

An aerial photograph of a large stadium, likely for American football. The playing field is noticeably tilted, sloping downwards from the top left towards the bottom right. The stadium is filled with spectators, and the field is green with white yard lines. A large stone wall is visible on the left side of the field.

# Implicit Biases and Unlevel Playing Fields: Making Physics a True Meritocracy

Rosi Reed - Lehigh University

# Introduction

- My experience
- Some statistics → Expectations and Reality
- Diversity and Bias
- Case Studies
- A Path Forward

**Note:** Much of the material comes from US sources → A bias itself, but there are some studies from Europe and Asia in my back-up which indicate the universality of the issue

# Path to being a physicist

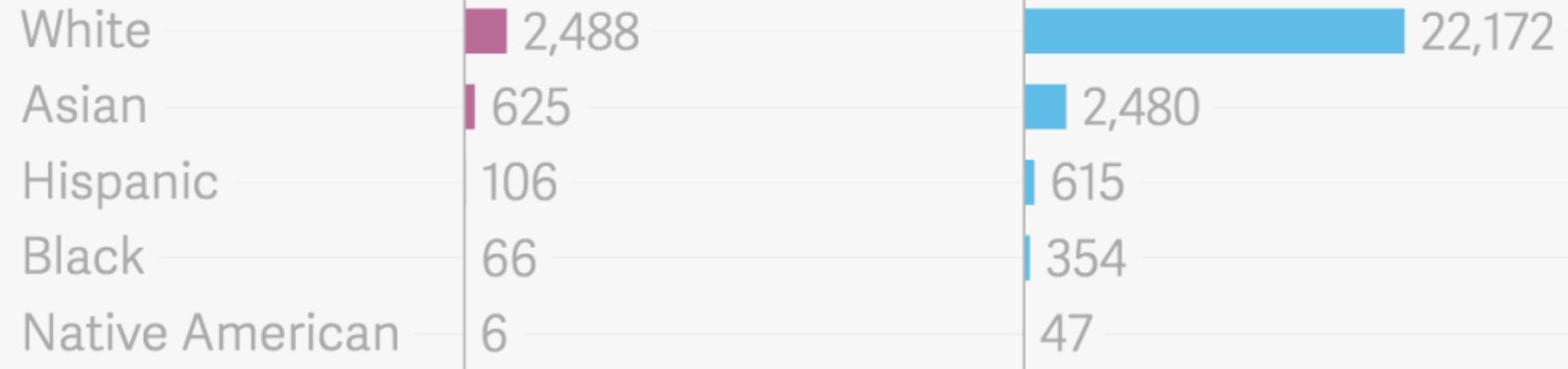
- I was always good at math, and was raised in a family dominated by women in STEM
- I discovered physics my Sophomore year of high-school and decided that I was going to be a physics professor
- There were many incidents of casual sexism, but the one that stands out to me:
  - A professor at my undergraduate university when finding out that I wish to attend graduate school said “Men are better at physics than women, but graduate schools are obligated to accept women so every time a girl applies it takes away from physics” – 2001

# Statistics

Americans who earned physics doctorates in the US from 1973-2012

Women

Men



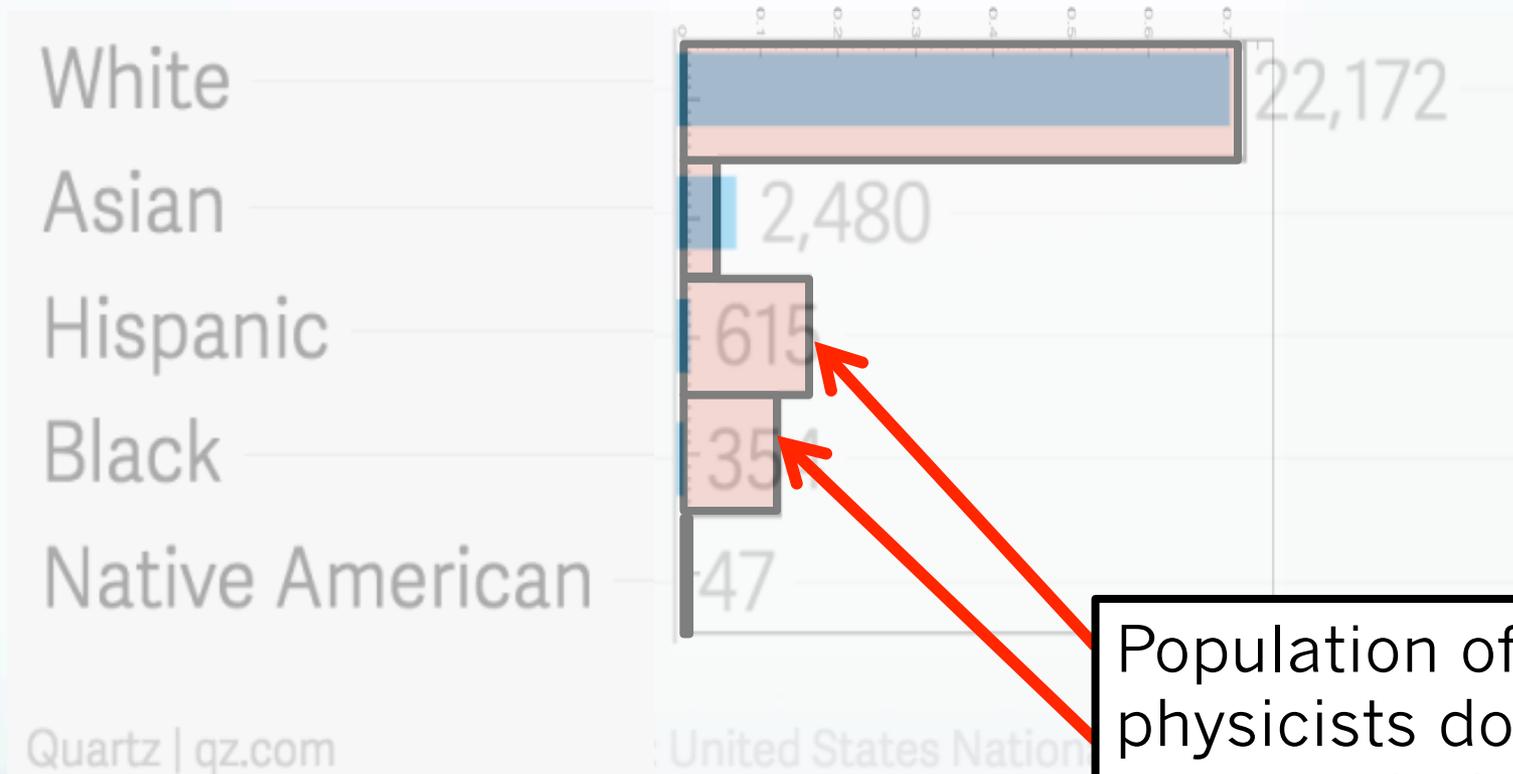
Quartz | qz.com

Data: United States National Science Foundation

<http://qz.com/432756/in-39-years-us-physics-doctorates-went-to-66-black-women-and-22000-white-men/>

Of course, in our field the % of non-Americans at American universities is high → But the message is the same

# Statistics



Population of physicists does not match the expectation value from the US Population!

**What causes this biased distribution?**

First we need to define our terms

# What is Diversity?

- Diversity refers to **difference**
  - A property of a group not an individual
  - An individual cannot be diverse, but groups of individuals can possess diversity
- There are many dimensions of difference
  - Causes confusion about what diversity means
  - Looking at differences in social identity
  - These include:
    - Race/ethnicity/nationality
    - Gender/sexual orientation
    - Disability status
    - Religious affiliation
    - Socioeconomic background
- Every person has **multiple, intersecting social identities**

# Why is Diversity Important?

- In western cultures scientific **narratives focus on a singular, “brilliant” scientist** who makes enormous contributions through innate genius
  - Example: Albert Einstein or Isaac Newton
- “Scientific talent” is not simply innate
  - Cultivated through many hours of training and effort → Genius is not enough
- Teams, not individuals conduct most scientific research today
  - STAR (for example) has 623 people from 57 institutions
  - The narrative of the brilliant, individual scientist fails
- In group problem solving the ability to see the problem differently often is the key to a breakthrough
  - **Diversity is not distinct from enhancing overall quality → it is integral to achieving it.**
- **Lack of diversity represents a loss of talent**

# Diversity

- Why is physics not diverse?
  - **Biases → Explicit and Implicit**
  - Changing the culture of a field is difficult
  - Underrepresentation creates a vicious cycle
    - Students/Post-docs
      - Don't have mentors and role models of their race/gender
      - Don't feel they belong in their department
      - Don't have a support system
- USSC Chief Justice Roberts: What unique perspective does a minority student bring to a physics class?
  - Physicists respond: [https://docs.google.com/document/d/1dc16llaM\\_TFNu1cNWmgWwcfYWYsNgUa5DBgCHQ0C0kM/edit](https://docs.google.com/document/d/1dc16llaM_TFNu1cNWmgWwcfYWYsNgUa5DBgCHQ0C0kM/edit)

# Neil deGrasse Tyson

What sets society's expectations?

- Random Old White Guy: “What’s up with chicks and science?”
- “Why aren’t there more women in science?” Neil deGrasse Tyson points out that he’s never been a woman, but **he does know what it’s like to pursue a career in a field that defied the expectations of society.** “Before we start talking about genetic differences, you’ve got to come up with a system that is equal opportunity. Then we can have that conversation,” he said

[https://www.youtube.com/watch?v=\\_Km9aveewAc](https://www.youtube.com/watch?v=_Km9aveewAc)



# Implicit Bias

## Definition

- Implicit social cognition
- Attitudes/stereotypes that **affect understanding, actions, and decisions in an unconscious manner**
- Bias can be favorable or unfavorable assessments
- Associations develop a lifetime through exposure to direct and indirect messages

## Characteristics

- **Pervasive** → everyone possesses them
- Implicit and explicit biases are related but distinct mental constructs → not mutually exclusive
- **Do not necessarily align with declared beliefs**
- **Malleable** → can be gradually unlearned

# Draw-a-Scientist Test

- Developed by David Wade Chambers in 1983
  - What age does the stereotypic image of a scientist appears?
  - 4807 primary school children in 3 countries completed drawings - 28 girls, and no boys, drew female scientists
  - Only 20 of the 1,600 drawings by both girls and boys depicted scientists of color (Fort and Varney 1989)
- What if they interact with real scientists? 7<sup>th</sup> graders draw scientists before and after a trip to FermiLab
  - Girls → 36% portrayed a female scientist “before”, 57% portrayed a female scientist “after”
  - Boys → 100% portrayed a male scientist “before”, 100% portrayed a male scientist in the “after” drawing
- 2008 – 50 % of girls drew a female scientist, 12.5% of boys drew a female scientist



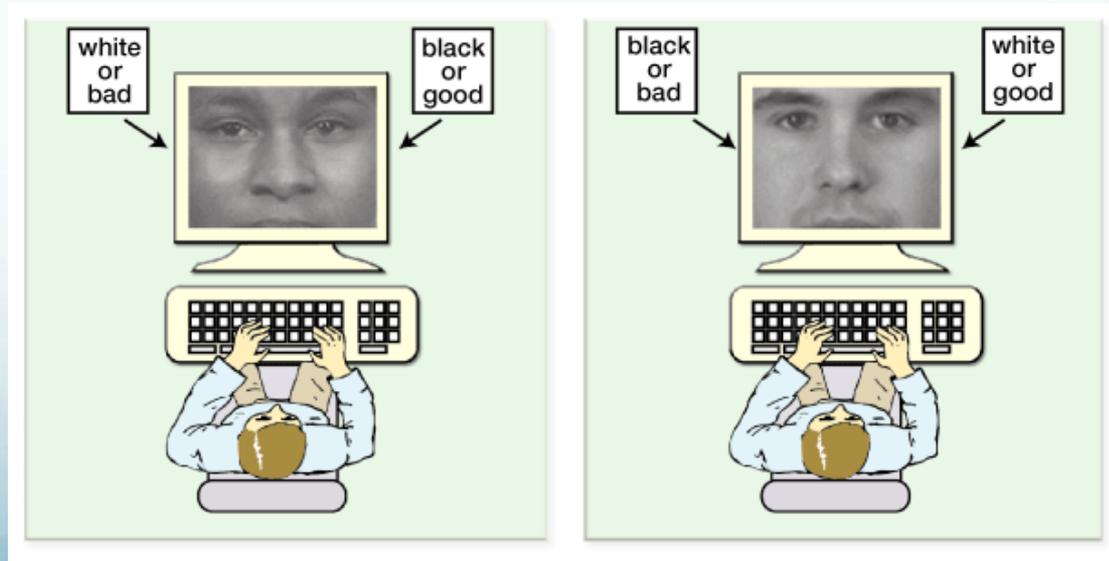
# Sexism: One form of Bias

- **Hostile sexism**
  - Explicit bias → The “usual” definition of sexism
  - Includes overtly sexual and unwelcome moves
- **Benevolent sexism**
  - When a person does or says something based on gender where they are supposedly acting from a place of good will
  - Often not recognized as sexism → The lack of malicious intent is supposed to excuse the behavior
- **Accidental or unintentional sexism**
  - Perpetuates sexist culture by doing and/or saying things that undermine gender equality
  - Without intended malice

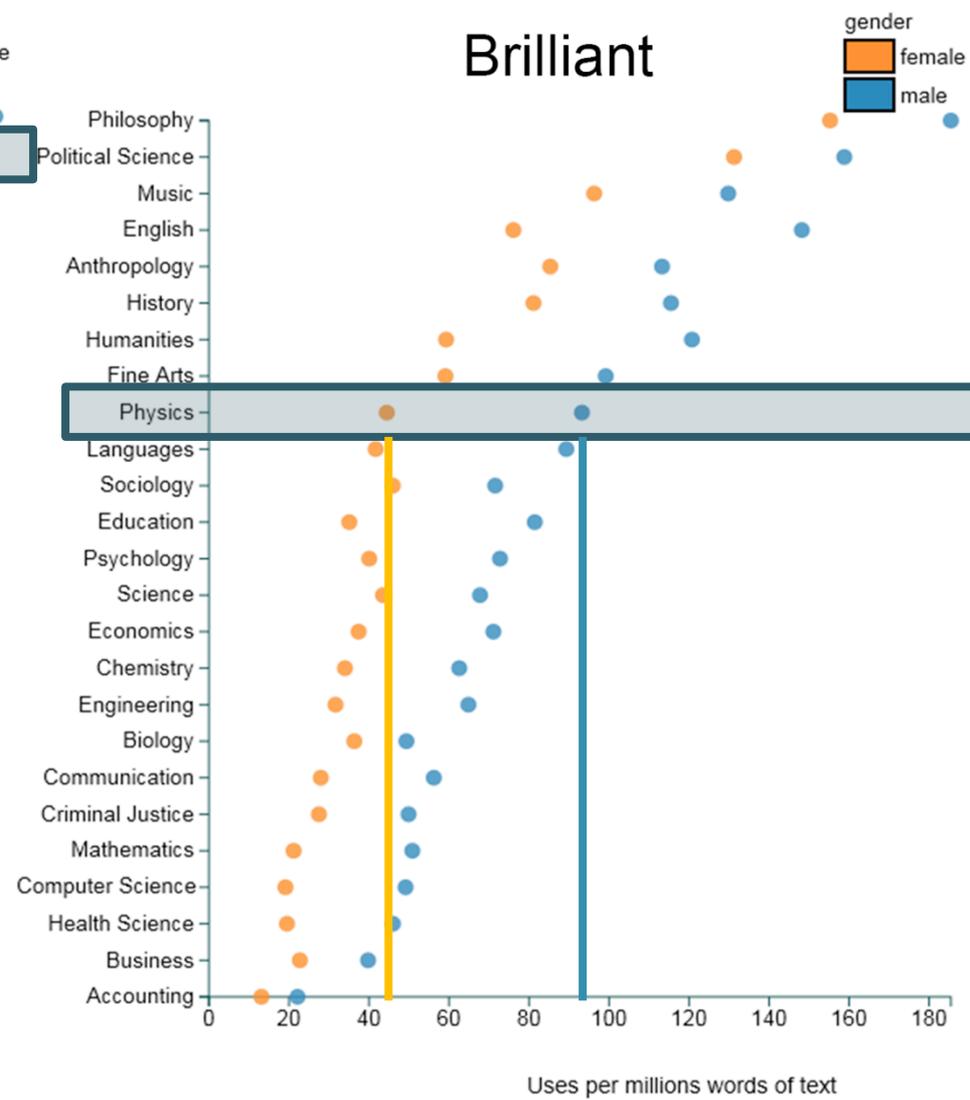
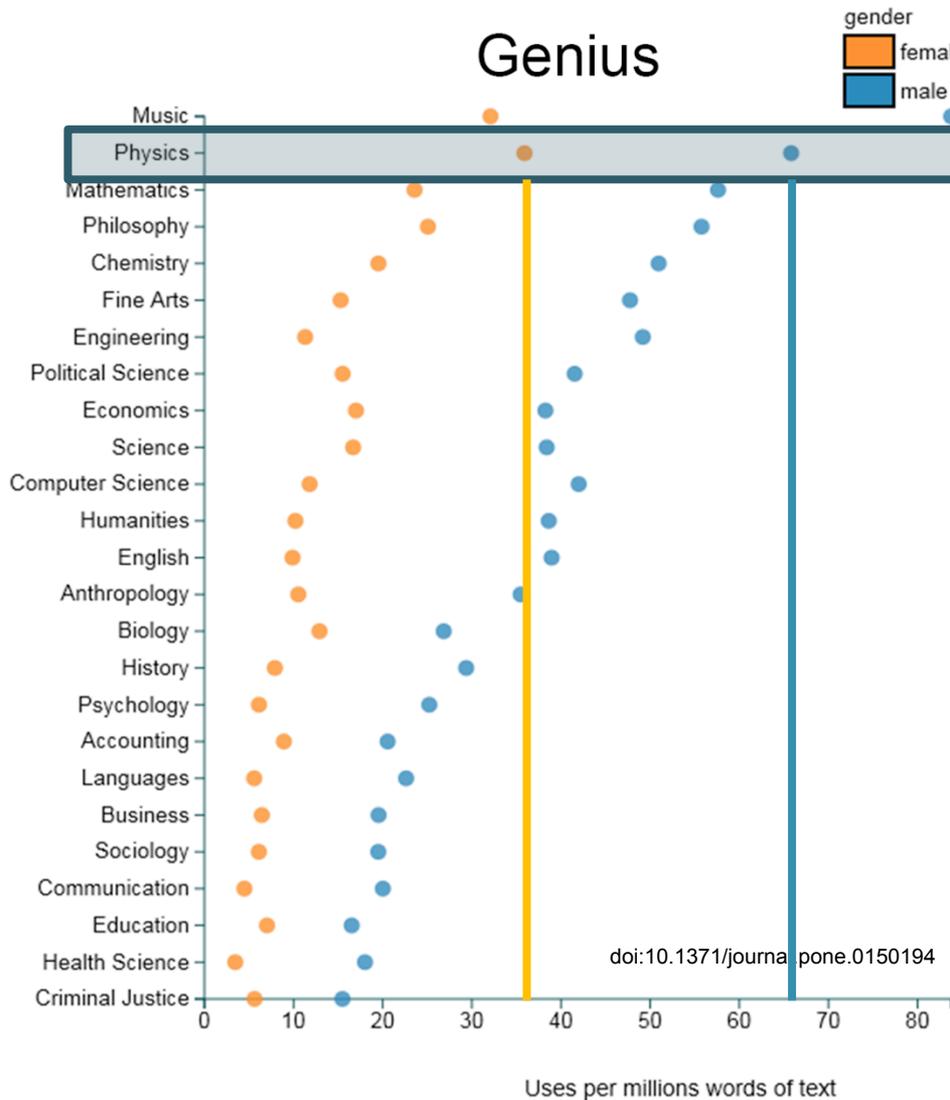
# IAT → Studies of Bias

- **70-90% of people** show gender and race bias
- Across hundreds of studies the Implicit Association Test (IAT) predicts judgments of women and people of color.
- Millions of participants

Take the IAT free at  
[implicit.harvard.edu/implicit/](https://implicit.harvard.edu/implicit/)



# Implicit Bias Example



Student descriptions of their professors on  
 RateMyProfessors.com (14M reviews)

# Checking Your Implicit Bias

- Social norms make prejudice against minority groups unacceptable Crandall, Eshleman, & O'Brien, 2002
  - Most people are motivated to follow norms Frantz, Cuddy, Burnett, Ray, & Hart, 2004
  - Many people would be upset to learn that they show a preference for one racial or ethnic group over another.
- Research demonstrates that for some white people taking the race IAT is threatening Howell, et al., 2013
  - Could confirm a negative stereotype which contrasts with how most people wish to see themselves Plant & Devine, 1998
- How do people respond when they can receive feedback from the test?
  - When people took the race IAT and were told that they likely would have a pro-White bias → they chose not to see their results (Monteith, Voils, Ashburn-Nardo, 2001)
- Performing poorly on the IAT → guilt → excuses
  - People will blame poor IAT performance on the difficulty of the test, their level of familiarity with the 2 groups, or cultural stereotypes
  - **By making an external attribution for their test results, people miss a valuable opportunity to correct their bias**

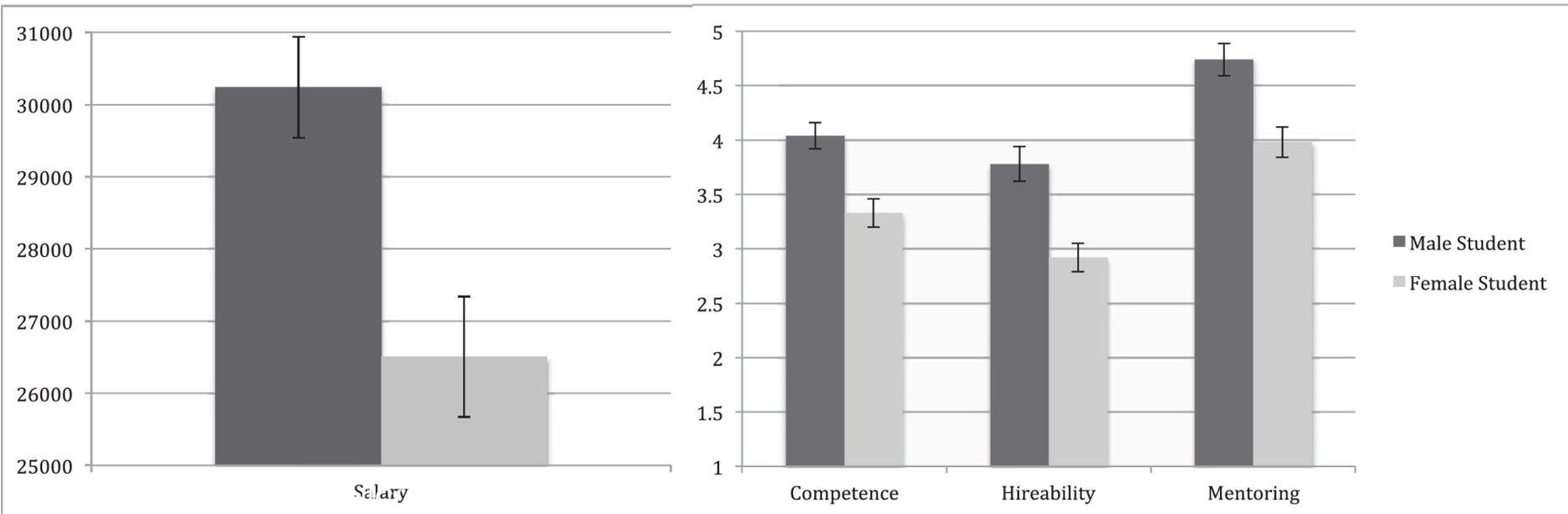
# Case study: Implicit Bias

- 6,500 professors across 250 of the U.S.'s top schools receive email messages sent by “students,”
  - Each identical message expressed admiration for the professor’s research, and requested a meeting
  - Randomly assigned names typically associated with specific racial categories
    - Brad Anderson vs Lamar Washington.
- **White men more likely than women and minorities to receive a reply** in every discipline except the fine arts
- Faculty in the sciences all showed significant biases against minorities and women
  - **No relationship between representation of any group among and the degree of bias**

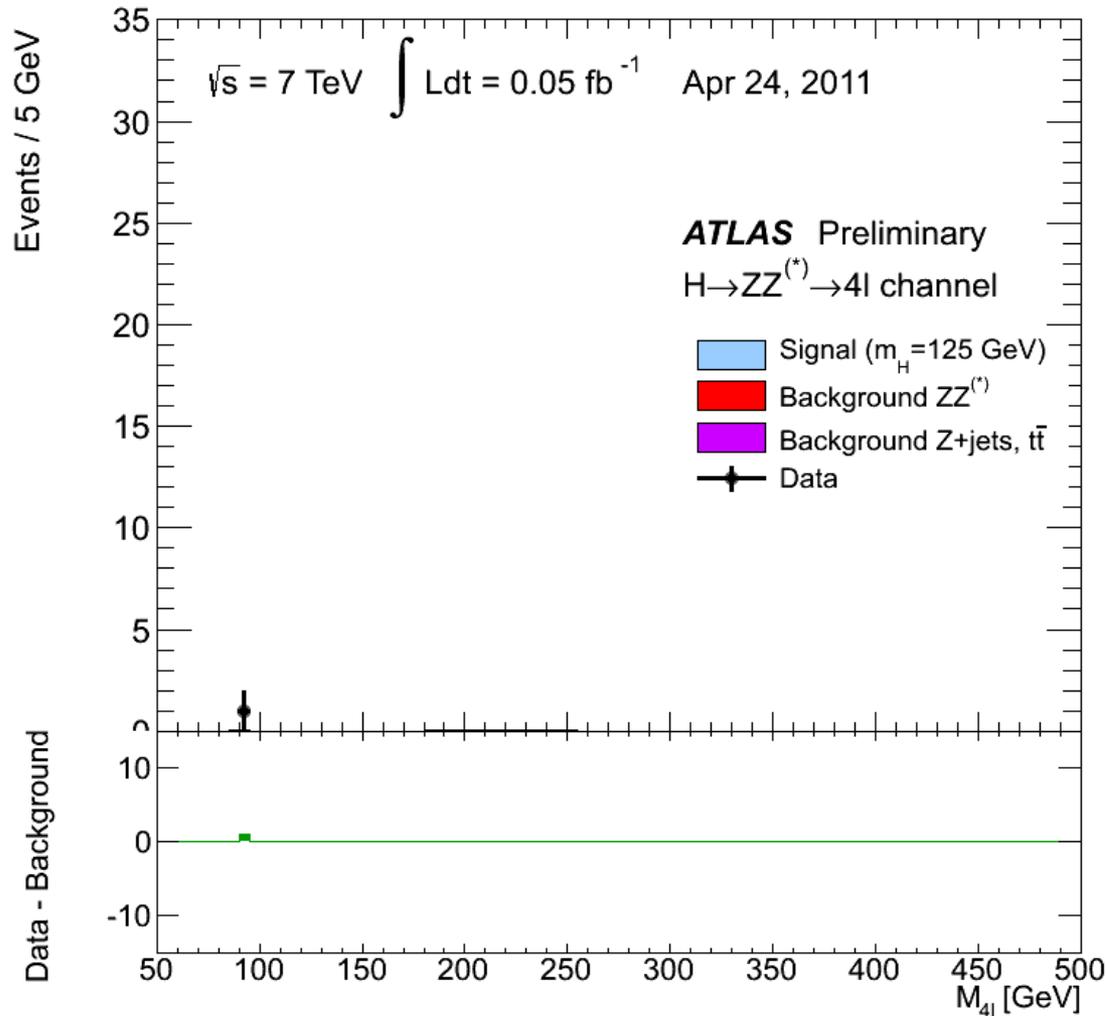
What Happens Before? A Field Experiment Exploring How Pay and Representation Differentially Shape Bias on the Pathway into Organizations, KL. Milkman, M Akinola, D Chugh

# Case study: Implicit Bias

- 200 academic researchers received the same application for a “lab manager” position, randomly assigned a male or female name
  - Asked to judge competency, potential salary, willingness to mentor
- Scientists have the same biases as other groups
  - **Both men and women** science faculty were **more likely to hire the male**, ranked him higher in competency, were willing to pay him \$4000 more, more willing mentor



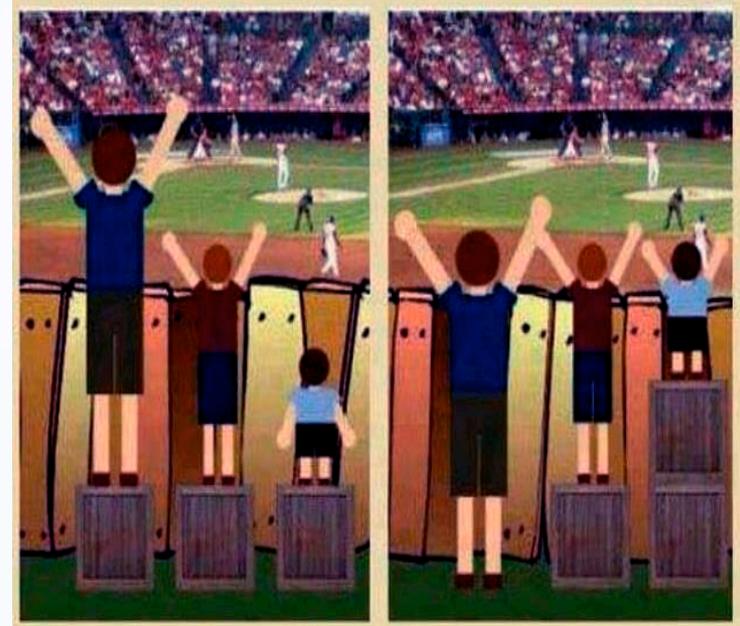
# Implicit Bias $\rightarrow$ Leaky Pipe Line



- Implicit bias  $\rightarrow$  impossible to see the bias in any one interaction
  - A career integrates over many interactions
- Correlation causes the societal structure to build up
- Leads to a net shift in the population

# Biases and trends

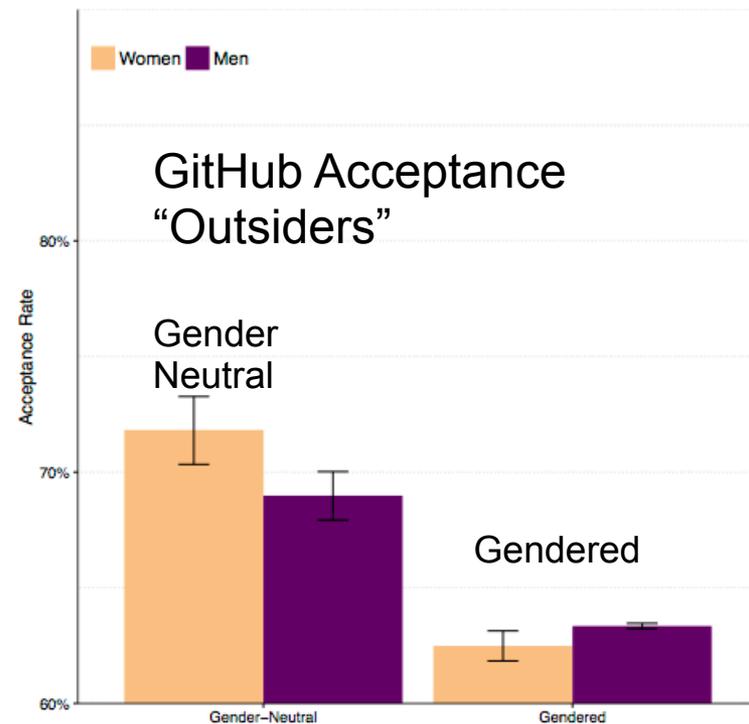
- There have been improvements in minority participation in physics
  - But the biases still exist
  - Many biases are “invisible”
  - **We are often blind to our own privilege**
- Mindfulness and deliberate choice are required to continue to see improvement
  - Difficulty is having people recognize this
  - We also need to recognize our **own biases!**



Treating everyone the same is not always “fair”. **What we strive for is fairness**  
Fairness → Meritocracy

# Meritocracy in coding

- Women ~11.2% of open source software developers
- Researchers examined ~3M pull requests
- Code women was approved at 78.6% compared to code written by men (74.6%,  $p < 0.001$ )
  - The study then differentiated between women whose profiles stated their gender vs those that were gender neutral
    - If their gender was identifiable → acceptance rate was worse than men's
- “The frequent refrain that open source is a pure meritocracy must be reexamined”

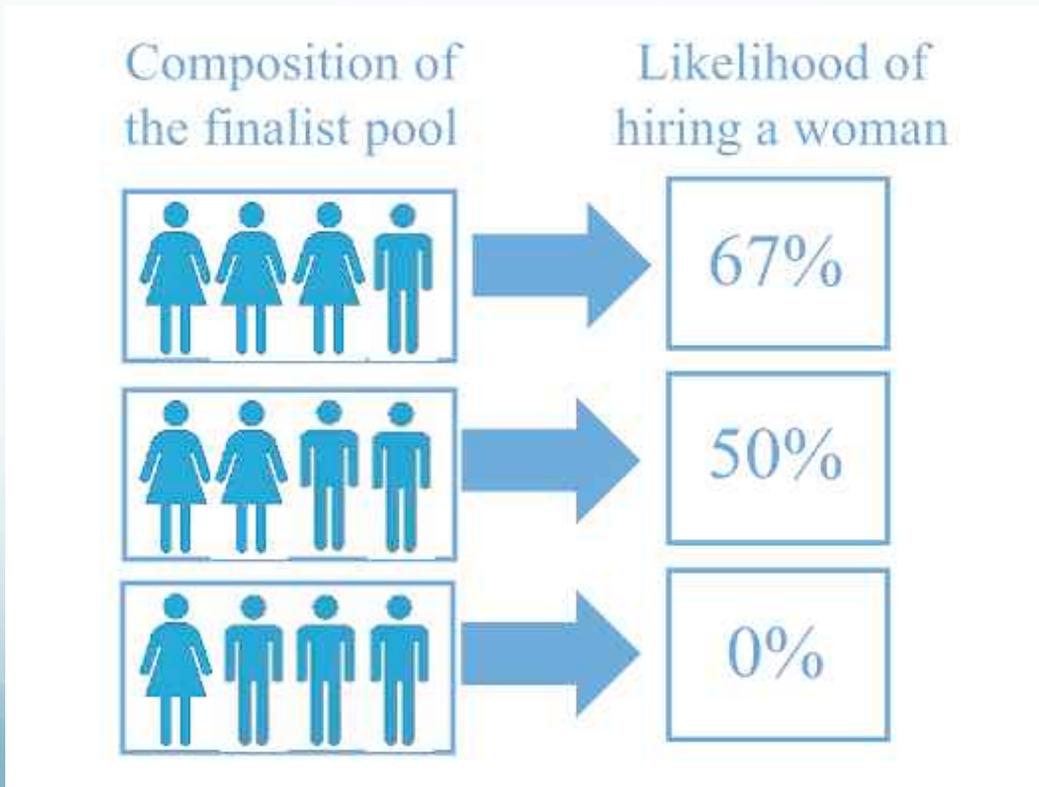


# How Can We Improve Physics?

- Combat your biases
  - When choosing:
    - Speakers for a conference
    - Students/Post-docs to hire
    - Nominations for an awards
  - Think about whether you are missing a meritorious choice
- Step in when someone is behaving poorly → Minorities need allies
- Mentor minorities → Please do not leave the issue of help young minority physicists to “older” minority physicists
  - We are all in this together!
- Unconscious biases cannot be wished away → **Institutions must strive to eliminate opportunities for implicit bias to affect decisions on hiring and promotions**
- Push for this in your institutions!

# Hiring Practices

Probability of hiring a minority drastically increases and nears the numerical expectation value when more than one minority is in the hiring pool



University of Colorado's Leeds – 598 finalists for university jobs with 174 receiving job offers over a three-year period. The average hiring pool for this study was four finalists

# Recognize This Picture?

39 Pictures: 3 women (8%) and 1 non-white person (3%)



# Recognize This Picture?

39 Pictures: 3 women (8%) and 1 non-white person (3%)



It is just one small thing, but it builds a cultural view that minorities do not belong here.

# Justice Ruth Bader Ginsberg

“So now the perception is, yes, women are here to stay. And when I’m sometimes asked when will there be enough [women on the Supreme Court]? And I say when there are nine, people are shocked. But there’d been nine men, and nobody’s ever raised a question about that,” she said.

Physics will not truly change until we stop thinking that the “default” is a straight white man



# Solvay Conference



First -- 1911

26<sup>th</sup> -- 2014



Rosi Reed - Diversity - RHIC/AGS 2016

# Conclusions

- The general cultural attitudes effect the culture of physics
- Everyone has biases
  - Hiring a minority does not “fix” the problem
  - It should also not be the responsibility of a minority to “fix” the problem
  - Think about your biases when making a decision
- Biases can not be magically fixed → Institutions need to have mechanisms in place to combat biases
- There are so many more issues → able-ness, sexual orientation, etc.

# Back-Up

- <http://scitation.aip.org/content/aip/magazine/physicstoday/news/10.1063/PT.5.8155>
- <http://eblur.github.io/scotus/>
- <http://blogs.scientificamerican.com/voices/diversity-in-stem-what-it-is-and-why-it-matters/>
- Williams and ceci

## The First Solvay Conference (1911)

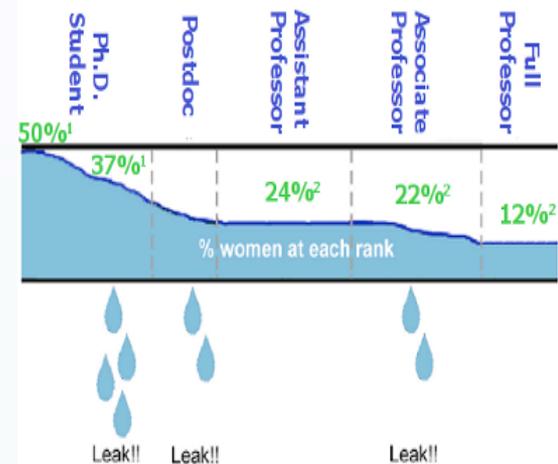


# The Academic Pipeline

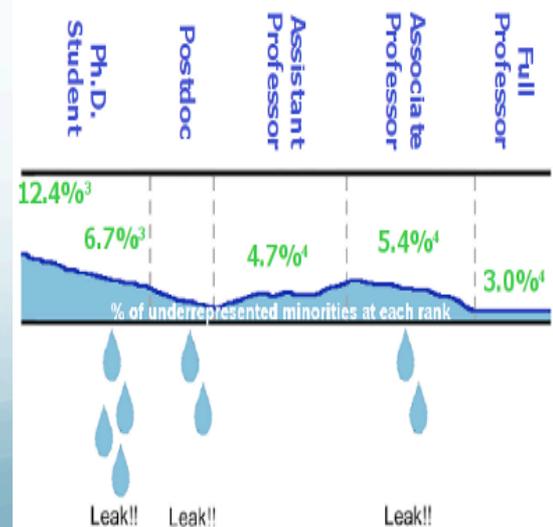
Chemistry

- “Leaky Pipe”
  - Do we lose a larger fraction of minorities at every step of the way? (Yes!)
  - Biases build at every step of the way, **cumulative probability** matters!
- “Glass Ceiling”
  - The cumulative build up of biases can prevent minorities from gaining leadership positions
  - Self-fulfilling prophecy when coupled with implicit bias

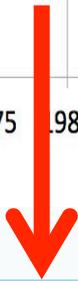
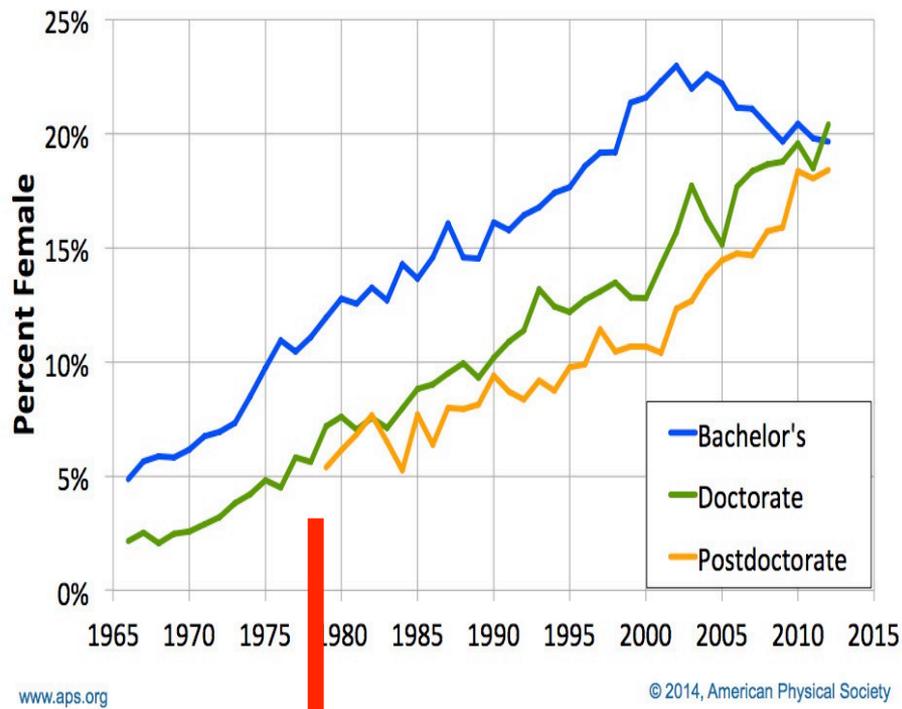
Leaks in the Academic Pipeline for Women



Leaks in the Academic Pipeline for Underrepresented Minorities



# Gender: Data (US)



Percentage of Physics Faculty Members Who Are Women

	Year			
	1998	2002	2006	2010
<b>by Academic Rank</b>	(%)	(%)	(%)	(%)
Full Professor	3	5	6	8
Associate Professor	10	11	14	15
Assistant Professor	17	16	17	22
Instructor / Adjunct	*	16	19	21
Other ranks	13	15	12	18
<b>by Highest Degree Offered by Department</b>	(%)	(%)	(%)	(%)
PhD	6	7	10	12
Master's	9	13	14	15
Bachelor's	11	14	15	17
<b>OVERALL</b>	<b>8</b>	<b>10</b>	<b>12</b>	<b>14</b>



Percentage of Newly-Hired Physics Faculty Who Are Women

<b>by Academic Rank</b>	Year		
	2006	2008	2010
	(%)	(%)	(%)
Full Professor	9	10	20
Associate Professor	8	20	14
Assistant Professor	25	22	29
Instructor / Adjunct	23	23	24
<b>OVERALL</b>	<b>22</b>	<b>21</b>	<b>26</b>

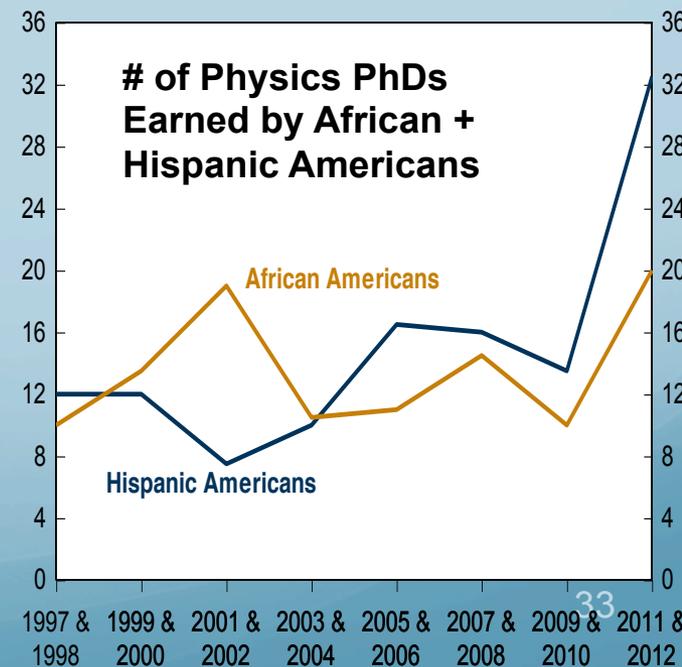
# Race: Data

- African Americans were 2.5% of the physics BS degrees in 2010 (down 50% from mid-1990's)
- The # of physics PhDs earned by Hispanic Americans has increased ~300% during the last decade.
  - The # of African Americans earning physics PhDs has been flat
- Trends at “higher” levels seem to reflect early level
  - Less statistics but quantitative trends are similar to gender
- Issues of race occur in many countries

Race and Ethnicity of Physics Faculty

	Physics			All Disciplines*
	2004 (%)	2008 (%)	2012 (%)	2009 (%)
African-American	2.0	2.2	2.1	6.6
Asian	10.6	13.2	14.3	6.0
Hispanic	2.7	3.1	3.2	4.0
White	82.2	80.0	79.2	74.9
Other	2.2	1.5	1.2	0.5

Number



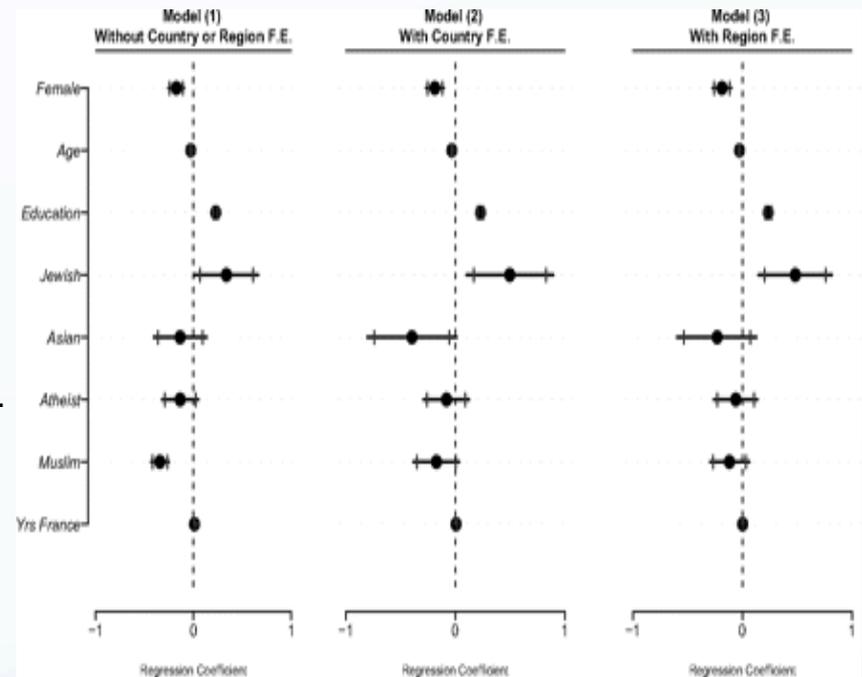
# Why are trends important?

- Each stage of the academic career feeds into the next one
  - Results from biases can accumulate
  - Changes happen slowly over years
    - Is there a “leaky” pipe?
- The question that is often asked, what is “fair”?
  - “Affirmative action” can lead to negative backlash
- It is often suggested that women “choose” to leave science
  - Case studies indicate that the impact of bias plays a role
- Diversity leads to better candidates
  - Bias leads to excluding good (and perhaps the best) candidates

# Discrimination Muslims in Europe

France: study shows that a Christian citizen with an African heritage is two-and-a-half times more likely to get called for a job interview than an equally qualified Muslim citizen with the same ethnic background.

Germany: To each of 528 advertisements for student internships we send two similar applications, one with a Turkish-sounding and one with a German-sounding name. A German name raises the average probability of a callback by about 14 percent. Differential treatment is particularly strong and significant at smaller firms at which the applicant with the German name receives 24 percent more callbacks.



## Discrimination of Arabic-Named Applicants in the Netherlands: An Internet-Based Field Experiment Examining Different Phases in Online Recruitment Procedures

<http://ftp.iza.org/dp4741.pdf>

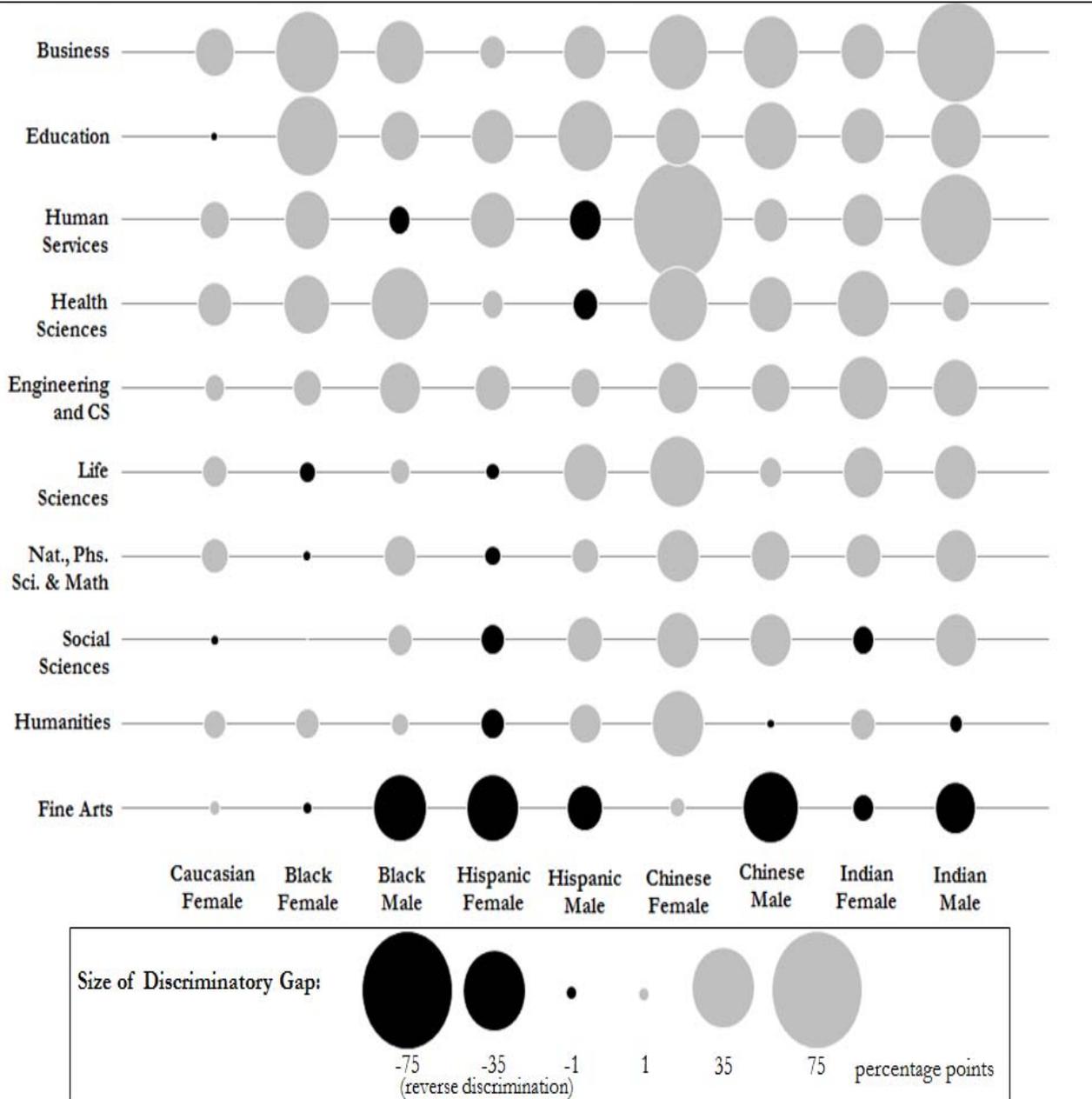
# Gender discrimination in China

We study gender discrimination in hiring markets by sending 19,130 fictitious matched resumes in response to professional employment advertisements posted on major Internet employment boards in China for positions such as engineers, accountants, secretaries, and marketing professionals in Beijing, Shanghai, Guangzhou, Shenzhen, Wuhan, and Chengdu. Our results show that, in general, state-owned firms tend to prefer male applicants. Foreign and private firms tend to prefer female applicants. On one hand, this evidence supports the hypothesis that economic reform and the market economy may mitigate gender discrimination. On the other hand, this evidence is consistent with statistics that describe discrimination based on gender segregation and information asymmetry that originated with higher ratios of female workers in foreign and private firms. With respect to regional income disparity, we find that the differences in gender discrimination between first- and second-tier cities are not significant. This result indicates that economic reform exerts limited mitigation effect on discrimination. We also find no evidence of taste discrimination based on traditional son preference in China.

# Gender: Trends (US)

- Women gaining PhD degrees has generally increased
  - 20% of 2012 physics PhDs (354 physics PhDs vs 153 in 2001)
  - up from 13% 11 years earlier.
  - This increase + growth in the overall number of physics PhDs results in a large increase in the number of women receiving degrees.
- The percentage of women physics faculty was 14% in 2010
  - The percentage of women in each academic rank continues to rise
  - Full professors are still less than 10% female
  - Departments that grant PhDs in physics have a lower percentage of women faculty than departments that do not
  - Women are hired as assistant professors (and instructors and adjuncts) at above their availability

**Figure 1b. Discriminatory Gap: Caucasian Males vs. Students of Each Race/Gender Combination**



What Happens Before? A Field Experiment Exploring How Pay and Representation Differentially Shape Bias on the Pathway into Organizations  
 Katherine L. Milkman  
 Modupe Akinola  
 Dolly Chugh

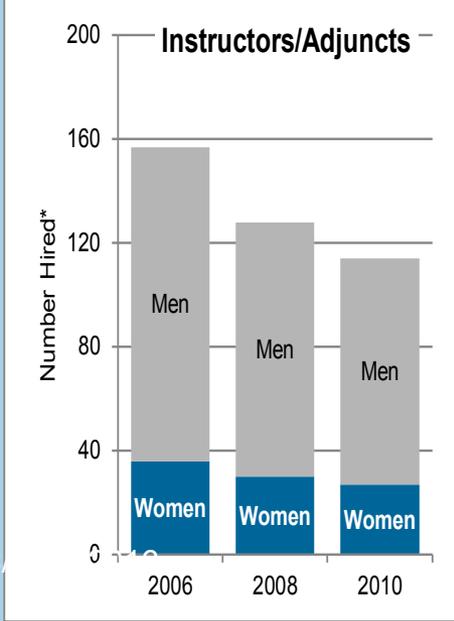
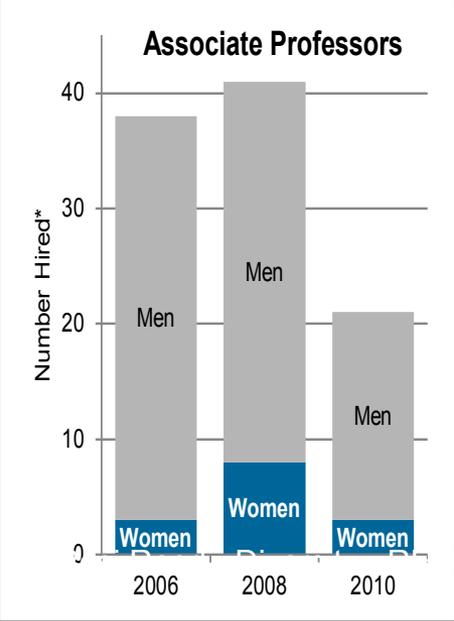
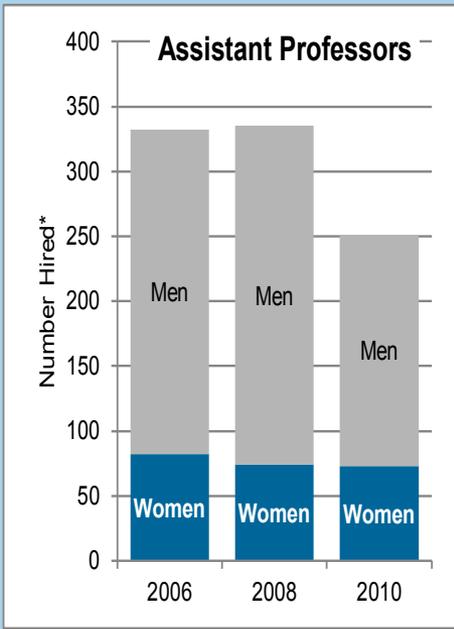
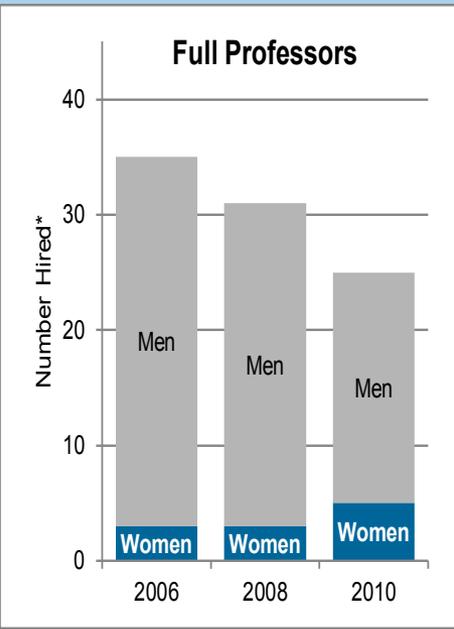


## Race and Ethnicity of Physics PhDs

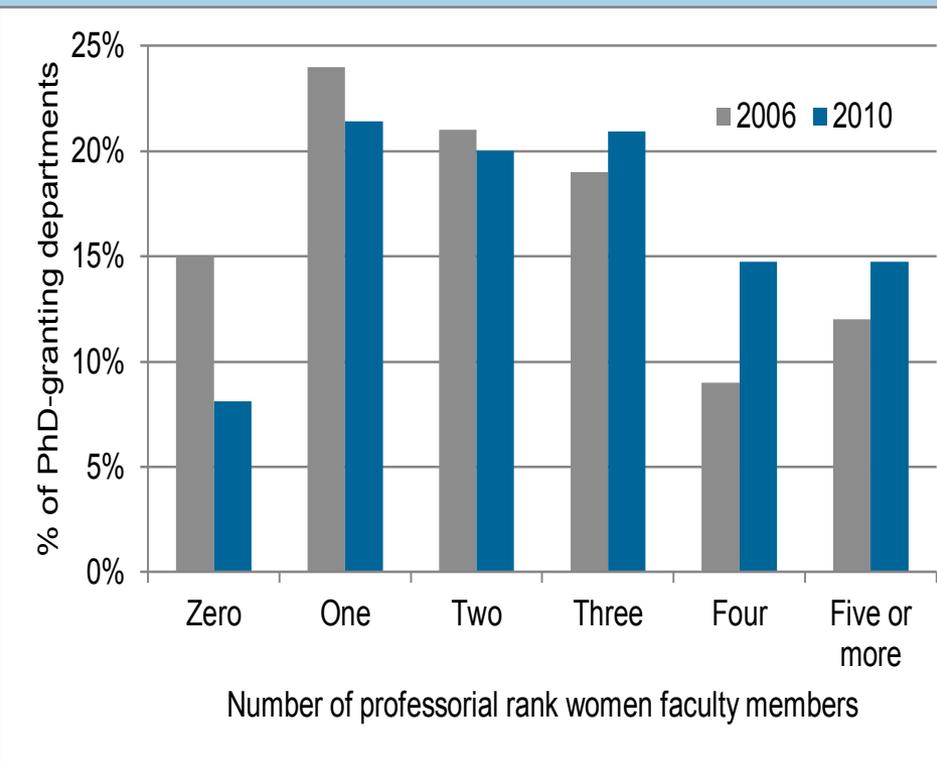
	3-Year Average Number	Percent of all Physics PhDs	Percent of U.S. Physics PhDs*
White	744	45	88
Asian American	41	2	5
Hispanic American	28	2	3
African American	17	1	2
Other U.S. Citizens	13	1	2
Non-U.S. Citizens	826	49	-
Total	1,669	100%	100%

# Men and Women among Newly-Hired Physics Faculty Members

<http://www.aip.org/statistics>



## Percentage of PhD-Granting Physics Departments by Number of Women Faculty Members



# African Americans in physics - statistics

- 12.4% of US population
- 9% of bachelor's degrees
- 2.9% of bachelor's degrees in physics

African Americans among bachelor's degree recipients in selected fields in 2008.

Degree Field	African Americans	All Bachelor's	Percent African American
Business & Mgmt	35,495	344,892	10.3
Psychology	10,271	92,966	11.0
Education	8,170	124,846	6.5
Biological Sciences	6,003	82,387	7.3
Engineering	4,568	86,048	5.3
Computer Science	4,011	38,916	10.3
Chemistry	910	11,829	7.7
Mathematics	796	15,840	5.0
Physics	144	4,875	2.9
Geoscience	89	4,313	2.1
Bachelor's across all fields	142,576	1,579,955	9.0

AIP Statistical Research Center compiled data collected by the NCES.

<http://www.aip.org/statistics>

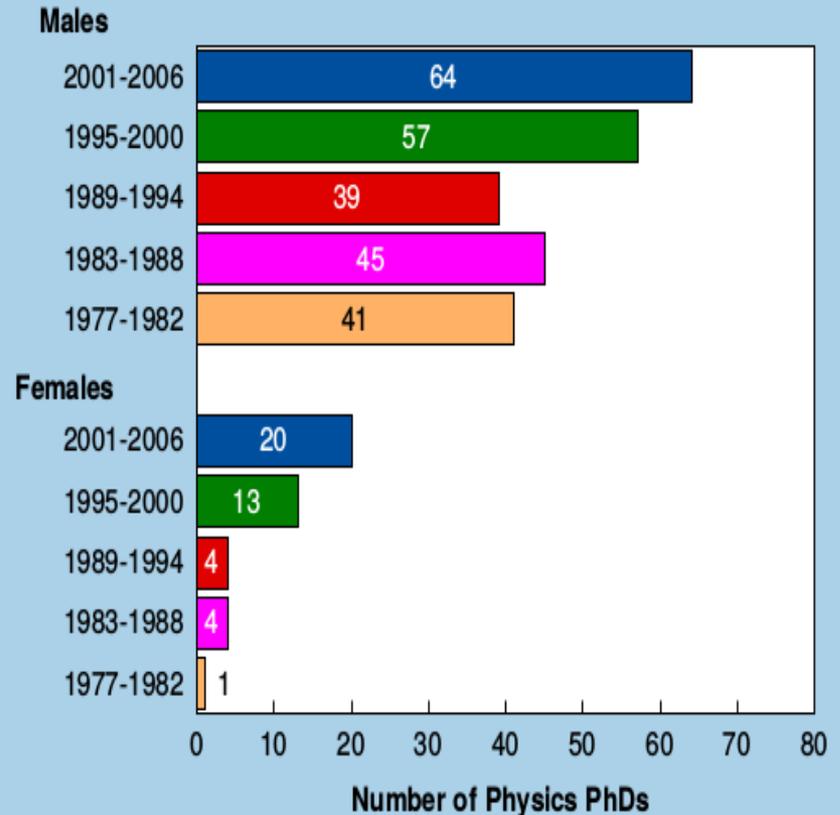
# African Americans in physics - statistics

- Number of African Americans getting physics degrees each year is decreasing
- 15/760 universities which offer a physics degree in the US graduated 37% of African Americans getting bachelor's degrees in physics
- All but two of these were Historically Black Colleges and Universities

# African Americans in physics - statistics

- 12.4% of US population
- 3.6% of PhD's
- <1% of PhD's in physics

African Americans earning physics PhDs by sex for each 6-year period from 1977 through 2006.



AIP Statistical Research Center compiled data collected by the NSF.

<http://www.aip.org/statistics>

# African Americans in physics - statistics

- 1.2% of faculty at PhD granting institutions
- 3% at bachelor's only departments
- Half of all African American faculty are at HBCUs

Number of African Americans who are physics faculty by highest degree awarded by department, 2000, 2004, and 2008.

Highest Degree Awarded	African American			All Faculty Members		
	2008	2004	2000	2008	2004	2000
By Department						
PhD	66	64	38	5,400	5,400	4,950
Masters	29	29	41	800	900	750
Bachelor's	88	78	62	2,900	2,700	2,550
All Departments	183	171	141	9,100	9,000	8,250

Data collected and compiled by AIP Statistical Research Center.

<http://www.aip.org/statistics>

# Minorities - statistics

**Minority and Ethnic Profile of Physics PhDs,  
Classes of 2007 & 2008.**

	Two-Year Average	Percent Physics PhDs
White	601	41
Asian American	32	2
Hispanic American	16	1
African American	15	1
Other US Citizens	17	1
Non-US Citizens	800	54
Total	1,480	100%

## BIAS | Implicit Biases in Perception



.We automatically perceive race and gender

People automatically encode ‘primitive category’ information.

Zarate, M. A., & Smith, E. R. (1990). *Person categorization and stereotyping*. *Social Cognition*, 8(3), 161-185.

“Men are better at math than women”

“Women are sweeter than men”

“Blacks are better athletes”

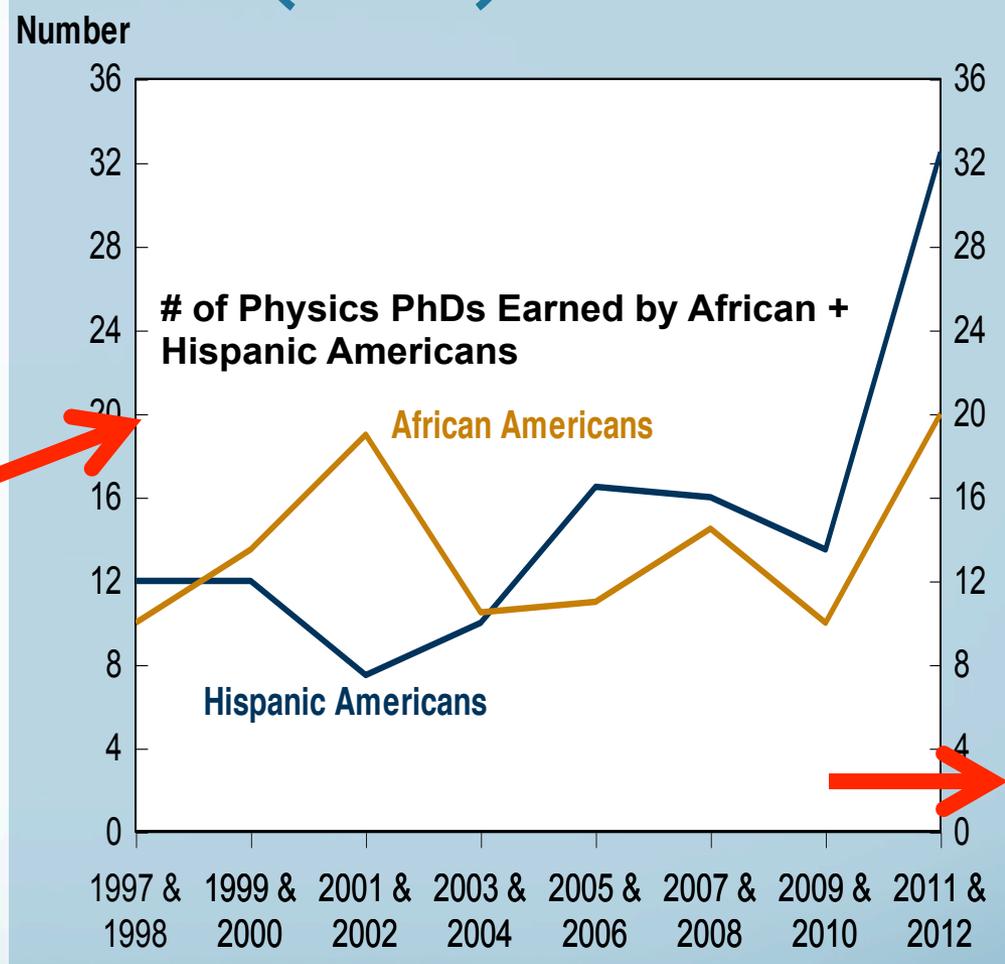
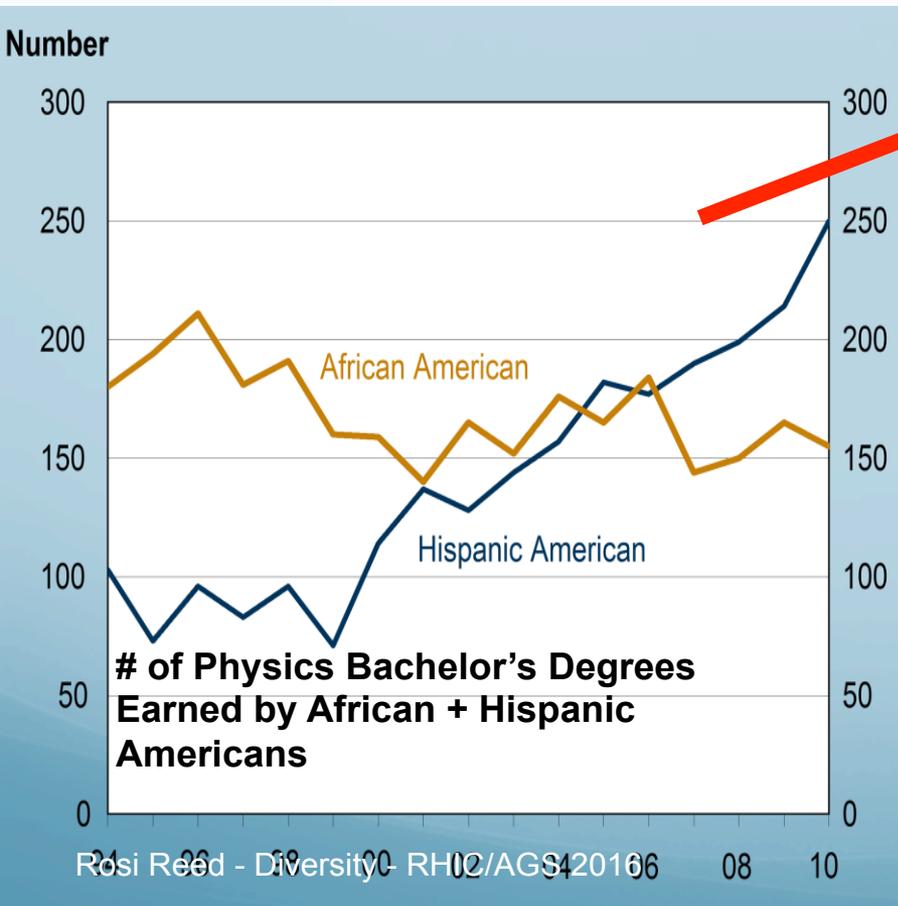


Brewer, M. B. (1988). *A dual process model of impression formation*. Lawrence Erlbaum Associates, Inc.

It happens unintentionally. Biases influence how we judge other people, whether we want them to or not.



# Race: Data (US)



In 2010 African Americans earned 2.5% of Physics BS degrees, down from 5% in 1994.

# Race: Data (US)

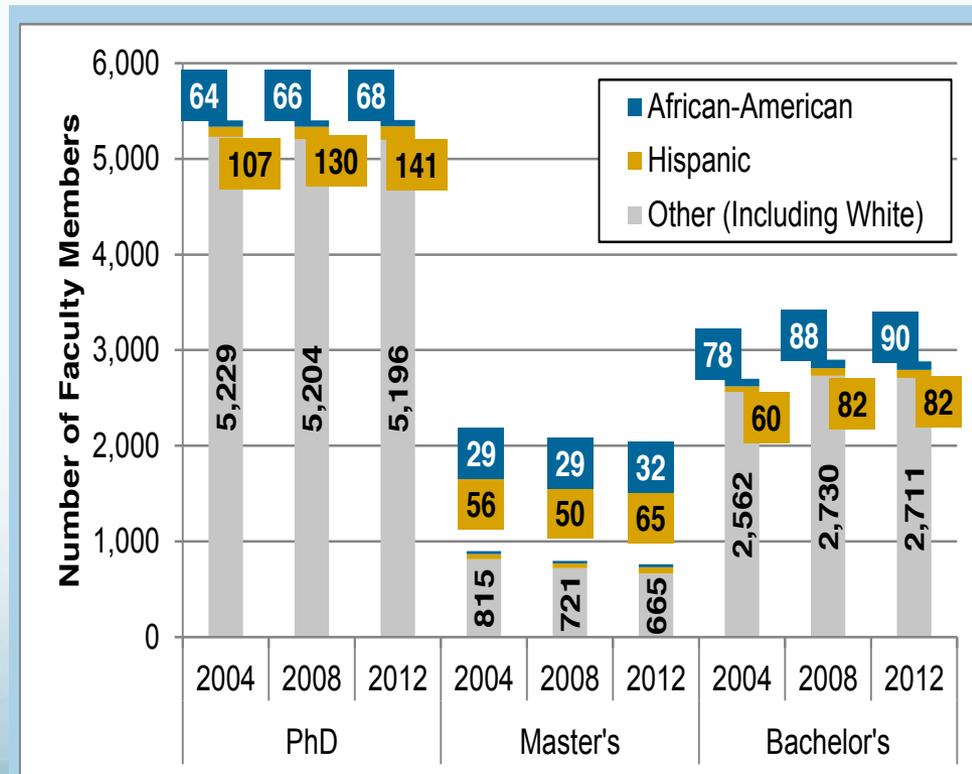
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	Physics			All Disciplines*
	2004 (%)	2008 (%)	2012 (%)	2009 (%)
African-American	2.0	2.2	2.1	6.6
Asian	10.6	13.2	14.3	6.0
Hispanic	2.7	3.1	3.2	4.0
White	82.2	80.0	79.2	74.9
Other	2.2	1.5	1.2	0.5



Trends in faculty seem to match the trends from lower levels

# of African + Hispanic Physics Faculty by Highest Degree Awarded by Department



# Race: Trends (US)

- African Americans were 2.5% of the physics BS degrees in 2010.
  - 50% of the proportion in the mid-1990's.
- The # of physics PhDs earned by Hispanics Americans has increased ~300% during the last decade.
  - The # of African Americans earning physics PhDs has been flat
  - About 10 and 20 PhDs a year
- The # of Hispanic faculty members in physics has increased 29% since 2004
  - There were 288 in 2012
- The # of African-American faculty has increased 11% over the same period
  - There were 190 African-American in 2012

# Male Faculty

- <http://www.pnas.org/content/112/43/13201.full.pdf>
- Results across experiments showed that men evaluate the gender-bias research less favorably than women, and, of concern, this gender difference was especially prominent among STEM faculty (experiment 2). These results suggest a relative reluctance among men, especially faculty men within STEM, to accept evidence of gender biases in STEM. This finding is problematic because broadening the participation of underrepresented people in STEM, including women, necessarily requires a widespread willingness (particularly by those in the majority) to acknowledge that bias exists before transformation is possible.