Goal: Double the number of African Americans in physics and astronomy

The recommendations of a new AIP report aim to catalyze and guide a huge cultural shift.

Over the past two decades, the numbers of bachelor's recipients in physics and astronomy in the US have rocketed to record highs. Yet even as the increase in African Americans earning bachelor's degrees across all fields has outpaced the overall population, the percentage of physics and astronomy bachelor's degrees earned by African Americans has stalled at around 4%, according to data from the Statistical Research Center at the American Institute of Physics (AIP, publisher of PHYSICS TODAY).

Other underrepresented groups have made larger gains. For example, from 1995 to 2018 the percentage of physics bachelor's degrees earned by women grew from 17% to 21%; for Hispanics that percentage rose from 2.7% to 8.8%. Across the physical sciences, technology, engineering, and mathematics, African Americans made up just 5.3% of bachelor's recipients in 2018. They made up 9.2% of bachelor's recipients across all fields. And in recent years they have made up 14–15% of high school graduates from US public schools. (Data are from the US Department of Education's Integrated Postsecondary Education Data System and its National Center for Education Statistics.)

Fostering a sense of belonging is essential for African American student persistence and success.

The reasons for the paucity of African American students in physics and astronomy are complex and long-standing. But two factors stand out: the lack of a supportive environment in many departments and the enormous financial challenges many of these students face.

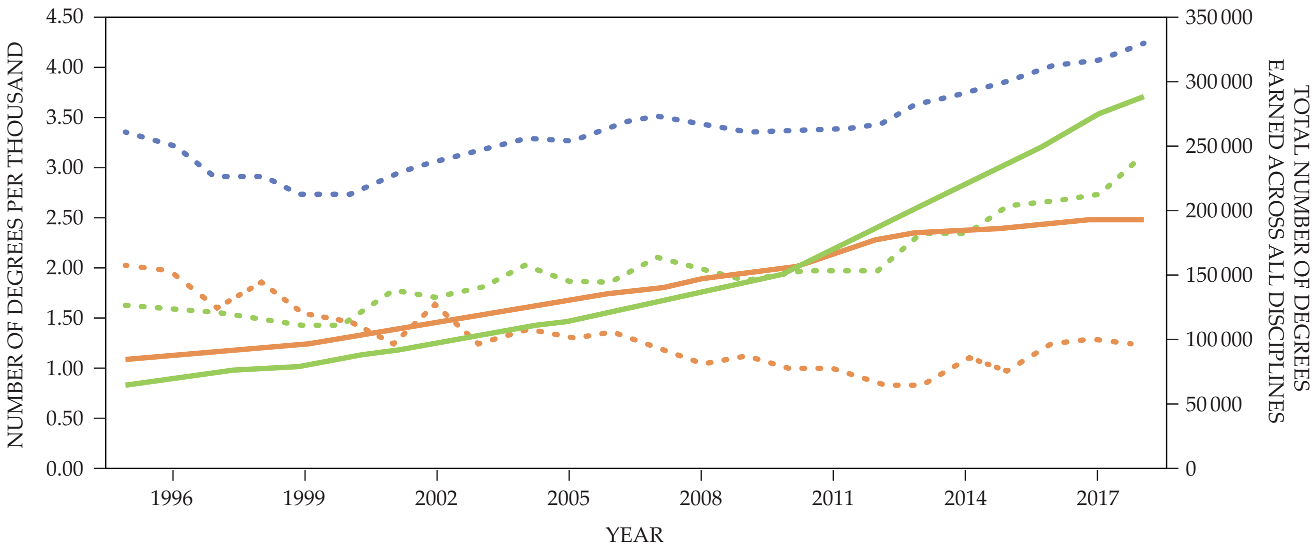
JEDIDAH ISLER (LECTERN), EDMUND BERTSCHINGER, and other members of the task force to elevate African American representation in undergraduate physics and astronomy unveiled their roughly 200-page report at the American Astronomical Society's January meeting in Honolulu. (Courtesy of AIP.)

That's according to TEAM-UP, the national task force to elevate African American representation in undergraduate physics and astronomy, which AIP convened in 2017. On 5 January 2020, at the American Astronomical Society's annual meeting in Honolulu, AIP unveiled the results of TEAM-UP's investigation into the persistently low representation of black students in physics and astronomy. In a nearly 200-page report, the task force, a panel of 10 physicists, astronomers, and social scientists plus two AIP employees, lays out recommendations to effect sweeping cultural change in the physics and astronomy communities—and to double the numbers of African Americans earning bachelor's degrees in those fields by 2030. (The red callouts are summaries of some of the report's findings.)

"The physics community is looking very deeply at itself," says Shirley Malcom, a senior adviser at the American Association for the Advancement of Science and director of the association's STEMM Equity Achievement (SEA) Change, who wrote the foreword to the TEAM-UP report. "I hope people are willing to look past the defensiveness that often emerges when you talk about these issues. There is no reason to be defensive. We were born into a society that tends not to value black people. Let's get over that and change behaviors that keep African Americans from thriving in our colleges and universities and contributing to the advancement of physics."

Cultural shift

TEAM-UP surveyed and interviewed students and department chairs; conducted department site visits; and consulted the literature on African American students in science, technology, engineering, and math and on women of color in physics. The task force's findings and recommendations are presented along six themes: Belonging, physics identity, academic support, personal support, leadership and structures, and change management. "Change management" refers to the need to understand the broad social context and the systemic changes sought, including the roles of individuals, orga-



AFRICAN AMERICANS EARN DISPROPORTIONATELY FEWER physics and astronomy bachelor's degrees. Over the past quarter century, the total number of bachelor's degrees (not shown) earned in the US has grown from 1.1 million to 2.1 million. The number earned across all fields by African Americans has more than doubled, from 85 856 to 193 567 ( ), and for Hispanics has grown even more ( ). But in physics and astronomy, neither group keeps pace with the proportion of degrees earned by the population as a whole, as shown by the dotted lines, which represent the numbers of degrees per 1000 degrees earned in those fields (all students, African Americans, and Hispanics). In 2018 African Americans earned a total of 223 degrees in physics and 10 in astronomy. (Plot created by the AIP's Statistical Research Center using data from the Department of Education's Integrated Postsecondary Education Data System.)

nizations, and society. Boosting participation of African Americans in physics and astronomy, the report says, "requires not only changing the way physicists train students, but how they *think* about training students."

Efforts at every level of the physics and astronomy communities are necessary. So are will and money. "African American students have the same drive, motivation, intellect, and capability to obtain physics and astronomy degrees as students of other races and ethnicities," the report notes, but many African Americans choose majors that "are perceived as being more supportive and/or rewarding, resulting in a loss of talent to physics and astronomy."

The goal of doubling the number by 2030 is intended to put African Americans' representation in physics and astronomy on a par with their participation in engineering and other physical sciences. African Americans got left behind in the huge increases that physics has seen in the past two decades, says Edmund Bertschinger of MIT, who with Mary James of Reed College chaired the task force. "We want to rectify that omission."

The task force did not identify a simple how-to list for achieving its goal. Instead, it crafted recommendations that individual faculty members, department chairs, professional societies, and funding agencies can turn to for guidance.

Still, the report does set priorities. For individual physicists and astronomers, the top priority is to read and discuss the TEAM-UP and related reports as a means to "consider their role in establishing their departmental culture and commit to creating an environment where African American students and those from other marginalized communities can thrive." Department chairs should identify and tap into resources on and off campus that can help meet students' financial and other needs. Next, they should "begin the hard work of culture change," by setting norms and values of inclusion and belonging; recruiting, developing, and supporting a diverse faculty; and overseeing policies and practices that enhance the success of African American students.

To persist, African American students must perceive themselves, and be perceived by others, as future physicists and astronomers.

For their part, professional societies should start by encouraging discussion in their organizations. And they should raise a $50 million endowment. That figure would provide an estimated annual $2.4 million from the endowment's presumed interest earnings.

Half the money would be used to cover the roughly $8000 a year in unmet needs for 150 students. The student total is not arbitrary. If the growth in physics degree production that didn't happen in the past 20 years at historically black colleges and universities had matched that of other campuses, 150 more black students would graduate annually with that major by now. African American students at any campus could apply for money to pay for tuition, fees, books, living expenses, conference travel, and the like. The other half of the money would be available to departments to implement the TEAM-UP recommendations that require funding. For example, a department might apply for money to hire extra lecturers so as to free up faculty to spend time on mentoring or to introduce new programs.

AIP's next steps will be to present and discuss the report at conferences and to convene workshops of department chairs, interested faculty members, representatives from diversity-related committees of professional societies, and other stakeholders. "We will take deep dives on the recommendations and conclusions and start a dialog on how the community can respond," says AIP chief executive officer Michael Moloney. "The goals are ambitious and challenging, so an ambitious response is appropriate." (The report is available at www.aip.org/teamup.)

The large number of findings and recommendations could be overwhelming, acknowledges Bertschinger. The idea, he says, is for people to go through the recommendations and prioritize for themselves. "We didn't want to be too specific, because not every individual and department will be in the same situation." Implementation could take years, he adds. The report also includes suggestions for faculty training, self-assessment tools for individuals and departments, a rubric for prospective students and their families to evaluate physics and astronomy departments, and more.

Black physicists matter

Unsurprisingly, TEAM-UP finds that African American students are more likely to persist in physics and astronomy if they feel a sense of belonging to their academic community. Interactions with faculty and peers, encouragement and inclusion in activities, and recognition of school and nonschool problems a student may be confronting all contribute, positively or negatively, to students' sense of belonging.

For sustainability, academic and disciplinary leaders must prioritize creating environments, policies, and structures that maximize African American student success.

Positive examples include praise about work, invitations to study or socialize, and high expectations for success. Negative examples include the slights and indignities that African American students in physics and astronomy encounter—everything from "Are you lost?" when they head to a basement lab for their research to "You should switch majors."

Sharon Fries-Britt, a task force member and University of Maryland professor of higher education who studies the experiences of black students in academia, says that they are consistently being "advised out" even before they have had a chance to display their skills. Those types of comments add up and contribute to feelings of isolation, she says.

African American students face challenges that other groups may not have to deal with as much. Harold Johnson, a second-year graduate student in theoretical physics at the University of Texas at Austin, grew up on Chicago's South Side. "It's a different reality," he says. "People don't talk about physics. Our priorities are how to stay out of prison and not become a statistic." One big factor is math, he adds. "If you don't get a good math grounding in school, then you are behind by the time you get to college. It would also encourage black kids if they saw more black people in college. It's a layered issue." (See why Willie Rockward switched from football to physics in the interview at http://physicstoday.org/rockward.)

The TEAM-UP report cites financial data from the US Federal Reserve Board: In 2016 the median wealth of white families in the US was \$171 000, 10 and 8 times more than that of black families (\$17 600) and Latino families (\$20 700). As a result, African American students disproportionately juggle work and financial or medical problems while in school. The TEAM-UP report recommends that physics and astronomy department staff familiarize themselves with campus resources, such as counselors to address stressful situations, and with funding sources to mitigate financial emergencies. An African American student may be selected for a research internship, for example, but be forced to decline due to lack of travel money. Physics and astronomy faculty members should help identify opportunities for African American students to work in areas related to their studies, the TEAM-UP report says.

It's not enough to invite students into the field, the report says, "especially if their social identity does not conform to stereotypes of who is a physicist." Underrepresented minority students "must continually navigate the incongruity of their social and physics identities." According to Fries-Britt, that challenge affects black students staying in the sciences. "They don't want to park other aspects of their identity outside the door, but when they bring those other things up, they often feel that they are perceived as being less serious scientists." That perception can be stronger in physics than in other fields, she adds, perhaps because it's often considered the toughest major. One way departments can help, the report says, is by creating opportunities "for students to discuss broader societal issues of concern such as gun violence, immigration, hate crimes, and protest movements." (See also PHYSICS TODAY, October 2019, page 24.)

Bertschinger notes that African Americans tend to be socially minded. "Giving back to the community is highly valued." The tendency goes back to the history of supporting each other in the face of systemic discrimination, racism, and hate crimes, he says, and that social context provides important grounding to the African American experience. Faculty may not realize that a physics degree provides a strong background to work in areas that undergraduates are interested in, such as climate change or how technology can enhance or diminish civil rights, Bertschinger says. "But physics training provides rigorous methodology for problem solving. We as physicists could do a better job if we recognized connections beyond our discipline." Along those lines, the report recommends that departments discuss career options for physics bachelors.

Many African American students need support to offset financial burdens and stress.

The TEAM-UP financial challenges are more straightforward than the cultural ones, says Bertschinger. It may not be easy to raise $50 million, but the objective is clear. Shifting attitudes is harder, he says. "Faculty may feel ill-equipped to deal with the issues, or that it's not their responsibility, but I am optimistic because there is so much awareness these days of the inequities in society and on campuses." S. James Gates, a theoretical physicist at Brown University and task force member, agrees: "This report comes at a fortunate time, as academics are already dealing with harassment issues." Partly because of the #MeToo movement, there are more "woke" people walking around, he adds. "I think we can make a difference."

Toni Feder

Weapons labs to build costly new device to better understand plutonium

Scientists say subcritical experiments with plutonium will eliminate the need for nuclear tests, a promise that was first made in 1995.

The pockmarked Nevada National Security Site, where more than 900 nuclear blasts were set off during the Cold War, will be host to a new billion-dollar-plus experimental weapons test facility located more than 300 meters underground. But the observations of how plutonium behaves under the extreme pressures that occur during detonation of a nuclear weapon will be made without those blasts.

The Enhanced Capabilities for Subcritical Experiments (ECSE) facility will capture x-ray images of the dynamics occurring during the implosion of scale models of plutonium pits, which are at the heart of a nuclear weapon's primary stage. When completed in 2025, the ECSE will consist of two major components. The most critical, and by far the most expensive, is Scorpius, a 20 MeV accelerator that will produce x rays from bremsstrahlung radiation generated by decelerating electrons as they hit a heavy metal target. The photons will capture images of the hydrodynamics occurring during the implosions. A second instrument, in an earlier stage of development, will probe the behavior of neutrons as the plutonium samples approach, but never attain, a critical assembly capable of sustaining a chain reaction.

The ECSE will work analogously to how aircraft manufacturers develop new planes, says Los Alamos National Laboratory (LANL) director Thomas Mason: "We can't fly the aircraft, but we can put the model in the wind tunnel." The results will be used to validate the codes that have been developed on high-performance computers to simulate nuclear blasts, "to fly the planes, if you will."

Scientists at LANL and Lawrence Livermore National Laboratory (LLNL) already have several devices for studying implosions. Both labs have aboveground machines that can create x-ray images of imploding targets. LANL's Dual Axis Radiographic Hydrodynamic Test (DARHT) facility is the more advanced of the two, capable of generating four images at 2 MHz of the hydrodynamics of imploding materials. Scorpius will at a minimum have the same imaging capability, but its design may be upgraded to capture eight images at 5 MHz, says David Funk, LANL senior director for the advanced sources and detectors project in Nevada, of which Scorpius is a part.

The aboveground devices have a major drawback: For environmental and safety reasons, they can experiment only on surrogate materials such as tungsten, lead, copper, and gold. Surrogate materials help validate some model properties, but "in the end, plutonium is a unique metal," Funk says. For example, it has seven phases that can be created in a lab without exotic equipment. "At very high pressures and temperatures its behavior may not be very well represented by surrogates."

Since the US halted nuclear tests in 1992, plutonium implosion experiments have been carried out in the U1a tunnel complex at the Nevada National Security Site. The high-explosive-driven experiments are done within containment vessels with quantities designed to remain subcritical.

Funk says the existing pair of 2.2 MeV accelerators located in the U1a complex produce photons with enough energy to