



# Beyond Representation

Data to Improve Equity in Physics  
Lattice Field Theory Conference

Rachel Ivie

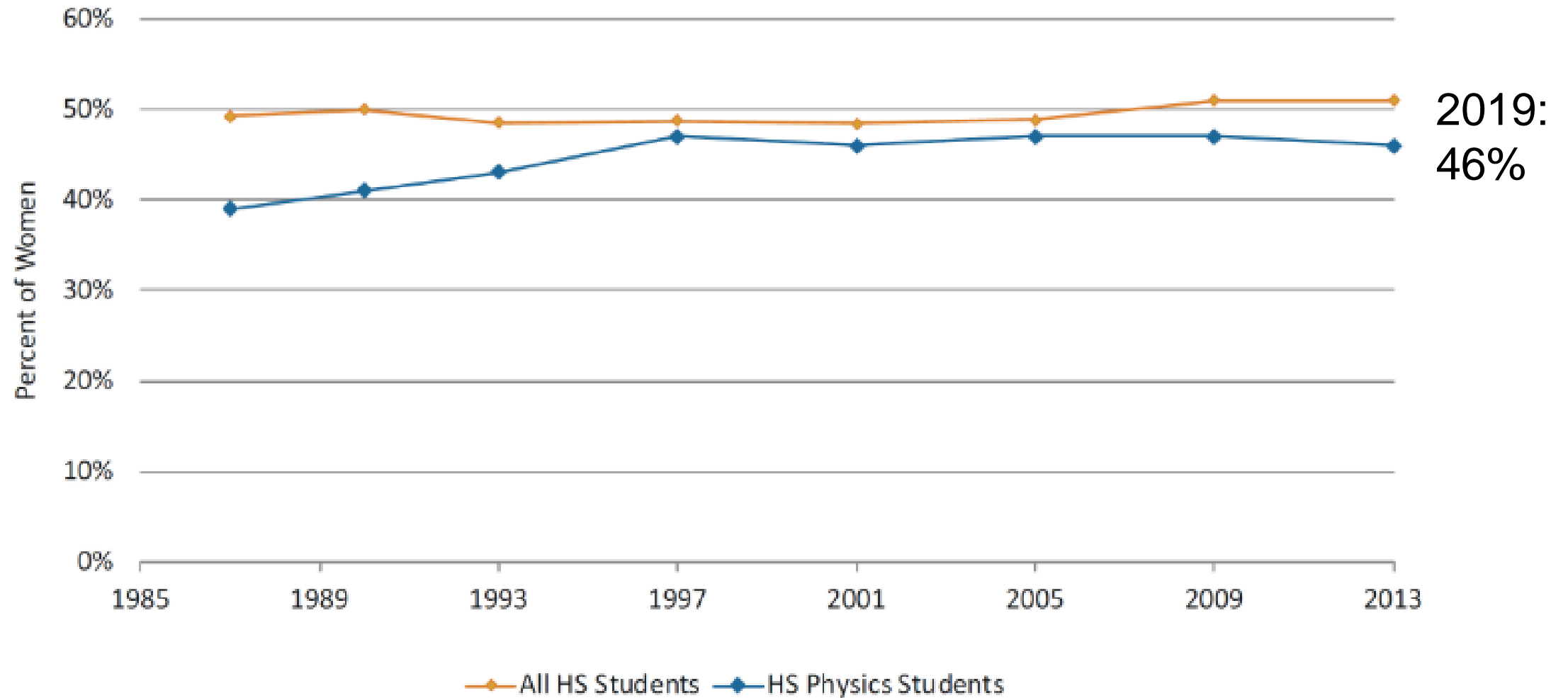
July 31, 2023

# REPRESENTATION OF WOMEN



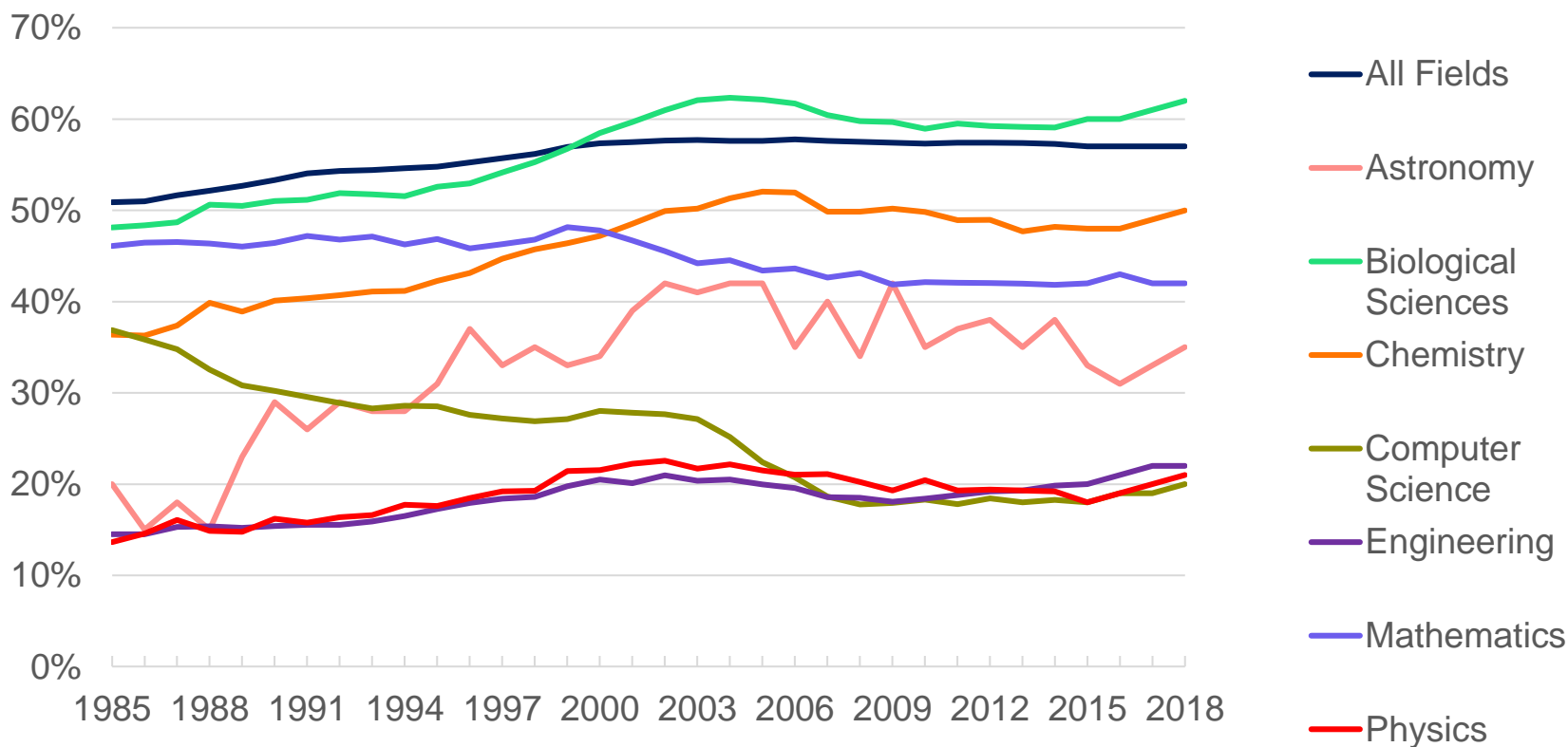
Check out our 2019 report at [aip.org/statistics](https://aip.org/statistics)

## Percent of Young Women Enrolled in High School Physics, 1987-2013

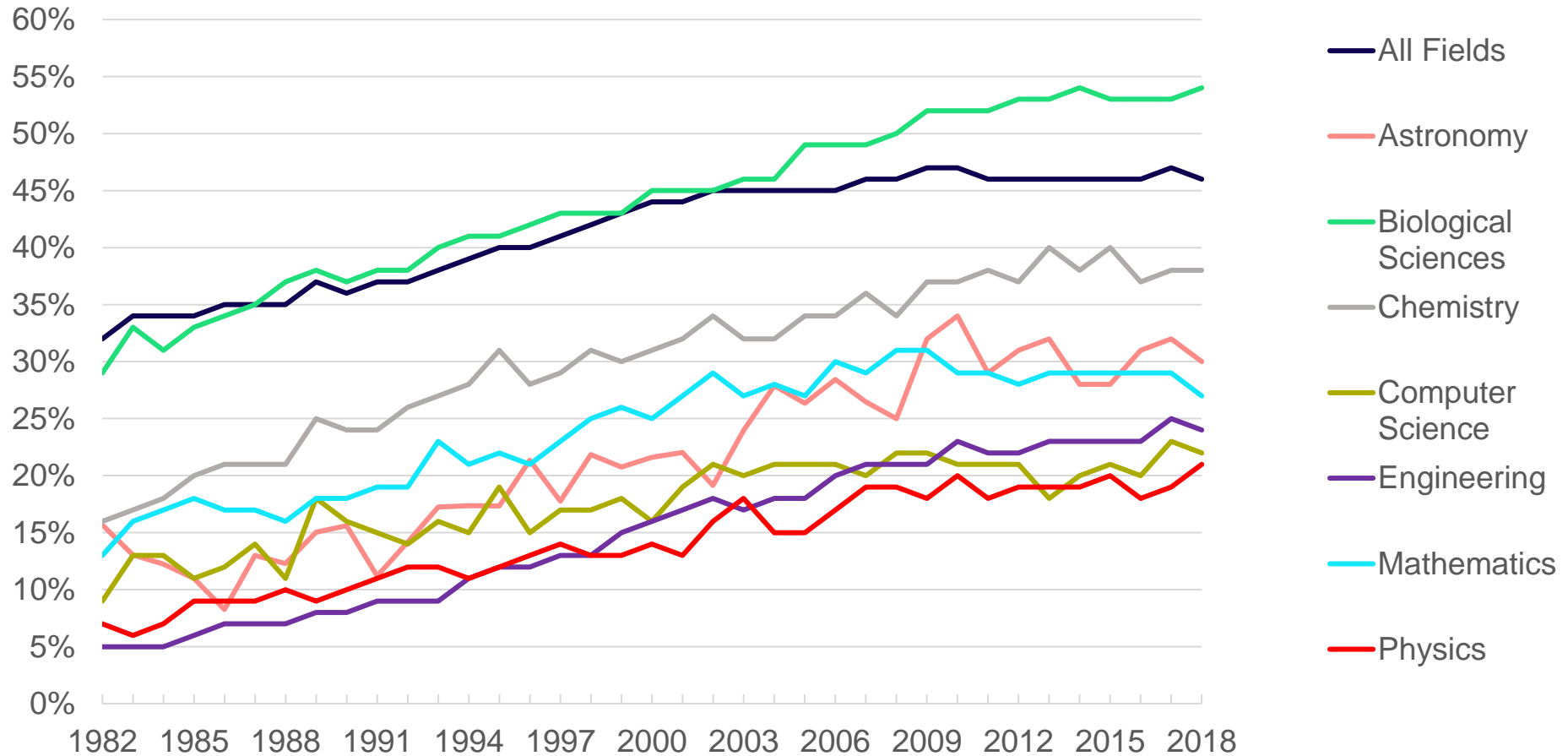


Source: AIP Statistical Research Center, Nationwide Survey of High School Physics Teachers

# Percentage of Bachelor's Degrees Earned by Women in Selected Fields, Classes 1984 Through 2018



# Percentage of PhDs Earned by Women in Selected Fields, Classes 1982 Through 2018



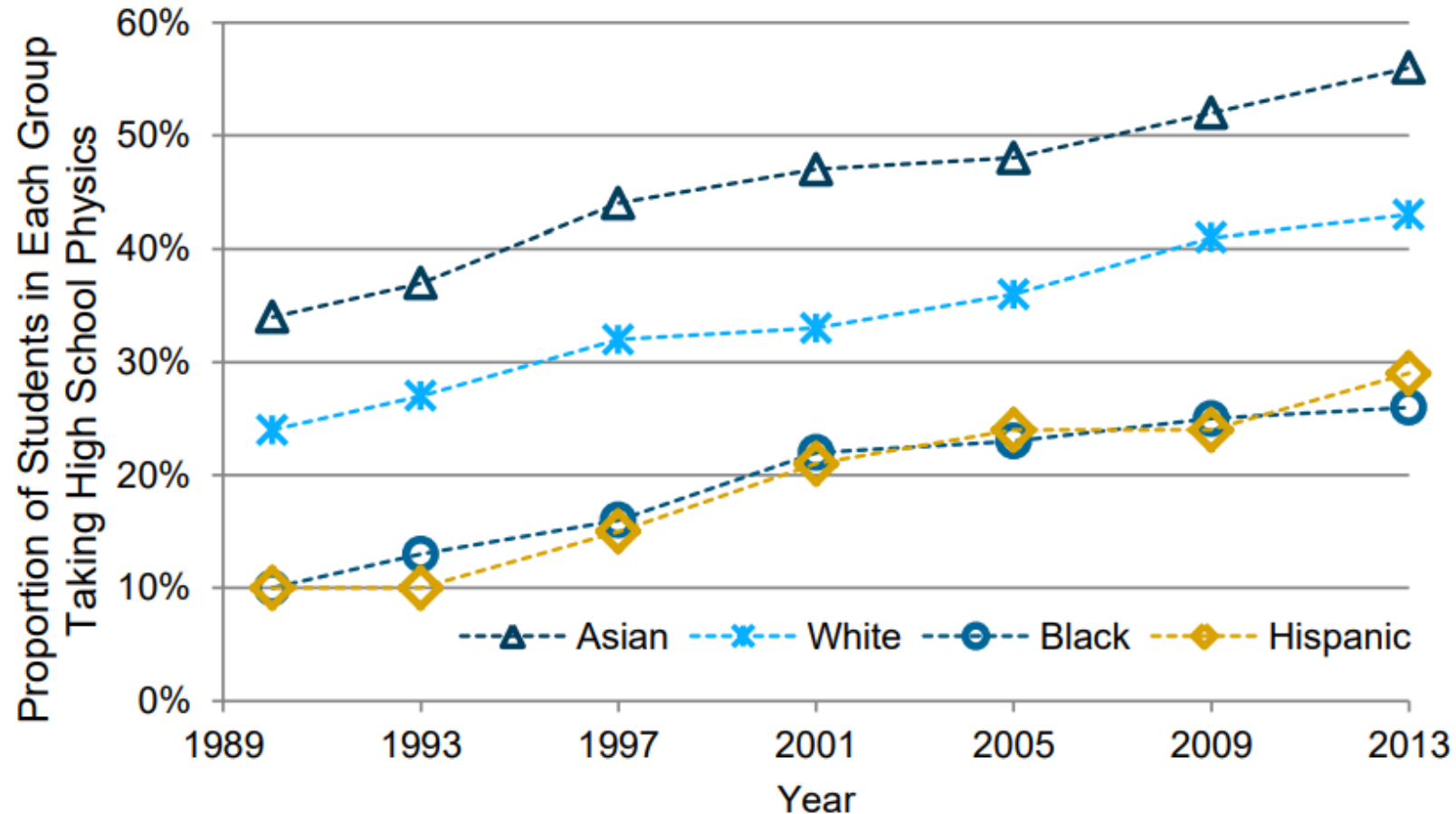
## Percentage of Physics Faculty Members Who are Women

	Academic Year						
Academic Rank	2002	2006	2010	2014	2018	2020	2022
Full Professor	5%	6%	8%	10%	12%	13%	13%
Associate Professor	11%	14%	15%	18%	21%	21%	22%
Assistant Professor	16%	17%	22%	23%	25%	25%	27%
Instructor/Adjunct	16%	19%	21%	23%	27%	27%	28%
Other Ranks	15%	12%	18%	20%	19%	19%	18%
Highest Physics Degree Offered							
PhD	7%	10%	12%	14%	16%	16%	18%
Master's	13%	14%	15%	18%	20%	21%	21%
Bachelor's	14%	15%	17%	20%	22%	23%	24%
<b>Overall</b>	<b>10%</b>	<b>12%</b>	<b>14%</b>	<b>16%</b>	<b>19%</b>	<b>19%</b>	<b>20%</b>

# REPRESENTATION OF PEOPLE FROM MINORITIZED GROUPS



# High School Physics Students by Ethnicity



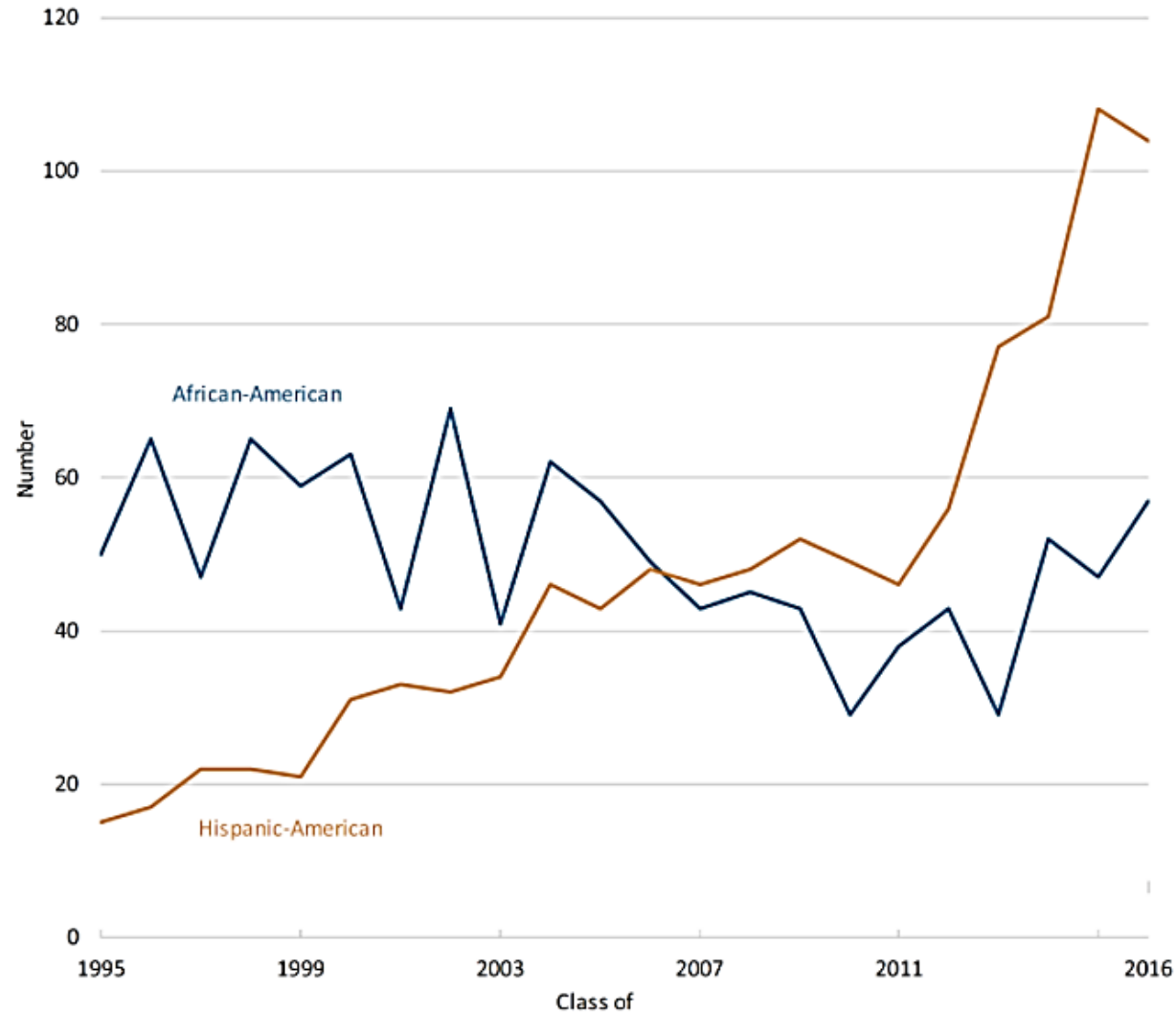
**A closer examination of the data reveals that these differences are likely driven more by socioeconomic factors than by race.**



# Race and Ethnicity of Physics Bachelors Classes of 2017 and 2018 (2-Year Average)

	Number	Percent of all Physics Bachelors
<b>White</b>	6140	77
<b>Asian American</b>	651	8
<b>Hispanic American</b>	686	9
<b>African American/Black</b>	284	4
<b>Other US citizens</b>	228	3
<b>Total US Citizen</b>	7989	100

# Number of African American and Hispanic Women Earning Physics Bachelor's Degrees



Source: NCES IPEDS Completions Survey.

# Race and Ethnicity of Physics PhDs

## Classes of 2018 and 2019 (2-Year Average)

	Number	Percent of all Physics PhDs	Percent of U.S. Physics PhDs*
<b>White</b>	860	45	84
<b>Asian American</b>	92	5	9
<b>Hispanic American</b>	42	2	4
<b>African American</b>	9	<1	1
<b>Other US citizens</b>	20	1	2
<b>Non-US citizens</b>	887	47	-
<b>Total</b>	1,827	100	100

\*Based on a 3-year average of 966 US citizens.

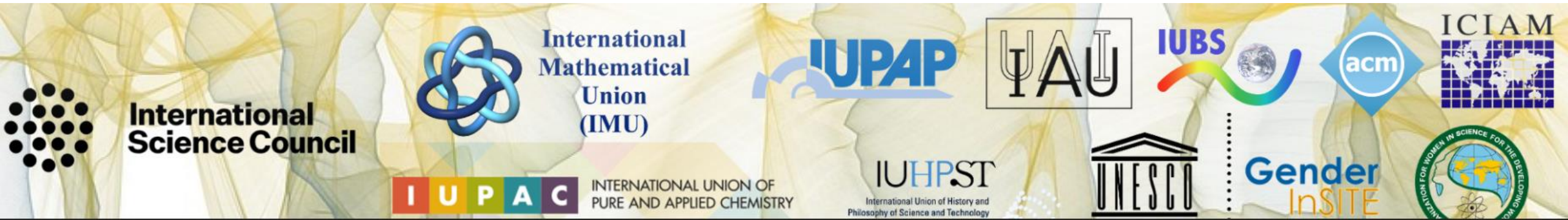
# Race and Gender of Physics and Astronomy Faculty Members, 2021

	Women	Men	Total
<b>American Indian or Alaska Native</b>	0.3%	0.3%	0.6%
<b>Asian or Asian American</b>	2.1%	6.3%	8.4%
<b>Black or African American</b>	0.8%	2.2%	3.0%
<b>Hispanic or Latino</b>	1.4%	3.2%	4.6%
<b>White</b>	17.9%	67.0%	84.9%
<b>Other</b>	0.6%	1.5%	2.1%
<b>TOTAL</b>	23.0%	80.4%	103.5%

# All of these are measures of diversity

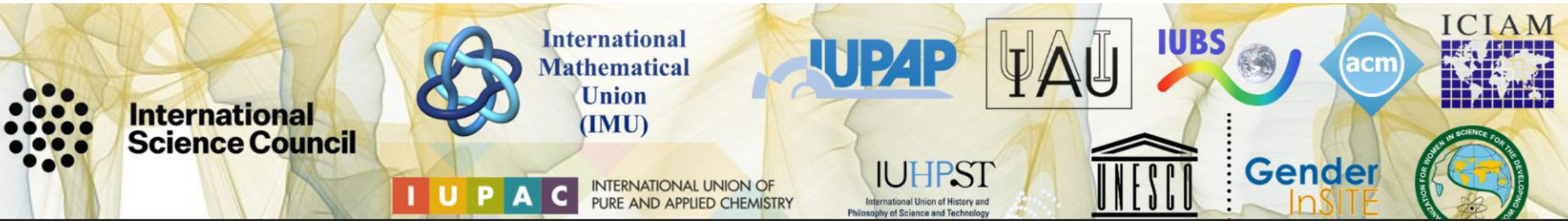
But we also need to measure INEQUALITY





- A Global Approach to the Gender Gap in Mathematical, Computing, and Natural Sciences:  
How to Measure It, How to Reduce It?

- To truly understand and reduce [the gender gap in science], it is necessary to identify the various factors that deter women from pursuing careers in scientific disciplines.
- Collaboration with IUPAP, IAU, and 10 other international science unions/organizations
- Three parts
  - Survey
  - Study of gender gap in publications
  - Database of good practices
- <https://gender-gap-in-science.org/>



# Career Resources in Physics

Resource	Significant differences by gender?
Had enough funding	Women were 128% less likely
Had enough clerical support	Women were 141% less likely
Had enough technical support	Women were 135% less likely
Had enough employees or students	Women were 132% less likely
Had enough support as a working parent	Women were 145% less likely
Had enough equipment	No
Had enough office space	No
Had enough lab space	No
Had enough travel money	No
Had enough computing capability	No
Had enough access to data	No
Had enough access to scientific literature	No

Source: Global Survey of Scientists, 2018

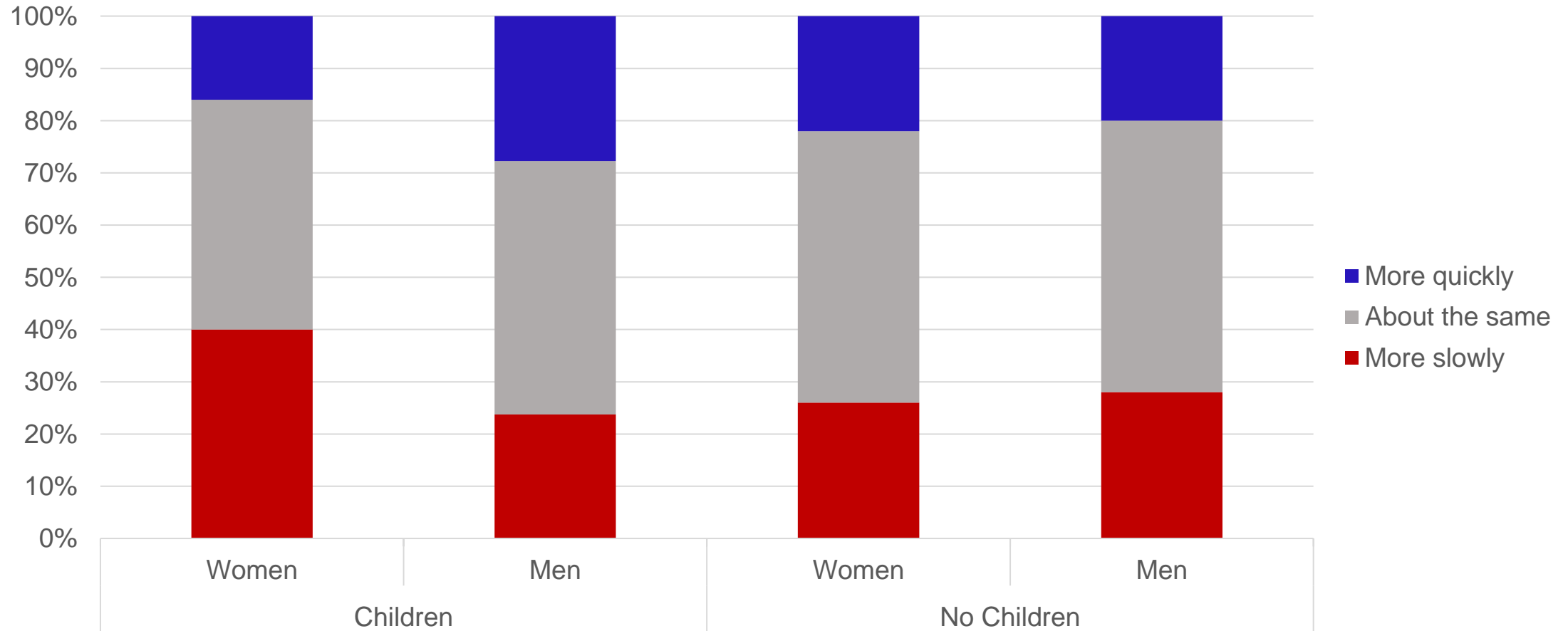


# Responding physicists' experiences of sexual harassment

Have you ever encountered sexual harassment at school or work? Please select all that apply.	Statistical Significance	Interpretation
<b>Yes, it happened to me</b>	Yes	Women (29%) were more likely than men (2%) to say they have personally encountered sexual harassment at school or work.
<b>Yes, I witnessed it happening to someone else</b>	Yes	Women (14%) were more likely than men (7%) to say they witnessed someone else encountering sexual harassment at school or work.
<b>Yes, I heard about it happening to someone else</b>	Yes	Women (33%) were more likely than men (22%) to say they heard about it happening to someone else.
<b>No</b>	Yes	Men (72%) were more likely than women (44%) to say they did NOT encounter sexual harassment at school or work.

Source: Global Survey of Scientists, 2018

# Compared to colleagues who completed their final degrees at the same time as you, how quickly have you progressed in your career? (Physics)



# All of these contribute to the gender gap

- Globally, women in science may receive fewer resources to do their work.
- Workplace environment, interaction with colleagues, and sexual harassment are additional barriers for women in science.
- Assignment of childcare and housekeeping to women reduces time for science.
- Women with children report slower career progression.

# The Matthew Effect in Science



The reward and communication systems of science are considered.

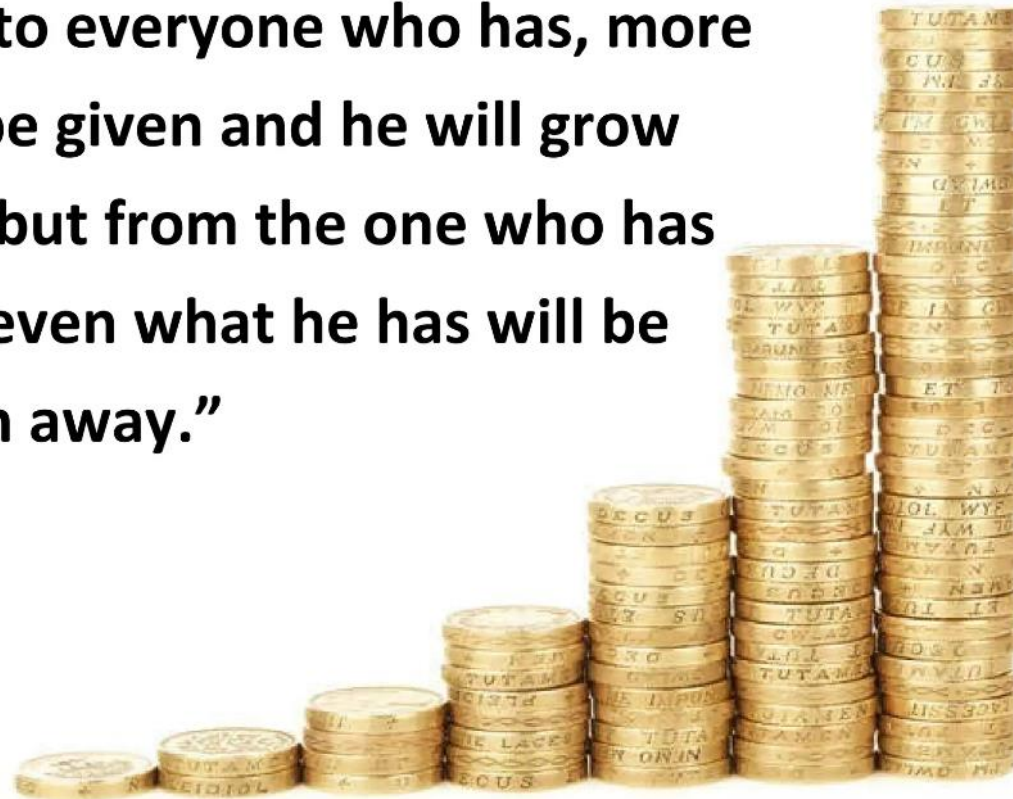
Robert K. Merton

This paper develops a conception of ways in which certain psychosocial processes affect the allocation of rewards to scientists for their contributions—an allocation which in turn affects the flow of ideas and findings

image and the public image of scientists are largely shaped by the communally validating testimony of significant others that they have variously lived up to the exacting institutional requirements of their roles.

# Matthew 25:29

**“For to everyone who has, more will be given and he will grow rich; but from the one who has not, even what he has will be taken away.”**



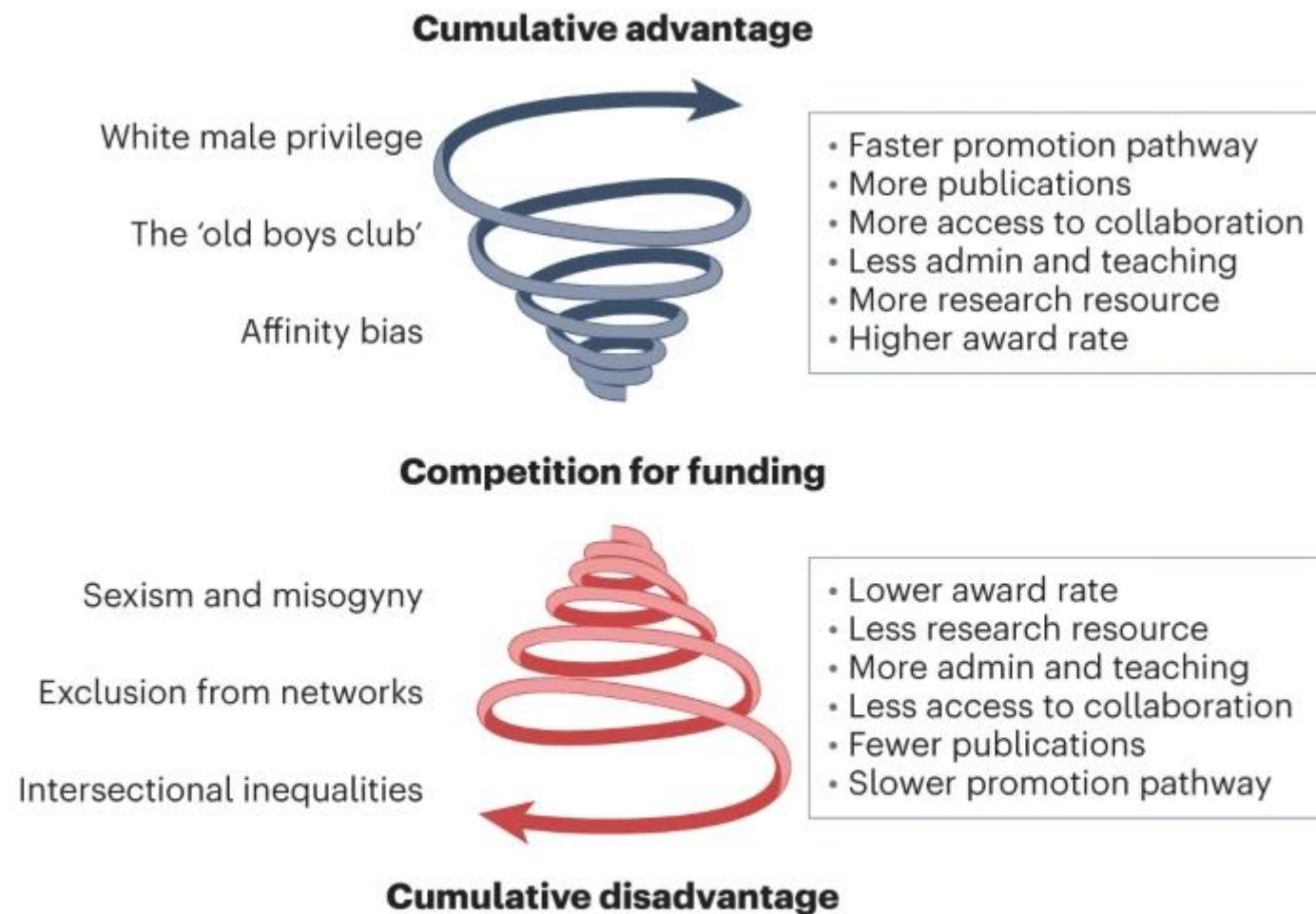


## accumulated advantage

*those who have more  
have an advantage to  
acquire more*

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**Fig. 1: A schematic representation of the Matthew Effect.**



Inequities are perpetuated when, for equally qualified applicants of different genders, funding is more likely to be awarded to a man than to a woman due to biases and systemic barriers. Such unjust funding decisions have a knock-on impact in multiple aspects of the funding applicants' research careers.

# Other contributors

- Gender bias in access to experiments and equipment
  - Gender bias in funding
  - Two-body problem disproportionately affects women.
  - Citation bias
  - Publication gap
- 
- Not as much data on bias due to race/ethnicity, LGBT+ status, and disability



# AIP'S TEAM-UP



- The AIP National *Task Force to Elevate African American Representation in Undergraduate Physics & Astronomy*
- Task Force spent two years investigating the reasons for the persistent underrepresentation of African Americans in physics and astronomy.
- TEAM-UP report
  - uncovers long-term systemic issues within the physics and astronomy communities that contribute to the underrepresentation of African Americans in these fields
  - makes important, actionable recommendations for community-wide efforts to reverse this trend.

# TEAM-UP Key Factors

## Belonging

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

## Physics Identity

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

## Academic Support

*Effective teaching and a strengths-based approach to academic support are necessary for African American student retention and success*

## Personal Support

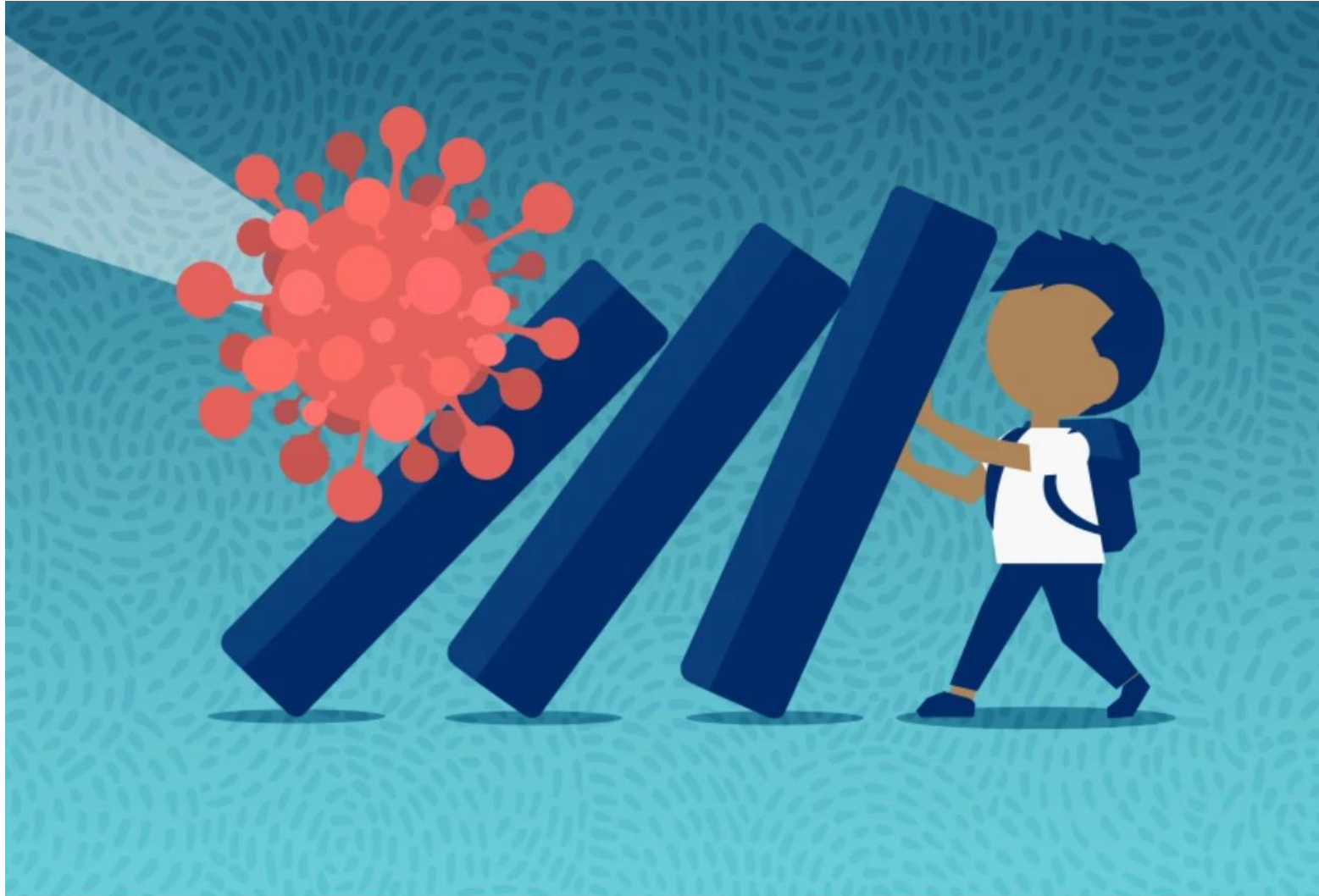
*Many African American students need support to offset financial burdens and stress*

## Leadership and Structures

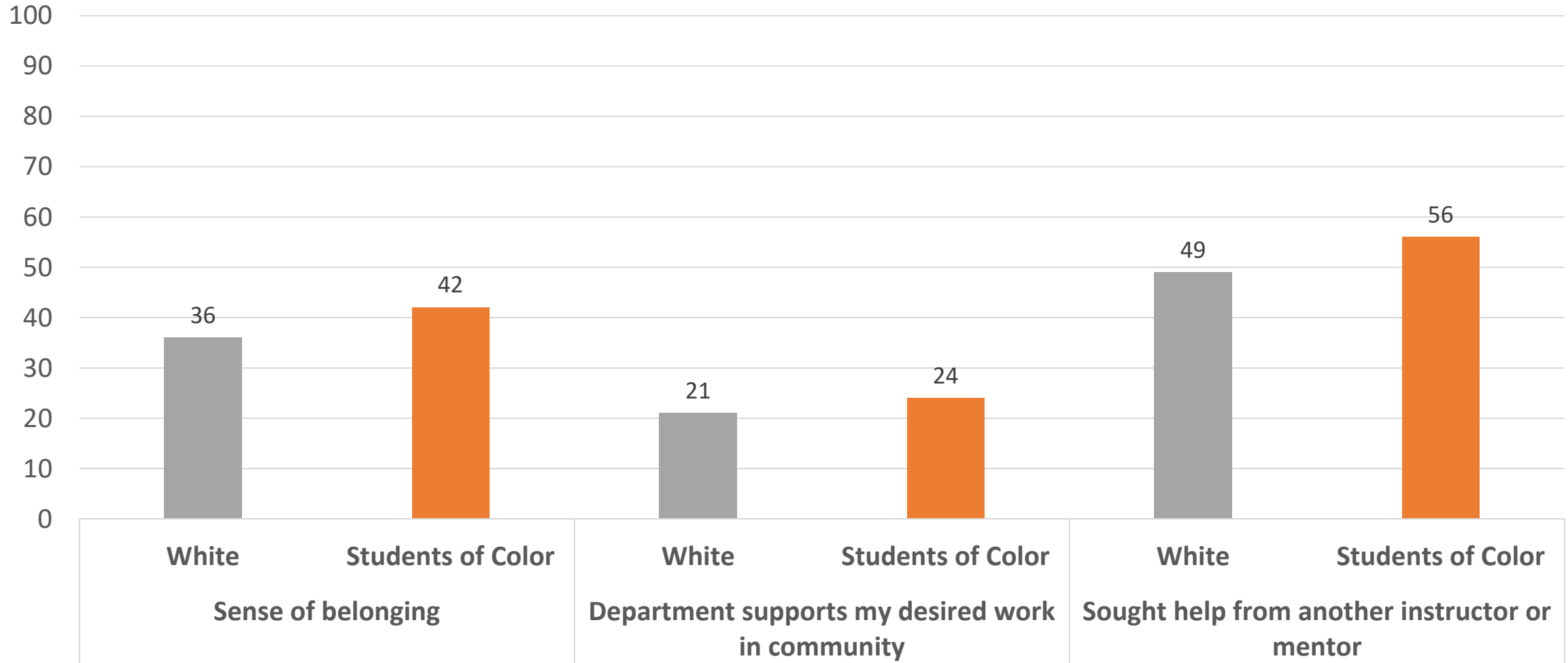
*For sustainability, academic and disciplinary leaders must prioritize creating environments, policies, and structures that maximize African American student success.*



# Gap worsened by pandemic



# Race/ethnicity differences in percentage of seniors who reported that the following happened **less frequently** during the pandemic



# Conclusions

- There are some inequities that we can't control
- However, that should not keep us from changing what we can
- Educate ourselves and refrain from causing inequity
- If we are in position of authority, do what we can
  - Distribute resources equitably
  - Reduce the gap by giving people what they need to succeed





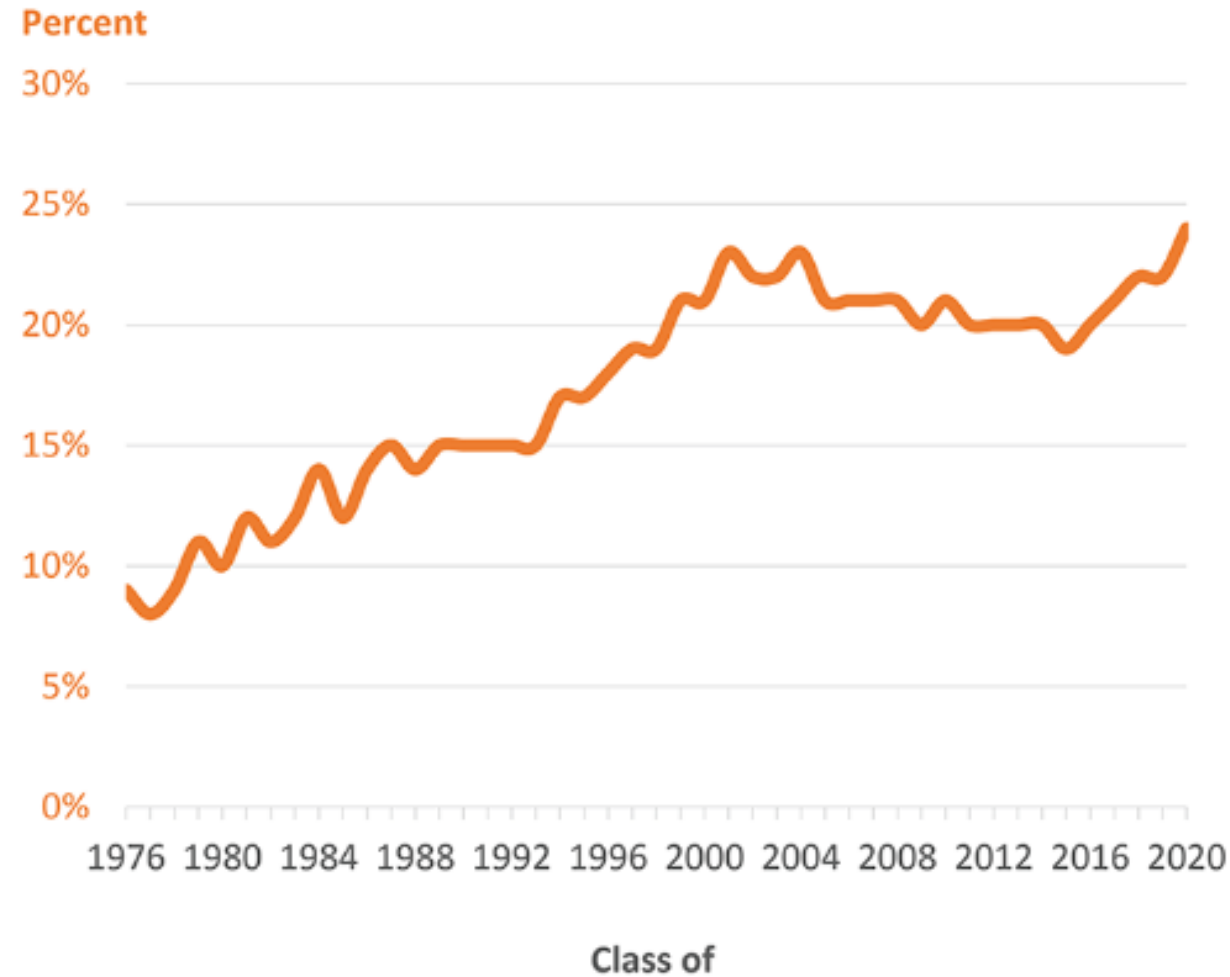
# Thank you!

Thanks to my colleagues: Susan White, John Tyler, Starr Nicholson, Jack Pold, Patrick Mulvey, Anne Marie Porter, & Arlene Modeste Knowles

Rachel Ivie

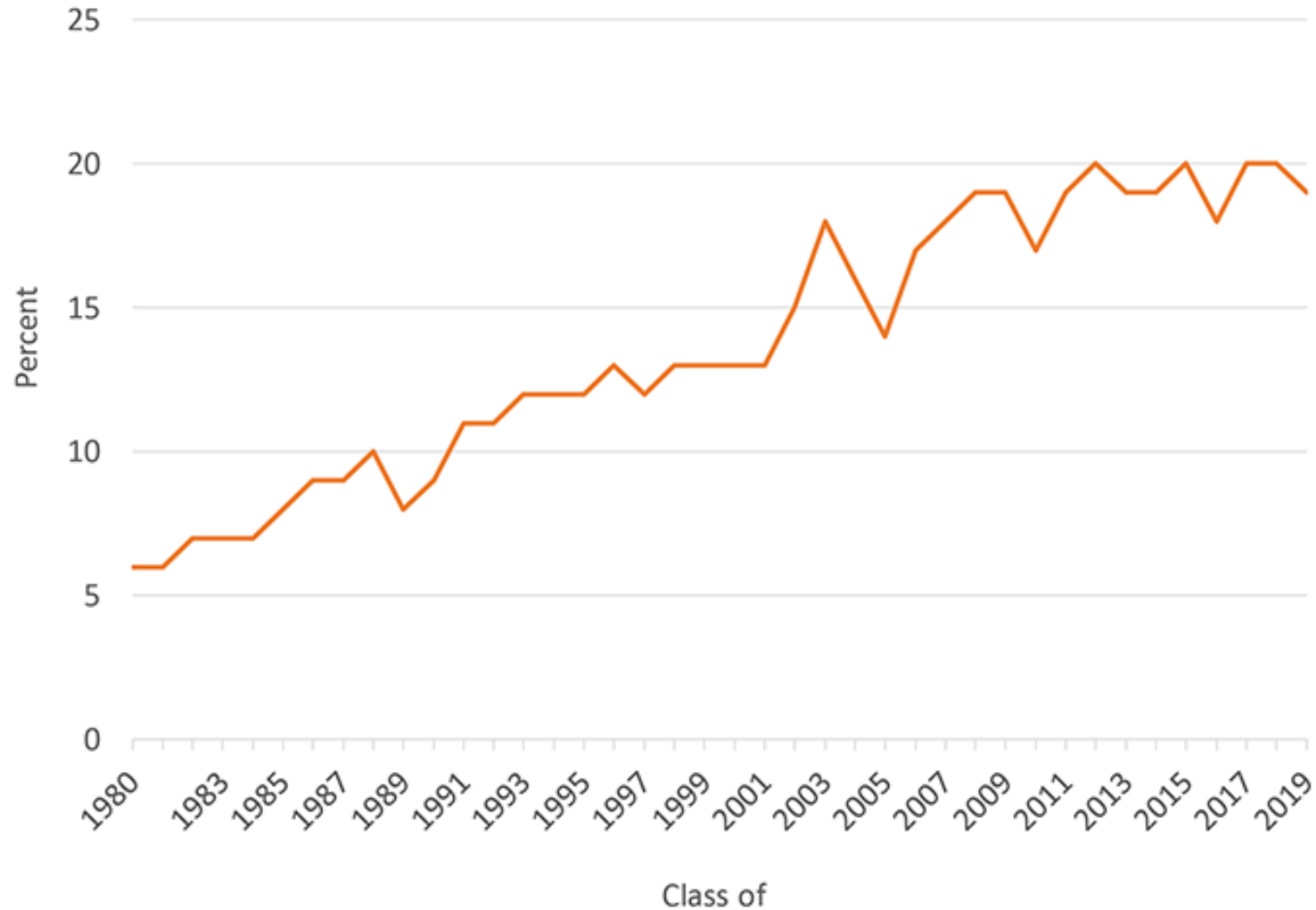
[rivie@aip.org](mailto:rivie@aip.org)

# Percentage of Physics Bachelors Earned by Women



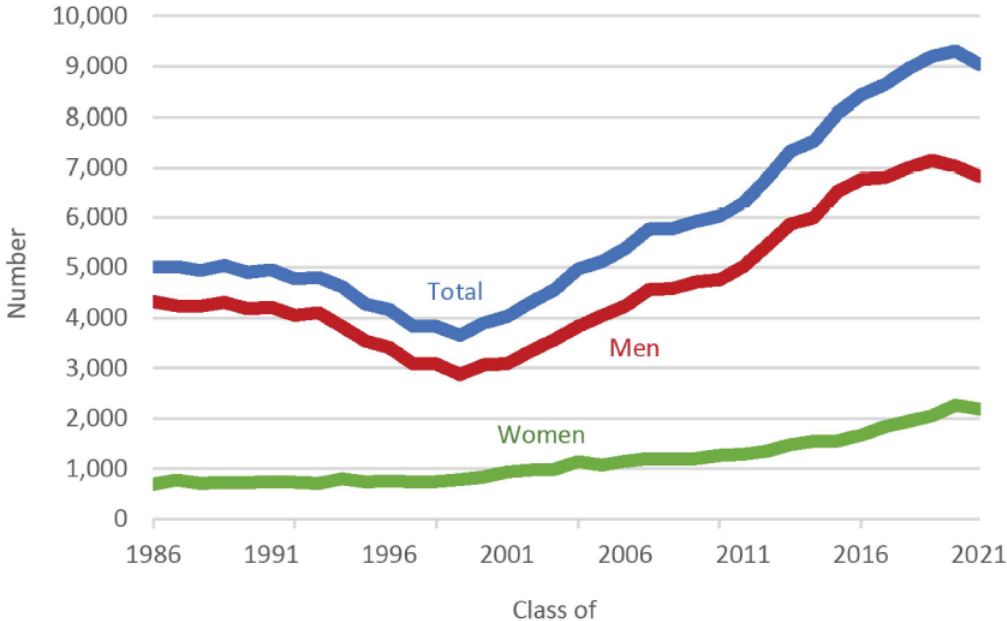


# Percentage of Physics PhDs Earned by Women



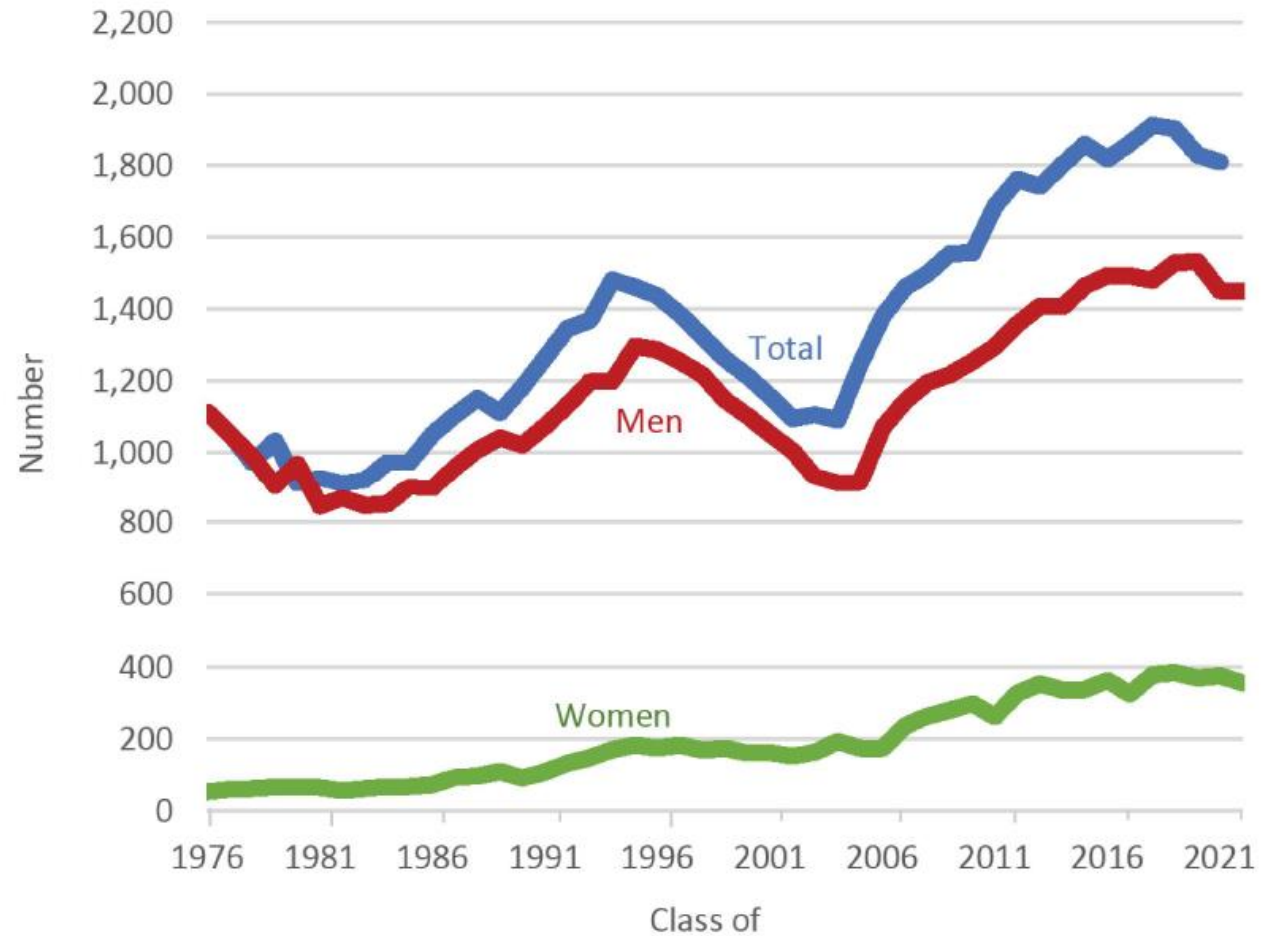
# Number of Bachelor's Degrees Earned in Physics

Number of Bachelor's Degrees Earned in Physics,  
Classes 1986 through 2021



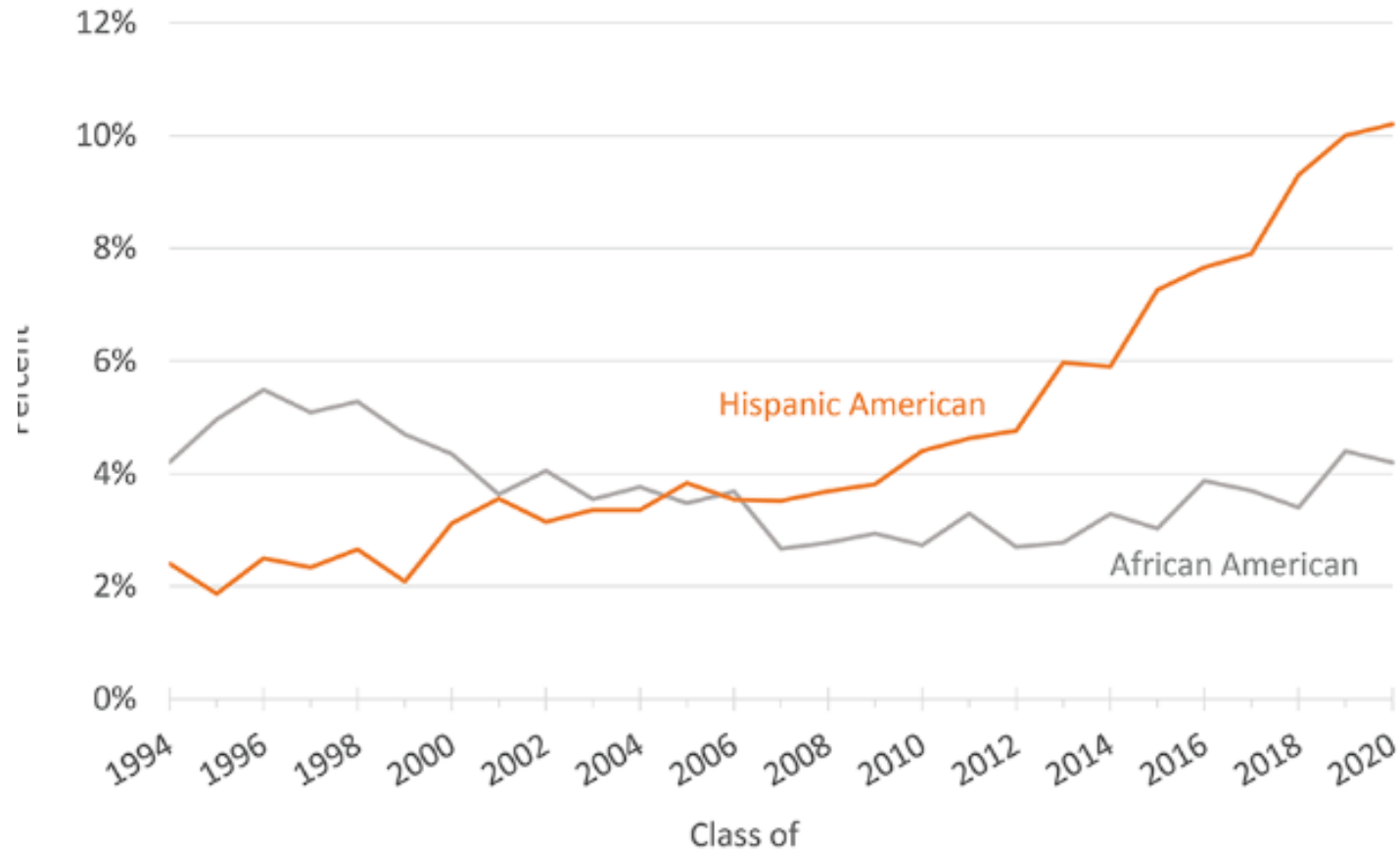
Physics departments reported 0.2% of their physics bachelor's degree recipients in the class of 2021 identify as a gender other than man or woman.

# Number of PhDs earned in physics



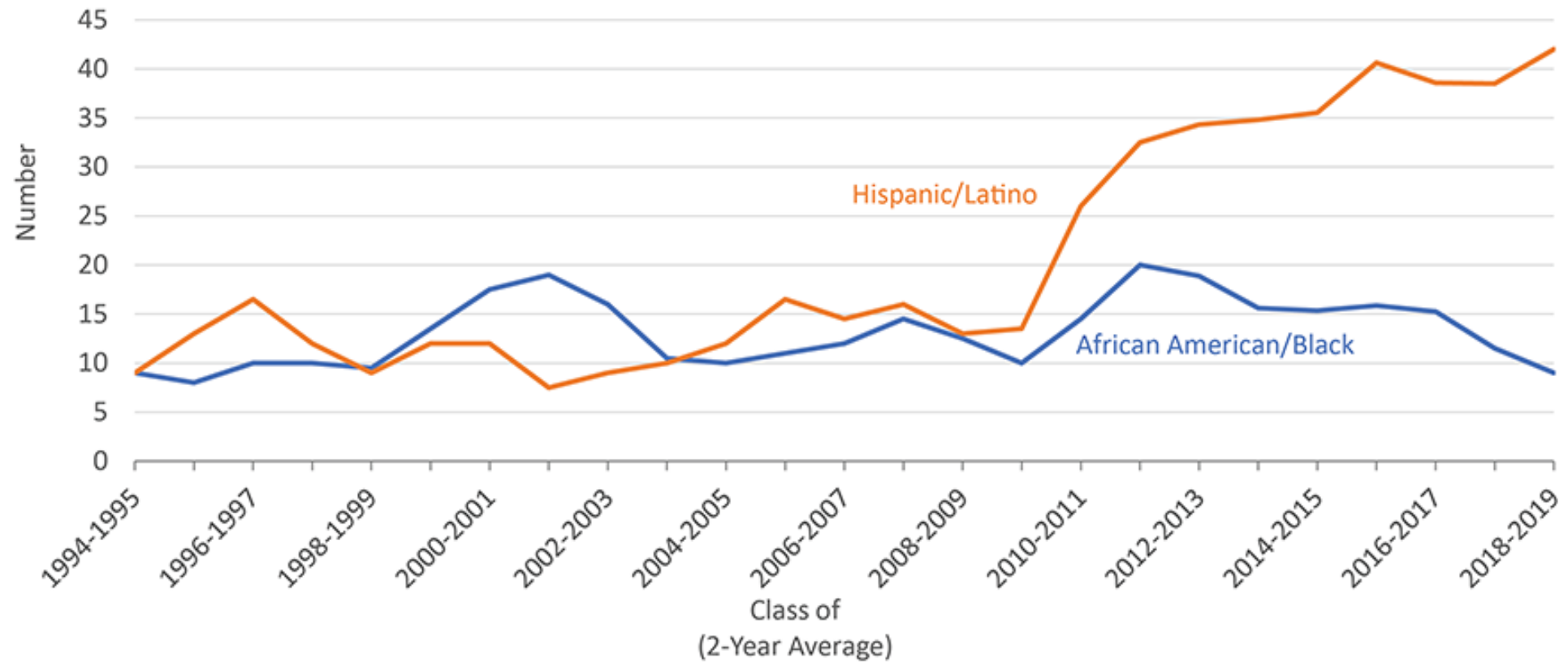
Physics departments reported 0.1% of their physics doctorate recipients in the class of 2021 identify as a gender other than man or woman.

# Percentage of Bachelor's Degrees in Physics Earned by African American and Hispanic People



Note: Between 5% and 11% of physics bachelors were awarded to non-US citizens over this time period. The percent of physics bachelor's degrees awarded to African-Americans and Hispanic Americans are based on US citizens only.

# Number of African American and Hispanic People Earning Physics Doctorates



# One Part of the Gender Gap Project The Global Survey of Scientists (2018)

# Career-advancing resources: Gender differences in physics

## Resources

- Funding
  - Office space
  - Lab space
  - Equipment
  - Travel money
  - Clerical support
  - Employees or students
  - Computing capability
  - Technical support
  - Access to data
  - Access to scientific literature
  - Support as a working parent
- Men report, on average, 0.4 more resources than women.
    - This difference may seem small, but it compounds over one's career: *The accumulation of disadvantage.*
  - Even after accounting for age, employment sector, geographic region, and level of development.
  - There were no instances in which women were more likely than men to say they had enough resources.

# How did your work or career change because you are a parent?

Data from 2018 Survey: Physicists only Model accounts for age, gender, global region, employment sector and HDI	Women	Men	Odds Ratio
<b>I chose a less demanding or more flexible work schedule</b>	<b>42</b>	<b>28</b>	<b>1.61</b>
<b>I changed my employer or field of employment</b>	<b>7</b>	<b>4</b>	<b>NS</b>
<b>I spent significantly less time at work</b>	<b>46</b>	<b>25</b>	<b>2.34</b>
<b>I was more productive and efficient at work</b>	<b>33</b>	<b>20</b>	<b>1.89</b>
<b>My career or rate of promotion slowed significantly</b>	<b>30</b>	<b>10</b>	<b>3.57</b>
<b>I became a stay-at-home parent</b>	<b>5</b>	<b>1</b>	<b>3.42</b>
<b>My work or career did not change significantly</b>	<b>22</b>	<b>52</b>	<b>(3.69)</b>

Odds ratio: the likelihood that women report this more (less) often than men

Differences shown are statistically significant at the 0.002 level after accounting for age, gender, employment sector, geographic region, and HDI



# Conclusions

“The persistent underrepresentation of African Americans in physics and astronomy is due to **the lack of a supportive environment** for these students in many departments, and to **the enormous financial challenges** facing them and the programs that have consistently demonstrated the best practices in supporting their success. **Solving these problems requires addressing systemic and cultural issues and creating a large-scale change management framework.**”



# AIP 2020-21 SURVEY OF SENIORS

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Purpose: understand the effects of COVID-19 on physics and astronomy students

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Sent to senior-level physics and astronomy majors during March and April 2021

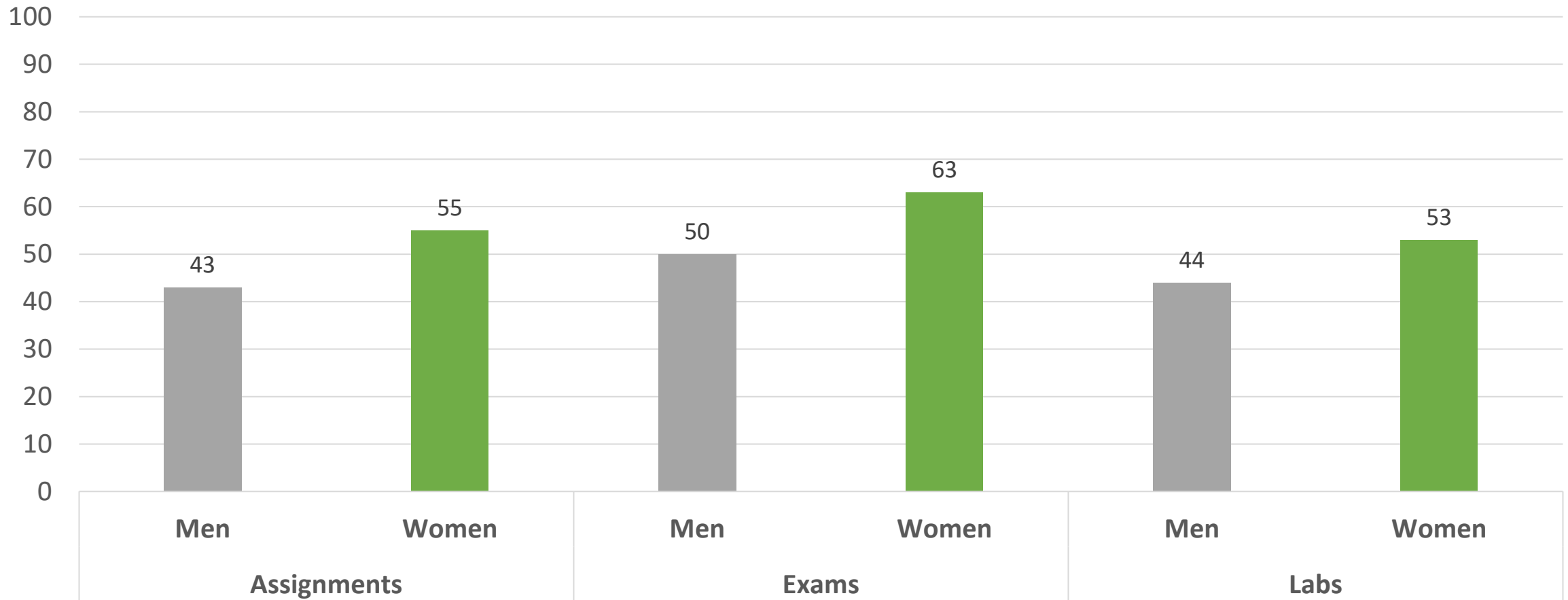
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Approximately 2000 replied

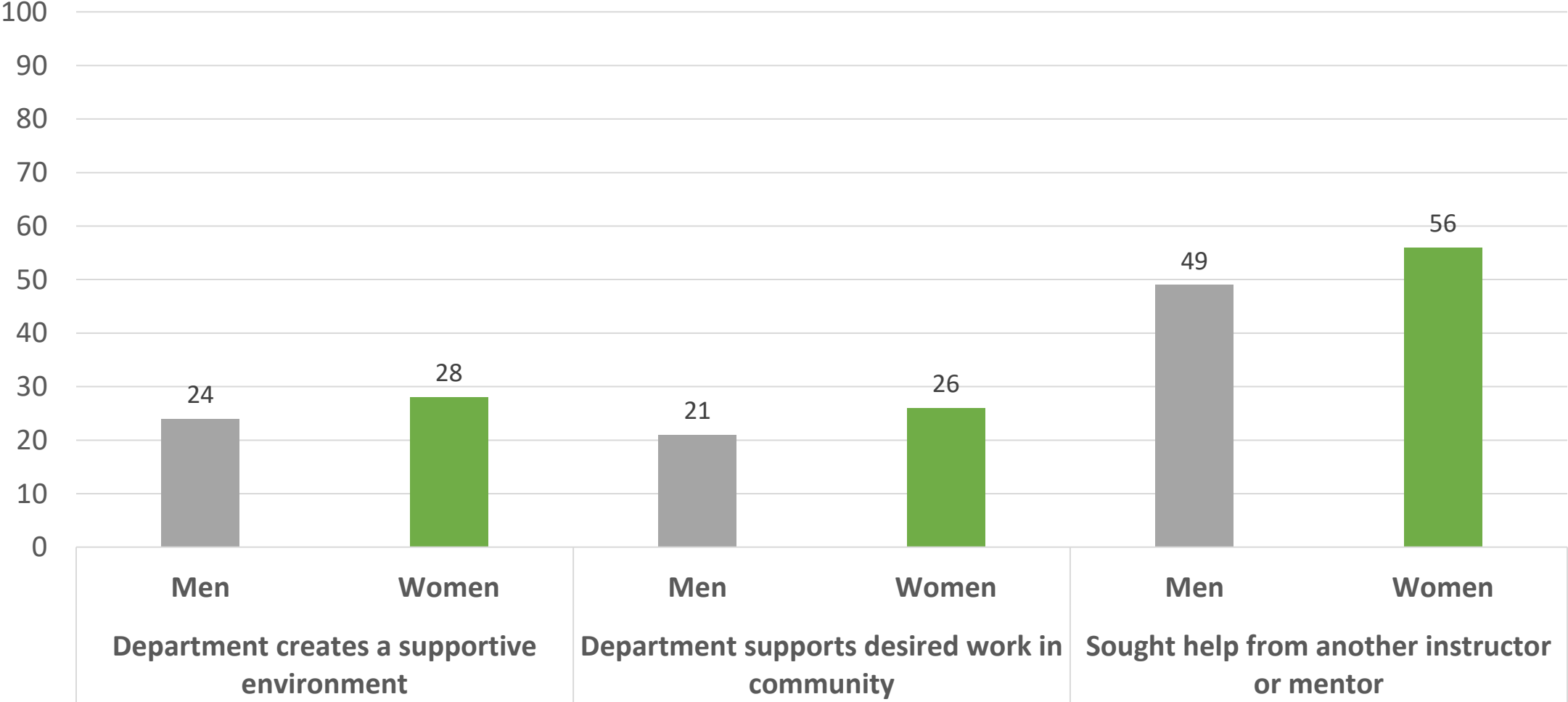
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Data show gender differences and race/ethnicity differences in the effects of COVID

# Percentage of seniors who reported being less confident about excellent performance than before the pandemic



# Gender differences in percentage of seniors who reported that the following happened **less frequently** during the pandemic than before



# Conclusions about students who are minoritized

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Some effects of the pandemic were more strongly felt by students who are minoritized.

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We are just beginning to understand the factors that create inequity in physics specifically.

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There is more to be done and learned for students who are Black and for those who are members of other minoritized groups.

	<b>Physics Bachelor's Degrees Earned (2011)</b>	<b>Physics Doctorates Earned (2018)</b>	<b>All Physics Faculty Members (2021)</b>	<b>Tenured Physics Faculty Members (2021)</b>
<b>African American</b>	3%	1%	3%	3%
<b>Hispanic</b>	5%	4%	5%	4%
<b>Asian American</b>	7%	10%	8%	7%