166 of them did so in physics, and only 65 of them did so in the geosciences. These numbers are well below the 356 we would expect in physics and 336 in geosciences if the representation in a given field was independent of one's race.

Again, some physicists claim that this situation exists because of the poor mathematics preparation (particularly calculus) of African American students. However, many African American students successfully complete a

mathematics degree. In fact, 6% of mathematics bachelor's degree recipients are African Americans, which translates into more than 800 African Americans with math bachelor's degrees each year. Furthermore, the math bachelors in these data do **not** include business math or accounting. These are included under business degrees in the Department of Education data.

Along similar lines, a significant number of African Americans earn bachelor's degrees in engineering. While they are under-represented at 6%, there are such large numbers of engineering majors overall that well over 4000 African Americans earn bachelor's degrees in engineering each year. This number is about the same as annual degree production (across all race and ethnic groups) in physics and in geosciences. In short, significant numbers of African American students with ability and interest in science, engineering and mathematics do exist.

Table 2. Number of universities by number of African American bachelors awarded in physics and geoscience, 2000-2004.

Bachelors 5-Year Total	Number of Universities: Physics N	Number of Universities: Geosciences N
None	520	312
One	136	93
2 to 5	83	44
6 or more	28	9
Total Universities	767	458

Note: Many universities have more than one bachelors granting department in the geosciences. The above data reflect the total number of bachelor's degrees awarded by all departments at a university.

Source: AIP Statistical Research Center analyzed data collected by the U.S. Dept. of Education.

Top Producers of Physics and Geoscience Bachelor's Degrees

There are some departments that produce large numbers of African American degree recipients in physics and the geosciences. ***Table 2*** illustrates the number of universities by the number of bachelors awarded to African Americans in physics and the geosciences.

The differences in number of African American graduates across universities are striking. In the case of physics, two-thirds—or more than 500—of all degree-granting departments awarded *no* degrees to African Americans from 2000-2004. Conversely, fewer than 30 physics departments awarded the majority of physics bachelor's degrees earned by African Americans during this span.

Similarly, of universities with at least one geoscience department, about 70% awarded *no* geoscience bachelor's degrees to African Americans from 2000-2004. In fact, fewer than 10 universities with geoscience departments are responsible for awarding the majority of bachelor's degrees earned by African Americans.

It is apparent that the vast majority of universities have failed to attract and retain any African Americans in physics or the

geosciences. We must then ask: what is unique about the small number of departments that succeed in attracting and retaining African Americans?

There are many reasons for these trends, but three features stand out: location, recruitment, and the role of Historically Black Colleges & Universities (HBCUs).

Location of Undergraduate Institutions

The databases we used for this report make it possible to identify the universities that award the largest number of bachelor's degrees to African Americans in physics and the geosciences (***Tables 3*** and ***4***). During the years 2000-2004, there were a total of 780 African Americans who earned bachelor's degrees in

Table 3. Universities that awarded the largest number of physics bachelors to African Americans, 2000-2004.

Alabama A&M University (AL)

Benedict College (SC)

Dillard University (LA)

Florida A&M (FL)

Hampton University (VA)

Lincoln University (PA)

Morehouse University (GA)

Norfolk State University (VA)

Spelman College (GA)

Southern University A&M (LA)

Xavier University (LA)

The top 11 universities awarded 288 of the 780 physics bachelors earned by African Americans.

Source: AIP Statistical Research Center compiled from data collected by the US Dept. of Education.

Table 4. Universities that awarded the largest number of geoscience bachelors to African Americans, 2000-2004.

CUNY City College (NY)

Jackson State University (MS)

Mississippi State University (MS)

North Carolina State University (NC)

Pennsylvania State University (PA)

Savannah State University (GA)

United States Naval Academy (MD)

University of New Orleans (LA)

University of Oklahoma-Norman (OK)

The top 9 universities awarded 82 of the 294 geoscience bachelors earned by African Americans.

Source: AIP Statistical Research Center compiled from data collected by the US Dept. of Education.

physics from all 767 degree-granting physics departments. The eleven departments listed on ***Table 5*** account for 288 of the bachelor's degrees earned by African Americans — 37% of the total.

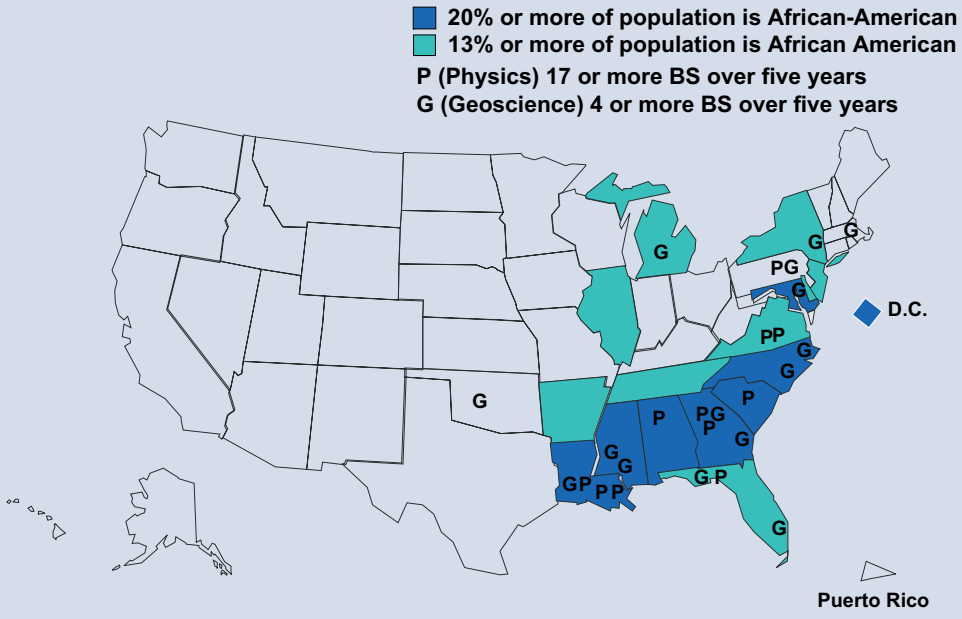
Xavier University of New Orleans has averaged about a dozen physics bachelor's degrees per year. This is all the more impressive given that these degree recipients are all African Americans. Xavier alone accounts for about 7% of the physics bachelor's degrees earned by African Americans each year.

From 2000 to 2004, the 458 departments that grant geoscience bachelor's degrees awarded 294 degrees to African Americans. The nine departments that are listed in ***Table 4*** account for more than one-fourth of these degrees.

As noted previously, students often attend college near where they live. This point is illustrated in ***Figure 3***. We plotted the universities cited in ***Tables 3 and 4*** onto the map originally shown in Figure 1. Virtually every physics or geoscience department that has produced a significant number of African Americans bachelors is located in one of the shaded states. However, African American students who have the capability to succeed in physics and in the geosciences exist in every state in the nation. It is incumbent upon every department to try to recruit and retain these students.

Figure 3. Where did African-Americans earn their bachelor's degrees?

The colleges mapped here account for almost 40% of all African-American bachelors awarded in physics and the geosciences from 2000-2004.



Note: Data are for the academic years ending in 2000, 2001, 2002, 2003, and 2004.

Source: AIP Statistical Research Center compiled from data collected by the US Census Bureau.

The University of Oklahoma is a good example of a university that has been successful although it is not located in one of the states shaded in ***Figure 3.*** To a significant extent, Oklahoma's success is due to its articulation agreement with Fort Valley State University (FVSU), which is in Georgia.

FVSU is the home of the Cooperative Developmental Energy Program (CDEP). This energy education program focuses on increasing the number of minorities and women working in the private and governmental sectors of the energy industry. CDEP has formed alliances with many energy companies and governmental agencies to provide internships, financial support or a combination of both. Some CDEP students earn bachelor's degrees from FVSU in feeder fields such as physics and chemistry, and then transfer to the University of Oklahoma to major in the geosciences. This program has been so successful that FVSU recently initiated articulation agreements with University of Nevada, Las Vegas and Georgia Tech. Clearly, much of the credit for the success of this program goes to the students and some to the sponsors. However, a significant portion of its success is also due to the commitment, planning and near-limitless energy of its director, Dr. Isaac Crumbly.

Student Recruitment

While location is important, it is not the only important feature of successful programs. A few departments succeed even though they are in states with comparatively low percentages of African Americans in their populations. Conversely, many departments at universities with diverse undergraduate populations attract too few African Americans into their programs.

Proactive recruitment and retention activities are important. Many physics and geoscience departments continue to be passive recruiters of potential majors. That is, they either wait for students to come to them, or they recruit from the students who are enrolled in their introductory courses.

These passive strategies are becoming less effective in today's academic environment. While it is true that the number of college students has increased significantly and is, in fact, at an all time high, it is also true that the number of different majors has increased even faster. This explosion in the number of different fields in which students can study has created an intense competition for the best students.

Passive recruitment is especially ineffective with minority populations. Successful departments have learned that, in order to recruit African American students, they must also recruit students' parents. Thus, they set up activities, e.g. an open-house on a weekend, that provide opportunities for the parents to meet faculty members. Professors provide information to both the students and their parents about why majoring in physics or the geosciences is a good idea.

If you visit the web sites of the departments with the largest numbers of African American students, you will notice several recurring themes. The departments challenge their students academically and intellectually, and they provide financial assistance. If you have occasion to speak with faculty from these departments, you will find that they are committed to undergraduate education, they have high expectations for academic success, and they enjoy working with their students.

Table 5. Role of Historically Black Colleges and Universities in the education of scientists and engineers, 2004.

	Blacks at All Institutions N	Blacks at HBCUs N	Blacks at HBCUs %
Geosciences	65	8	12
Physics	166	81	49
Chemistry	756	294	39
Mathematics	783	289	37
Engineering	4,470	1,191	27
Computer Sciences	6,259	1,563	25
Biological Sciences	5,039	1,802	36
All Fields	122,618	26,488	22

Source: NSF, Division of Science Resources Statistics, special tabulations of data collected by the US Dept. of Education.

Additionally, these departments have a variety of activities focused on retention, including a student-focused atmosphere that is intended to make the students feel like part of the department. Such activities include an active chapter of the Society of Physics Students, a space for undergraduate majors to study together and interact, and opportunities for students and faculty to interact, including extensive mentoring, social events, and an active undergraduate research program.

Table 6. HBCUs with bachelor's degree-granting departments in the geosciences.

University	Field of Major
Savannah State University (GA)	Environmental science and marine science
Jackson State University (MS)	Atmospheric science
Elizabeth City State University (NC)	Geology, environmental and marine science
Central State University (OH)	Geology, earth sciences & water resource mgt.

Hampton's Department of Marine Sciences awards many bachelor's degrees; however, the Department of Education does not classify them with geoscience degrees.

Source: AIP Statistical Research Center compiled from data collected by the US Dept. of Education.

Proactive recruitment and activities focused on student retention often require little money. But, they do involve something that may be more precious: faculty time and energy. When done well, however, these activities are effective for recruiting and retaining African Americans and, in fact, make the program more attractive to all students regardless of gender, race or ethnic background.

The Role of HBCUs in Physics and the Geosciences

Historically Black Colleges and Universities (HBCUs) continue to play an essential role in the education of African Americans. According to data collected by the National Center for Education Statistics (NCES), there are 87 HBCUs that offer at least a bachelor's degree in

Table 7. Historically Black Colleges and Universities with physics degree-granting departments.

Institution	Highest Physics Degree	Institution	Highest Physics Degree
Benedict Coll.	BS	Talladega Coll.	BS
Bethune-Cookman Coll.	BS	Tennessee State Univ.	BS
Dillard Univ.	BS	Tougaloo Coll.	BS
Elizabeth City State Univ.	BS	Tuskegee Univ.	BS
Grambling State Univ.	BS	Univ. of Arkansas, Pine Bluff	BS
Jackson State Univ.	BS	Univ. of the District of Columbia	BS
Lane Coll.	BS	Xavier Univ.	BS
Lincoln Univ. (PA)	BS	Clark Atlanta Univ.	MS
Lincoln Univ. (MO)	BS	Delaware State Univ.	MS
Morehouse Coll.	BS	Fisk Univ.	MS
Morgan State Univ.	BS	North Carolina A&T State Univ.	MS
Norfolk State Univ.	BS	Southern Univ. and A&M Coll.	MS
North Carolina Central Univ.	BS	Virginia State Univ.	MS
Prairie View A&M Univ.	BS	Alabama A&M Univ.	PhD
Shaw Univ.	BS	Florida A&M Univ.	PhD
South Carolina State Univ.	BS	Hampton Univ.	PhD
Southern Univ. New Orleans	BS	Howard Univ.	PhD
Spelman Coll.	BS		

Source: AIP Statistical Research Center.

Table 8. Bachelors earned by African Americans by type of institution, 2004.

	Number Awarded per 1,000 Bachelors		
	All Colleges All Students	Blacks Not HBCU	Blacks at HBCUs
Geosciences	2.8	0.6	0.3
Physics	3.0	0.9	3.1
Chemistry	6.6	4.8	11.1
Mathematics	9.8	5.1	10.9
Computer Sciences	40.8	45.5	58.9
Biological Sciences	45.4	33.2	68.0

Source: AIP Statistical Research Center tabulations of data collected by the US Dept. of Education.

any field. As ***Table 5*** indicates, these few HBCUs award a significant percentage (about 20%) of all bachelor's degrees earned by African Americans and even higher percentages in mathematics and science (*Women, Minorities and Persons with Disability in Science and Engineering*, NSF, 2002).

Table 9. Representation of women among bachelor's degree recipients who are white or African American, 2000-2004.

Total bachelors: 6,076,752

56% of the white students were women

65% of the African American students were women

Physics bachelors: 22,643 total students

20% of the white students were women

36% of the African American students were women

Geoscience bachelors: 21,259

36% of the white students were women

46% of the African American students were women

Source: AIP Statistical Research Center compiled from data collected by the US Dept. of Education.

However, there are only four HBCUs that have degree-granting departments in any of the geosciences, that is, solid earth, atmospheric, or ocean sciences (***Table 6***). Still, these four departments account for one-tenth of all the African Americans who earn bachelor's degrees in the geosciences.

When compared to geoscience, physics looks progressive. There are 35 HBCUs (***Table 7***) with physics degree-granting departments. In fact, four HBCUs offer PhDs in physics. More than 150 African Americans earn physics bachelor's degrees each year. The 35 HBCUs with physics departments account for 50% of the

bachelor's degrees earned by African Americans. The remaining 95% of physics departments at majority institutions — a total of 732 departments — *combined* award fewer than 80 physics bachelors to African Americans in any year. In fact, all of the dominant producers of physics bachelor's degrees shown in ***Table 3*** are HBCUs. Physics, chemistry, math, biological sciences, and computer sciences are all fields in which African Americans are more likely to earn degrees from an HBCU than they are from a majority institution (***Table 8***).

African American Women in Physics and the Geosciences

In 2004, women earned 58% of all bachelor's degrees awarded in the U.S. This is the result of a long term trend as women have increased their share of bachelor's degrees by about ½% per year for the last three decades. The U.S. Department of Education projects that this trend will continue through at least 2010, by which time women are expected to earn more than 60% of all bachelor's degrees.

What is the representation in higher education of women relative to men among African Americans? ***Table 9*** shows that women represent two-thirds of all African American bachelor's degree recipients. Among African American students, women earn a larger percentage of bachelor's degrees in general, in physics, and in the geosciences than do women among white students.

These gender trends are the result of many complex dynamics, some of which have been covered in the general press. A common explanation is that men are not going to college. This is only partially correct. It would be more accurate to state that the number of men going to college has not increased as rapidly as the number of women. ***Table 10*** compares the number of men and women who earned bachelor's degrees recently to a decade ago. As these data show, the numbers have actually increased for each group of men and women

Table 10. Bachelor's degrees awarded by race and sex, 1994 & 2004.

		2004 N	Change from 1994 to 2004 %
American Indian	Female	5,957	72
	Male	3,957	56
Asian American	Female	47,635	70
	Male	38,395	47
Hispanic American	Female	64,818	78
	Male	40,347	58
African American	Female	81,926	58
	Male	40,692	37
White	Female	546,765	10
	Male	416,122	0

Source: AIP Statistical Research Center compiled from data collected by the US Dept. of Education.

Table 11. Educational attainment and annual income, 2004.

Of people who worked full-time for the past year and were 25-34 years old, percent who earned $25,000 or more

	High School Dropouts %	High School Graduates %	Bachelor's Degrees %
Men			
White	53	70	91
African American	49	52	81
Hispanic	40	55	88
Women			
White	27	48	87
African American	23	42	84
Hispanic	19	41	79

Source: AIP Statistical Research Center compiled from data collected by Bureau of the Census, Current Population Survey.

among all students, white students, and black students, with the sole exception of white males, who are earning bachelors in approximately the same numbers as a decade ago.

Why are women attending and graduating from college at increasing rates compared to men? One reason that does not get as much press as it deserves is economic opportunity. The range of employment opportunities for women with little formal education is much more restricted than it is for men with similar educational backgrounds. Formal education improves everyone's employment options, but the effect is more pronounced for women and is especially pronounced for African American women.

Table 11 provides annual income data published by the Bureau of Labor Statistics for people who were full-time employed and were 25-34 years old. About 40% of African American women who have a high school diploma earned $25,000 or more in 2001. By comparison, over half of African American men earned at least $25,000 that year. However, among African Americans with bachelor's degrees, 84% of the women and 81% of the men earned more than $25,000.

There continues to be a disparity in income by both sex and race. Even when one takes educational attainment and age into account, women earn less than men and people of color earn less than whites. However, an encouraging trend is also evident in these data. As a group, people of any race and sex will earn more as their educational attainment increases.

Table 12. Master's degrees awarded in the U.S., 2000-2004.
7063 Total master's degrees in physics
181 African Americans earned masters in physics
7175 Total master's degrees in the geosciences
86 African Americans earned masters in the geosciences

Source: AIP Statistical Research Center compiled from data collected by the US Dept. of Education.

Masters in Physics and Geosciences

Although nearly 500,000 people earn master's degrees in the U.S. each year, the master's degree is a misunderstood degree. This is of little surprise when one takes into account the variety that exists in master's programs, their goals and even their structural features. In some fields such as petroleum geology and medical physics, a masters is the entree into the profession.

Over 35,000 African Americans earn master's degrees each year (7.8% of the total awarded annually in the US). The representation of African Americans differs markedly by field. African Americans earn a comparatively large percentage of the master's degrees awarded in psychology (10.3%) and education (9.7%). However, the representation of blacks among physics masters (2.5%) is far below the national average. The geosciences have the unenviable distinction of having the poorest representation of African Americans (1%) among master's degree recipients.

Because of the small size of these numbers and the dramatic fluctuations that can occur from year to year, we combined data from a five-year period. ***Table 12*** provides the number of master's degrees awarded during this five year period. On average, more than 1,400 master's degrees are awarded each year in physics and about 1, 400 in geosciences. However, fewer than 20 of the geoscience masters and fewer than forty of the physics masters are earned by African Americans.

Of the 35 HBCUs with degree-granting physics departments, six award master's degrees, and four award PhDs. ***Table 13*** lists the universities

Table 13. Universities that awarded the largest number of physics masters to African Americans, 2000-2004.
Alabama A&M University (AL)
Clark Atlanta University (GA)
Fisk University (TN)
Florida A&M University (FL)
Hampton University (VA)
Johns Hopkins University (MD)
Norfolk State University (VA)
University of Michigan-Ann Arbor (MI)
University of New Orleans (LA)
The top 9 universities awarded 81 of the 181 physics masters earned by African Americans.

Source: AIP Statistical Research Center compiled from data collected by the US Dept. of Education.

that produced the largest numbers of African Americans who earned master's degrees in physics. Combined, these nine universities account for about 45% of all the physics master's degrees earned by African Americans from 2000-2004. Six of these nine universities are HBCUs.

African Americans among PhDs

From 1973-2004, the total number of PhDs awarded and the number of PhDs earned by African Americans both increased. The PhD class of 1973 was comprised of almost 34,000 doctorates. (1973 was the first year the NSF collected data on ethnicity from PhD graduates, so our analysis cannot go back any farther.) Only 1.9% of the 34,000 were African Americans. In 2004, about 42,000 people earned PhDs, of whom 4.7% were African American. Nearly 40,000 African Americans earned PhDs in the U.S. between 1973 and 2004.

Although 4.7% of the PhDs earned in 2004 were earned by African Americans, African Americans make up about 13% of the US population. Therefore, African Americans are under-represented among PhD recipients, as they are at other degree levels.

PhDs in Physics and the Geosciences

Earning a PhD is an entree into the most coveted jobs in science, from faculty member to researcher. These jobs offer a great deal of autonomy and the ability to control one's own research agenda. This is no where more true than in physics, where it is often assumed that one is not a physicist unless one has a PhD.

African Americans are under-represented among PhD recipients overall, but are even more so among physics and geoscience PhDs. In 2004, just one percent of the people who earned doctorates in physics and geosciences were African American (***Table 14***). These rates are much lower than the representation of African Americans among PhD recipients in all fields combined.

As with bachelor's degrees, the reasons for the low percentage of African Americans among physics and geoscience PhDs are numerous. One factor is that science in our society is primarily seen as a white male enterprise. This stereotype is very difficult to ignore, and instructors may inadvertently discourage minority students. Another factor is the relatively low number of HBCUs that offer PhDs in physics. There are only four: Howard, Hampton, Alabama A&M, and Florida A&M. In geoscience, we know of only two: Hampton and Howard. Hampton offers a PhD in atmospheric and planetary sciences. Howard's program is still young; it began offering a PhD in atmospheric sciences in 2002.

Table 14. PhDs earned in 2004

	Percent African Americans	Number All Groups
Physics	1.0	1186
Geoscience	1.0	686
All Fields	4.7	42,155

Source: AIP Statistical Research Center analyzed data collected by the National Science Foundation.

Table 15. Universities that awarded the largest number of physics PhDs to African Americans, 1973-2004.

Alabama A&M University (AL)
Florida State University (FL)
Georgia Inst. of Technology (GA)
Hampton University (VA)
Howard University (DC)
Kent State University (OH)
Massachusetts Inst. of Technology (MA)
Stanford University (CA)
University of California-Berkeley (CA)
Univ. of California-Los Angeles (CA)
University of Michigan-Ann Arbor (MI)
The top 11 universities awarded 138 of the 291 physics PhDs earned by African Americans.

Source: AIP Statistical Research Center compiled from data collected by the National Science Foundation.

For years, the percentage of bachelor's degrees earned by African Americans in physics (around 4% to 5%) has been higher than the percentage of PhDs earned by African Americans in physics (usually between 1% and 2%). This troubling fact means that something is happening to African American physics students between the bachelor's degree and the PhD. Either black bachelor's degree holders are choosing not to enter physics PhD programs, or they are dropping out at higher rates than other students during the course of the PhD. Further research is needed to determine the exact time of the exit point for African Americans in physics and the causes of this decline. Data which are collected at an individual level, rather than an aggregate level, are needed to answer these questions.

Unlike physics, there does not appear to be much of a drop-off between bachelor's degrees and PhDs in the geosciences. Between one and two percent of 1995-1998 bachelor's degrees in geosciences were earned by African Americans. In the 2002 to 2005 time frame, about the same percentage of PhDs in geosciences were earned by African Americans. However, this conclusion is based on aggregate numbers, and further research based on individual data is

Table 16. Universities that awarded the largest number of geoscience PhDs to African Americans, 1973-2004.

Georgia Inst. of Technology (GA)
Harvard University (MA)
University of Arizona (AZ)
University of Michigan-Ann Arbor (MI)
University of California-Santa Cruz (CA)
University of Rhode Island (RI)
University of South Carolina (SC)
University of Texas-Dallas (TX)
University of Texas-El Paso (TX)
University of Washington (WA)
The top 10 universities granted 37 of the 111 geoscience PhDs earned by African Americans .

Source: AIP Statistical Research Center compiled from data collected by the National Science Foundation.

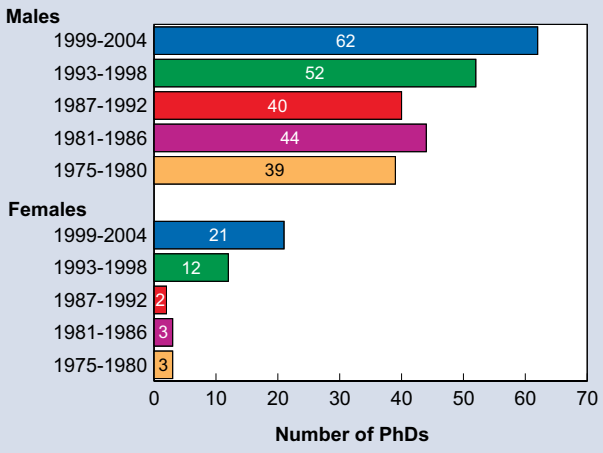
needed to see if the same people who earn bachelor's degrees in geoscience continue on to earn PhDs.

Top Producers of PhDs in Physics and the Geosciences

Cumulatively, the number of African American PhDs in physics and geosciences is very low. Between 1973-2004, more than 37,600 PhDs were awarded in physics. However, only 291 African Americans earned physics PhDs during that span. In other words, for every one thousand physics PhDs awarded, fewer than eight were earned by African Americans.

The representation of African Americans among geoscience PhDs is poorer still. Between 1973 and 2004, about 21,000 PhDs were awarded in the geosciences. However, only 111 of those PhDs were earned by African Americans. That is, for every one thousand PhDs awarded in the geosciences, just over five were earned by African Americans.

Figure 4. Number of African Americans who earned PhDs in Physics, 1975-2004.



Source: AIP Statistical Research Center compiled data collected by the National Science Foundation.

Tables 15 and 16 list the universities that have awarded the largest numbers of PhDs in either physics or the geosciences to African Americans. As with bachelor's degrees, a small number of universities account for a large percentage of the PhDs earned by African Americans. There are about 185 departments that grant PhDs in physics. During the 32-year period 1973-2004, PhD-granting physics departments awarded 291 PhDs to African Americans. Almost half of these PhDs were earned by African Americans at just eleven departments, which are listed on ***Table 15***.

The universities on ***Table 15*** are either large, prestigious physics departments, e.g. Stanford, MIT, and Michigan, or they are HBCUs like Howard, Hampton, and Alabama A&M. Alabama A&M is interesting, in part, because it is among the largest producers of African American physics PhDs even though it is relatively new — awarding its first PhD only about 15 years ago. Even the largest producers of African American physics PhDs averaged less than one per year over three decades.

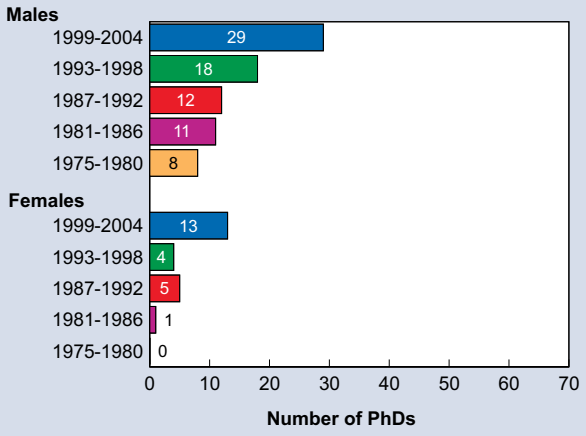
As indicated in ***Table 16***, the situation in the geosciences is even worse. There are about 190 institutions that award PhDs in geosciences. Between 1973 and 2004, 111 African American earned PhDs in geosciences, for an average of less than one per university. In fact, one-third of the PhDs earned by African Americans were granted by one of the ten institutions listed on ***Table 16***. Even the largest producer of African American PhD geoscientists, Harvard, averaged only one PhD in geosciences to an African American every six years.

African American Women among PhDs

Compared to white bachelor's degree recipients, a larger proportion of African American bachelors are women. At the PhD level, this is still true, but the numbers of African American women earning PhDs in these fields are tiny.

Despite the remarkably small numbers, it is possible to find encouraging trends. ***Figures 4*** and ***5*** indicate that there has been real change over time. During the 1970s and early 1980s, only a handful of African American women earned PhDs in physics or the geosciences. In fact, only one African American woman earned a PhD in the geosciences during the 12 academic years from 1975 through 1986 (***Figure 5***). The base rate for physics was only marginally better at six African American women over the same 12 years (***Figure 4***).

Figure 5. Number of African Americans who earned PhDs in Geoscience, 1975-2004.



Source: AIP Statistical Research Center compiled data collected by the National Science Foundation.

The numbers of female African Americans who earn PhDs in physics or the geosciences has increased recently. However, there is still an average of only about two African American women PhDs per year in geosciences, and an average of only 3.5 African American women PhDs per year in physics.

African American Physics Faculty

While the rest of the data in this report comes from the National Science Foundation, the Statistical Research Center of AIP has collected data on minority representation on physics faculties for several years. Unfortunately, we do not have similar data for geosciences.

Qualitative studies of African American faculty members in chemistry have shown that these faculty members are attracted to institutions similar to the ones where they obtained their undergraduate degrees (see the work of Willie Pearson, Jr.). As we have seen, many African Americans in the sciences earned their bachelor's degrees at HBCUs. African American physics faculty are also attracted to HBCUs. In fact, our data show that the majority of all the African American physics faculty in the U.S. work at one of the 35 HBCUs that offer at least a bachelor's degree in physics.

As of 2004, there were only 171 African American physics faculty members in the whole US (***Table 17***). Although there were 185 physics departments that granted PhDs in 2004, there were only 64 African American faculty members at these departments. Part of this is the result of the concentration of African American faculty members at HBCUs. In fact, 28 of the

Table 17. African American physics faculty, 2004.				
	Type of Department			
	PhD	Masters	Bachelors	Total
2004	64	29	78	171
2000	38	41	62	141

Source: AIP Statistical Research Center, 2004 Academic Workforce Survey.

African American physics faculty members at PhD departments work at just three institutions (Hampton, Howard, and Florida A&M), all of which are HBCUs. Only 30 other PhD-granting physics departments had any African American faculty members, and most of these had only one.

The situation is similar at bachelors-granting physics departments. Out of more than 500 such departments, fewer than 10% have any African American faculty members. Only 12 bachelors-granting physics departments have more than one African American faculty member, and ten of these departments are at HBCUs. Most physics students of all races will never see an African American physics professor in the classroom. This undoubtedly contributes to the perpetuation of the stereotype of physics as a white male enterprise.

The concentration of African American physics faculty members at HBCUs might suggest that all physics faculty members there are African American; this is not true. Faculty members of all ethnicities work at HBCUs and educate the majority of African American physics bachelors.

As one can see in ***Table 17***, the number of African American physics faculty members at PhD-granting departments increased between 2000 and 2004. However, this is not because PhD departments hired many more African Americans during this time period. Rather, this happened because one HBCU, Florida A&M, granted only master's degrees in 2000, but by 2004, had started granting PhDs in physics. This decline is apparent in the African American faculty at master's-granting departments.

In terms of the total number of African Americans serving as faculty members in physics departments, as with PhDs granted to African Americans, there is real change. In 2000, there were only 141 African American physics faculty members. By 2004, this number had increased by 30.

Concluding Comments

This report has examined the representation of African Americans in physics and geosciences within the context of the US educational system. The proportional representation of African Americans decreases as one progresses through the various academic degrees. It is

distressing that physics and the geosciences do worse than other fields in attracting and retaining African Americans.

Some physicists have expressed the belief that poor high school preparation explains the dearth of African Americans in physics and geosciences. However, this belief is not supported by evidence. For example, the representation of African Americans among math majors is higher than in physics and geosciences. Further research is needed to determine why the percentages of African Americans in physics and the geosciences are so low. It is equally important to look for models of physics and geoscience departments that have been successful in attracting and retaining African American students. We have identified bachelors and PhD departments that have been successful in this endeavor. Further analysis might identify best practices to be adopted by other institutions.

This report documented the relationship between the geographical location of the African American population and the institutions that award bachelor's degrees to African Americans in physics and the geosciences. Nevertheless, undergraduate departments in every state can take steps to actively recruit African American students who attend their institutions. Furthermore, graduate departments wishing to recruit African American students can be aware of the location of African American students and can use this information in their recruitment strategies.

Graduate departments recruiting African American students should also look to HBCUs, especially in physics. Many of the institutions that have been successful in producing African American physics and geoscience graduates are Historically Black Colleges and Universities (HBCUs). This report has documented the essential role that these institutions play in educating physicists and geoscientists, especially at the undergraduate level.

The data in this report allow institutions to evaluate the extent to which they have been serving the science education needs of African American students. These data can be used by departments that have noticed that the racial composition of their majors differs significantly from the composition of the undergraduates attending their institutions.

Even though the numbers are distressingly small, especially in physics and the geosciences, the trend over time is upward. Increasingly, African American men and women are choosing the sciences. There are several routes to increased recruitment and retention of African American students. Among the features of successful programs are supportive faculty, financial resources for students, and encouragement combined with high expectations for academic excellence.