

# Dismantle racism in science

**W**illiam Shockley Jr. of Stanford University was an American physicist who jointly won the 1956 Nobel Prize in Physics for his role in inventing the transistor. Modern computing and communications would have been unthinkable without Shockley's work. But the Nobel laureate was also a proponent of eugenics and firmly committed to the racial inferiority of Black people. Shockley was not just a physicist who held racist views. He was part of a wider academic system that then, and now, perpetuates racial inequality. The persistence of this biased ecosystem means that dismantling it will require unrelenting tenacity by all of academia.

I've spent years studying how racism operates in science, technology, engineering, and mathematics (STEM) fields, especially in higher education institutions in the United States. Structural inequities perpetuate tendencies that discriminate against STEM faculty of color and stifle their progress.

For example, institutions often expect these faculty to lead the charge when it comes to anti-racist efforts. They are approached to mentor students of color, to serve on diversity committees, and to speak on panels about diversity—activities that are tangential to their research. Although many people of color in STEM have a fervent desire to make their field and workplace more equitable, pressure to perform duties unrelated to their research creates a service burden that many of their white colleagues do not bear. By contrast, white faculty are busy advancing their research, thereby earning grants, joining collaborations, and publishing papers that bolster their careers. This imbalance disadvantages faculty of color in tenure and promotion decisions. People of color who do “make it” in STEM disciplines often do so while taking on a superhuman workload that is unfair and unsustainable.

Moreover, to function in the present biased ecosystem, underrepresented people of color are pressured to conform to a predominantly white male culture and are discouraged from bringing their authentic selves into the workplace. For example, STEM faculty of color are encouraged to remove any language about racial justice, including diversity, equity, and inclusion, in their grant proposals. Additionally, some alter their appearance, demeanor, and speech to assimilate into—and survive in—the mainstream STEM culture. This stress is a burden and humiliation that can take a psychological toll.

Because there are fewer people of color in university leadership positions, there are fewer leaders who are cognizant of these impediments. As a result, the barriers for people of color in STEM are rarely addressed because leaders' priorities are elsewhere.

To change the situation, the dominant culture needs to assume the burden of providing remedies. In the field of physics, for example, people of color are called upon to figure out how to “create change,” rather than those who benefit from the status quo. STEM ecosystems need to distribute this responsibility to everyone, especially to those faculty who hold the power and privilege to implement compelling and sustainable changes. Doing this involves the most influential people in efforts to innovate and restructure spaces in ways that support STEM equity.

Faculty of color across academia often take on students of color who are outside of their departments but who desperately need mentorship. Institutions need to recognize when faculty of color are functioning as de facto university leaders and reward these staff with the titles, compensation, and resources appropriate to the responsibilities they have assumed.

Higher education must also recruit more faculty of color. This is the most powerful way STEM departments can demonstrate that racial equity and diversity are a priority.

Students, faculty, and administrators who are women of color experience both raced and gendered forms

of abuse in academia. Hostile environments span from negative comments about their abilities, qualifications, and performance to sexual harassment. In my research, I have found that Black women have great difficulties convincing their professors and colleagues that they are worthy of belonging in STEM. Instead of creating programs to “fix” students, how about coaching STEM faculty and administrators on the toxicity associated with racially unwelcoming conditions and the particular effects it has on women of color? Having more women of color leadership in STEM academia would be a strong start.

Anti-racism work is hard work, but unless actions move beyond simply tossing about diversity and equity buzzwords, people of color will remain underrepresented in STEM fields. And the United States will continue to miss out on the STEM talent and innovation that exist within communities of color.

—Ebony Omotola McGee



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## Dismantle racism in science

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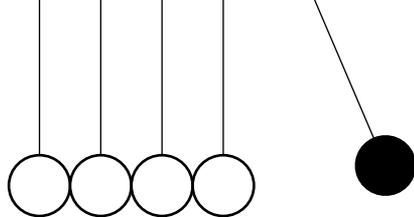
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# CAN U.S. PHYSICS OVERCOME ITS RECORD OF EXCLUSION?

Data show white institutions falling short and Black colleges leading the way

By Jeffrey Mervis; Graphics by Kelly Franklin

In the 1990s, physics departments at U.S. universities faced an existential crisis. The number of undergraduate physics majors had plummeted by 25% over 10 years, prompting fears that many departments might disappear or be merged into other programs. Academic physicists scrambled for ways to attract more students, making lectures more interactive and updating the curriculum. The changes had the desired effect: The annual number of physics majors, the first rung in the career ladder, nearly tripled over the next 2 decades (see graphic 1).

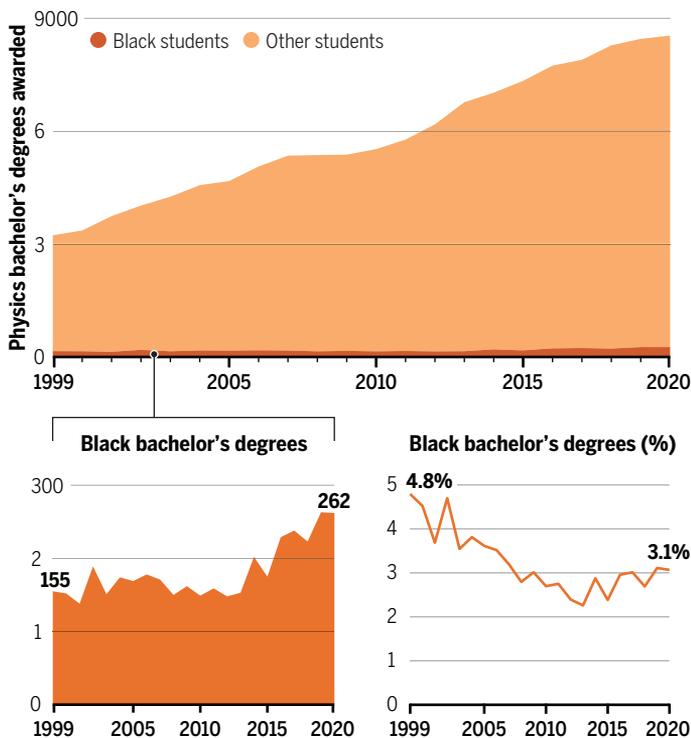
Black students, however, were left behind. In 2017, the American Institute of Physics (AIP) assembled a National Task Force to Elevate African American Representation in Undergraduate Physics & Astronomy (TEAM-UP), the discipline's first deep dive into the lack of diversity at the undergraduate level. The task force's 2020 report documented the crisis in dispiriting detail.

Data from the U.S. Department of Education show the percentage of undergraduate degrees awarded to Black students dropped from 4.8% in 1999 to 3.1% in 2020. Had the number of Black undergraduates earning physics degrees simply kept pace with the overall growth in the major, the current annual total would exceed 350. Instead, it was 262 in 2020.

As bad as those numbers are, they hide how rare Black students are on most U.S. campuses. Some 30% of the 853 U.S. departments awarding physics degrees did not graduate a single Black student between 1999 and 2020, and an additional 30% graduated just one or two (see graphic 2). In contrast, historically Black colleges and

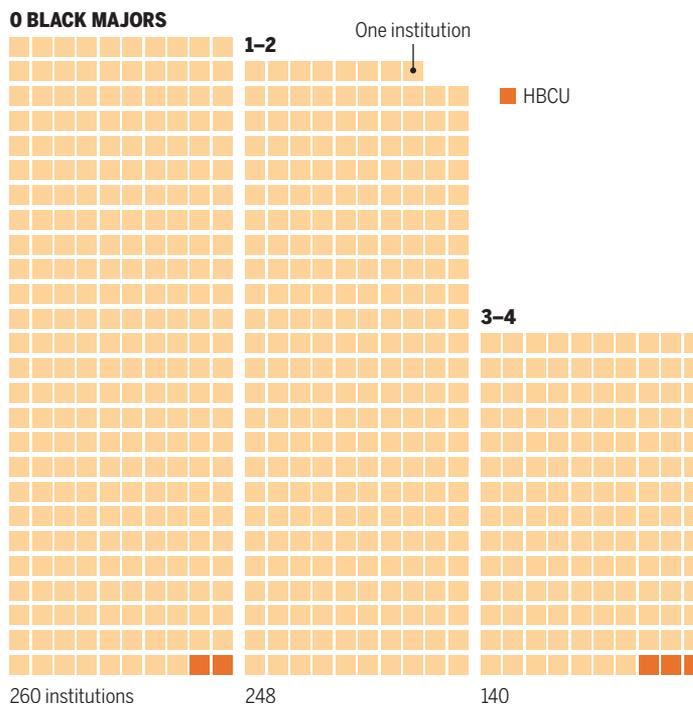
## A rising tide, but not for Black students (1)

The number of U.S. undergraduate degrees in physics had tripled by 2020 compared with 1999. Although the absolute number of Black physics majors also rose, their share of the total plummeted.



## Black majors rare at most U.S. campuses (2)

Some one-third of all U.S. physics departments graduated no Black physics majors between 1999 and 2020. Despite their small size, historically Black colleges and universities (HBCUs) far outpaced predominantly white institutions in awarding bachelor's degrees in physics to Black students.



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universities (HBCUs) lead the nation in graduating Black physics majors despite their relatively small size and limited resources.

The demographics at the graduate level are even more depressing. Black students made up less than 1% of Ph.D. recipients in physics in 2019 (see graphic 4). Over the past 2 decades, the absolute number of physics Ph.D.s awarded to Black students each year has remained essentially flat. In contrast, the number awarded to Hispanic students has increased substantially (see graphic 3).

The near invisibility of Black people has made it easier for the physics community to ignore their perspective. This special package, which draws from interviews of more than 50 Black scientists, seeks to rectify that situation and amplify their voices. They tell of battling systemic racism, which creates an uneven playing field, as well as pushing back against a culture that continues to question their ability and desire to do physics. They describe how that dominant culture in academic physics expects Black people to lead the way in correcting a problem not of their making. They talk about struggling to gain the same professional recognition, respect, and rewards that accrue to white physicists, and how working to improve diversity can jeopardize their own scientific careers. They also describe isolation and debilitating self-doubt, and their frustration and anger that decades of rhetorical support for improving diversity haven't translated into better demographics.

Especially poignant are the experiences of those who have broken through the double barriers of race and gender. In 1972, Willie Hobbs Moore became the first Black woman to earn a U.S. doctoral degree in physics. Exactly 50 years later, the total stands at only 150, according

to a list (at aawip.org) compiled by physicist Jami Valentine Miller, a senior examiner with the U.S. Patent and Trademark Office. In 2007, she became the first Black woman to earn a Ph.D. in astrophysics from Johns Hopkins University. Many U.S. graduate physics departments have never handed a diploma to a Black woman.

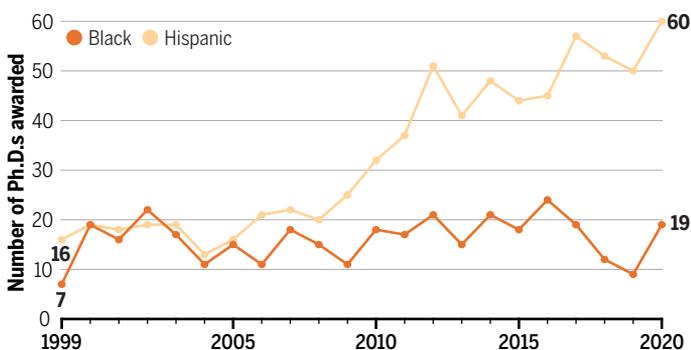
Although Black scientists in other disciplines face similar barriers, this package examines physics because, as the TEAM-UP report notes, the community's record on diversity "is particularly depressing." The stories describe how the "priesthood," the white men who constitute a majority in the field, has stymied efforts to make meaningful change through a sense of white privilege (see p. 952), and how some universities are building a more welcoming environment by dismantling policies that disadvantage students from marginalized groups (see p. 956). One story examines the outside role HBCUs have played in educating Black physics undergraduates, and how that role is threatened (see p. 960). Another shows how a graduate program at an elite, predominantly white institution has been more successful than its peers in training black Ph.D.s, using a model that was not intended to address diversity at all (see p. 967). The package also explores the disproportionate number of Black Ph.D. physicists who are drawn to teaching at the precollege and community college levels (see p. 964).

Together, these stories attempt to portray the Black experience in U.S. physics and identify institutions and programs that offer models for change. But there are no simple prescriptions. As the TEAM-UP report emphasizes, the physics community must first internalize how it got to this dismal point before it can make meaningful improvements in the culture. ■

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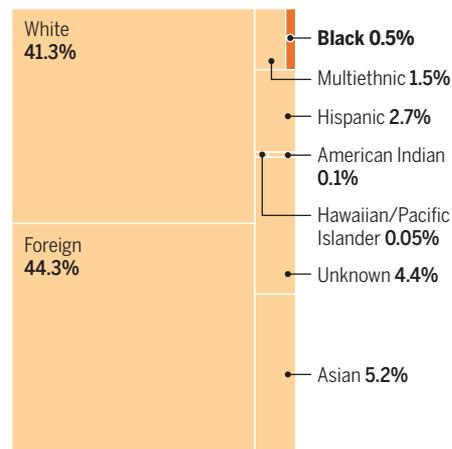
### Growing gap with Hispanic students (3)

The number of U.S. physics Ph.D.s awarded to Hispanic students has tripled over the past 2 decades while remaining essentially flat for Black students.



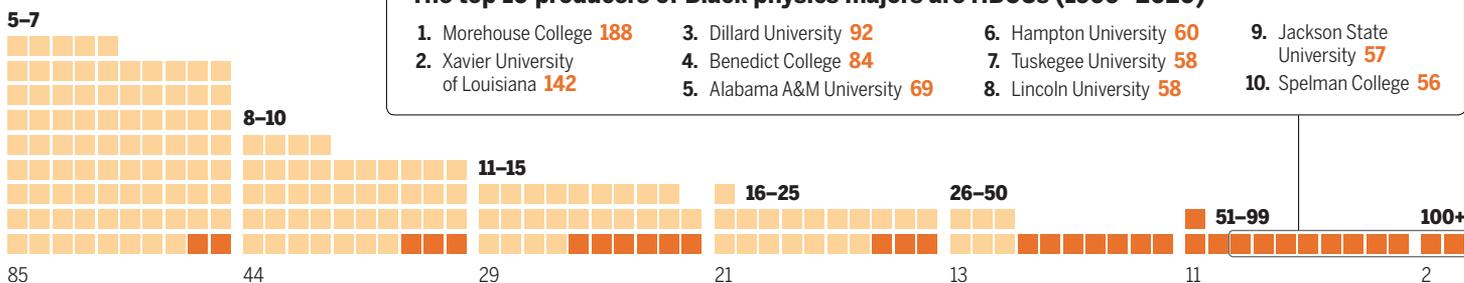
### A dearth of Ph.D.s (4)

Black students are underrepresented by a factor of 10 in U.S. doctoral physics programs, which train mainly domestic white students and those from other countries.



### The top 10 producers of Black physics majors are HBCUs (1999–2020)

- |  |                                 |                                  |                                       |
|--|---------------------------------|----------------------------------|---------------------------------------|
| 1. Morehouse College <b>188</b>              | 3. Dillard University <b>92</b> | 6. Hampton University <b>60</b>  | 9. Jackson State University <b>57</b> |
| 2. Xavier University of Louisiana <b>142</b> | 4. Benedict College <b>84</b>   | 7. Tuskegee University <b>58</b> | 10. Spelman College <b>56</b>         |
| 5. Alabama A&M University <b>69</b>          | 8. Lincoln University <b>58</b> |                                  |                                       |



## Can U.S. physics overcome its record of exclusion?

Jeffrey Mervis

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Physicist April Hodari has documented how the views of a white male “priesthood” shape the culture of U.S. physics.

# THE TOLL OF WHITE PRIVILEGE



How the dominant culture in physics has discouraged diversity *By Jeffrey Mervis*

**A**priel Hodari has spent many years studying how to improve training and reduce inequity in the scientific workforce. That research has brought her face to face with “the priesthood,” her name for the dominant white male culture in U.S. physics. White men, for example, hold 70% of the faculty positions at U.S. universities that grant physics Ph.D.s.

Hodari wondered whether there was a connection between the priesthood’s views on issues such as racism and sexism and the profession’s deplorable record on diversity. So in 2017, Hodari, a senior scientist at a California company that helps researchers obtain federal grants, and Melissa Dancy, a physics educator at the University of Colorado, Boulder, received support from the National Science Foundation to interview 27 white, male, academic physicists, from senior professors to graduate students.

What the researchers heard during those conversations didn’t surprise Hodari, who is one of only 150 Black women to earn a physics Ph.D. in the United States over the past 50 years. “Not me. Not my colleagues. Not my time. Not my field,” is how Dancy, who is white, summarized their thoughts on why U.S. physics lacks diversity during a presentation last year to a meeting of science education researchers.

Most of those in the small sample—chosen from those who volunteered to participate—voiced concerns about equity and diversity, Hodari and Dancy found. But they were

skeptical that racism and sexism were prevalent in physics. They also couldn’t think of any instances of racist or sexist behavior in their classrooms or labs. And to a man, they believed they were in no position to ease the harm such biases might have on the profession. “In other words, [any problem] is very far away from me,” Dancy reported, “and I have no responsibility for it.”

Hodari and Dancy believe their interviews also offer a peek into the corrosive impact of white privilege on physics. Scholars coined the term decades ago to describe how white people use their membership in a dominant group to assert political, cultural, and economic power over those outside that group.

White privilege allows physicists to “not pay attention to systemic racism because there aren’t any consequences,” Hodari says. She thinks it also explains why many of her colleagues “are completely clueless” about the harmful effects on their profession of attitudes and actions born of privilege and racism.

Black physicists don’t have the luxury of ignoring white privilege. Every one of the more than 50 Black scientists interviewed for this special package described experiences, beginning in their student years and extending into senior faculty positions, in which they were confronted with pernicious behavior associated with white privilege. Some episodes were blatantly racist—white people mocking their appearance or denigrating their intellect—whereas others were more subtle, such as

comments based on negative assumptions about their backgrounds or reasons for wanting to be a scientist.

Battling white privilege requires constant vigilance, and it can take a heavy toll. “I didn’t choose physics to clean up a mess I didn’t make ... [but] I’m bleeding so that people can learn about this toxic environment we face,” says Jessica Esquivel, an associate scientist at Fermi National Accelerator Laboratory (Fermilab) and an advocate for social justice and greater opportunities for Black girls in science. Esquivel, who identifies as an Afro-Latinx lesbian, says she’d rather be recognized for her work on the properties of the muon or neutrino physics. But her activism, she says ruefully, is often “the only thing [my colleagues] notice about me.”

White privilege must be fought on the individual and institutional levels, says Marta McNeese, chair of the physics department at Spelman College, an all-women historically Black college in Atlanta. “Removing barriers to participation isn’t enough,” says McNeese, who is Black. “If you have someone in your department who is toxic, you need to figure out how to protect students from them.”

**ONE DAMAGING** consequence of white privilege is what’s known as “the Black tax.” It stems from an assumption that Black faculty members, because they are the victims of racism, should do more than their white colleagues to promote diversity. That means spending more time recruiting and mentoring students from underrepresented groups,

more service on diversity committees, and more community outreach. The tax carries a double penalty because those extra efforts—which many Black physicists take on willingly and without compensation—are often discounted, if not ignored, when physicists come up for tenure and promotions.

Physicist Adrienne Stiff-Roberts started to pay that tax in 2004 after coming to Duke University in North Carolina, where she says she became the “first—and still only” Black member of the physics department. The North Carolina native says she “knew that Duke had a reputation for not being a welcoming place for Black people,” a history that university officials have acknowledged. But she accepted the tenure-track position with the hope of improving the situation.

As Stiff-Roberts moved up the academic ladder, she poured her energy into fostering greater diversity by training graduate students, mentoring undergraduates, and running a Saturday morning academy for middle-school students. “You can get sucked into trying to make your institution a better place,” she says. But she also kept track of the toll such activities were taking on her research and turned down invitations that didn’t feel genuine. “Don’t ask me to do a lot of work that you don’t value,” Stiff-Roberts says. Instead, she says, “I decided that the best thing I can do is to succeed and become an existence proof.”

Computational cosmologist Brian Nord faces similar challenges at Fermilab, the U.S. government’s premier particle physics center. Along with Esquivel, Nord is part of a group of five Black lab employees who issued a 17-page “Change-Now” manifesto in June 2020, just days after Minneapolis police officer Derek Chauvin murdered George Floyd. In addition to demanding that Fermilab officials hire and retain more Black scientists and adopt policies to achieve social justice, the manifesto urged them to “listen to and do what Black employees say they need, and not make plans for us without us.”

Several months later, Fermilab’s director, Nigel Lockyer, who is white, asked Nord to lead efforts to hire and promote more minority scientists. “I want to build around Brian,” Lockyer said about Nord, who had recently been promoted to become the lab’s only tenured Black scientist. “I need somebody to be an attractor, if you will, so that a young Black scientist [looking for a job] would say, ‘Gee, I want to work with Brian.’”

The 39-year-old Nord says he is honored to receive such a vote of confidence and believes he has “demonstrated that I can lead on these issues.” But he thinks Lockyer’s approach falls far short of the necessary institutional commitment. In particular, Nord wonders why Lockyer decided to put all his eggs into one



Physicist Jessica Esquivel, who works on the Muon g-2 experiment at Fermi National Accelerator Laboratory, says battling white privilege can take a heavy toll.

basket—and one carried by a Black man.

“What if for some reason I had to leave?” Nord says. “Why not build upon the work of the entire cohort of Black scientists at the lab?” Nord is also worried about what happens if the lab’s demographics don’t improve. “Does it then become my fault?”

**LOCKYER WON’T** be around to see whether his strategy of asking Nord to lead Fermilab’s diversity effort succeeds, having announced his retirement in fall of 2021. But a similar effort at Stanford University 5 decades ago suggests expecting one Black leader to shoulder the burden can falter without sustained institutional support.

In the 1970s, Stanford administrators tacitly agreed to let Arthur Walker, a solar physicist recruited in 1974 as the first Black member of the department, take on the task of diversifying both graduate enrollment and the faculty ranks. “Art was a top scientist, and he brought in others [Black students and faculty],” recalls physicist Arthur Bienenstock, a white emeritus professor and special assistant to the Stanford president who served as the university’s first affirmative action officer in the early 1970s. “Looking back, I can’t say that I or anyone else did anything that was really effective.”

Walker, however, had an impact. In fact, Stanford often claimed that, from the early 1970s to 2000, it led the nation in awarding physics Ph.D.s to Black students. (The total is believed to be roughly two to three dozen, but *Science* could not confirm that because of

a lack of documentation.) The flow of Black graduate students had already begun to dry up, however, by the time Walker died of cancer in 2001. And since his death, Stanford’s track record is indistinguishable from that of other elite graduate physics programs.

Current and former white Stanford professors say one reason for the drop-off was their failure to recruit Black students. Robert Wagoner, who retired in 2012 after 40 years on the physics faculty, recalls “edicts” from department chairs to recruit at conferences they attended that attracted large numbers of students from marginalized groups. But Wagoner always came away empty-handed.

“Everybody wanted them,” he says about the students Stanford tried to recruit. “We did all we could. We’d call them and encourage them to come. But the pool was so tiny.”

Such explanations infuriate Roscoe Giles, a computer engineer at Boston University and longtime diversity advocate who in 1975 became the first Black student to earn a Stanford physics Ph.D. “It drives me crazy,” he says, “to hear people from elite places like Stanford say, ‘We can’t compete.’ It’s the opposite of what you hear them say the rest of the time about their ability to attract the most talented faculty and students.”

**OTHER BLACK PHYSICISTS** told *Science* they have had difficulty gaining institutional support for efforts to increase diversity—even when they volunteered to lead them. Physicist Kim Lewis, for example, says she worked hard to attract Black students and

faculty to the Rensselaer Polytechnic Institute (RPI), a predominantly white institution in upstate New York where she was a faculty member between 2006 and 2017. But she says senior administrators often pushed back against her efforts.

"I had been doing a lot of recruiting, on my own time," Lewis says, "and one day I realized that none of these students looked like me." Changing the demographics would require RPI to commit time and money, she concluded. "But whenever I tried to bring it up, the response was, 'We shouldn't need to make an extra effort to attract them. They should want to come. We're RPI.'"

In 2018, Lewis moved to Howard University, a historically Black college in Washington, D.C., where she is now a professor of physics and associate vice president of research. RPI's attitude toward recruiting a more diverse student body wasn't the only reason for the move, she says. Another factor was the way she was treated by RPI undergraduates.

"The students there can be brutal," she says. "They didn't like my hairstyle, they accused me of speaking Ebonics [rather than English], and they said I looked like a monkey standing in front of the class."

In contrast, she says, "At Howard I can take off my dean's hat and, for a few minutes, be an aunt," alluding to her approach to mentoring. "I couldn't do that at RPI."

Lewis says she chose not to file a formal complaint at RPI because, as a petite Black woman, she feared for her safety. "I have to walk around campus, and I just don't trust [the students]," she says she told a university official at the time. RPI declined requests from *Science* to address the issues Lewis raised.

The arrogance Lewis says she encountered at RPI is a common manifestation of white privilege in physics, Hodari says. "It's hard to empathize with the problems of marginalized populations when you think you're the smartest person in the room and have all the answers," she says.

Such smugness also hinders efforts to improve diversity, says Mary James, a physicist at Reed College and co-chair of an American Institute of Physics task force that issued a 2020 report on how to reverse the declining percentage of Black undergraduates majoring in physics. "It's hard for some physicists who think they are good at everything to say to themselves: 'Maybe what I've been doing for so long hasn't been effective,'" she says.

Another impediment to change, says James, who is Black, is that physicists can harbor condescending attitudes toward advice from experts in other fields. For example, physicists who pride themselves on making

decisions based on "hard data" may scoff at survey data from social scientists in which students describe deficiencies in their training, she says. "But qualitative data are data, too," James says. She and others think social scientists could help physicists address cultural, sociological, and institutional issues that might sabotage diversity initiatives.

**EVEN MEMBERS** of the priesthood who have embraced the value of diversity say change doesn't come easily. Keith Bechtol, a white cosmologist at the University of Wisconsin (UW), Madison, says he barely noticed the absence of Black students among the 18 physics majors in his graduating class at the College of William and Mary in 2007. And Bechtol thought little about having "maybe one Black man" among the 45 students in his graduate program at Stanford, where he earned his Ph.D. in 2012.

“

If you have someone  
in your department  
**WHO IS TOXIC,**  
you need to figure out  
how to protect  
students from them.

**MARTA MCNEESE,**  
SPELMAN COLLEGE

What finally opened his eyes to the corrosive effect of white privilege, he says, was his first teaching assignment at UW as an assistant professor in 2018. After asking students in his introductory physics class to write a paper on a physics Nobel laureate, he says, "I realized that I was perpetuating all these inequities by forcing them to write almost exclusively about white males."

Bechtol revised the assignment to allow students to write about any physicist. Then he began to devote one class period in the course to a discussion of diversity, equity, and inclusion. Last year, he won a departmental grant to fund research fellowships for a handful of undergraduates from groups traditionally underrepresented in physics.

He's hoping other faculty members will sign up to mentor those students, leading

to a more welcoming environment at UW. "We're not there yet," he admits. The top-tier research institution has no Black faculty in its 48-member physics department, he notes, and records show only two Black students earned undergraduate physics degrees in the 5 years from 2015 to 2019.

Advocates for greater diversity say many more white male physicists will have to follow Bechtol's lead if the field wants to reverse the declining participation by Black students. And Nord says the first step is a real commitment to change.

"At every place I've worked, I've witnessed promises unkept and seen racism in their committees," Nord told the leaders of the American Physical Society last year during a webinar on the value of diversity. "Most of my secure, senior colleagues—white men—encourage gradualism, and whitesplain to me that 'change takes time.'"

Any change must also be accompanied by greater accountability, Nord says. "Most of the talk I hear about helping people of color navigate the treacherous waters [in physics] amounts to suggestions on how to hop from one lily pad to another to avoid falling into deep water," Nord says. "But that's not enough. You also need to take the negative players out of the game by identifying and enforcing consequences for bad behavior." Those consequences, he says, could include preventing scientists and institutions from receiving federal research grants if they can't show progress in improving diversity, equity, and inclusion on their campuses.

Other diversity advocates, however, think such a punitive policy would be counterproductive. They want the federal government and other funders to use the carrot rather than the stick, offering additional support to institutions and departments that are doing the right thing.

Either way, diversity advocates agree that lasting change won't happen until the priesthood becomes fully engaged. Nadya Mason, a professor at the University of Illinois, Urbana-Champaign, says she is still waiting for that to happen.

Mason, who is Black, recalls a senior white faculty member asking her for advice during a 2020 campus event on how to combat racism. "I don't know what to do. Can you help me?" he asked her.

"I told him that the point of the event was for whites to think about their actions," Mason says, "not to ask Black people what they think. I don't think he liked my answer. But until white people educate themselves, nothing will happen." ■

## The toll of white privilege

Jeffrey Mervis

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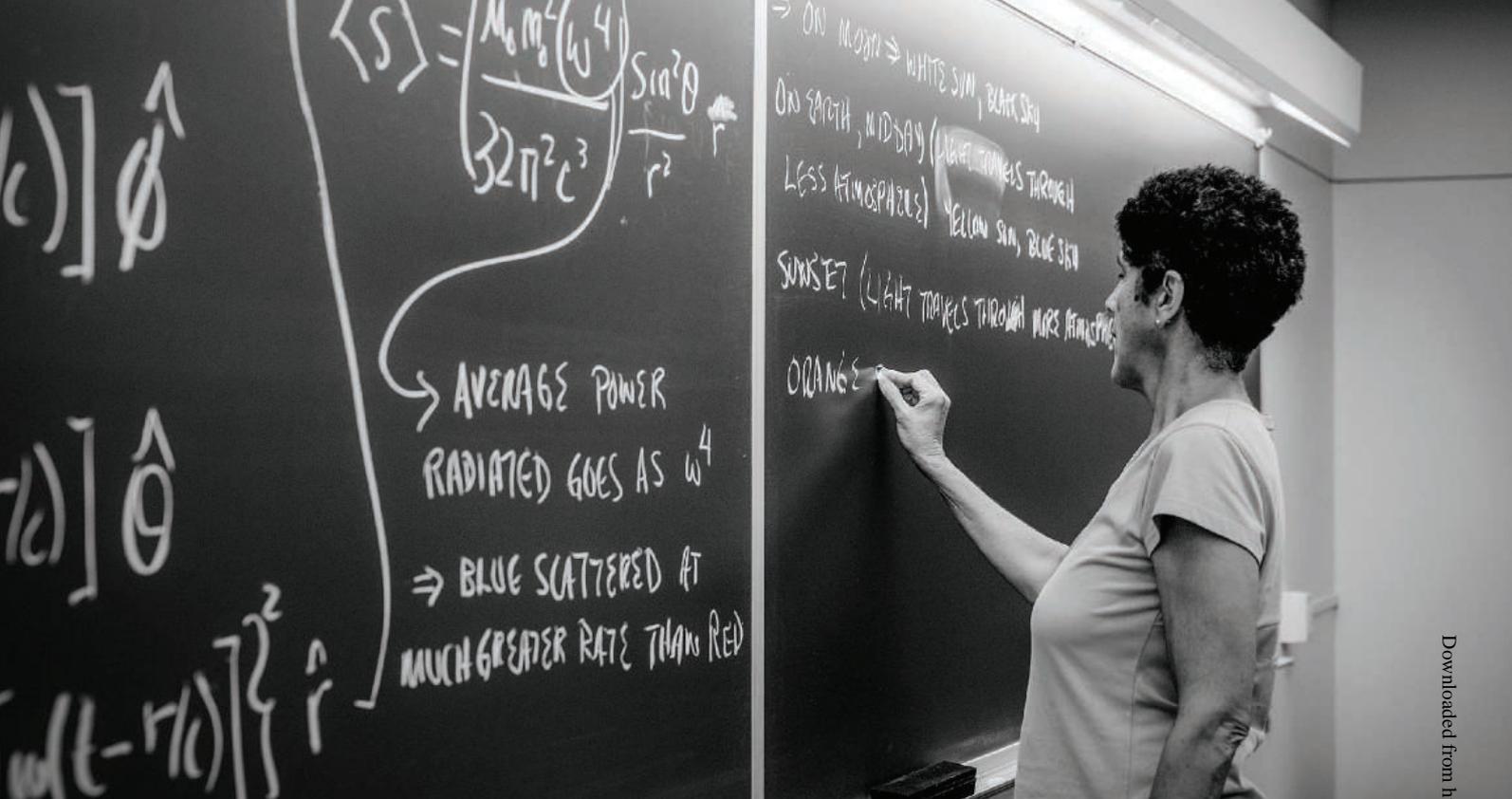
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# FIX THE SYSTEM, NOT THE STUDENTS

Change requires building bridges, removing barriers *By Jeffrey Mervis*

Physicist Mary James was a sophomore at Hampshire College in Massachusetts in 1974 when a professor encouraged her to apply for a prestigious internship at a world-class laboratory. Such competitive internships are often an essential step to becoming an academic scientist, which was her goal. But for a young Black woman from Chicago, the idea of spending 10 weeks at what is now called the SLAC National Linear Accelerator Laboratory in California seemed far-fetched.

"I had never been west of the Mississippi," she says. "And the brochure was so intimidating that I thought, 'This isn't even worth a stamp,'" James recalls. But her Hampshire professor kept pushing her

to apply, and the next year she did—and was accepted. Spending two summers at SLAC set her on the road to earning a Ph.D. from Stanford University and then to Reed College, where she's been a faculty member for 35 years.

Nearly a half-century later, James can still recall a lunch at SLAC that cemented her future. "A bunch of us students were sitting at the grown-ups' table," she says, "eavesdropping on a very lively conversation, when I had an epiphany: 'They are getting paid to do this! I hadn't realized you could make a living doing physics.'"

James also didn't realize that the internships were making her more acceptable to the white male "priesthood" that sets the discipline's culture (see p. 952). That culture, which has historically excluded people

who look like James, expects students to meet a certain standard. And rather than giving students the help they need, James and other Black physicists say, the priesthood too often decides that those students are unworthy of joining the profession.

That way of thinking is so common in physics that it even has a name. Diversity scholars call it the deficit model, and they say it's a major reason fewer than 4% of all undergraduate physics degrees awarded by U.S. institutions go to Black men and women. Sadly, that underrepresentation is getting worse: A 2020 report by the American Institute of Physics (AIP) found Black people now comprise a smaller slice of those degrees than they did 2 decades ago.

James was co-chair of AIP's National Task Force to Elevate African American Represen-



Reed College physicist Mary James co-chaired a 2020 American Institute of Physics report on improving recruitment and retention of Black physics majors.

for astronomy and astrophysics by the National Academies of Sciences, Engineering, and Medicine (NASEM), in which Stassun took part. It reports that, among undergraduate students who say they intend to major in physics or astronomy, those from groups underrepresented in science are almost three times less likely to complete the degree than are white students.

Studies have shown research internships like the one James did at SLAC can help keep students engaged in physics. But some students who would benefit most from such an experience can't participate, argues Sheila Kannappan, an astrophysicist at the University of North Carolina (UNC), Chapel Hill. Kannappan identifies as a woman of color—"I'm half-Indian, and I appear vaguely brown." She is also the department's associate chair for diversity, and once ran summer research internships at UNC funded by the National Science Foundation (NSF). But after several years, she realized NSF's research experiences for undergraduates (REU) program wasn't a great fit for her target audience of students from groups underrepresented in science.

"You had to be a superstar to get in," Kannappan says. But many of the students she wanted to serve "don't look good on paper—they don't have 4.0 [grade point averages] and previous research experience. They may also need to work during the summer, or if they are transfer students from a community college, they may need to go to summer school" to catch up on prerequisite courses for their major.

Instead of trying to win another REU grant, Kannappan decided to create a 2-week paid boot camp just for UNC students, including those from marginalized groups. It teaches them computational skills applicable to any area of physics, and is supported by institutional funding and a supplement to her standard NSF research grant. Its short duration, she says, "still allows [students] to go home or take [other] classes."

In fall of 2021, Kannappan also helped stand up a new peer mentoring program that pairs UNC graduate students in physics with undergraduate students in the department. "We understand that there are other things besides their coursework that affect someone's ability to succeed in school," says Zack Hall, who co-directs the program. All of the participants in the inaugural class—six mentees and five mentors—are from groups underrepresented in physics, says Hall, who is on track to become the first Black student to earn a physics Ph.D. from the university.

tation in Undergraduate Physics & Astronomy (TEAM-UP), which wrote the report. It calls on physicists to reject the deficit model and replace it with something that assigns them primary responsibility for diversifying their profession. Black students "have the same drive, motivation, intellect, and capability to obtain physics and astronomy degrees as students of other races and ethnicities," the report says. "[But] they are choosing majors that are perceived as being more supportive and/or rewarding."

"Black students don't need to be fixed," James says, driving home the point. "We know that there are a robust number of African American students capable of doing physics because they are majoring in other STEM [science, technology, engineering, and math] fields. So instead of trying to change them, let's talk about why they are turned off by the environment in physics and work to change that."

**THE TEAM-UP REPORT** recommends several ways to improve that environment. One is for departments to help students develop what it calls a "physics identity"—the ability to see themselves as a future member of the profession. Another is for physics professors to abandon their traditional role as gatekeepers who only let the "best" students advance and instead find ways to attract and retain a more diverse group of students.

Students at historically Black colleges and universities (HBCUs, see p. 960) take that kind of nurturing for granted, says

Arlisa Richardson, who also served on the TEAM-UP task force. Richardson is a physics professor at Chandler-Gilbert Community College and an alumna of Grambling State University, an HBCU in Louisiana. "At Grambling, people were rooting for us and helping us deal with any problems," says Richardson, who nearly dropped out of physics during graduate school at a predominantly white institution because of what she and a small cohort of other Black students regarded as a hostile learning environment. Richardson has spent the past decade at Chandler trying "to re-create the experience I had at Grambling," she says, "by providing students with a welcoming environment, hands-on learning, clubs that are student-led, and free tutoring."

Even before the TEAM-UP report, some academic physicists had begun to take similar steps. At Vanderbilt University, astrophysicist Keivan Stassun was moved to act by data showing Black undergraduates are being pushed out of the field they want to study.

"The percentage of incoming freshmen who express interest in astronomy [1%] is not different between majority and minority students," says Stassun, who identifies as Hispanic and says he has "lived the life" of someone from an underrepresented group in science. "But 2 years later, 60% of all students have fallen away, while the rate is 90% for Black students. It's a massive disparity from which we never recover."

Similar attrition is occurring across the country, according to a recent decadal study



University of North Carolina, Chapel Hill, physics professor Sheila Kannappan (second from left) is flanked by graduate student Zack Hall (left), undergraduate Nathnael Kahassai (second from right), and graduate student Derrick Carr.

The program relies on volunteer mentors, and Hall says he's careful to make sure the 10 hours or so a week he spends coordinating their activities doesn't interfere with his work on lattice quantum chromodynamics. But Julieta Gruszko, a white assistant professor of physics at UNC, thinks such mentors should be compensated in order to recognize their value to strengthening the profession. So in 2020, when she negotiated her startup package, she included funding for a graduate student to work with individual students and organize public events to promote diversity.

Kannappan and Hall hope these and other efforts will ultimately help UNC improve its mediocre record of training Black physicists. Black students earned just seven of the 232 undergraduate physics degrees it awarded over the past decade, a rate slightly below the national average.

Similar efforts are still uncommon at other campuses around the United States, according a 2020 AIP survey of 310 physics department chairs. Three out of four chairs identified "low enrollment or retention of historically underrepresented groups" as a major challenge. However, barely half of the department chairs listed "creating an inclusive learning environment"—exactly what the TEAM-UP report says is essential for improving retention rates and increasing diversity—as something they need to address. And fewer than two in five identified improving the department's "climate" as a priority.

**PRODUCING MORE** Black majors at the undergraduate level is only the first step in diversifying the profession. Such efforts will be for naught if they aren't sustained. Graduate training at predominantly white institutions poses its own set of challenges, because physics departments historically have only recruited from a small and homogeneous group of undergraduate schools and use entrance requirements that often put Black students at a disadvantage.

One increasingly popular alternative is for those departments to partner with institutions that serve large numbers of students from minority groups. Those arrangements, often called bridge programs, come in many flavors. But they share the goal of increasing the number of Black students earning graduate degrees in the natural sciences. Simultaneously, many departments have broadened their definition of a viable candidate.

In 2004, Stassun decided to combine those elements into a bridge program that has become a national model. Students apply to a master's degree program at Fisk University, an HBCU also located in Nashville, Tennessee, that feeds into a doctoral program at Vanderbilt. It caters to promising students with holes in their undergraduate education that need to be filled before they can begin a research-based doctoral training program.

Simultaneously, Vanderbilt reduced what Stassun calls an "overreliance on standardized test scores," in particular

the graduate record examination (GRE) in physics, to winnow the initial applicant pool. Studies have shown GRE scores are poor predictors of success in graduate school, and many minority students who are otherwise qualified do poorly on the exam, Stassun told a meeting last year of the Roundtable on Black Men and Women in Science, Engineering, and Medicine sponsored by NASEM.

The Fisk-Vanderbilt program puts more weight on factors such as perseverance, the ability to set long-term goals, leadership, and community engagement. Those qualities, Stassun says, don't penalize students of color and are also seen as better metrics for success.

Using those criteria helped Vanderbilt attract a more diverse pool of students. But that was only the first step toward producing more Black Ph.D.s in the natural sciences, Stassun explains. "The next challenge was building a sense of community." Vanderbilt's partnership with Fisk serves that role, he says, by giving minority students "1 to 3 years to capitalize on what Fisk has to offer."

And once students began their doctoral work at Vanderbilt, Stassun took on a third challenge: creating a more hospitable environment. That required creating mentoring networks that went beyond the traditional mentoring "dyad" between a graduate student and their adviser, he says.

"I can't be their only source of support," Stassun says. He says the broader mentor-

ing networks, which include faculty from other departments and peers, allow students to tap into “all the experiences they will need” to succeed.

The bridge program has made impressive strides in increasing diversity: Some 80% of the 150 students who have earned master’s and doctoral degrees identify as either Black or Hispanic, according to data compiled by the program, and more than half are women. Along the way, says Stassun, who stepped down as director of the program in 2015, Fisk has become the nation’s top producer of Black students with master’s degrees in physics and materials science. “And my lab has awarded more Ph.D.s in astrophysics to African Americans than any other lab in the country,” he says.

**THE FISK-VANDERBILT** bridge program has shown that pairing a minority-serving and a predominantly white institution can boost the flow of Black students into physics. A half-dozen major research universities have adopted variations of the model, and the American Physical Society is using the concept to build a nationwide network of graduate programs that have pledged to train more minority students. (Hall earned his master’s degree at California State University, Long Beach, under one such program, which he says “really bolstered my confidence.”)

But not every pairing has been successful. For example, the checkered history of the former Center for Integrated Space Weather Modeling (CISM) based at Boston University shows what can go wrong.

In addition to advancing research in the emerging field of space weather, CISM hoped to alter the field’s overwhelmingly white demographics. So the center partnered with Alabama A&M University (AAMU), an HBCU with a new graduate program in space physics. The plan was to have students earn a master’s degree from AAMU before pursuing doctoral work at that university or elsewhere. The center received 10 years of funding from NSF, which wanted to foster greater diversity in the discipline.

But AAMU’s program only graduated two Black students—Fana Mulu-Moore and Samaiyah Farid—over its decadelong affiliation with the center. And both women say the partnership was little help to their careers. In particular, they viewed themselves as tokens in a program they say only gave lip service to diversity.

“Sometimes it felt that they were just checking a box,” says Mulu-Moore, who spent 10 years trying to find her place in physics after also earning her Ph.D. from AAMU in 2009. “We were doing a lot of outreach to minority schools for CISM. But I don’t know of a single minority student who came through the CISM program and went into the field.”

Farid left the AAMU program after her master’s degree to work at the Harvard-Smithsonian Center for Astrophysics. She hoped it would be a springboard into space physics. But she says she was the only Black scientist there and was subject to racial taunts. After leaving that job and enrolling in a doctoral program at the Uni-

nity stigmatizes the students,” Farid says about the Fisk-Vanderbilt bridge. “People assumed I was in the program because I was Black. And if you’re in the program, people also assume that you’re not up to par.”

At the same time, her affiliation with the program has helped advance her career. She is now doing a postdoctoral fellowship at Yale University that is only available to astrophysics students who have gone through bridge programs at Vanderbilt, Columbia, and Ohio State universities.

Mulu-Moore now teaches at Aims Community College in Colorado. Last summer, after several years living a precarious existence as an adjunct, she was hired as the department’s only full-time faculty member. She relishes teaching first-generation college students who remind her of herself when she arrived in the United States 20 years ago from Ethiopia. “It’s a small, nurturing school, and I feel that I’ve found my niche,” she says.

Along with engaging in extensive community outreach to broaden the pool, Mulu-Moore tries to connect her most promising students with the kind of high-quality summer internships that helped launch James’s career. One of those students is Carter Woodson, a biracial student who graduated from a rural West Virginia high school and has spent 10 years trying to acquire a college education, the cost of which is often beyond his means.

Woodson teaches and tutors at a local high school that Aims operates, a job that pays the tuition for his science courses and feeds his long-term ambition of becoming a science and math teacher. When

Mulu-Moore told him about a 10-week, paid summer program run by the National Solar Observatory in conjunction with the University of Colorado, Boulder, he jumped at the chance. “I’ve always loved math,” he says, “and this sounds like the chance to do something really interesting.”

Mulu-Moore knows he’ll face stiff competition. “These internship programs are usually looking for students from the top universities,” she says. “But Carter checks all the boxes. He’s very smart, he’s a full-time student, and he’s absolutely determined to get a degree.”

To Mulu-Moore, Woodson is exactly the kind of student the U.S. physics community should be encouraging and welcoming. “He’s just as capable,” she says, “as somebody from an Ivy League school.” ■

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Black students don’t need to be fixed. ... So instead of trying to change them, let’s talk about **WHY THEY ARE TURNED OFF** by the environment in physics and work to change that.

MARY JAMES,  
REED COLLEGE

versity of New Hampshire (UNH), Farid said she experienced a similar sense of isolation and hostility toward her as a Black person. It was a “horrible experience,” she recalls. Although the department was a partner in CISM, Farid felt it offered her no additional support or guidance.

But Farid didn’t give up. After dropping out of UNH and taking a short respite, she resumed her doctoral studies at Vanderbilt under Stassun. Although Farid was too advanced to qualify for a master’s degree through the bridge program, she participated in many of its activities.

Looking back, Farid thinks her experiences at AAMU, UNH, and Vanderbilt show that a partnership between a predominantly white institution and a minority-serving institution is no panacea. “It defi-

## Fix the system, not the students

Jeffrey Mervis

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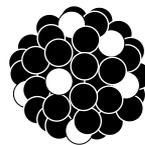
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# BLACK COLLEGES CAN'T DO IT ALL



At historically Black colleges and universities, tight funding threatens an extraordinary record of nurturing Black physicists

By **Jeffrey Mervis**



Robert Dixon has spent more than 50 years mentoring physics students at historically Black colleges and universities.

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Historically Black colleges and universities (HBCUs) in the United States have had outsize success in launching Black students into physics. Although only 9% of all Black undergraduates attend the country's 100 HBCUs, those schools for decades have awarded the majority of physics degrees earned by Black students. HBCUs also claim all the slots on a top 10 list of schools graduating the most Black physicists, despite having departments that are much smaller and have less funding than those at predominantly white institutions (PWIs).

How do they do it? The key, say dozens of Black scientists who have worked at HBCUs or are knowledgeable about them, is that they provide a nurturing environment that addresses the academic, financial, emotional, and cultural needs of their students.

But HBCUs' ability to do so is threatened by declining overall enrollments over the past decade and the worsening of already serious financial constraints. In 2019, HBCUs garnered \$341 million in federal research funding, down 15% from 2001; over the same 2 decades, the amount going to all U.S. universities grew by 65%, to \$38 billion. The absolute number of Black students earning undergraduate physics degrees from HBCUs fell by half between 1996 and 2018, according to data from the American Institute of Physics (AIP). And HBCUs' share of all Black physics graduates, which stood above 50% in 2006, was only 28% in 2019. (Only one-third of HBCUs offer an undergraduate degree in physics.)

That shifting balance would matter less if the physics departments at the nation's research heavyweights—all PWIs—were doing a better job of deploying their large research budgets and hefty endowments to fill the pipeline with Black physicists. But even those with the best records are falling far short of what's needed to improve diversity.

The data for the Massachusetts Institute of Technology (MIT), one of the nation's leading universities, bear that out. Between 2012 and 2017, MIT awarded more undergraduate physics degrees to Black students—12—than any other PWI, according to AIP statistics. Even so, none of the 42 physics majors graduating from MIT in 2017 was Black. By comparison, eight Black students earned physics degrees that year from Morehouse College, an all-male HBCU in Atlanta.

That stark racial disparity is why Sylvester James Gates, an eminent theoretical physicist who is Black, views HBCUs as a precious resource for the community. "They are our intellectual lifeboats," Gates said last year

during an American Physical Society webinar on diversity that he chaired as APS president. "Investing in them is a bet on ourselves."

**FOR HBCUs** trying to build robust physics programs, Morehouse has long been an exemplar. A 2020 report from AIP's National Task Force to Elevate African American Representation in Undergraduate Physics & Astronomy (TEAM-UP) found the college produced 32 Black physics majors between 2012 and 2017, a dozen more than second place Alabama A&M University. A generation earlier, Morehouse had enjoyed similar success under Robert Dixon, a Black physicist who led its physics department from 1988 until 2004.

"Bob Dixon has probably trained more African American physics undergraduates than anyone else in the country," says Warren

“  
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**WARREN BUCK,**  
UNIVERSITY OF WASHINGTON, BOTHELL

Buck, a Black physicist and former chancellor of the University of Washington (UW), Bothell. "He's underrated because he doesn't look for glory. But he's very effective," adds Buck, a former chair of the physics department at Hampton University, an HBCU in Virginia.

Now 80 and semiretired, Dixon has worked as a faculty member and administrator at a half-dozen HBCUs over more than 5 decades. Arguably his greatest success came at Morehouse, where he earned an undergraduate degree in 1964 and then returned 2 decades later to join its faculty. Its small physics program was limping along, he says, and after becoming chair he realized the only way to build it up was "to look for grant opportunities."

His success in winning federal funding allowed him to grow the number of faculty from three to 11, offer scholarships, and hire

staff to plan a range of events that raised the department's campus profile. "We became a hub of activity," he says, "and it drew students into the program."

Nicholas Fuller was one of them. Raised in Trinidad and Tobago by a single mother who regarded a good education "as the only path to success," Fuller excelled at science in high school. When it was time to go to college, he chose Morehouse because it offered him a full scholarship. Dixon's approach to training the next generation of physicists also resonated with him.

"The level of nurturing is the key," says Fuller, who went on to earn a doctoral degree in applied physics at Columbia University and now directs global hybrid cloud services for IBM. "If you failed an exam, Dr. Dixon let you know that you still had a bright future. Without that support, students lose confidence in their ability to become a scientist or engineer, especially if they don't see many people in those jobs who look like them."

In 1996, Dixon won a \$7.3 million grant from a U.S. Department of Defense (DOD) program designed to strengthen undergraduate science at HBCUs. "DOD's original plan was to fund 20 schools," he recalls. "But I asked for all of the money, on the grounds that we had the best proposal."

Dixon used the money to create the Center for Excellence in Science, Engineering, and Mathematics (CESEM) at Morehouse. CESEM provided full scholarships and intensive academic and career guidance to 50 Morehouse freshmen seeking an undergraduate degree in the natural sciences, math, and engineering, including 17 in physics. Some 85% had earned degrees by the end of the grant, and upward of 80% chose to continue to a graduate science, technology, engineering, or math (STEM) program. Two hundred additional Morehouse STEM majors were able to take advantage of a subset of those activities.

The grant also supported a cohort of 50 ninth grade students from Atlanta public schools, providing academic and career counseling for the students, all of whom graduated, and professional development for their teachers. Although the program was not designed to be a recruiting device for Morehouse, some participants enrolled there and majored in science.

Yet Morehouse's success, like that of other physics departments at HBCUs, rested on a shaky foundation. In 2001, DOD officials declined to renew the 5-year grant that supported CESEM, and Dixon asked senior college administrators for internal funding to continue the program. But they turned him

down, he says, forcing him to shut the center and lay off its five-person administrative staff.

Without the scholarships and paid internships, students drifted into other fields. Over the next 2 years, Morehouse's annual production of Black physics majors plunged from six, a number that had sustained its top ranking, to zero. In 2004, after 16 years as department head, Dixon threw in the towel and took a job at Grambling State University, a Louisiana HBCU. "It was very disappointing that the college didn't give us a chance to continue what we were doing," he says. Physicist Walter Massey, Morehouse's president at the time, declined to comment.

However, Dixon had sown the seeds for the program to thrive again when, in 1997,

retired, said recently that seeing that initiative falter was one of his biggest regrets.

Even at the time, Rockward and his colleagues say, Georgia Tech didn't match the welcoming atmosphere of an HBCU. Rebuffed when they tried to join a study group, for example, the Black students converted a departmental storage room into a retreat they called "the Black Hole."

Moving to Morehouse required Rockward to make adjustments. "No startup package, and all I had to work with were undergraduates," he recalls. But he won a string of federal grants that included collaborations with colleagues at research-intensive universities, which provided internships for students to apply what they were learning in class.

One big attraction was the chance to replicate his success at Morehouse on a larger scale. "[Morgan State] had a strong record in the 1980s for graduating African Americans before things started to slide, and they were interested in reviving that tradition," he says.

Even better, Rockward says, school administrators had vowed that Morgan State would become a Tier 1 institution by 2030, a designation based on the amount of its external funding. Rockward hopes meeting that goal will catapult Morgan State into the ranks of Georgia Tech and other heavy-weight physics programs at PWIs.

**WARREN BUCK**, former physics chair at Hampton, is another Dixon protégé who built a successful program at an HBCU by following his mentor's template—and by adding his own wrinkles. Buck was an undergraduate at Morgan State in 1966 when he met Dixon, then a new faculty member in his first academic job. "Bob convinced me I could do physics," Buck says.

He earned his Ph.D. from the College of William and Mary and joined the Hampton faculty in 1984. He expanded its physics department and also created a doctoral physics program, one of only five at an HBCU. Those efforts profited from the university's proximity to the Department of Energy's newly opened Thomas Jefferson National Accelerator Facility (JLab), home of the Continuous Electron Beam Accelerator Facility. Buck also won federal funding for a research center of excellence in nuclear and high energy physics, using the money to recruit faculty as well as to fund students to work with the world-class physicists at JLab. "I wanted to show that we could play with the big guys," he says.

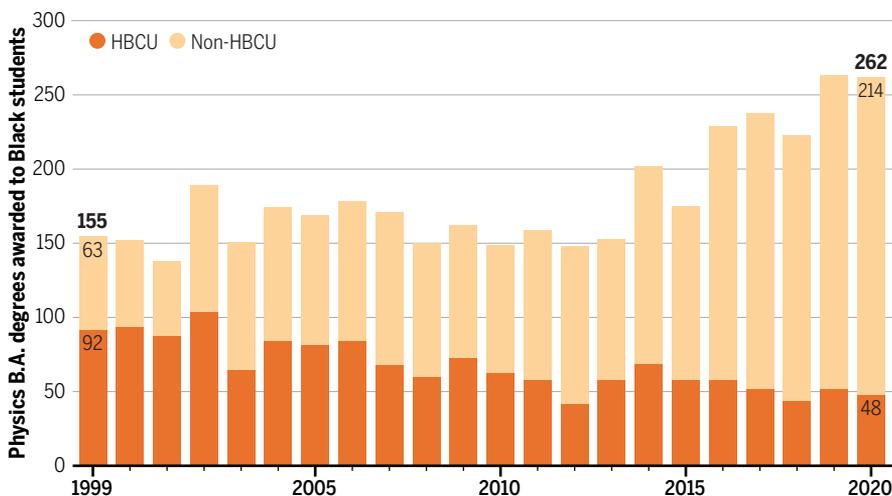
That approach appealed to Devin Walker, now an assistant professor at Dartmouth College. In 1994, Walker was a Black high school student in Memphis, Tennessee, with his sights set on MIT. "I had the grades, they had lots of resources, and I knew that smart kids went to MIT."

MIT accepted Walker—but didn't offer him a scholarship. So he sought out Buck during an event at Hampton, where Walker's siblings were enrolled. Walker's initiative—and resume—convinced Buck to offer him a full scholarship. In 2006, Walker became the first U.S.-born Black student to earn a physics Ph.D. at Harvard University, working under prominent particle physicist Howard Georgi, whom he had met during a JLab summer internship.

Despite Buck's success at Hampton—in 2001, five Black students earned physics Ph.D.s, an extraordinary feat the department repeated in 2002—he says the

## Waning clout

Historically Black colleges and universities (HBCUs) once accounted for more than half of all U.S. physics degrees awarded to Black undergraduates. That share has now declined to less than one-fifth of the total.



he recruited Willie Rockward, a Black physicist. Rockward had graduated from Grambling, where he was drawn into the field by the school's small but nurturing physics department. "Dr. [Odom] looked like me," Rockward says about the department's long-time chair, Thomas Odom Jr., one of several Black faculty members in the department. (Black science faculty are often in the minority at HBCUs as well.)

Rockward went on to earn his Ph.D. from the Georgia Institute of Technology (Georgia Tech), where he was part of a first ever cohort of five Black students recruited by physicist Henry Valk, a senior administrator. A few years later, Valk, who is white, recruited a second cohort of similar size. It was a short-lived attempt to diversify the physics department, and Valk, long since

In 2011, Rockward became department chair, giving him a chance to revamp a sequence of three calculus-based courses with notoriously high attrition rates. He reshuffled the instructors to match their strengths with the content of each course. Their success in retaining students led to larger graduating classes in physics, a virtuous cycle that made it easier to attract more majors.

Those and other moves helped Morehouse return to the top of the national rankings in producing Black physics majors. But eventually Rockward, like Dixon, felt that his efforts were not valued and that his career was stagnating. "I didn't get promoted to full professor," he says. "So I said, 'OK, that's your call.' And I started to look around."

In 2019, Rockward landed at Morgan State University, an HBCU in Baltimore.



At Morgan State University, a historically black university, physics professor Ramesh Budhani (left) works with undergraduate Don-Terry Veal Jr. in a spintronics lab.

school's senior administrators balked at supporting his vision for a more robust program. "Physics is expensive, and they didn't see its value," Buck says. Hampton officials declined to comment. But the online biography of its longtime president, William Harvey, emphasizes his concern for the bottom line by noting that "Dr. Harvey is an astute businessman who runs Hampton as a business for educational purposes."

Buck, who says he was "worn out and very frustrated" at Hampton, saw UW Bothell, an emerging 4-year college that caters to students from groups traditionally marginalized in science, as a chance to start over. Within a few years after he left to become UW Bothell's first chancellor in 1999, the flow of Black graduate students into physics at Hampton had dried up.

**TOP U.S. RESEARCH** universities have long relied on HBCUs to be the first rung on the academic ladder for Black physicists. The success enjoyed by Dixon, Rockward, and Buck shows how crucial federal research grants are to that role. But those dollars are in short supply at HBCUs. In 2019, for ex-

ample, North Carolina A&T State University led all HBCUs in winning federal research support, with \$22 million. In contrast, five PWIs received more than \$750 million each in federal research that year.

In competing for those funds, HBCU faculty are at a decided disadvantage compared with their peers at PWIs. Heavy teaching loads often leave them little time to do the preliminary work needed to win a federal grant, and few HBCUs have the institutional funds to supplement any grants to support student research.

In addition, the federal government prefers to back one-off experiments in education. "We don't make long-term, sustained investments in STEM education like we do for research projects," says physicist Claudia Rankins, former dean of science at Hampton who recently retired from the National Science Foundation after 2 decades of managing programs to broaden participation. "If you study some small particle, you can ... be funded for decades as long as you show progress. But if you are proposing to do something in STEM education, or institutional capacity building, you're fortunate to get 5 years of fund-

ing. And then you're expected to move onto something else."

The TEAM-UP report calls for U.S. physics departments to double the number of Black majors by 2030. Reaching that goal will require PWIs to boost their output, and collaborations with HBCUs are one obvious route to success. But Marta McNeese, chair of the physics department at Spelman College, an all-women HBCU in Atlanta, says those relationships will need to be genuine partnerships, not a check-the-box exercise.

"I've had people ask me to sign a letter of support [on a grant application], giving me 48 hours to sign, and telling me that all I need to do is send our students to their summer program," McNeese says. "They want to address diversity, equity, and inclusion, but they don't involve us in the planning."

The PWIs will also need to emulate the nurturing environment at HBCUs. "Our students are already stressed academically, politically, and economically," McNeese says. "The role of an HBCU today is to give students a place where they can be themselves." ■

## Black colleges can't do it all

Jeffrey Mervis

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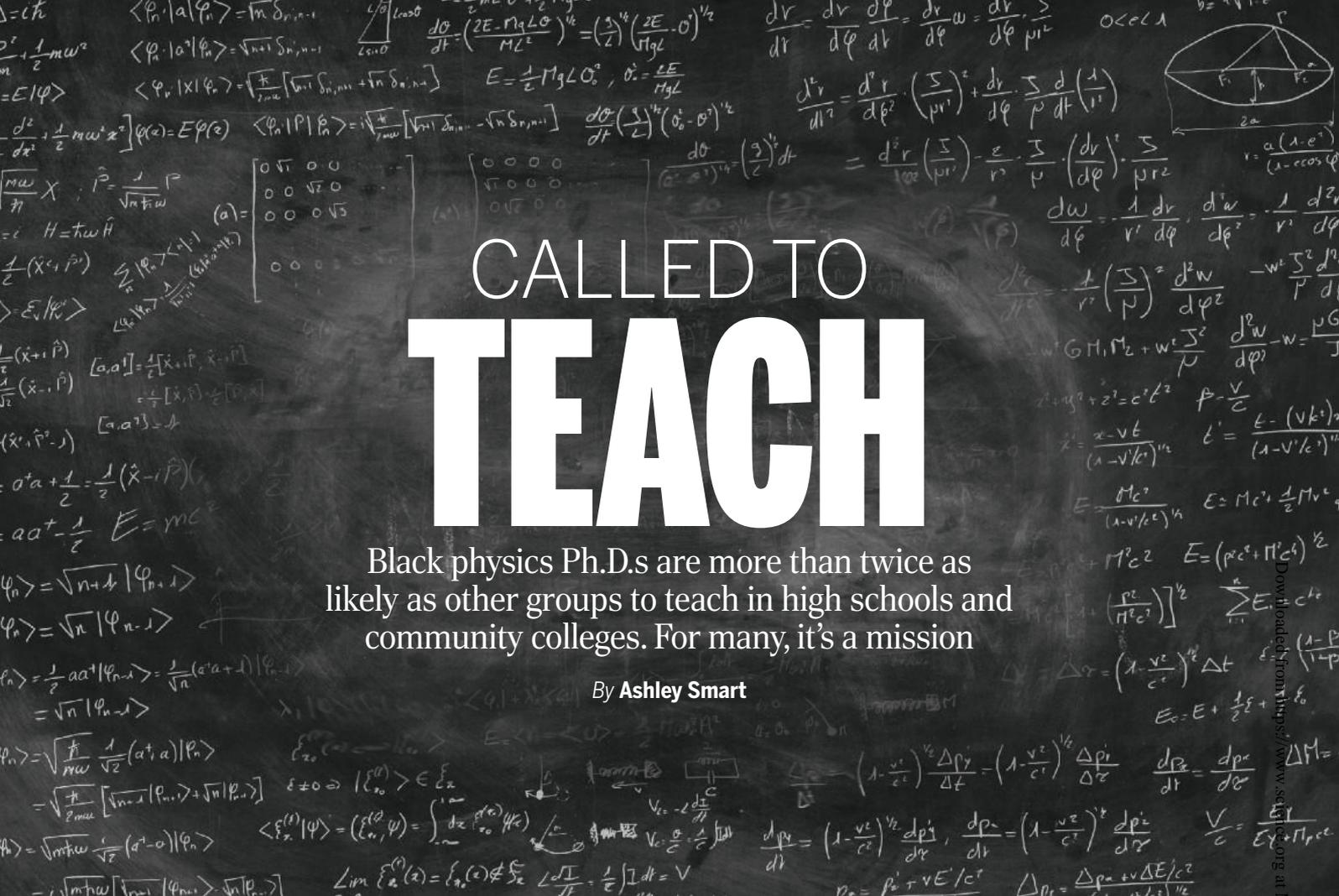
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# CALLED TO TEACH

Black physics Ph.D.s are more than twice as likely as other groups to teach in high schools and community colleges. For many, it's a mission

By Ashley Smart

For years, Maritza Tavarez-Brown couldn't talk about the end of her astronomy career without tears. She'd wanted to be an astronomer since high school. But she struggled in her introductory physics classes at Yale University. At one point, she remembers, the department chair told her she should reconsider her major. Determined, she transferred to New York City's Hunter College, earned bachelor's and master's degrees in physics, and completed a Ph.D. on the properties of dark matter halos at the University of Michigan, Ann Arbor. She was offered a postdoc at the University of California, Berkeley, the kind of prestigious apprenticeship that could catapult her to an academic faculty position.

She turned it down. She and her husband had just relocated with their 5-year-old daughter to Seattle, and they decided moving to the San Francisco Bay Area wouldn't work for their family. That was more than 16 years ago, but Tavarez-Brown remembers it as if it were yesterday.

"I was devastated," recalls Tavarez-Brown, who is of Afro-Cuban descent. "In Spanish, we have this saying, 'You're work-

ing so hard that you're burning your eyelashes,'" she says. "I had done all this hard work, and now the thing that I was looking for ... I can't really do." Instead, she took a position as a long-term substitute physics teacher at Forest Ridge School of the Sacred Heart, a middle and high school for girls in nearby Bellevue, Washington.

Today, "Dr. T," as her students call her, is still at Forest Ridge, and she is part of a long but little-known tradition in U.S. science education: For decades, Black Ph.D. scientists have opted to teach outside the ivory tower in proportions higher than any other race or ethnicity. They are more than twice as likely as their non-Black peers to teach at 2-year colleges, high schools, or other precollege institutions, according to an analysis of the National Science Foundation's (NSF's) Survey of Doctorate Recipients. The disparity is present across a range of disciplines, but it has been especially pronounced in the physical sciences, where roughly one in 10 Black Ph.D. holders teaches outside of 4-year higher learning institutions—and where in some years Black Ph.D. holders have been more than three times as likely as the average to hold those jobs. These trends

date back at least to 1999, the first year NSF published the relevant data.

Education experts puzzle over the causes of the disparity. But for their part, Tavarez-Brown and other Black Ph.D. physicists who have made the leap say they are finding fulfillment on a career path that many science graduates never consider traveling. For the students they teach, their career choices mean a chance to learn from trained scientists—and to see new role models in science.

**THE RELATIVE SURPLUS** of Black Ph.D. scientists teaching in high schools and 2-year colleges has slipped under the radar of many researchers. Ebony McGee, an associate professor of diversity and science, technology, engineering, and math education at Vanderbilt University, calls it "extremely surprising." But she sees a possible explanation, pointing to evidence that many Black scientists and engineers flee the ivory tower because they find the environment constraining, marginalizing, and systemically racist. "What it sounds like to me is that the structures don't allow them to see themselves as authentically in [uni-

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iversity] faculty positions as they do in community college or high school positions.”

A close look at the NSF data suggests additional factors may be at work. The data indicate Black scientists who obtain doctorates are no less likely to teach at 4-year higher learning institutions than Ph.D. scientists from other racial and ethnic groups. (The NSF data don’t show what fraction of those faculty are at research-intensive as opposed to teaching-intensive schools.) Rather, for reasons that remain unclear, the surfeit of Black doctorates opting to teach at high schools and 2-year colleges appears to be offset primarily by a deficit of Black doctorate holders working in private industry.

Kimberly Griffin, a professor of higher education, student affairs, and international education policy at the University of Maryland, College Park, cautions that it would be a mistake to assume that Black Ph.D. holders who opt for precollege and community college teaching careers are somehow settling. “This might be a very intentional choice,” Griffin says—“different than what they anticipated when they started [their Ph.D.], but still very intentional.”

**VANESSA COHEN GIBBONS’S** decision to pursue a teaching career was very much intentional. She realized toward the end of her Ph.D. that what she enjoyed more than crunching numbers and writing papers was talking to people. Both of her parents taught at community colleges, and she had an aunt and a cousin who taught at public schools. Plus, she had enjoyed the teaching she’d done as a graduate student—and she’d excelled at it, winning student teaching awards.

It wasn’t that she lacked the research credentials to pursue a university faculty position. Her dissertation was on the dynamics of merging black holes, an area that would soon become one of the hottest in physics, with the dramatic first detection of gravitational waves from such mergers. In the run-up to academic hiring season, her adviser had even helped arrange for her to give a series of symposia and public talks—which, she says, were “very well received.”

But Cohen Gibbons, who is Black, figured a high school teaching position would offer her a chance “to be much more than just somebody who’s delivering content”—to engage with students in areas such as social and emotional learning and social

Maritza Tavarez-Brown left behind a budding career in astronomy and found fulfillment as a teacher.

justice. So, just months before the academic hiring season began, she decided to apply exclusively for high school teaching jobs. Before long she had multiple offers. She accepted a position at the Garrison Forest School, a private, all-girls K-12 school in suburban Baltimore. (The high school teachers interviewed for this story all opted for private schools, noting, among other factors, that those jobs allowed them to bypass the time-consuming certification process many public schools require.)

Cohen Gibbons’s realization, years into her graduate studies, that an academic research career wasn’t for her is hardly unusual. Studies have repeatedly found that, in aggregate, students tend to lose interest in faculty positions over the course of their graduate careers. In a 2017 study that surveyed more than 850 U.S.-based Ph.D. students in physics, chemistry, engineering, computer science, and the life sciences, nearly one-third of students who entered their Ph.D. programs expressing an interest in academic research careers had cooled on the idea by the time they neared graduation. The drop-off appears to be especially steep for women from underrepresented racial and ethnic groups.

In focus group studies, these women are also more likely to credit “externally focused” values—such as a desire to mentor students or to solve health problems facing their communities—as motivating factors in their career choice. A study conducted by the American Institute of Physics similarly found that Black physics students were more likely than physics students of other ethnic groups to express a commitment to benefitting their community.

Griffin, who co-authored some of those studies, thinks those values—particularly a desire to give back through education—could help explain the disproportionate numbers of Black Ph.D. scientists opting for careers in K-12 and community college teaching. “I could see someone getting a [science] Ph.D. and using that as their pathway to fulfill this cultural commitment.”

Fana Mulu-Moore likely falls into that category. As a postdoctoral fellow studying solar physics at NASA’s Marshall Space Flight Center, she did a lot of outreach, speaking to and working with students at historically Black colleges and universities (HBCUs) in the southeast. Those interactions felt meaningful, she says. Meanwhile, she’d begun to feel burnt out by research, and she found it isolating being one of just a few Black women in her field. So in 2013, when Mulu-Moore took a year off to care

for her newborn child, she decided she would pursue teaching jobs. After a summer stint as a high school physics teacher, she landed at Aims Community College, a small school in Greeley, Colorado, about 1 hour's drive north of Denver. In the spring of 2021, she was promoted from an adjunct position to become the school's only full-time physics professor.

Mulu-Moore describes Aims as a small, nurturing community that reminds her of her own alma mater, Alabama A&M University, the HBCU where she earned both her bachelor's degree and her Ph.D. Its student body, like those of many community colleges, is diverse—roughly 40% students of color, many of them first generation students. “It’s a great place to make an impact,” she says.

mathematicians into secondary school teaching. Some high school administrators the committee interviewed speculated that Ph.D. scientists would be “overspecialized and overprepared for teaching secondary school students.” They also noted they could not match the pay Ph.D.s could earn outside the classroom. Still, the council concluded that if high schools could woo Ph.D. scientists into their classrooms—and provide them with the necessary pedagogical training—the rewards would be plentiful.

For Mark Hannum, a white physics teacher who serves as K-12 programs manager at the American Association of Physics Teachers and heads the science department at Thomas Jefferson High School for Science and Technology, an important advantage of having

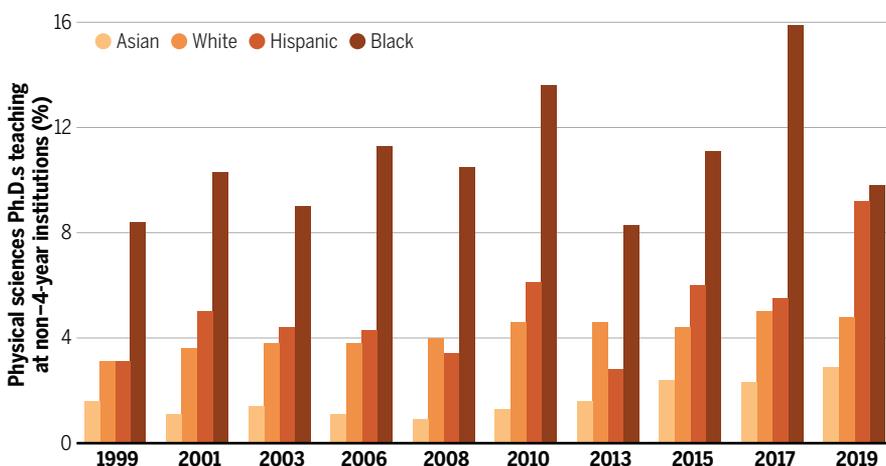
scientific process over content memorization, he says, and they bring a keen understanding of what it means to produce knowledge through experimentation.

The prospect of bringing research know-how into the classroom appealed to Angela Meyer. After finishing a Ph.D. in astronomy at Georgia State University, Meyer—a biracial Black woman—took a tenure-track faculty position at Florida Gulf Coast University, where she expected to help develop a new earth and space sciences major and launch a new observatory. But those plans never panned out. After a conversation with a cousin-in-law who taught biology at a private high school, Meyer figured a private school setting might offer her the opportunities she sought.

Meyer wound up at Culver Academies, a private boarding high school in northern Indiana. The job allowed her to pursue science without the constant pressure to write grants and publish. She developed a new astronomy curriculum, and she explored the use of classroom observatories—small, remote telescopes designed for educational use that can be controlled through the internet. One such observatory she’s worked with, a network of telescopes maintained by the Harvard-Smithsonian Center for Astrophysics, can be used for classroom projects on finding and characterizing exoplanets. “It’s not research at the level I was doing,” Meyer says. But it allows her to combine her passion for working with students with her passion for working with data. “Those are my two great loves.”

## From the lab to the classroom

For decades, Black Ph.D.s in the physical sciences have opted to teach outside the ivory tower—largely at high schools and community colleges—in proportions higher than any other race or ethnicity.



**TEACHERS WITH MULU-MOORE'S** credentials are a boon to community colleges and high schools. According to a 2005 report from the American Association of Community Colleges, only about one-quarter of the science faculty at 2-year colleges hold doctorate degrees. In high schools, most physics, chemistry, and earth science teachers lack even an undergraduate degree in the discipline they teach, let alone a doctorate. According to recent data from the American Institute of Physics, just 27% of high school physics teachers hold a degree in physics, and about 4% have doctorates.

Two decades ago, the paucity of teachers trained in the sciences so troubled U.S. educators that the National Research Council convened a committee to explore the feasibility of recruiting more Ph.D. scientists and

trained researchers in the classroom is that, unlike many other science teachers, they think of themselves as scientists. Hannum, who has bachelor's and master's degrees in physics, counts himself among that group. Having a teacher who identifies as a scientist can profoundly impact the way the students see science, Hannum says. It gives them a role model—and all the better, he says, if that role model is someone who can broaden students' perceptions of who does science. To that end, he says, “having Black Ph.D.s working in schools is immensely valuable.”

Having a scientific background can also affect how the teachers approach their work, Hannum says. “I think that mindset has subtle ramifications that spill over in a lot of ways.” For example, trained scientists are typically better prepared to emphasize the

**AS FOR TAVAREZ-BROWN**, she still feels twinges of regret. Once in a while, she'll pull out her doctoral thesis and thumb through the pages, reminding herself of the work that went into it: the weeks in New Mexico learning to analyze data from the Very Large Array; the weeks in the Netherlands learning to reduce data from the Westerbork Synthesis Radio Telescope. For her, an academic research career was always the prize. It stings to know that the goal has likely drifted permanently out of her reach.

But, like so many other Ph.D. physicists who have followed similar paths, she is ultimately at peace with the way things worked out. “To have a girl come up to you and be like, ‘I never thought I was good in science,’ or ‘I never thought I can do this and like it,’ ... honestly, you're not gonna get that being an astronomer,” she says. “I know I'm making an impact—right here, right now, for the future generation.” ■

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## Called to teach

Ashley Smart

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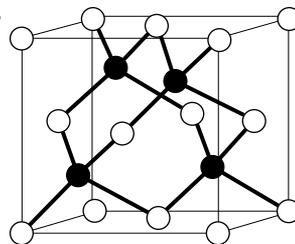
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# MICHIGAN'S SURPRISING PATH TO DIVERSITY



Black graduate students find a nurturing culture in its applied physics program *By Jeffrey Mervis*

**R**oy Clarke missed the freewheeling atmosphere of the legendary Bell Telephone Laboratories after he left Bell to join the physics faculty at the University of Michigan (UM), Ann Arbor, in 1979. He realized that UM's graduate physics program, as is the case at most universities, operated within tight disciplinary silos that prescribed what students should learn and whom they studied with. "It limited the scope of the research you could do, and its impact," he says about an educational philosophy that he compares to the master-apprentice model of a medieval guild.

Rather than trying to change age-old practices, Clarke won approval for a new graduate program in applied physics (AP). And in making graduate physics training far more collaborative and interdisciplinary, Clarke unwittingly also found a formula to improve its racial, ethnic, and gender diversity. "We found that our approach attracted a lot of interest from students of color," he says.

That's a typical understatement by the white, Australian-born Clarke. Within a few decades of its 1987 debut, UM's AP program was producing roughly 10% of all Black students earning U.S. physics Ph.D.s each year, according to a 2017 study by Julie Posselt, an education researcher at the University of Southern California, who is white, and colleagues at UM. Black, Latino, and Native American students made up as much as one-third of the program's typical entering cohort compared with 5% nationally. And women

comprised one-third of a typical graduating class, twice the national average.

One factor behind those numbers, says Clarke, who stepped down as director in 2002 but maintains ties to the program, is that "we don't engage in the hand-to-hand combat" so common among graduate programs. Instead of winnowing out any student who is struggling, he says, "we make it clear that we expect people who come here to succeed."

What Clarke and his successors have done, the study notes, is discard the traditional playbook for graduate training in physics "that had implicitly created barriers to access and inclusion for underrepresented students." The new approach removes those barriers, Posselt explains, by "reconceptualizing the vision of the ideal student, empowering administrative staff to serve as cultural translators across racial and faculty-student boundaries, and creating a familylike climate." Meeting the needs of students needs to be a priority, she adds, not an afterthought.

**SCIENCE SPOKE** with eight alumni of UM's AP program to learn how those principles were implemented. One is Kim Lewis, now a professor of physics and associate research dean at Howard University, a historically Black institution in Washington, D.C.

In 1997, Lewis was a physics major at Dillard University, a historically black college and university (HBCU) in her hometown of New Orleans, when she first heard about UM's program. It checked most of her boxes for graduate school.

"I really still wanted to be an engineer," Lewis recalls, "so an applied physics program was very appealing. I also knew that I wanted to be an academic, and nobody would question my qualifications if I had graduated from Michigan."

But Lewis also wanted to go someplace where she felt comfortable—and Ann Arbor wasn't at the top of her list. "It would be the first time I had been in a school setting where the people did not look like me," says Lewis, who attended an all-Black high school. "It also meant being away from home."

It helped that four of the eight students in her class were Black, and that many had attended HBCUs. And Lewis says she was grateful to Clarke for setting up meetings that might lead to a lasting relationship. "You're about to be best friends," Clarke told Lewis when he introduced her to Adrienne Stiff-Roberts, who entered the program a year later. "And he was right."

After graduating with their Ph.D.s in 2004, both women have more than achieved the AP program's goal of preparing its students for success. Lewis spent 11 years on the faculty at the Rensselaer Polytechnic Institute before moving to Howard in 2018. Stiff-Roberts immediately joined the faculty at Duke University, where she is now a professor of computer and electrical engineering.

In addition to supporting students traditionally underrepresented in physics, Lewis says, the UM program has shattered the myth that a graduate physics program must sacrifice quality to achieve diversity. And she gives

Clarke a huge amount of credit for that.

“He’s a scholar, one of the best condensed matter physicists in the country,” says Lewis, who works in the same field. “He has great compassion for his students, but he’s never watered down the program.”

**THE UNIVERSITY’S** sterling reputation also attracted Mitaire Ojaruega. He entered the AP program in 2003 and soon benefited from another tenet of Clarke’s philosophy: ensuring staff and faculty work together to provide students with the help they need.

The 11th of 17 children, Ojaruega was born in the United States and spent much of his childhood in Nigeria. But he attended high school in Washington, D.C., and enrolled at the University of the District of Columbia (UDC). “It was a very safe environment, and the professors were very supportive, but it gives you a narrow view of the world,” he says about UDC, an HBCU that focuses on undergraduate teaching and has a tiny research budget. Summer internships at Northwestern University and UM “were my first exposure to the big leagues,” Ojaruega recalls, and he chose UM over other top-tier graduate physics programs after a professor promised “to make sure you graduate.”

Ojaruega benefited from that supportive environment, which he calls his “circle of trust,” after he initially failed his qualifying exams. That circle included Brad Orr, a white physicist who succeeded Clarke as director of the program. “Brad looked at my [undergraduate] transcript, saw that I hadn’t taken solid state physics, and suggested I sit in on those [undergraduate] classes I had missed,” Ojaruega recounts. Some students might have been too embarrassed to take a step back, he says, but he wasn’t. “And it helped a lot.”

“Michigan was hard as hell,” Ojaruega adds. “They didn’t babysit you. But they also were invested in your success.”

Another key member of his circle was Charles Sutton, who served as a recruiter for the program from 2001 to 2015. Sutton, who is Black, didn’t fit the stereotype of a departmental program staffer: “I had gold chains, an earring, and the whole bit,” he says. He was also an unlikely mentor: He was younger than many of the graduate students, having just earned a communications degree from UM, and he held down a weekend gig as a DJ.

But Clarke regarded Sutton’s outgoing personality, along with his experiences growing up in Mississippi and as a student at an overwhelmingly white university, as valuable assets. When Clarke hired Sutton, “he told me to just be myself, and not change,” Sutton says. For the next 14 years,

Sutton became the “eyes and ears of the program,” as one UM professor told Posselt, serving as an intermediary to help students and faculty better understand one another.

Ojaruega had met Sutton at a recruitment fair and the two became good friends. “Sometimes I would pick him up at the library at 3 a.m.,” Sutton recalls. And after Ojaruega failed his qualifying exams, Sutton spoke up for his friend.

“I had heard that some faculty members wanted to let him go,” Sutton recalls, “so I went to professor Orr and told him, ‘I know how hard [Ojaruega] is working. And I can promise you he won’t let you down.’”

Sutton was right. Ojaruega passed his exams on the next try and sailed through the rest of his doctoral program, earning his degree in 2010. He has spent the past decade with the federal government and is now developing quantum sensor technology for the National Geospatial-Intelligence Agency within the Department of Defense.

“

Michigan was hard as hell. **THEY DIDN’T BABYSIT YOU.** But they also were invested in your success.

**MITAIRE OJARUEGA,**  
DEPARTMENT OF DEFENSE

**THE AP PROGRAM** is an interdepartmental program, not a free-standing department with its own assigned faculty. That arrangement is a boon to the type of interdisciplinary projects that Clarke encourages, with students free to choose an adviser from across the university. But it can backfire if those faculty members don’t share the AP program’s passion for putting students’ welfare first.

That’s what happened to Bryan Ramson, who earned his undergraduate and master’s degrees from Howard. “I enjoyed being in the midst of high-achieving Black folks” and a predominantly Black faculty “committed to my success,” says Ramson, who is Black. That support evaporated, however, after he entered the AP program in 2011. Instead, Ramson says he went through “major culture shock” triggered by what he calls a “horrible”

environment in the university’s traditional physics department.

“Some of the professors there are really old-guard, and very resistant to teaching” in ways that recognize different learning styles, Ramson says. “My professors were not interested in my success; their focus was on the research.”

Sutton was there to reassure him that better times lay ahead. “It was the AP program staff, and Chuck in particular, who convinced me to stay whenever I would think about leaving,” Ramson says. He did, earning his Ph.D. in 2017. He’s doing a postdoc at Fermi National Accelerator Laboratory (Fermilab), where he began working as a graduate student in 2013.

Kelly Nash, a professor at the University of Texas, San Antonio (UTSA), battled that same “old-guard” culture—and lost. “It was traumatic for me from the very beginning,” says Nash, a Black physicist who entered the AP program in 2000 after graduating from

Dillard. The Ann Arbor campus was in turmoil as a lawsuit questioning the university’s use of race as a factor in admissions wended its way to the U.S. Supreme Court. In addition to being bombarded by the divisive rhetoric, Nash was also subject to pervasive racist stereotyping.

“I remember taking a quantum mechanics class with three or four other Black students,” Nash recalls, “and our professor pulled us aside one day early in the semester. ‘I just wanted you to know that you’re all going to struggle in this class because you come from HBCUs,’ he said. He was basically saying that we didn’t belong. My science identity was constantly under assault.”

Failing her qualifying exams turned out to be the final straw for Nash. “There was a huge debate about what should happen to me,” she says. “I had never failed a course [at UM] and never been on academic probation. But I had to fight to [even] get my master’s degree.” She departed feeling “exhausted and demoralized.”

One year later she took another shot at graduate school and ended up at UTSA, which was starting a doctoral physics program. The fact that Latino students make up a majority of its undergraduate enrollment contributed to a welcoming environment that allowed her to thrive, she says.

“Being a new program, they may not have had preconceived notions about African American students,” she adds. And her productivity was undeniable. “By the time I graduated [in 2009], I had 13 papers,” she says. A few years later she returned as a faculty member, earning tenure in 2016 and becoming a full professor in 2020.

By putting students first, University of Michigan, Ann Arbor, physicist Roy Clarke achieved unprecedented diversity in the applied physics graduate program he created.



Undeterred—or perhaps driven—by their experiences at UM, both Ramson and Nash have spent years working to increase diversity in physics. Ramson co-directs Fermilab's long-running Saturday morning physics program for Chicago-area students and is a member of Change-Now, a collective of young Black physicists who are pushing Fermilab, the Department of Energy's leading high energy physics facility, to improve equity and social justice within the profession and in the community. Nash is involved in several programs to attract more women and people of color into science. For example, she has helped her university participate in a national program sponsored by the American Physical Society that finds spots for qualified students from underrepresented groups who have been passed over by other graduate physics programs.

**UM'S AP PROGRAM** has continued to evolve. Cagliyan Kurdak, a Turkish-born physicist who joined the department in 1998 and became the program's director in 2010, added a component for students who need to strengthen their academic background before diving into a doctoral program. Students from groups underrepresented in science receive 2 years of funding while they earn a master's degree, and over the years two-thirds have transitioned into a doctoral program, where their 80% completion rate is more than 20 percentage points higher than the national average. But Kurdak and his team can't rest on their laurels. "Creating conditions to support access and inclusion is not a one-time event, but an ongoing struggle," Posselt wrote in her 2017 study.

Posselt flagged two recurring challenges. One is what she calls the "negative racial climate" for many students of color at UM, a predominantly white institution. Those whom Posselt interviewed also spoke about a "negative feedback loop, in which poor representation of women and students of color raises red flags for prospective students ... and deters them from matriculating."

Posselt says the UM AP program has replaced those red flags with a welcome sign through its "commitment to diversity." Its interdisciplinary approach to science, flexible admissions criteria, and family atmosphere are baked into the AP program, agrees Sutton, who went to the White House as Clarke's guest when, in 2010, Clarke received the Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring.

"They just care so much about people," says Sutton, now a recruiter for Thermo Fisher Scientific in Atlanta, about his former colleagues. "And in the end, that is what has made them so successful. I hope the program lasts forever." ■

## Michigan's surprising path to diversity

Jeffrey Mervis

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