



Planetary Decadal Survey State of the Profession

- The Numbers – demographics
- Diversity, Equity & Inclusion
- Cultural Factors

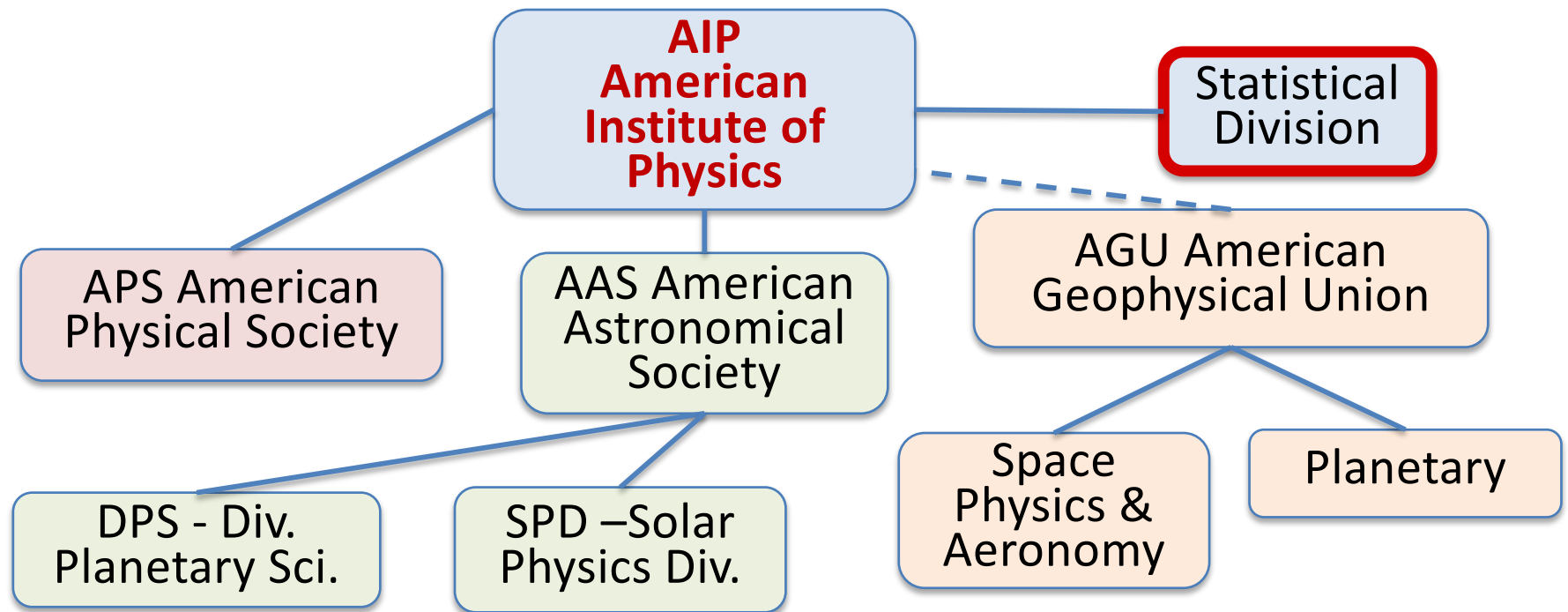
Task 9: “The state of the profession including issues of diversity, inclusion, equity, and accessibility, the creation of safe workspaces, and recommended policies and practices to improve the state of the profession.”



*Think Global, Act Local –
some personal observations*

The acronym soup of professional organizations

AIP Statistical Research Center
best position to gather numbers
- they know their stuff!



Also GSA, LPSC....

National Academy of Sciences & NASA

- NASA cannot do surveys of the workforce
- NASA can pay NAS to run independent studies
Such as Decadal Surveys and focused studies

*The National
Academies of* | SCIENCES
ENGINEERING
MEDICINE

About Us

Event

**Increasing Diversity and Inclusion in the Leadership of
Competed Space Missions**

How large are these overlapping areas?

EXOPLANETS!

Exoplanet magnetospheres

Astronomy & Astrophysics

Planetary Sciences

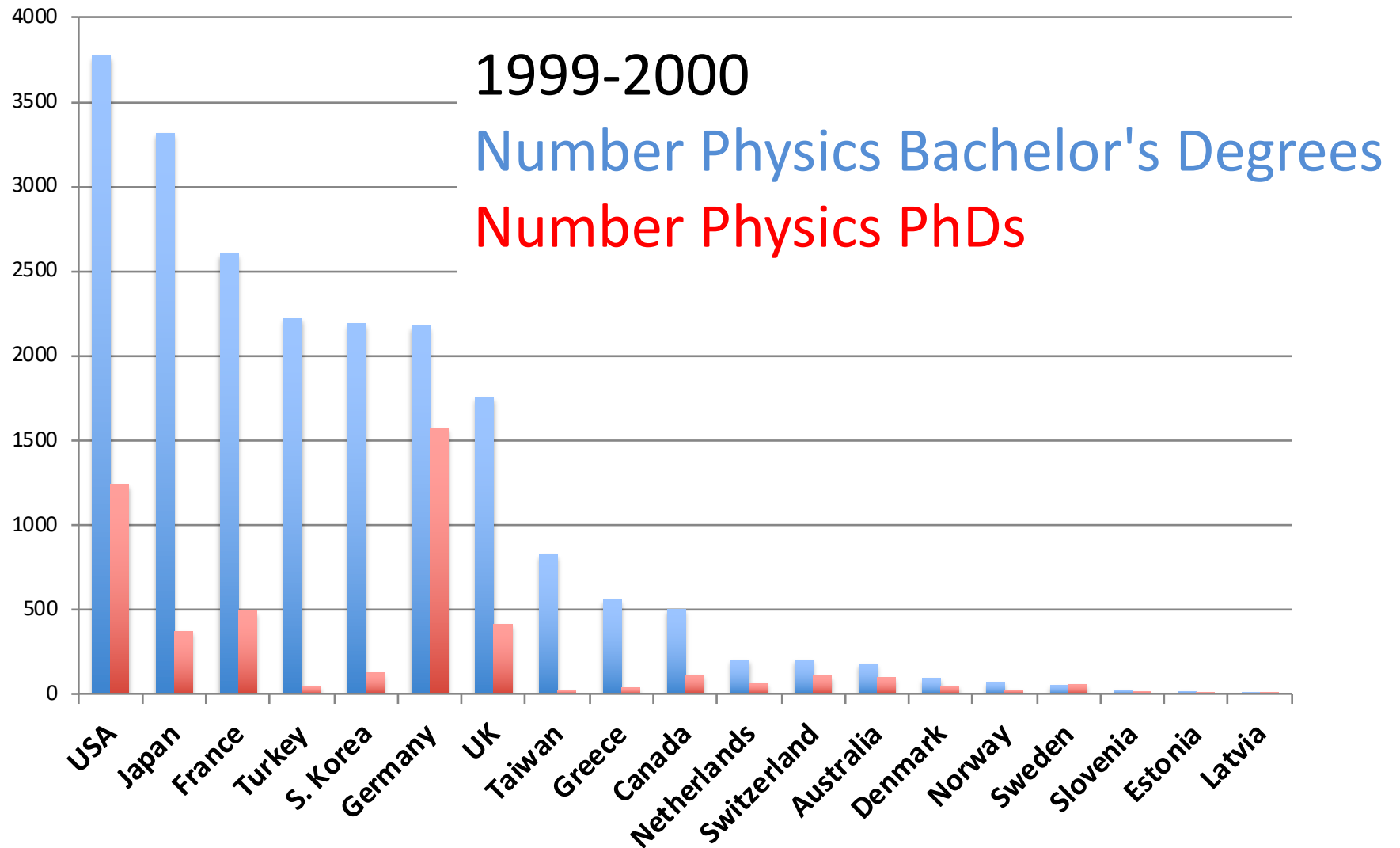
Solar & Space Physics

Stellar/solar winds
Star-nebula
momentum

Magnetospheres
Atmospheric escape
Comets, Radiolysis

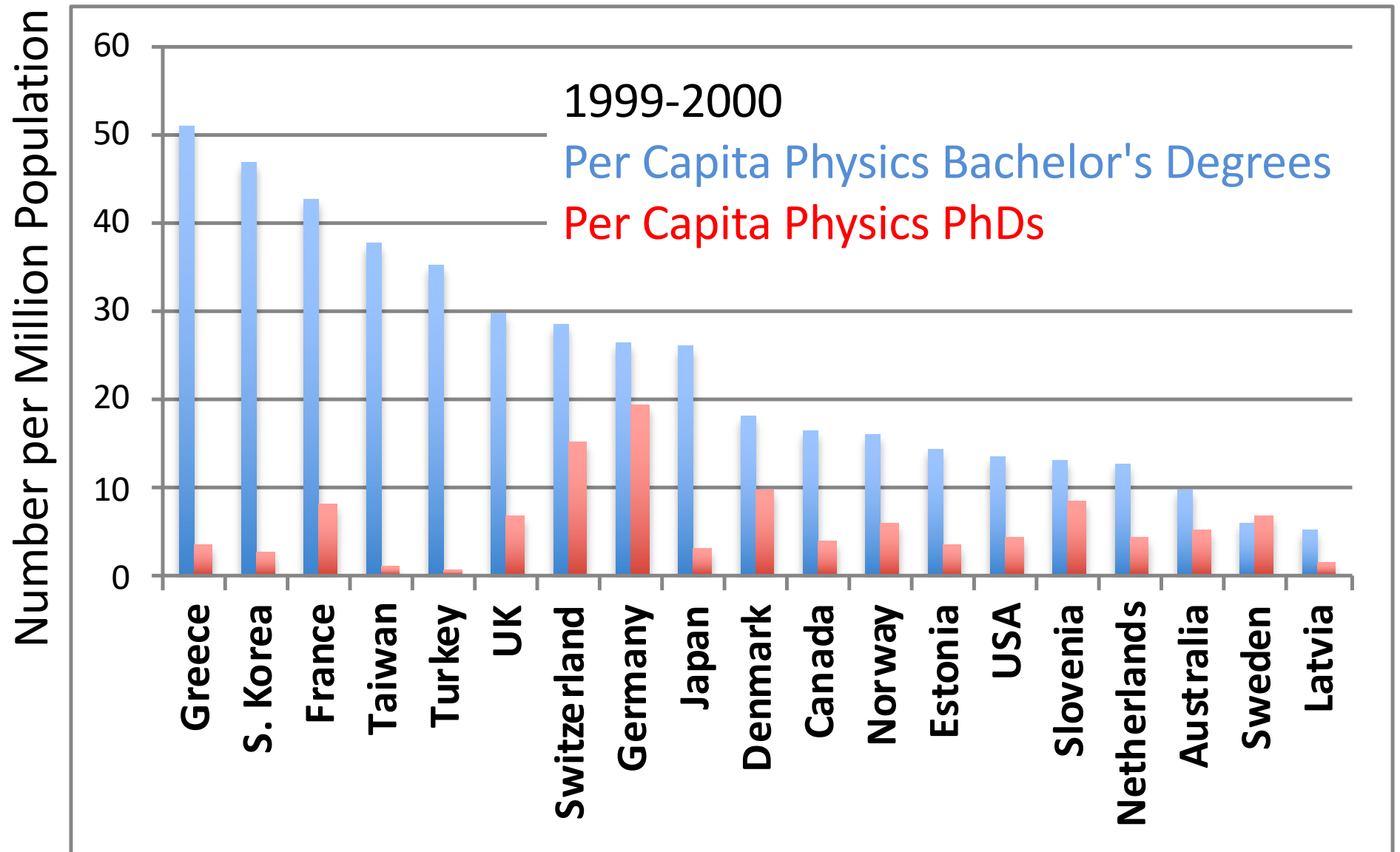
Ideally.... We need
demographics of
**NASA's Science
Mission
Directorate**

International



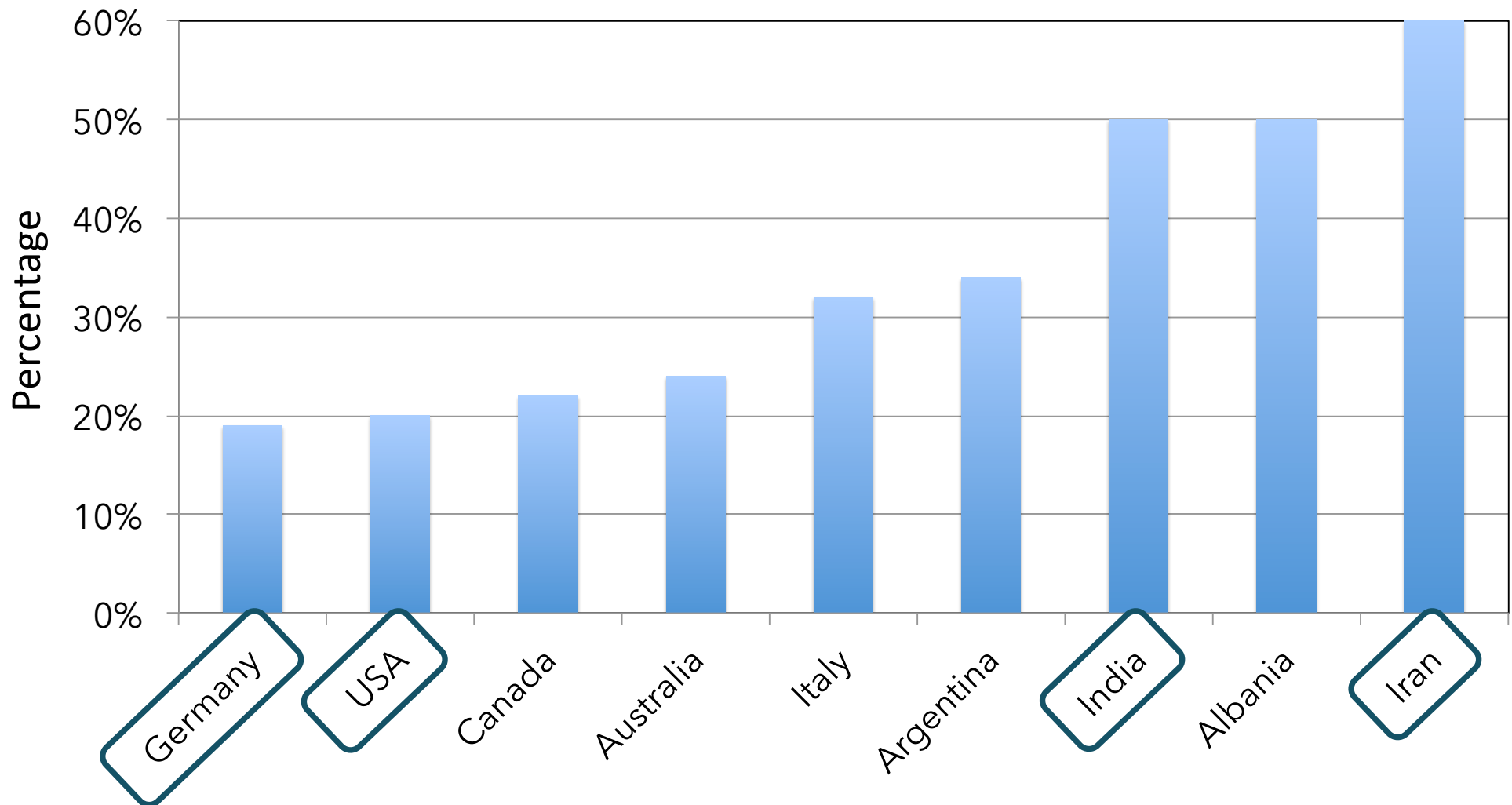
Many countries missing – India? China?

International



Probably not what you expect....

Percentage of **Undergraduate** Physics Degrees Awarded to Women

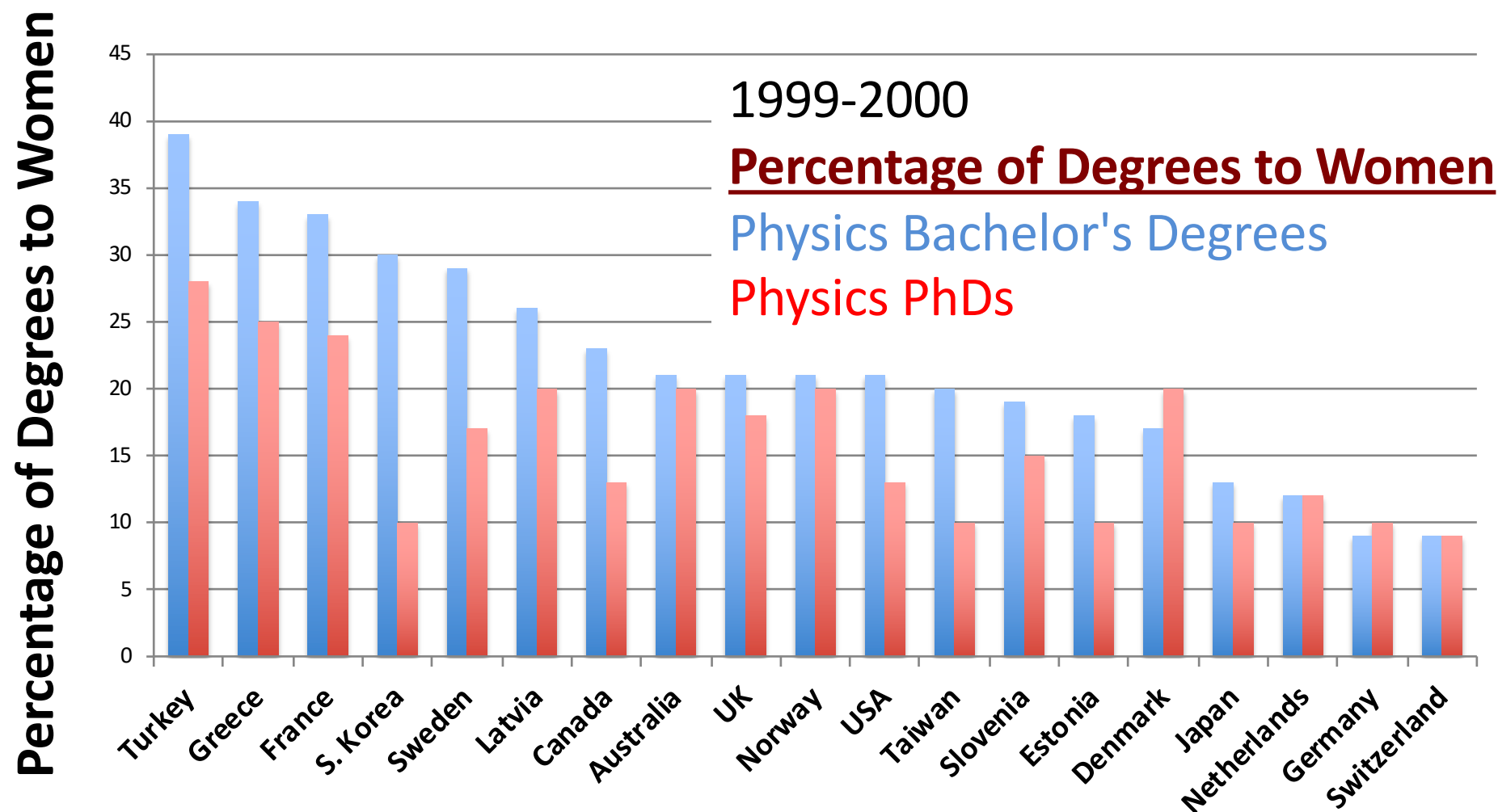


(IUPAP International Conference on Women in Physics Proceedings, 2005-2013)

International

Compiled by the AIP Statistical Research Center

<http://www.aip.org/sites/default/files/statistics/women/women-speakagain-05.pdf>



National Surveys

Astrophysics: 2013 AAS Survey by AIP

63% response = 1583 Respondants

-> **2040 PhD astrophysicists in US**

Not all PhDs

Solar & Space Physics: 2013 NRC Decadal Survey

AGU-SPA, AAS-SPD, Space Weather Week

51% response = 1305 Respondants

-> **2300 PhD solar, space & upper atmos. in US**

Planetary: 2011 AIP Survey

62% Response = 2622 Respondants

-> **1200 PhD planetary scientists in US**

Attendees/Members of Planetary Conference/Section

	LPSC	AGU	DPS	All Three
LPSC	1280	345	90	
AGU		264	124	
DPS			358	
All Three				161

Planetary Survey 2011 Results

Attendees/Members of Planetary Conference/Section

	LPSC	AGU	DPS	All Three
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DPS			358	
All Three				161

Missing:

- Geological Society of America
- American Meteoritical Society

<https://lasp.colorado.edu/home/mop/resources/planetary-science-workforce-survey/2011-planetary-science-survey/>

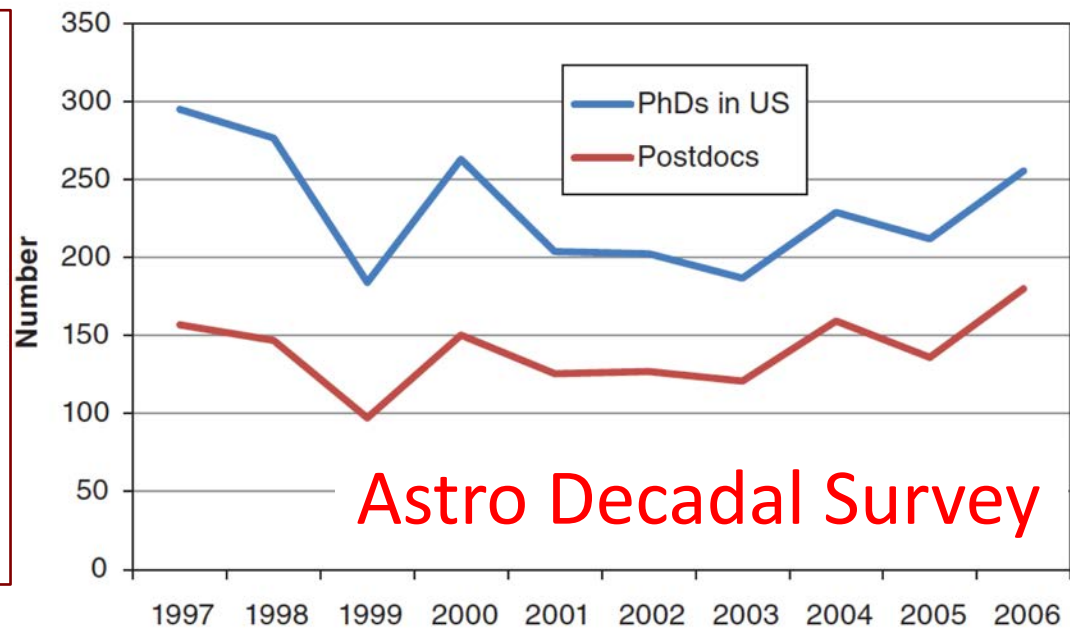
Planetary Science is a very interdisciplinary field – scientists span wide range of professional organizations, go to different conferences

PhDs/year in US

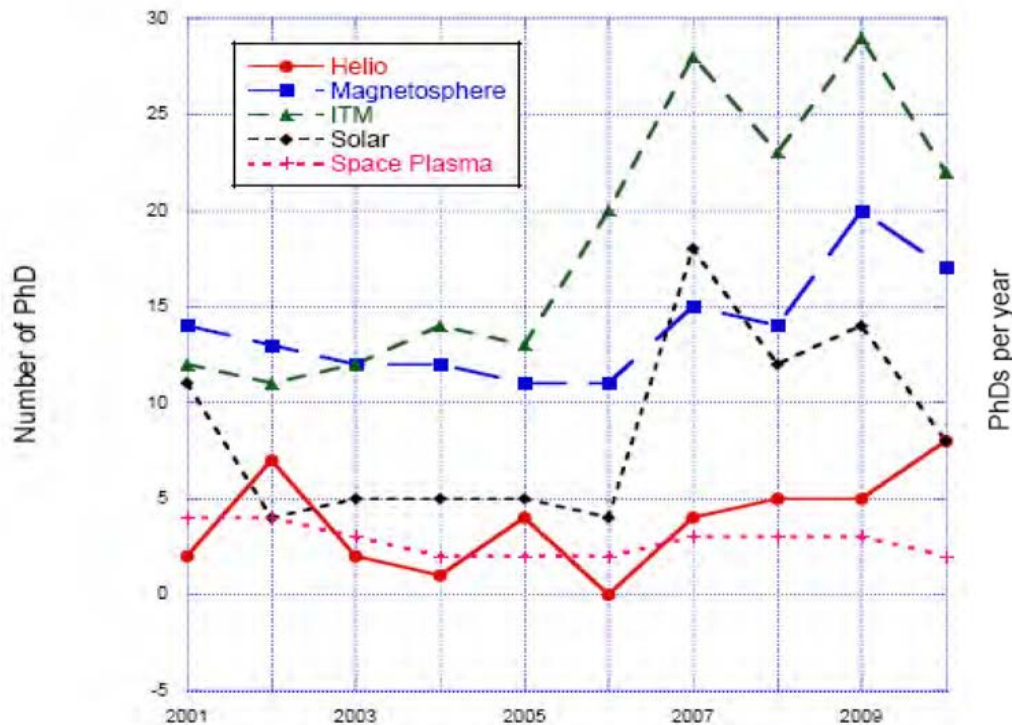
Astro ~250

Solar & Space Physics ~62

Planetary ~65



Solar & Space Physics



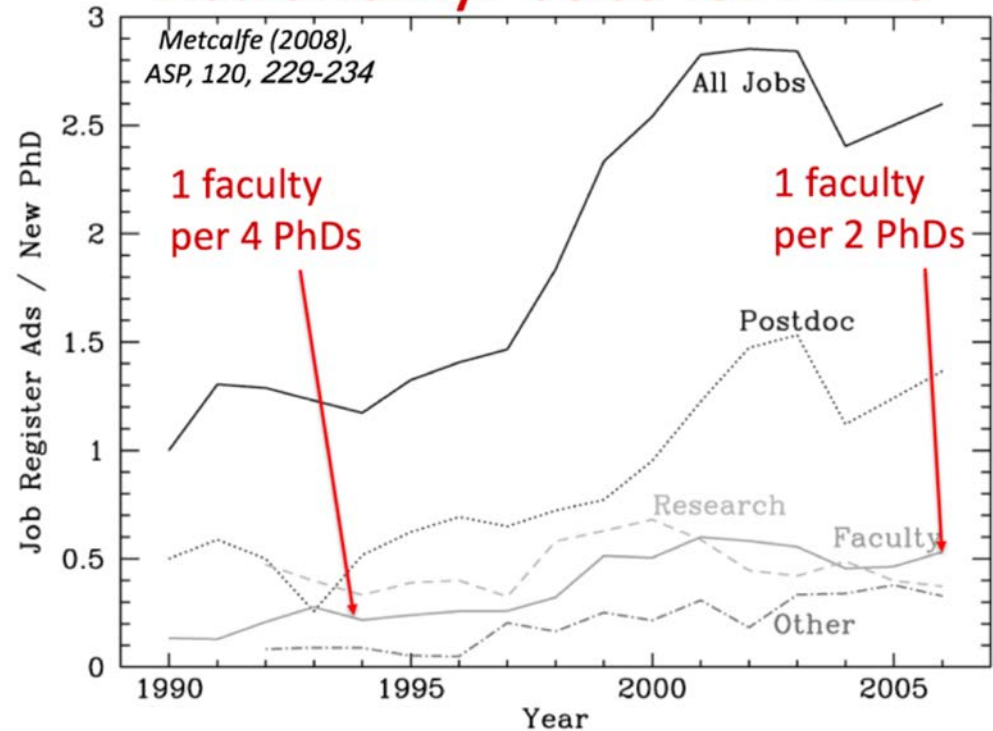
Solar & Space Physics



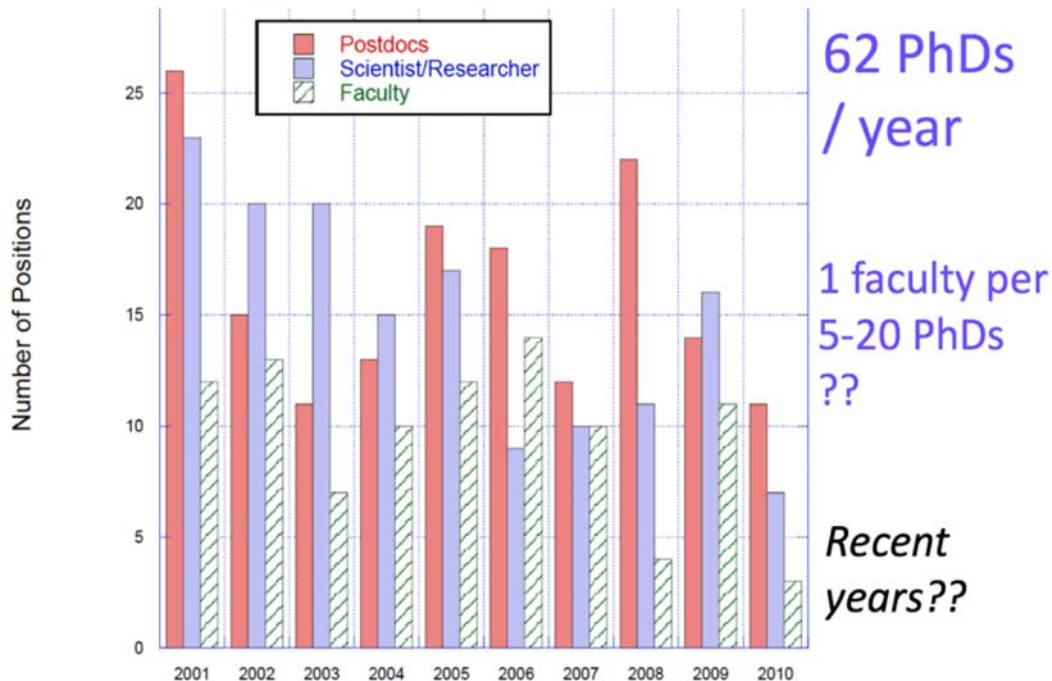
US National Surveys

1. Half PhDs leave academia
2. Few faculty jobs per PhD
3. PhDs get great jobs
- 4. *More non-academic career advice needed!***

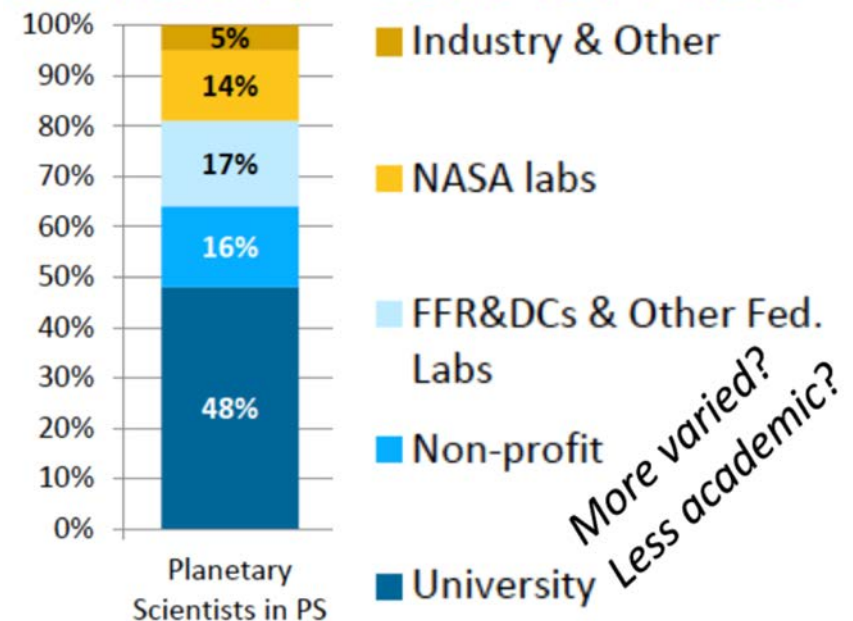
Astronomy: Jobs for PhDs



Solar & Space Physics - Jobs for PhDs

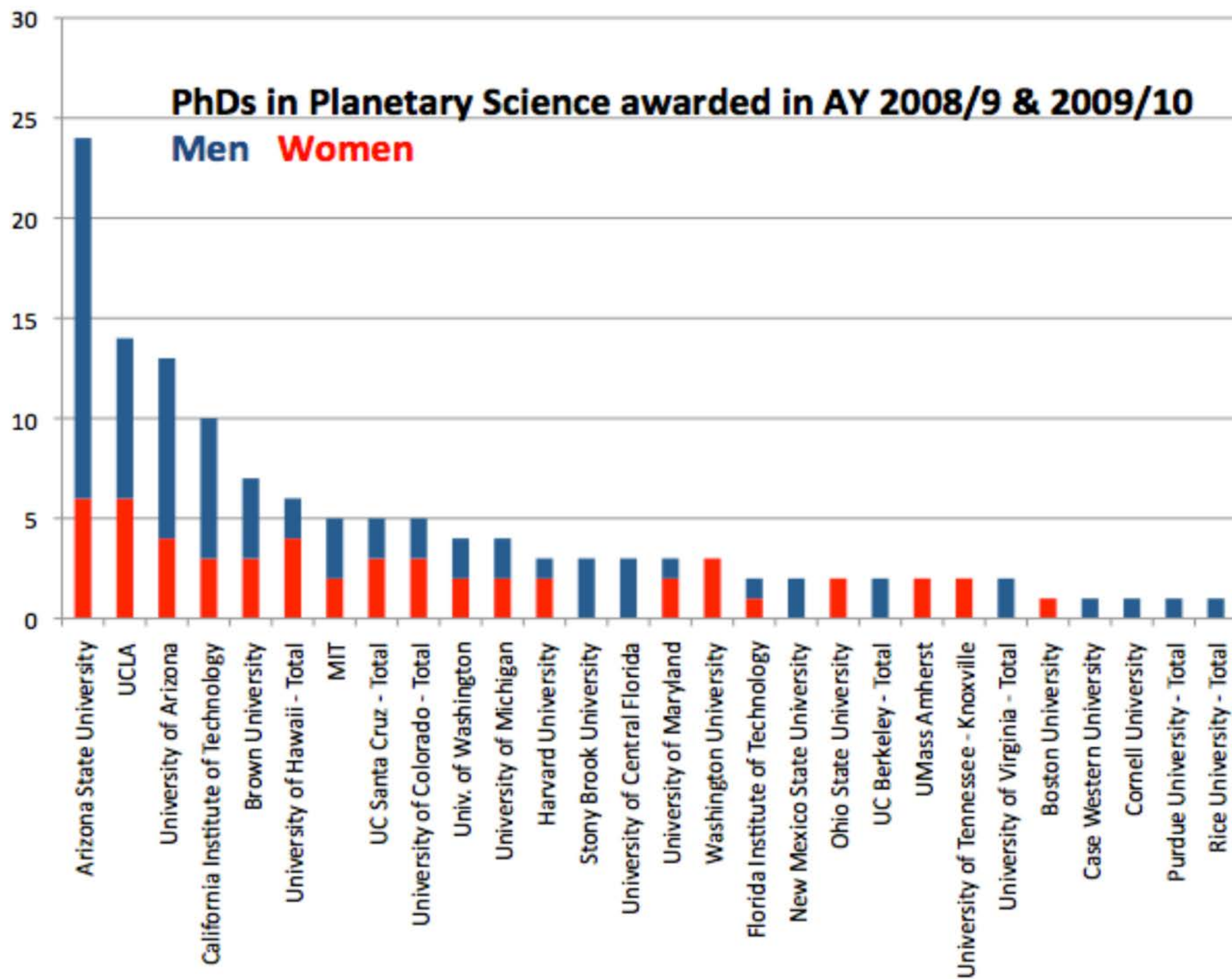


Planetary - Jobs for PhDs



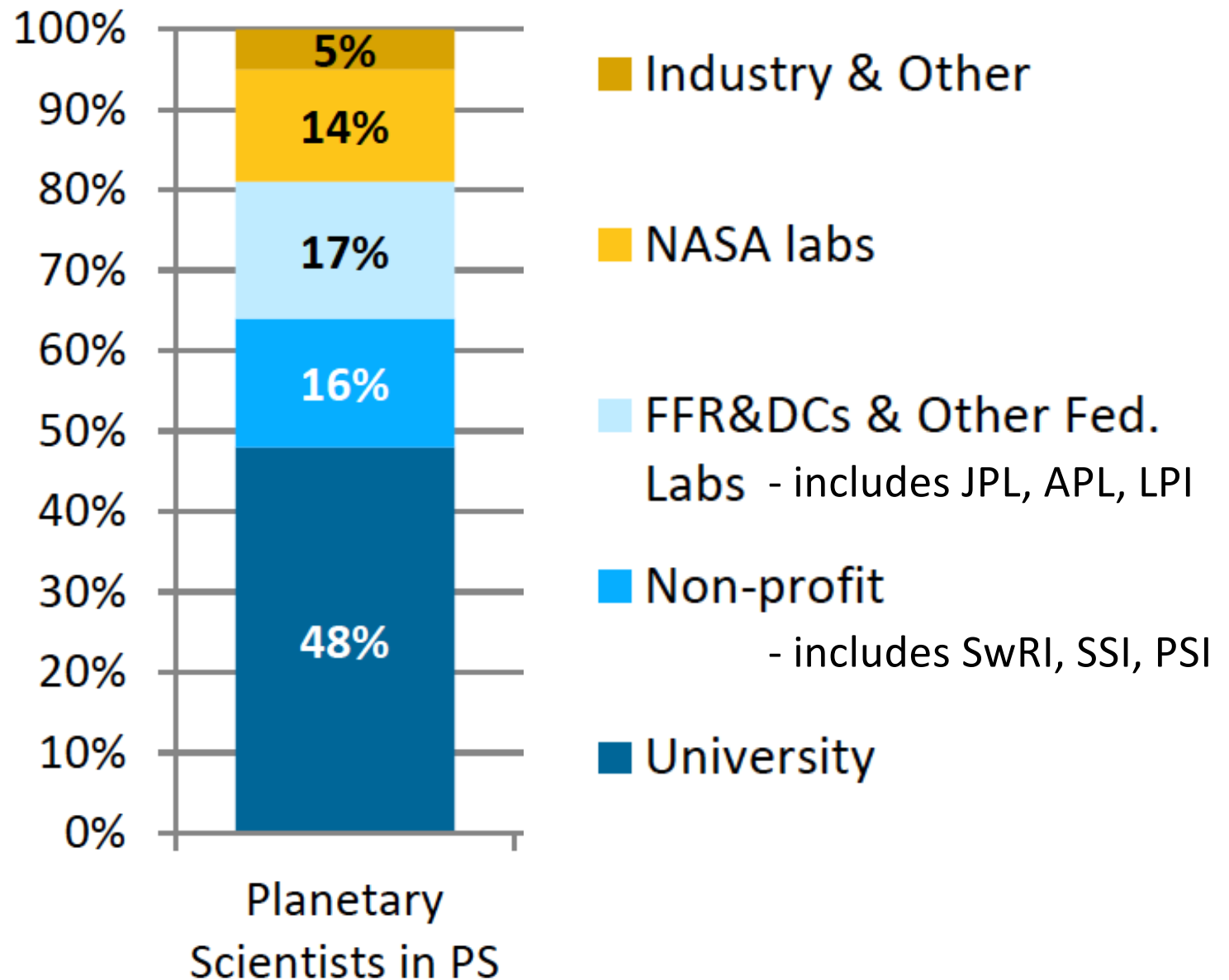
PhDs in Planetary Science awarded in AY 2008/9 & 2009/10

Men Women



EMPLOYMENT

Planetary Survey 2011



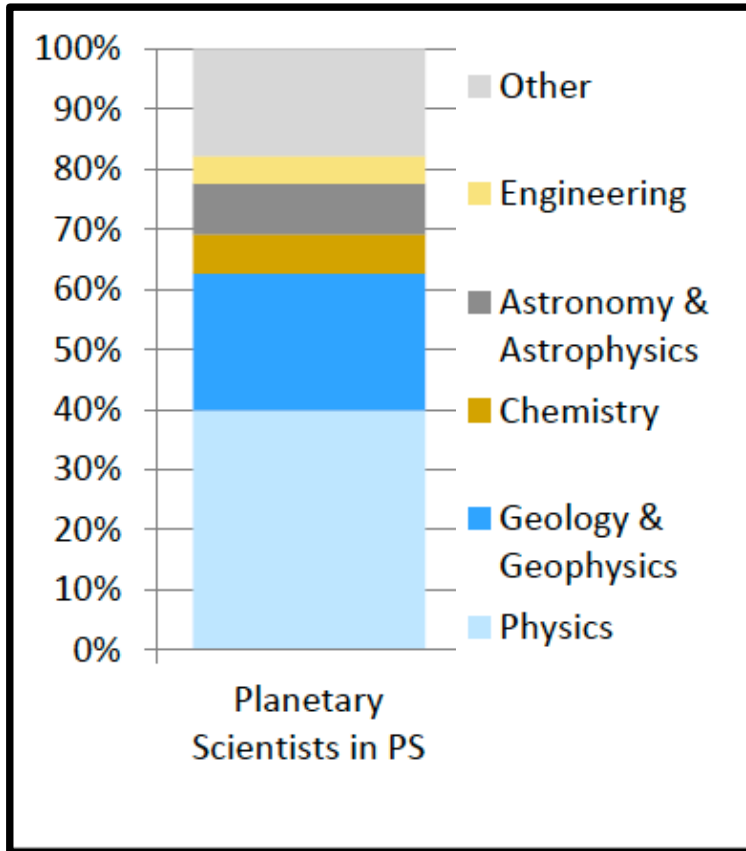
Planetary Survey 2011 Results

	Men	Women
Age Respondents	Respondents	Respondents
Lower quartile	38	33
Median	48	38
Upper quartile	58	48

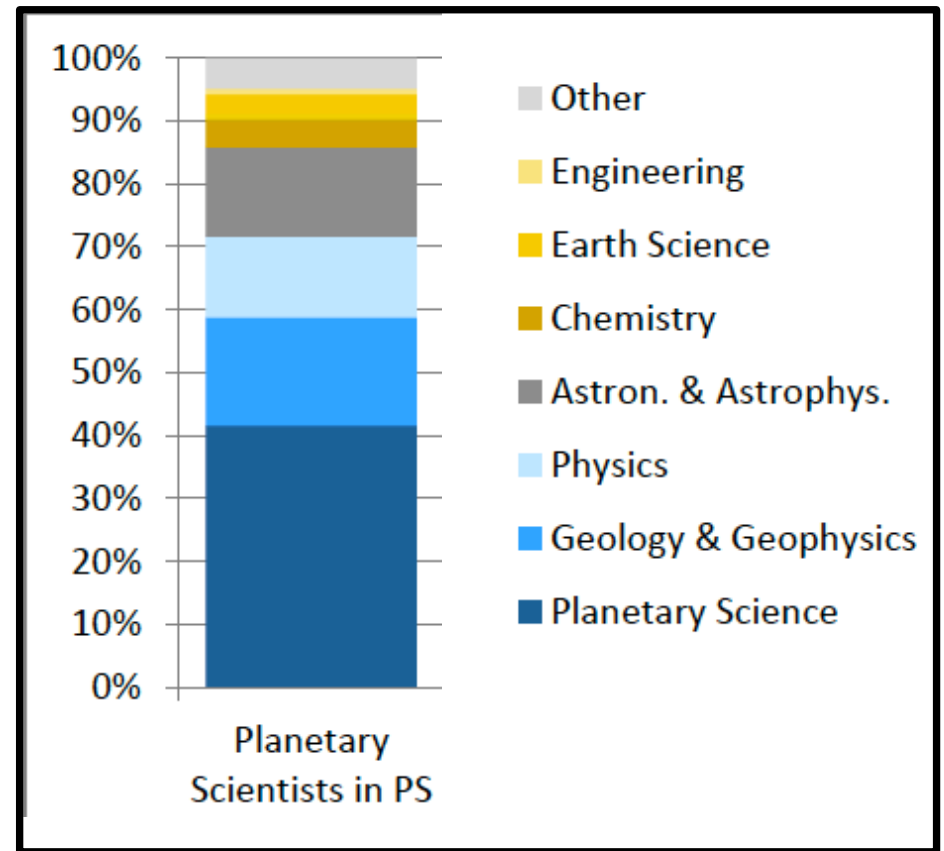
Female population is a little younger

Planetary Survey 2011 Results

Undergraduate Degree

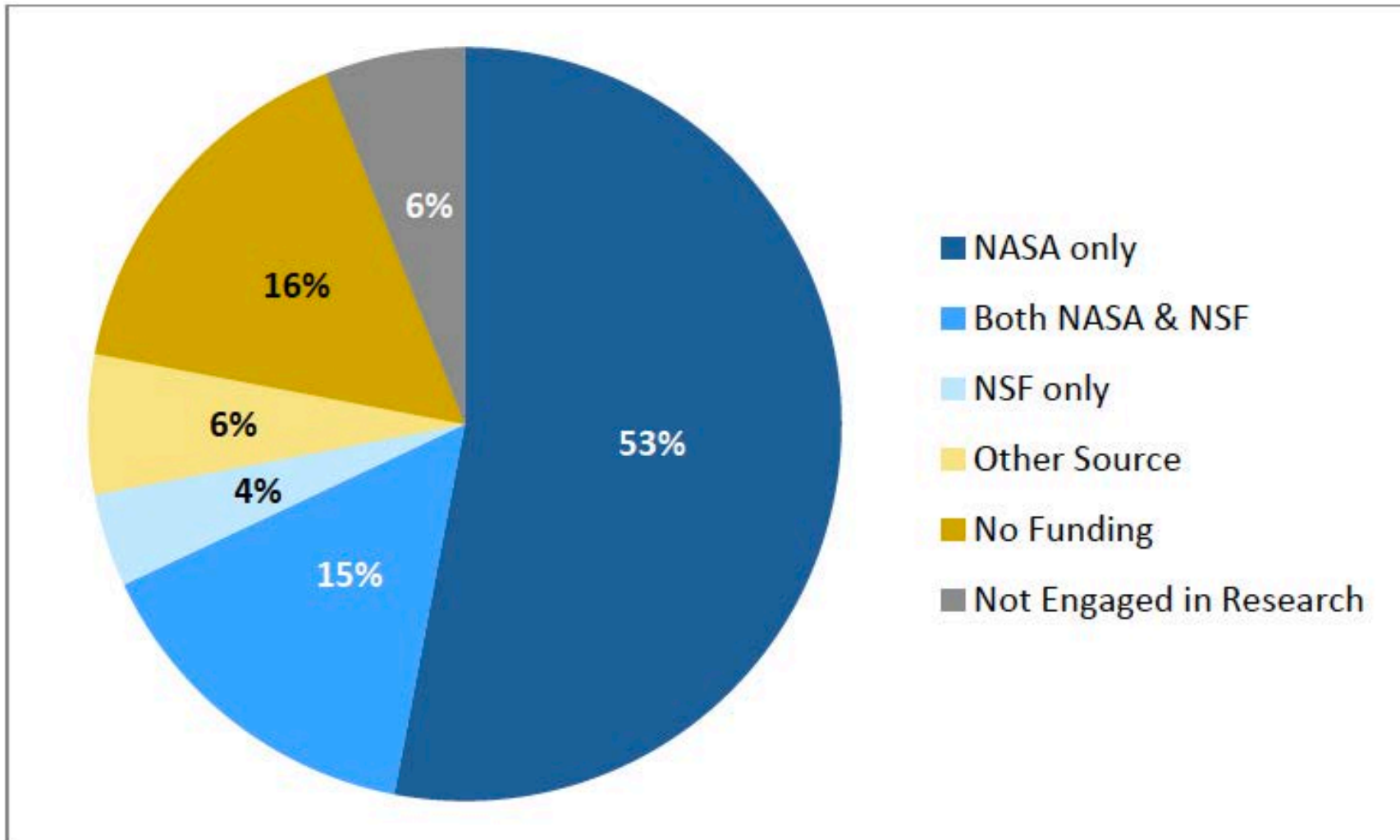


PhD Degree



Planetary Survey 2011 Results

Source of Funds to Support Research

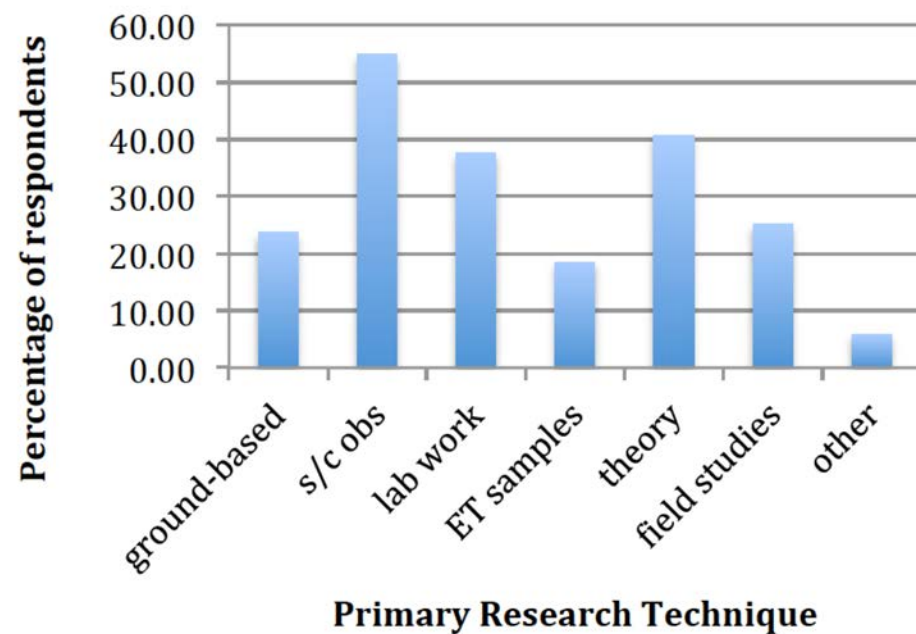
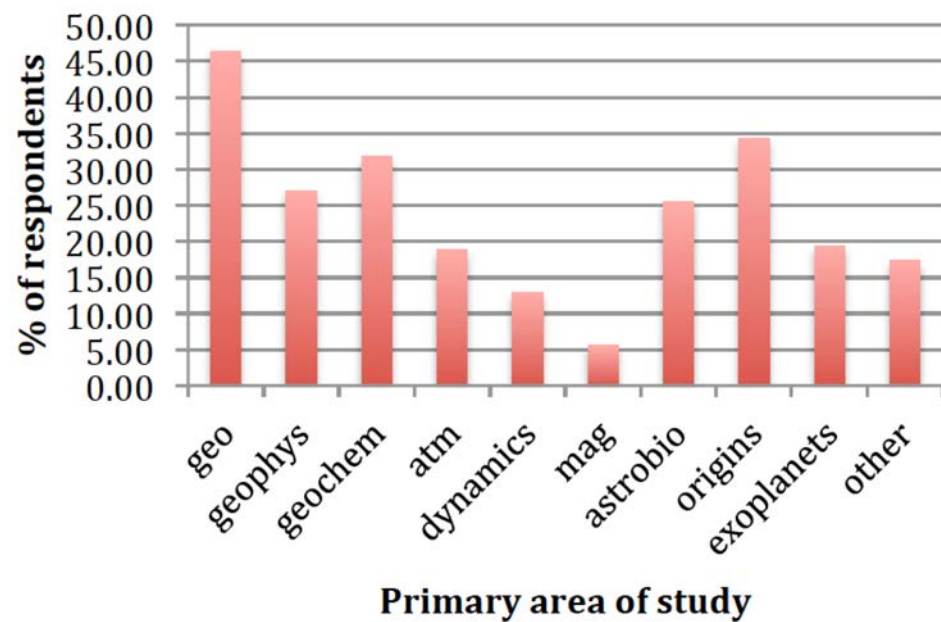


Planetary Survey 2020 Results

- DPS, GSA, LPSC – no AGU!
 - 47% response
 - 2400 respondents (include students)
 - DPS paid AIP for the survey. But did not provide funds to do full analysis.
 - The Decadal Survey (via NAS->AIP) should pay for full analysis to be done.
-
1. PhD production rate increasing – to ~70/year (~30/yr before 2005)
 2. Studying in diverse areas (~45% do not use spacecraft data)
 3. Population more diverse
 4. 42.5% at universities, 31.8% at research institutes, 8.1% at NASA centers
 5. PI of instrument or mission - significantly different male vs. women & URM
 6. NASA grants & missions support -> ~61% funding of non-faculty

Planetary Survey 2020 Results

White Paper



White Paper - Hendrix – DPS Survey – 5 Findings, 2 Recommendations

White Paper - Hendrix – DPS

2020 Survey

- Finding #1: Planetary Science as a field is getting larger.
- Finding #2: Planetary Scientists have diverse backgrounds and areas of study
- Finding #3: The vast majority of planetary scientists are employed at either Universities or Research Institutions
- Finding #4: The majority of scientists use NASA grants to fund their research

White Paper - Hendrix – DPS

2020 Survey

- Finding #5: While relatively few planetary scientists have proposed a mission as a PI, white men are more likely to have been involved in a mission proposal as either a PI or Co-I.
 - Recommendation #2: NASA should continue, and increase, their efforts to diversify mission leadership.
- Finding #6: Planetary Scientists' careers are most negatively affected by the balance

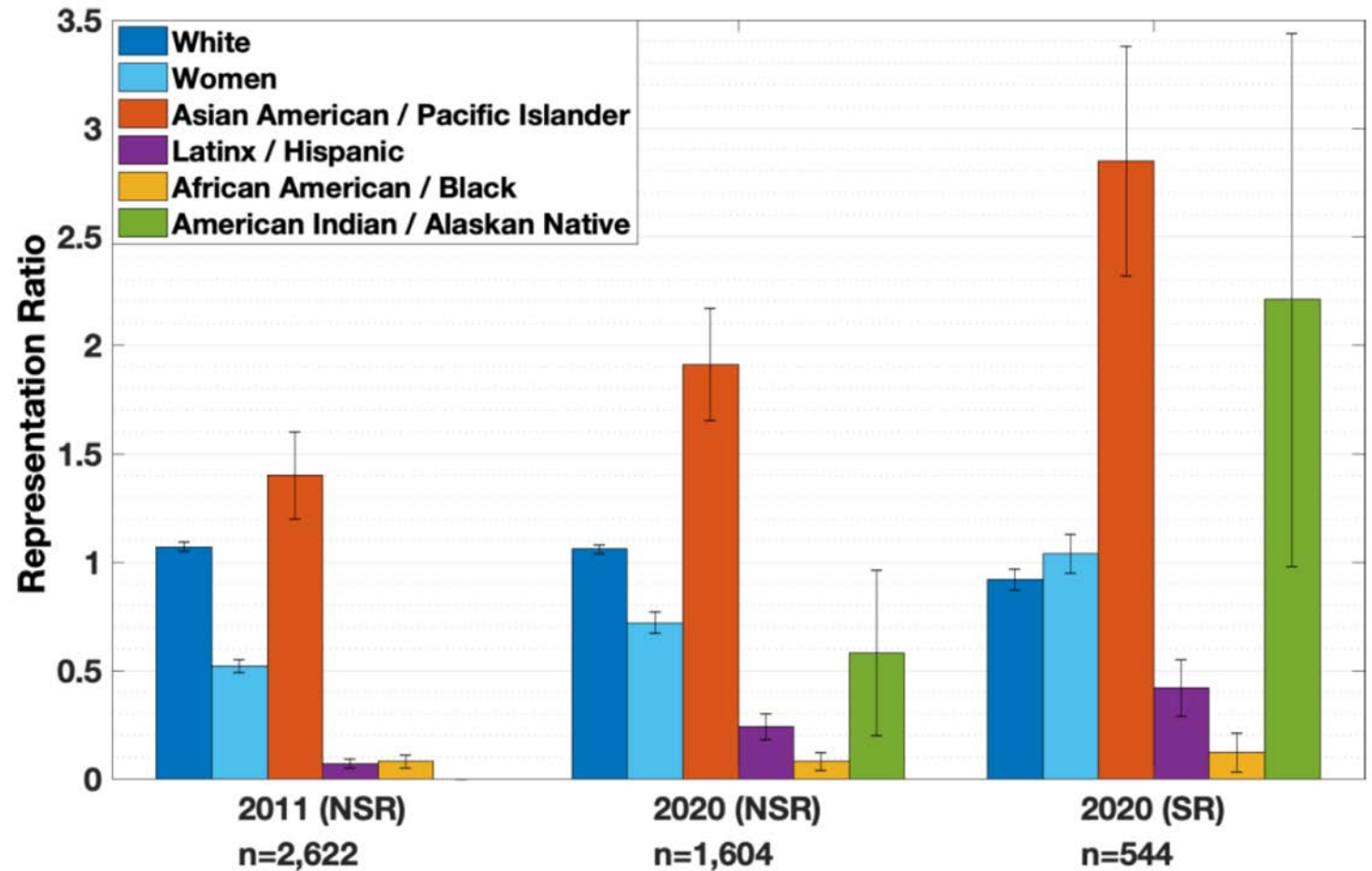
White Paper - Rivera-Valentin - Equity

White Paper

Used 2011 & 2020
surveys

Normalized to National
Civilian Labor Force

SR = Student
Researcher
NSR = Non-Student
Researcher

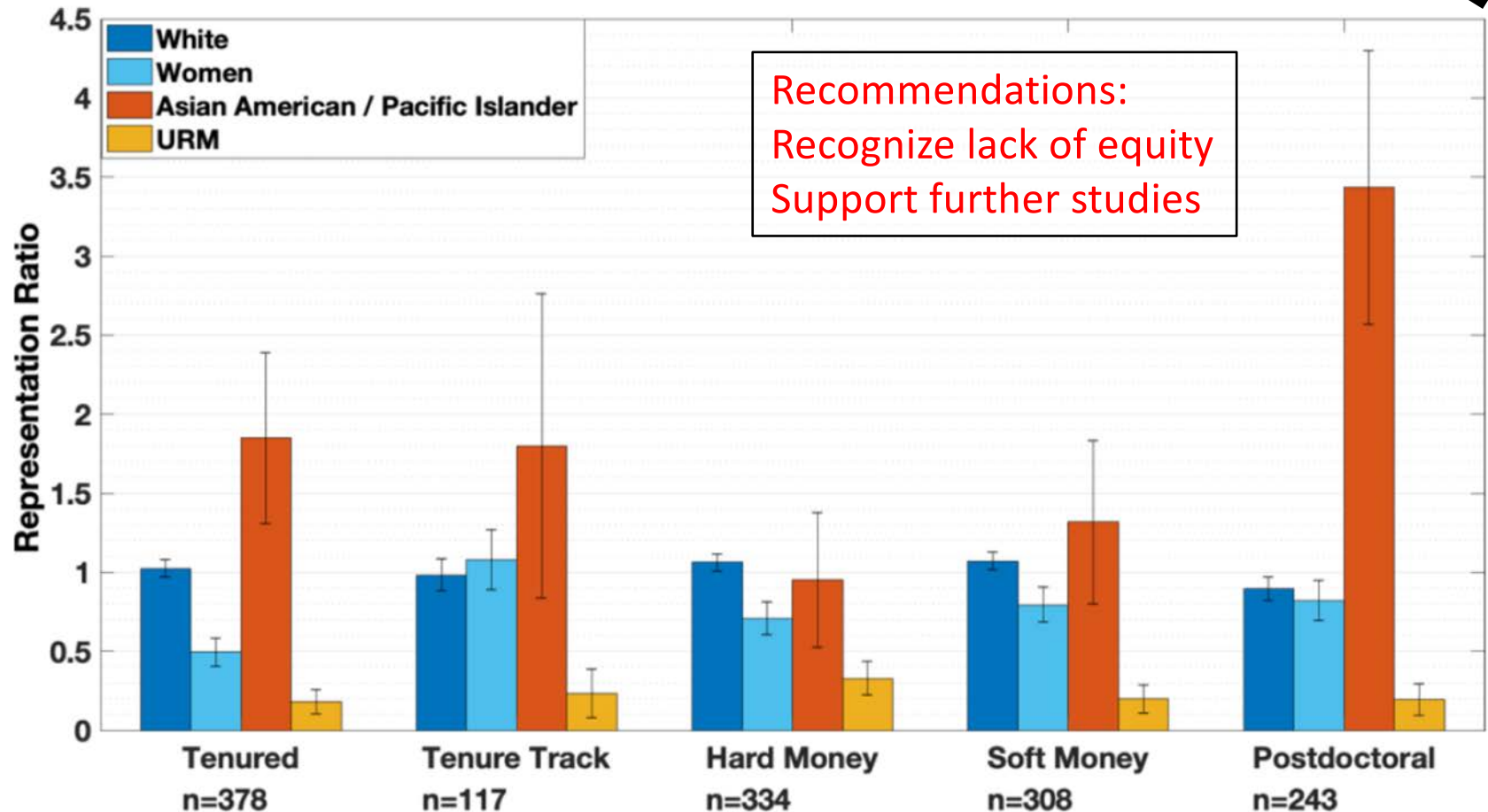


White Paper - Rivera-Valentin -

White Paper

Used 2011
& 2020
surveys

Normalized
to National
Civilian
Labor Force



White Paper - Rathbun-1 - Diversity

White Paper

"For every 3 white men that make it through the pipeline, there is 1 white woman. But, for every 20 white women, there are only 1-2 women of color. This means that more than 95% of potentially talented women of color are being left behind and thus are unable to contribute to the planetary science community."

Proposes 9 Recommendations
from:

Recommendation #1. The decadal survey report should explicitly **recognize the statistically significant underrepresentation** of people of color—particularly Black / African Americans, Latinx / Hispanics, and American Indian / Indigenous / Alaskan Native people—and that the diversity initiatives of the past several decades have not succeeded in substantially changing this .

To:

Recommendation #9: Planetary Scientists, their employers, professional societies, and other groups should actively and intentionally **find their own ways to assist in improving the diversity** in the field.

White Paper - Rathbun-2 - Inclusion

White Paper

"Problem: How can we ensure that the voices of the most marginalized in Planetary science are represented in the current Decadal Survey Process?"

Proposes 15 Recommendations to DS process
from:

The Decadal Survey co-chairs need to ensure that **voices** of underrepresented groups, particularly African-American, Latin American and indigenous scientists, are **represented in the final survey report** .

To:

All Decadal Survey committee members should undergo **implicit bias and racial sensitivity training** as early in the process as possible.

White Papers related to State of the Profession

27 White Papers on

1. Demographics (4)
2. Improving Diversity & Inclusion at NASA (4)
3. Improving Diversity & Inclusion generally (6)
4. Preventing Harrassment (4)
5. Other issues (9)

Note:

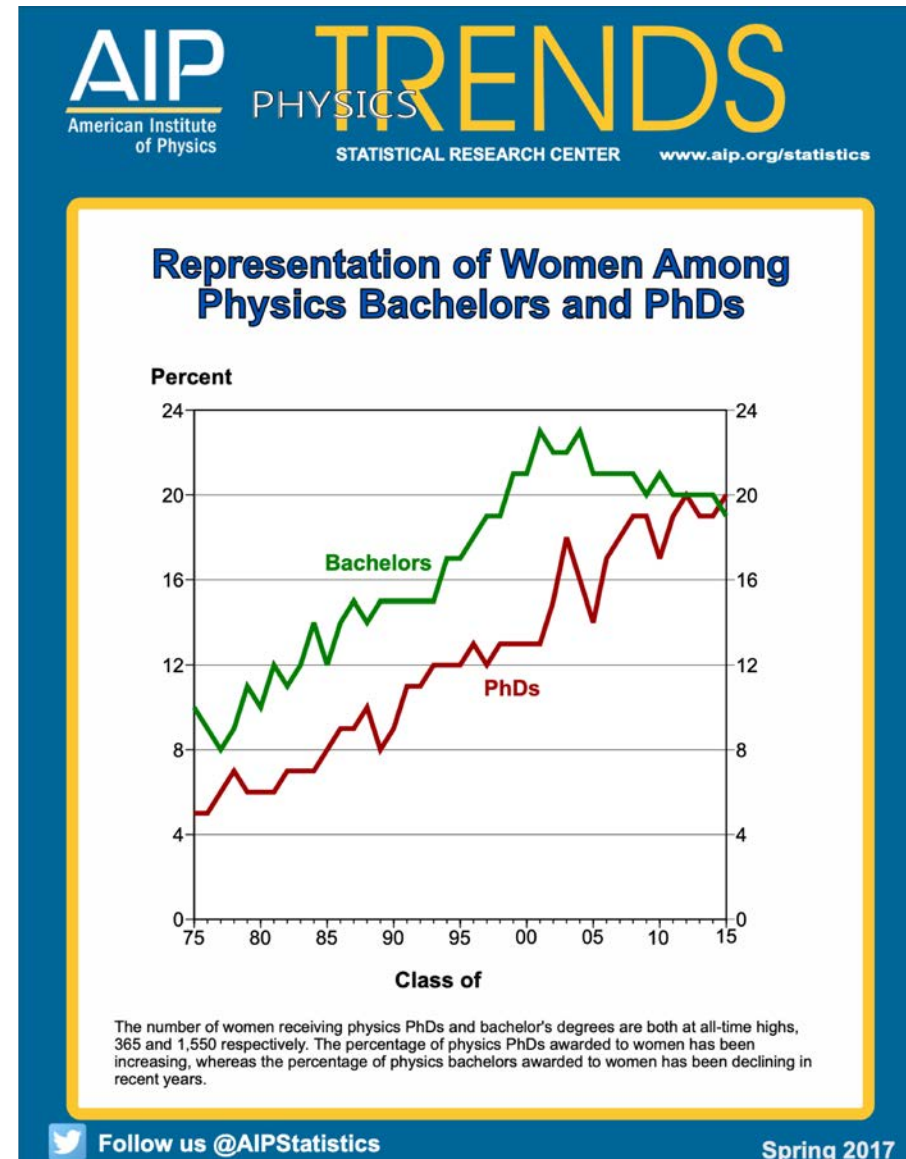
- There is NOT a separate panel for State of the Profession.
- Each panel & the steering group are expected to address these issues – and put statements – including Findings and Recommendations.
- Will the DS fund further analysis of Workforce Survey data?

Think Global, Act Local

– Fran's reflections

- I've been involved in women in physics – stats, culture – for decades
- I saw this 2017 bulletin and thought *"Really?! The percentage of bachelors to women has been dropping for 20 years?!"*

Physics
– the building blocks of our profession

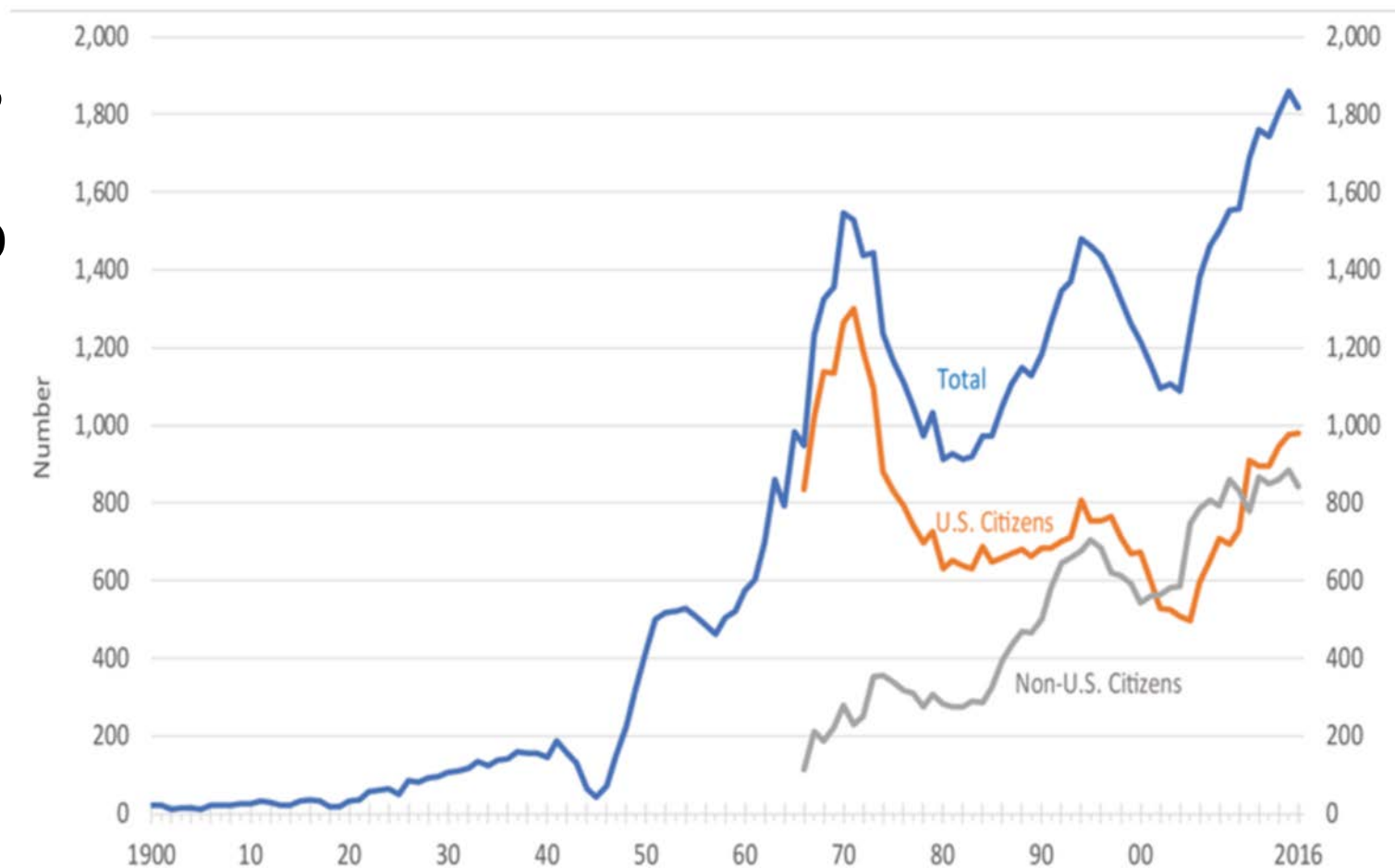


US PhD Statistics

– AIP

- ~2000 Physics PhDs/year
- ~50% non-US
- Does the PhD production meet the workforce needs of our science?
- How will this evolve?

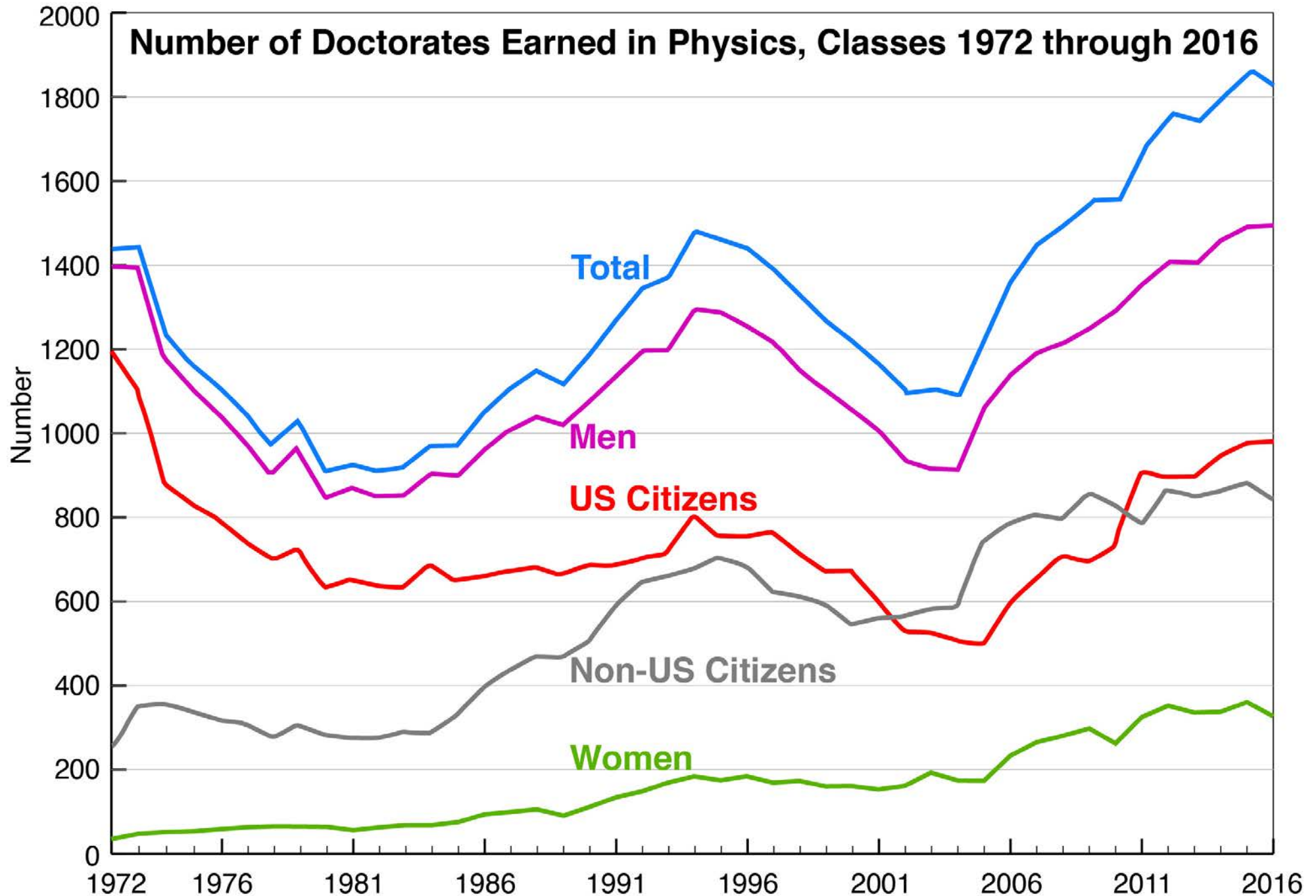
Physics PhDs Conferred in the U.S., 1900 through 2016.



US PhDs – AIP

~2000 Physics PhDs/year

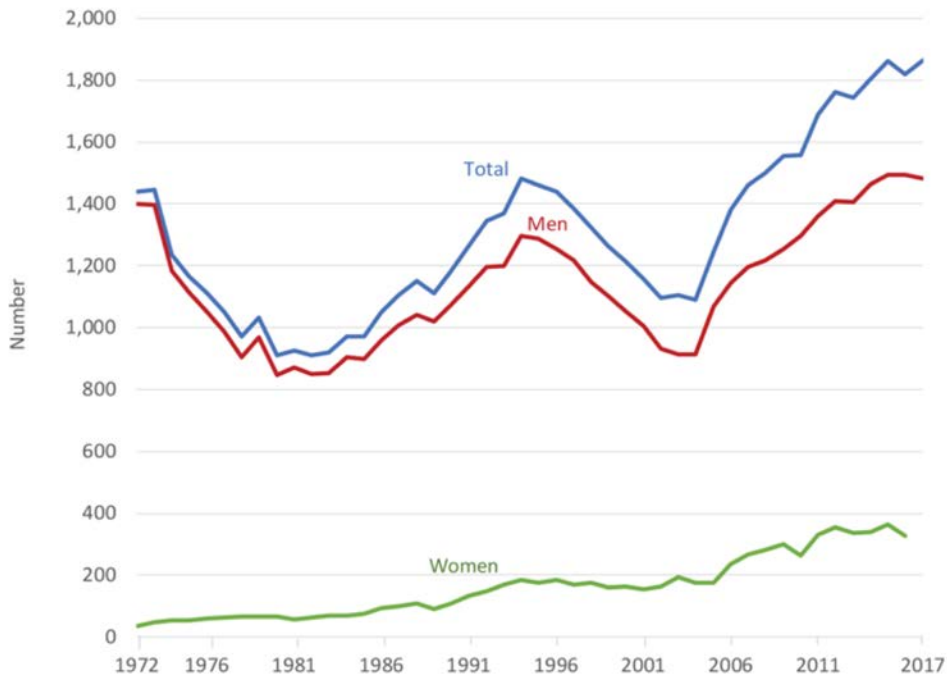
~20% women



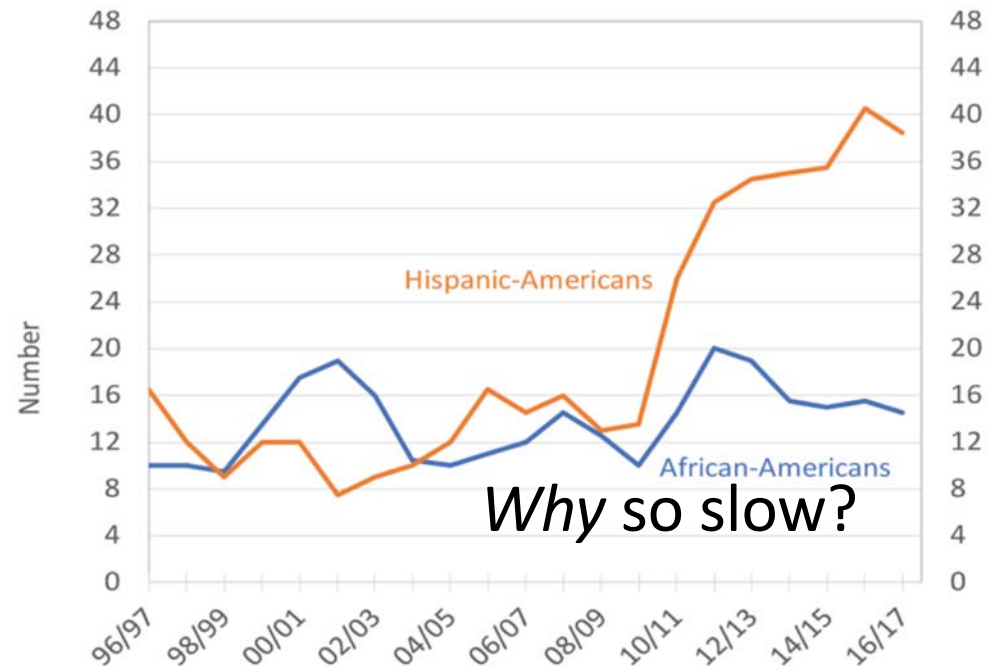
US PhD Statistics - AIP

- ~2000 Physics PhDs/year
- ~20% women
- ~3 % Hispanic-American or African-American
- Diversity is changing *slowly*

Number of Doctorates Earned in Physics, Classes 1972 through 2017.



Number of Physics Doctorates Earned by African-Americans and Hispanic-Americans, Classes 1996 through 2017.



Why so slow?

Note factor ~40 in vertical scale

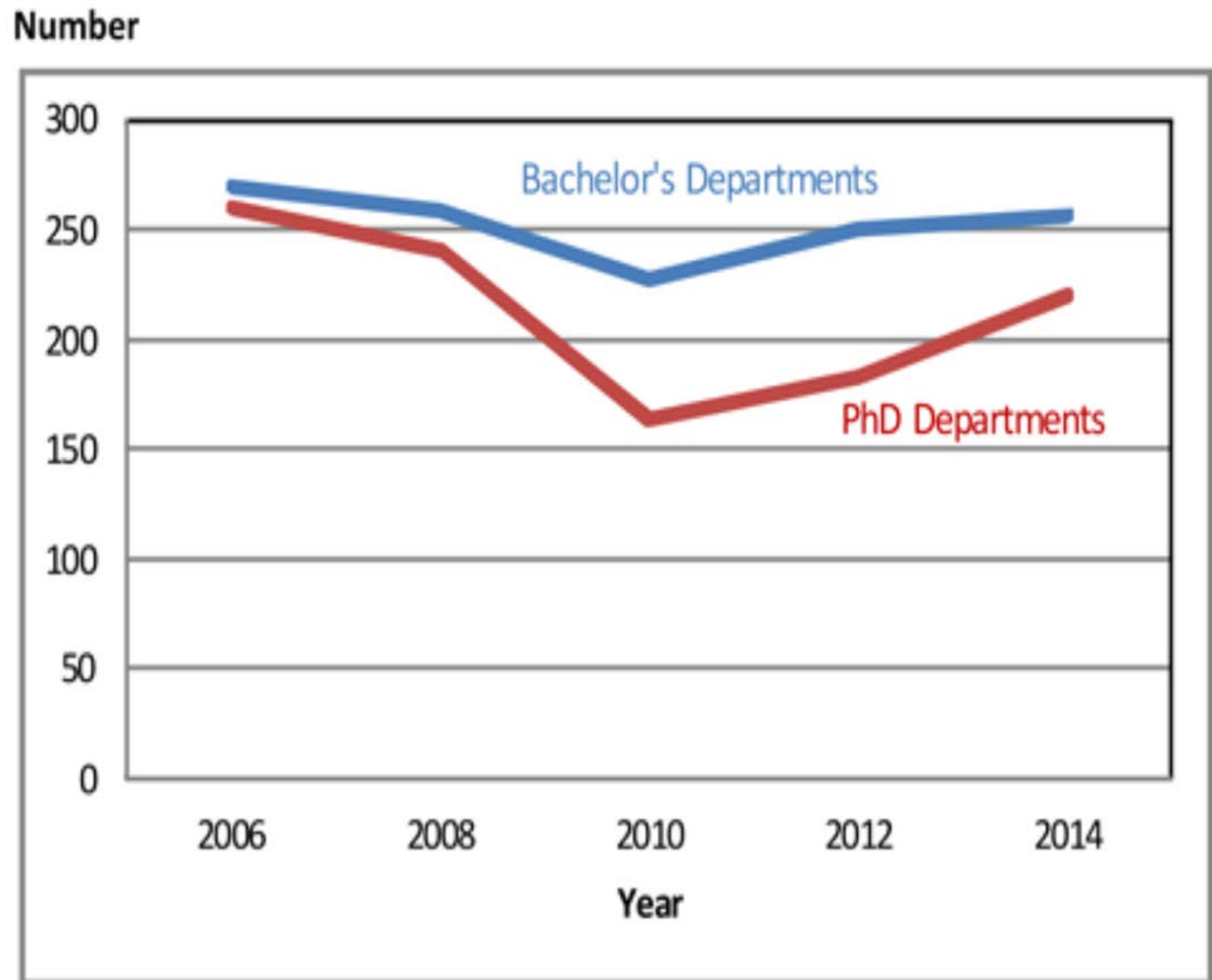
1,800 PhDs /
500

positions
= 1 in 3.5

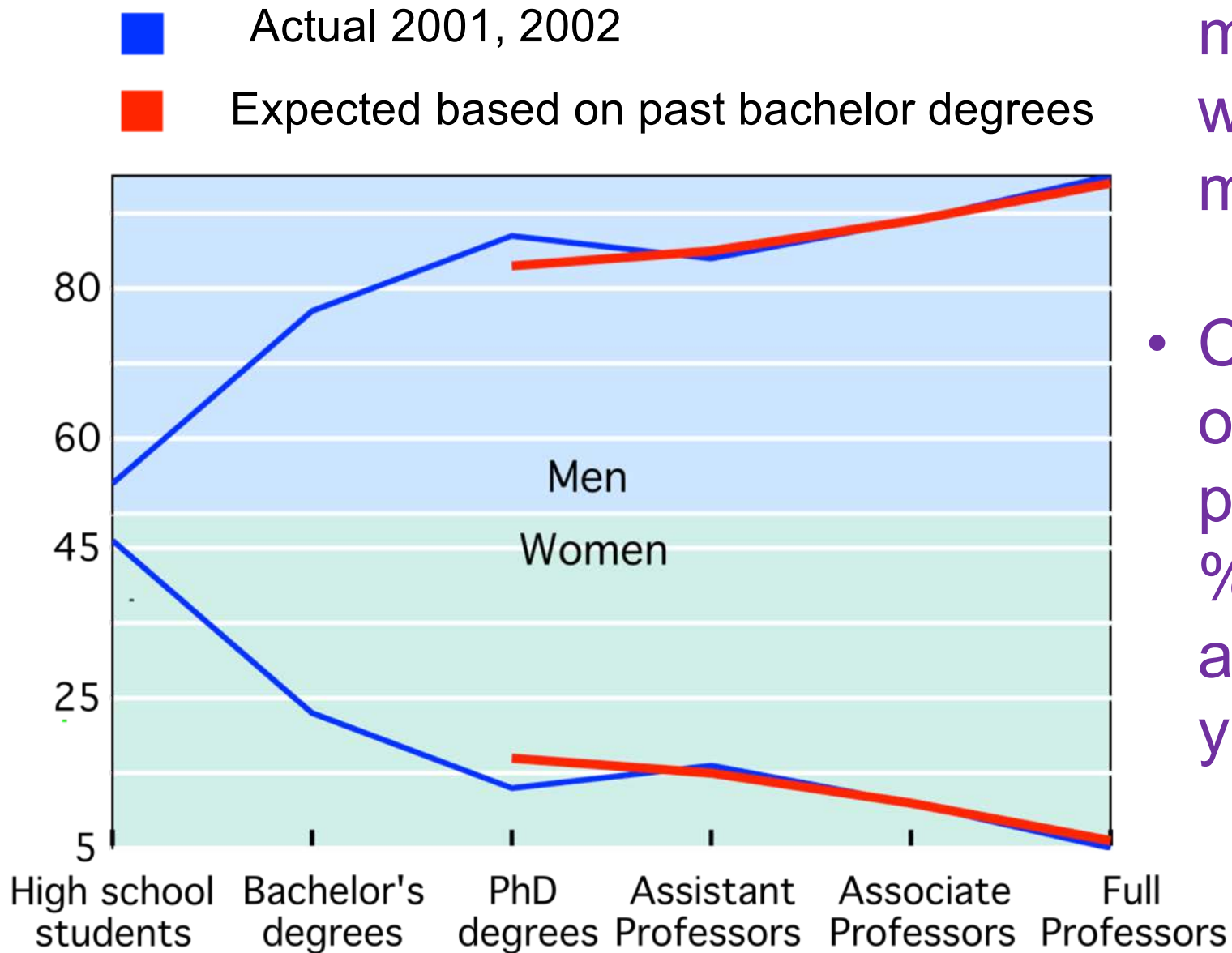
other 70% need
to find non-
academic job

*Career
advice
needed!*

Number of New Faculty Members Physics Departments in the US



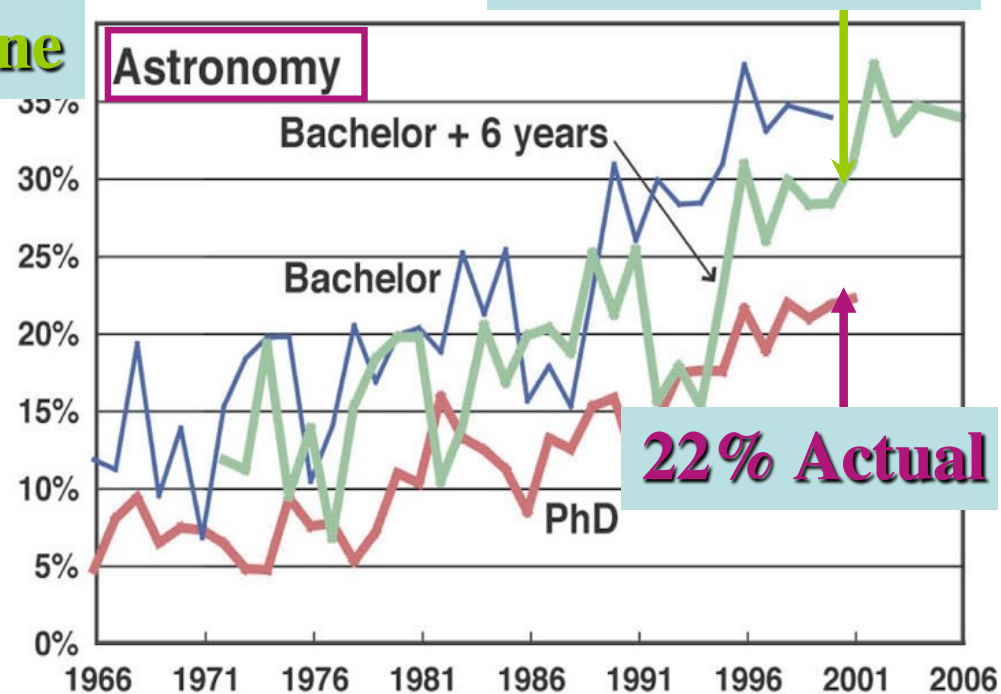
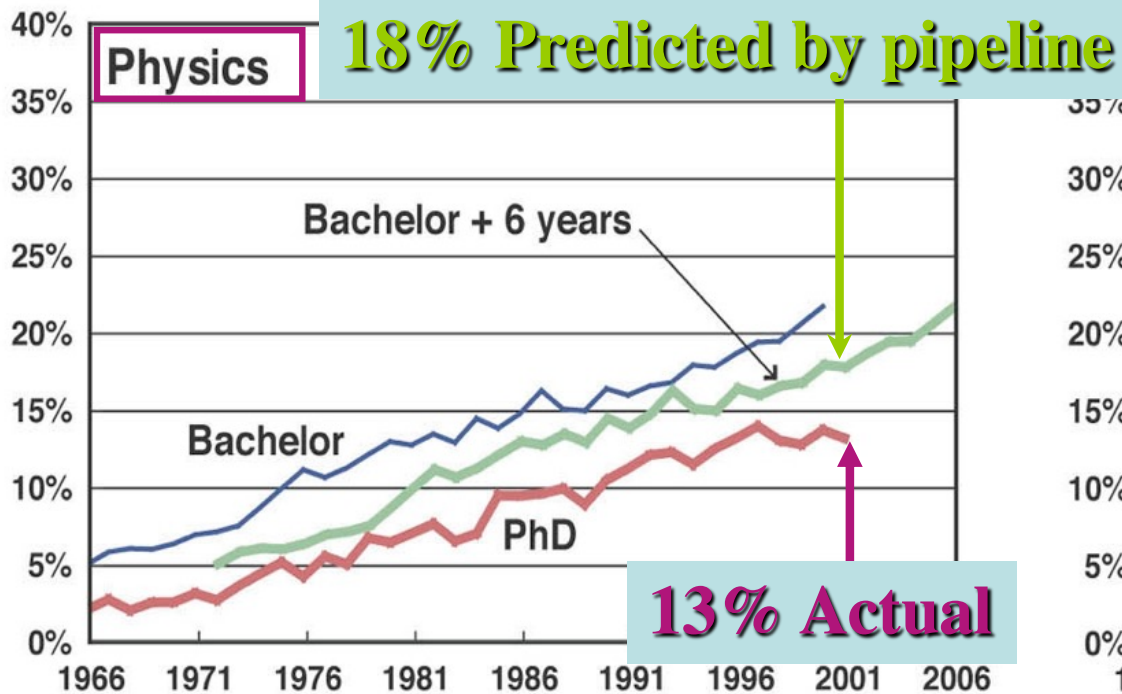
Actual and Expected Percentage of Women and Men in Physics in the US



- Pipeline is more leaky for women than men
- Current %age of faculty predicted by % bachelors appropriate years ago

The Leaky Pipeline

% Women



Graduate school is differentially leaky for women

Is this partly due to pet theory here?

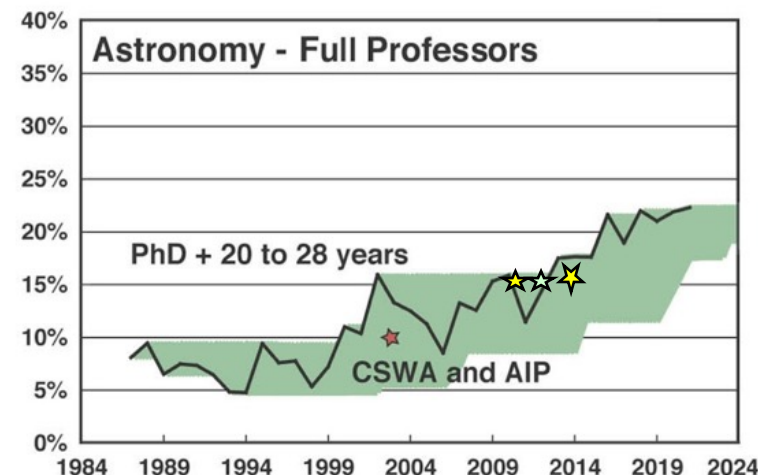
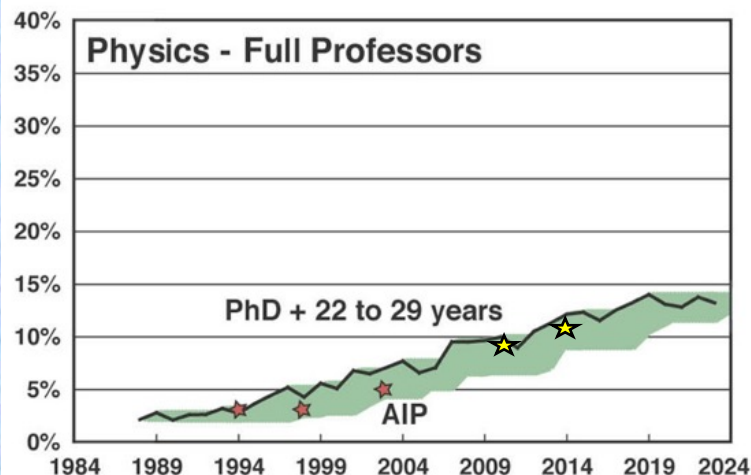
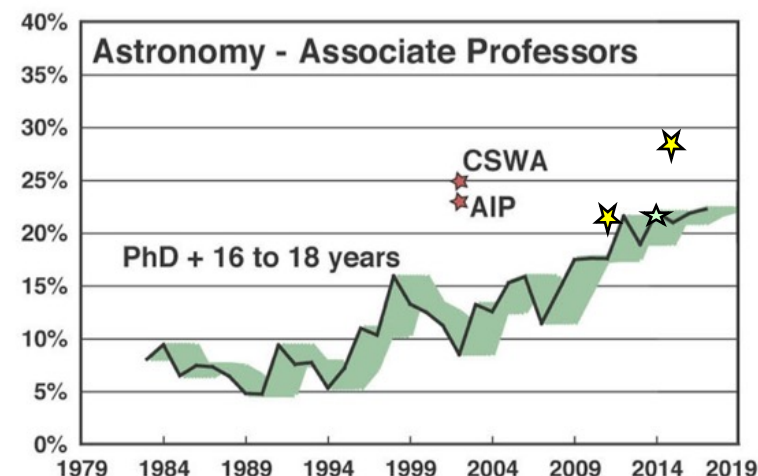
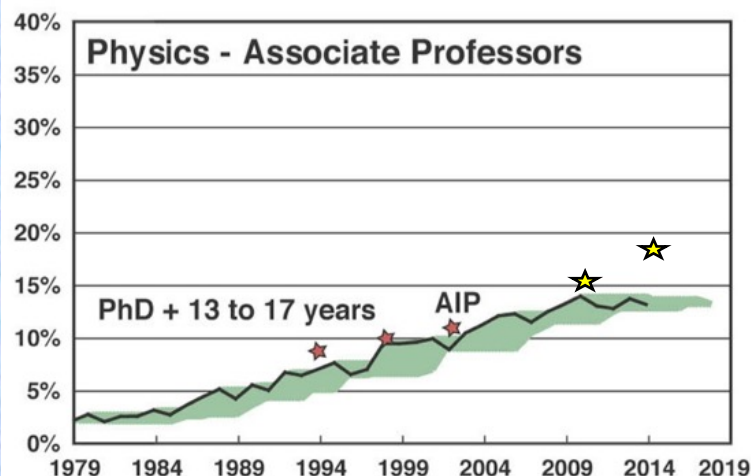
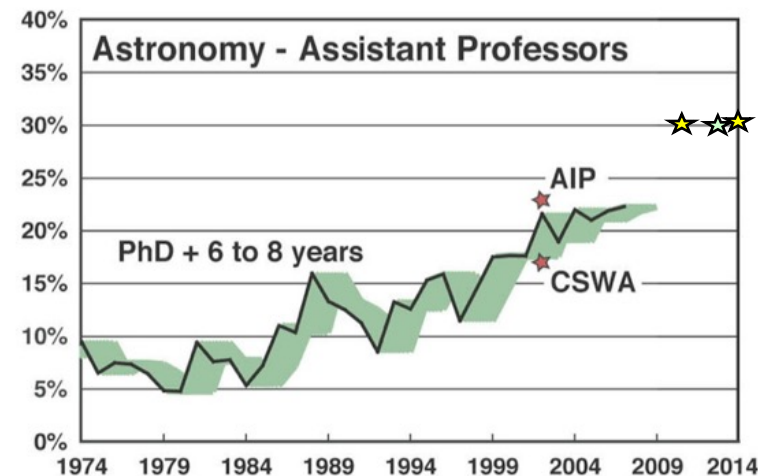
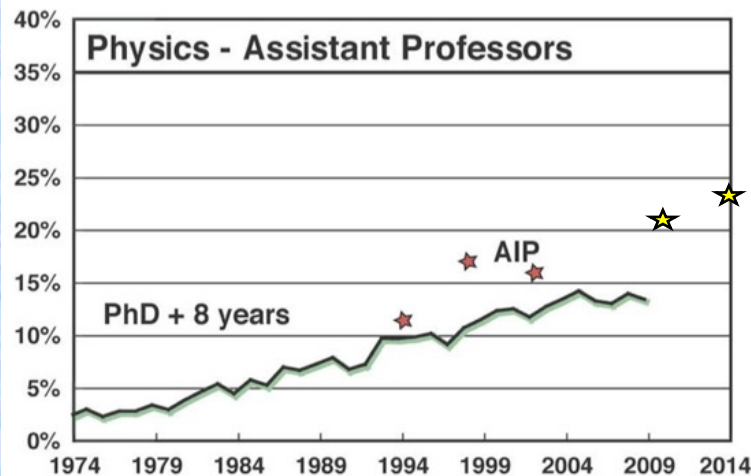
★ AIP 2010 & 2014

☆ CSWA 2013

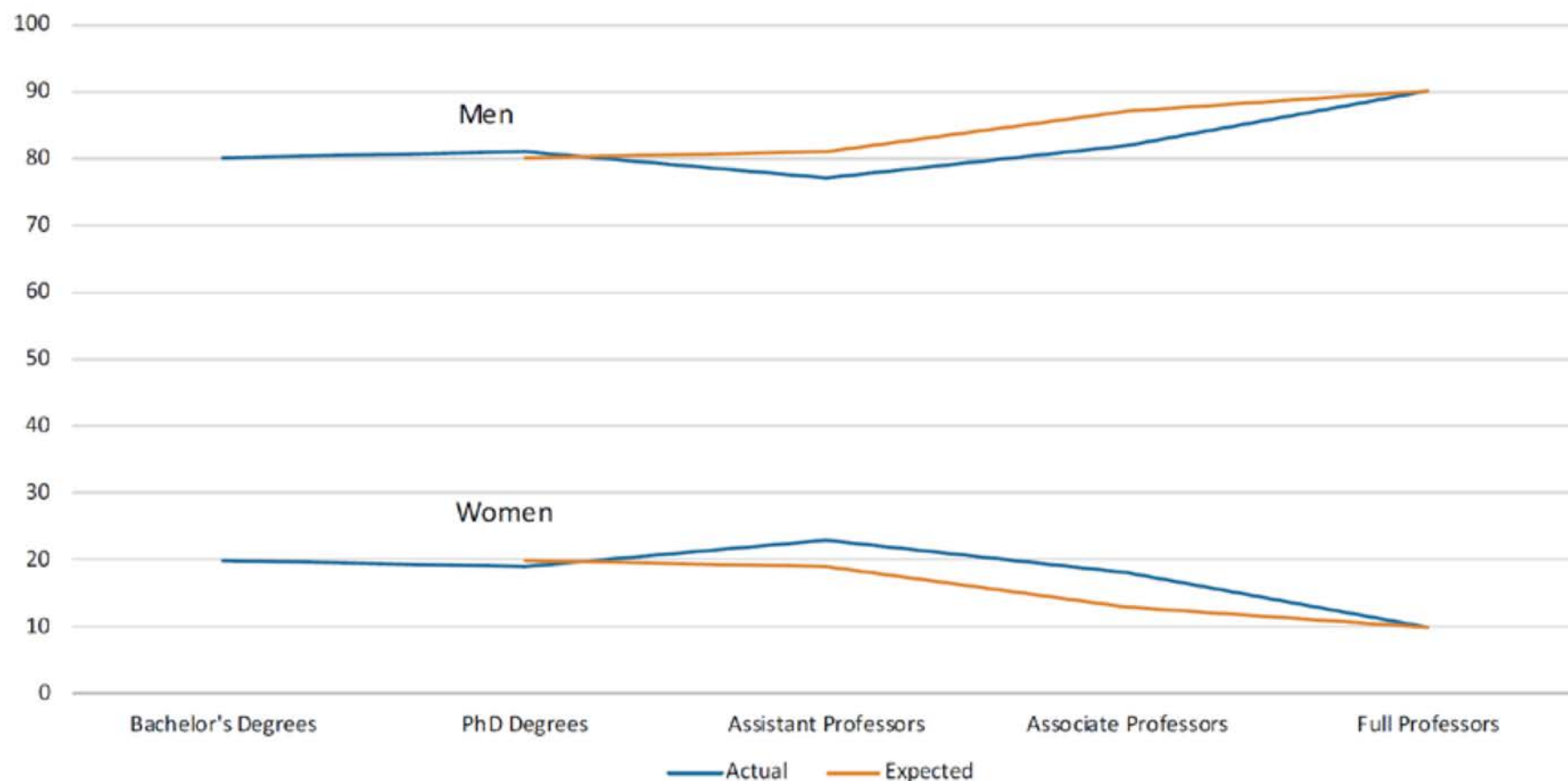
*Good
news at
the
faculty
level!*

*Once on the
faculty, the %-
age of women
tracks over time*

Bagenal (STATUS 2004)

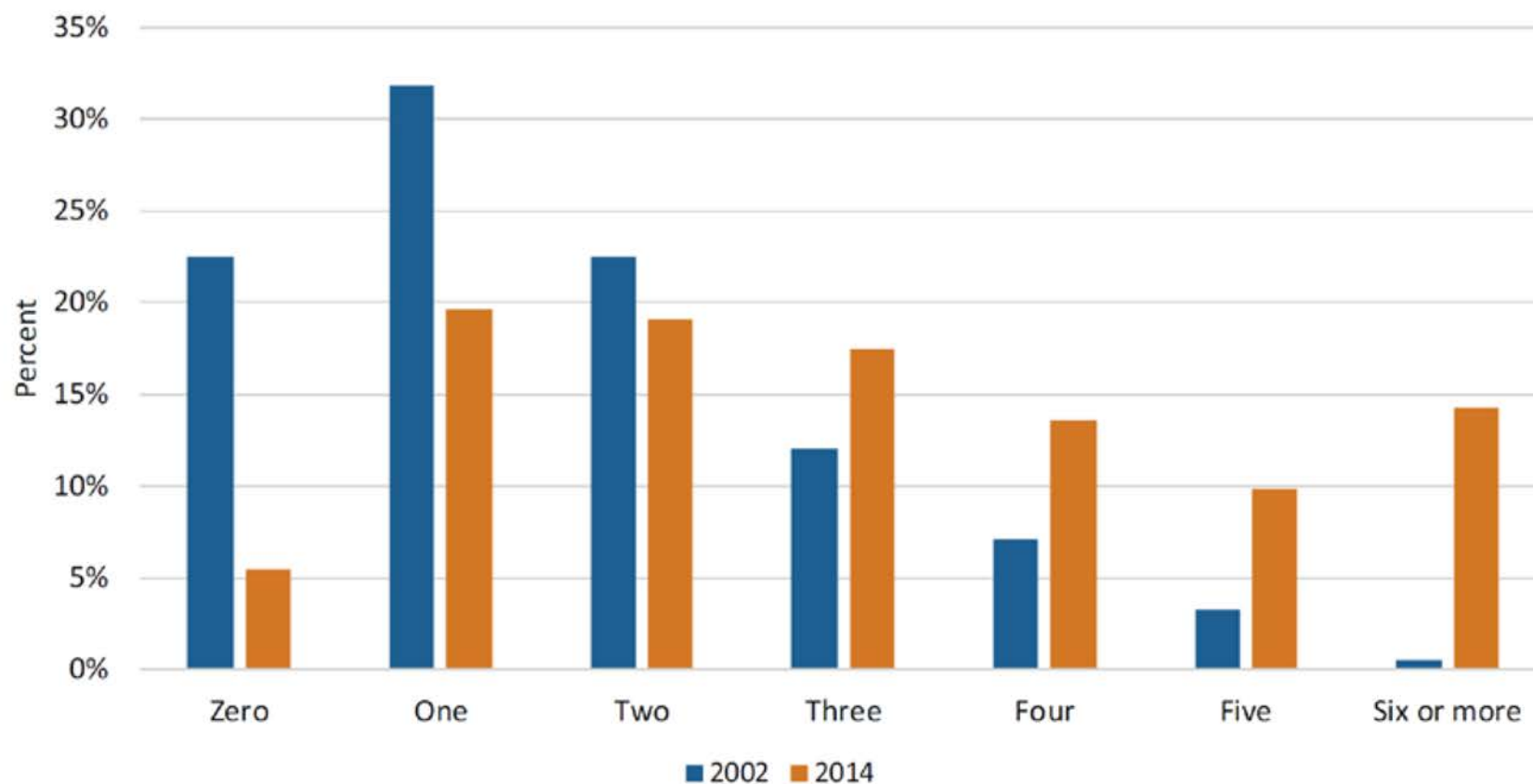


Actual and Expected Percent of Men and Women Faculty Members at Different Academic Ranks, 2014



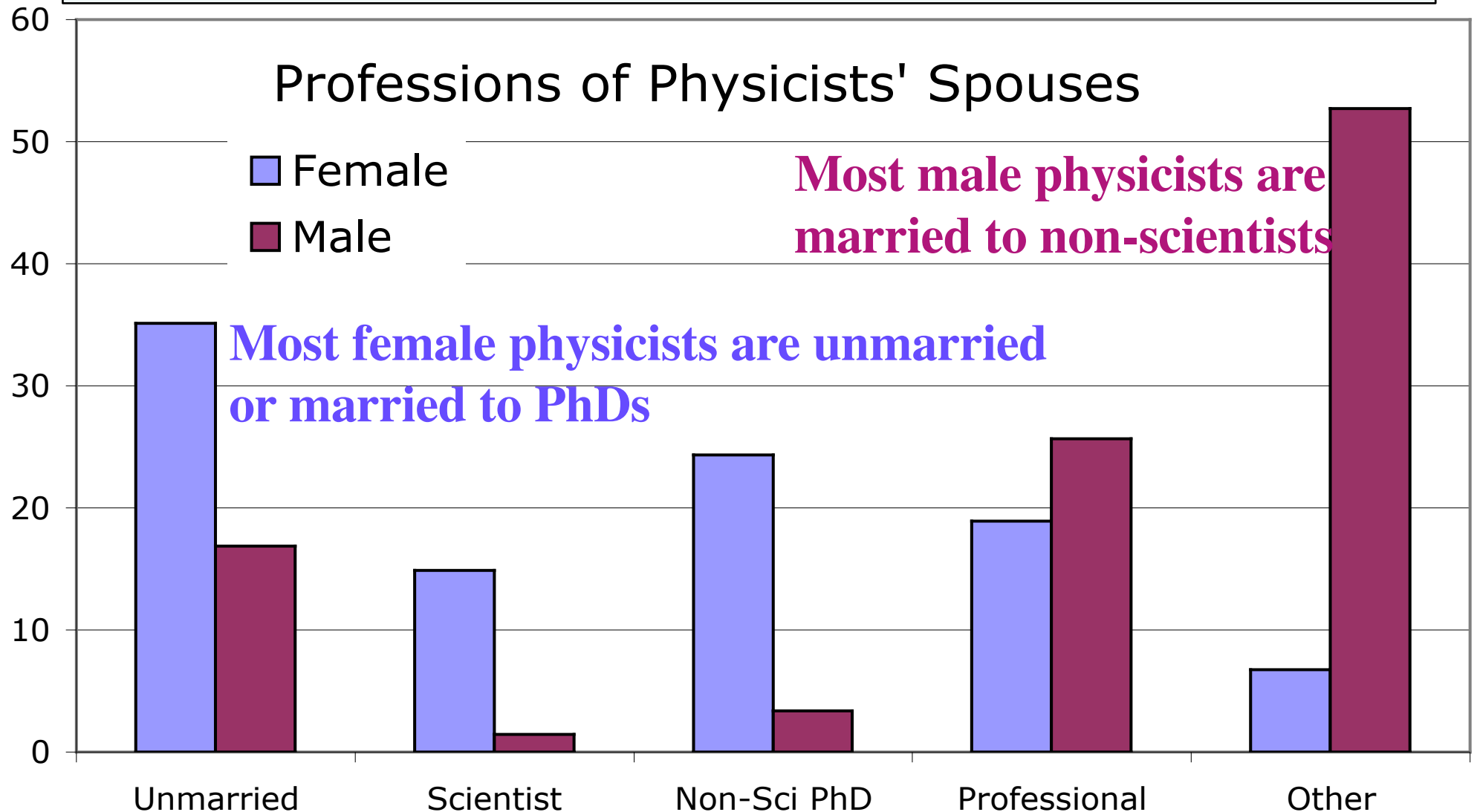
Source: AIP Statistical Research Center, 2014 Academic Workforce Survey provided data on the actual percent of faculty members, and 2016 Faculty Member Survey provided data on the expected percent of faculty members.

Percent of PhD Physics Departments by Number of Women Faculty Members in Professorial Ranks, 2002 & 2014



Source: AIP Statistical Research Center, Academic Workforce Survey.

Two-Body Problem



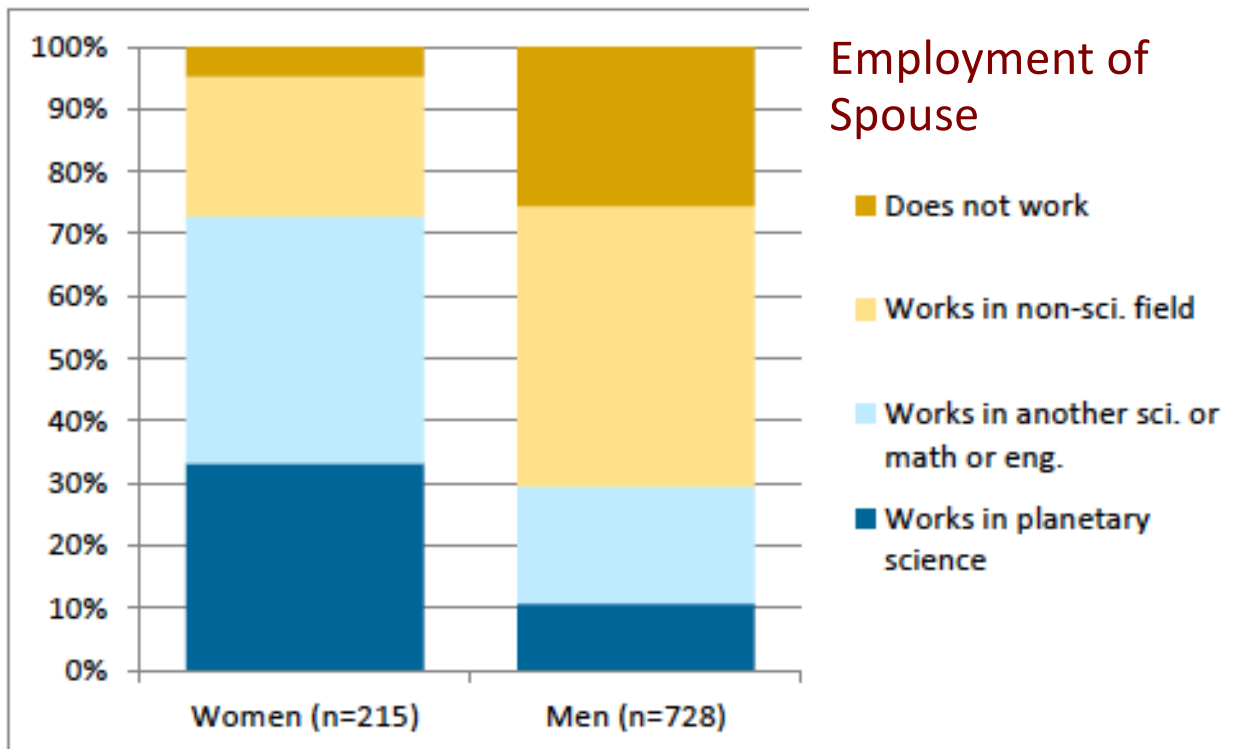
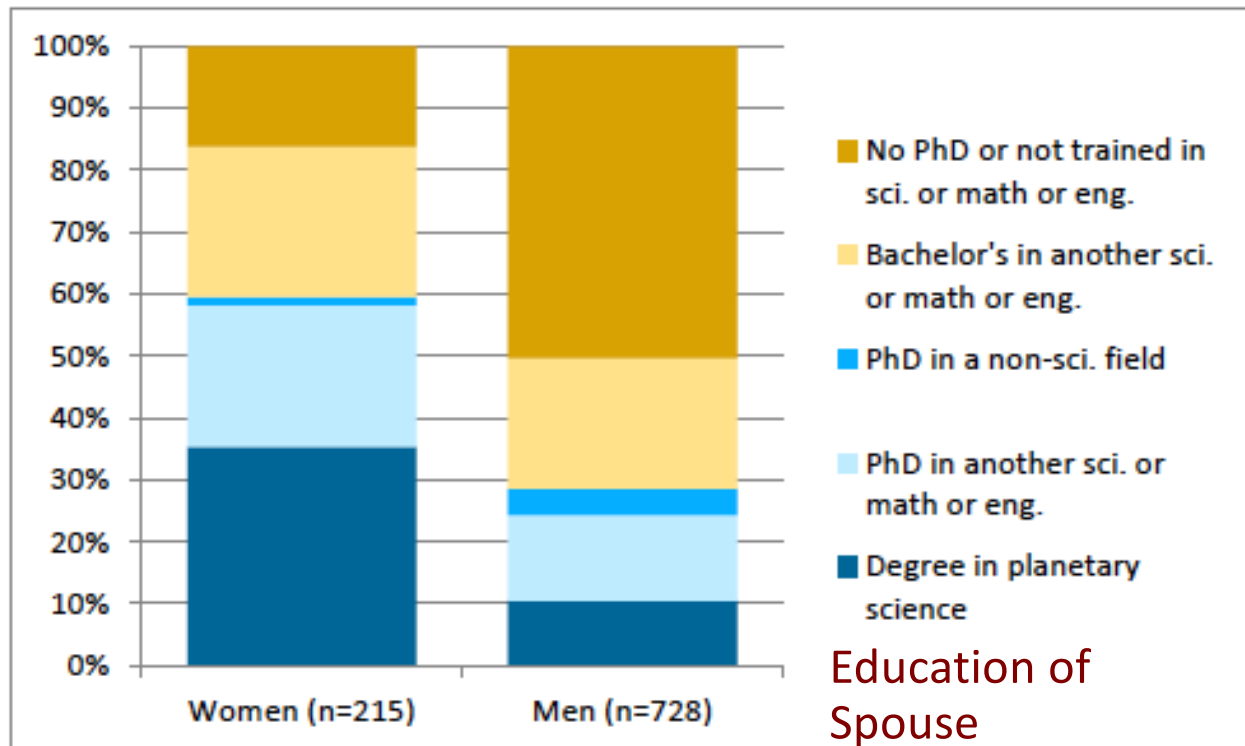
Institutions need Dual-Career Programs!

2 –Two-Body Problem

2011 Planetary Science Survey

Same story....

BIG ISSUE



Gender Differences in Career Opportunities, Advancement, and Resources

Career Opportunities and Resources	Survey Source	Gender Differences
Number of promotions	PhD Plus 10 Survey, 2011	No significant difference
Number of publications	PhD Plus 10 Survey, 2011	No significant difference
Gave a talk as an invited speaker	Global Survey of Physicists, 2010	Men were 45% more likely
Acted as a manager	Global Survey of Physicists, 2010	Men were 33% more likely
Acted as a journal editor	Global Survey of Physicists, 2010	Men were 27% more likely
Supervised undergraduate students	Global Survey of Physicists, 2010	No significant difference
Supervised graduate students	Global Survey of Physicists, 2010	Men were 32% more likely
Had enough funding	Global Survey of Physicists, 2010	Men were 53% more likely
Had enough equipment	Global Survey of Physicists, 2010	Men were 36% more likely
Had enough office space	Global Survey of Physicists, 2010	No significant difference
Had enough lab space	Global Survey of Physicists, 2010	Men were 15% more likely
Had enough employees	Global Survey of Physicists, 2010	Men were 36% more likely

"PhD + 10 years"
survey

Which factors are
most important
for pay??
for promotion??

Men had 10%
higher salary

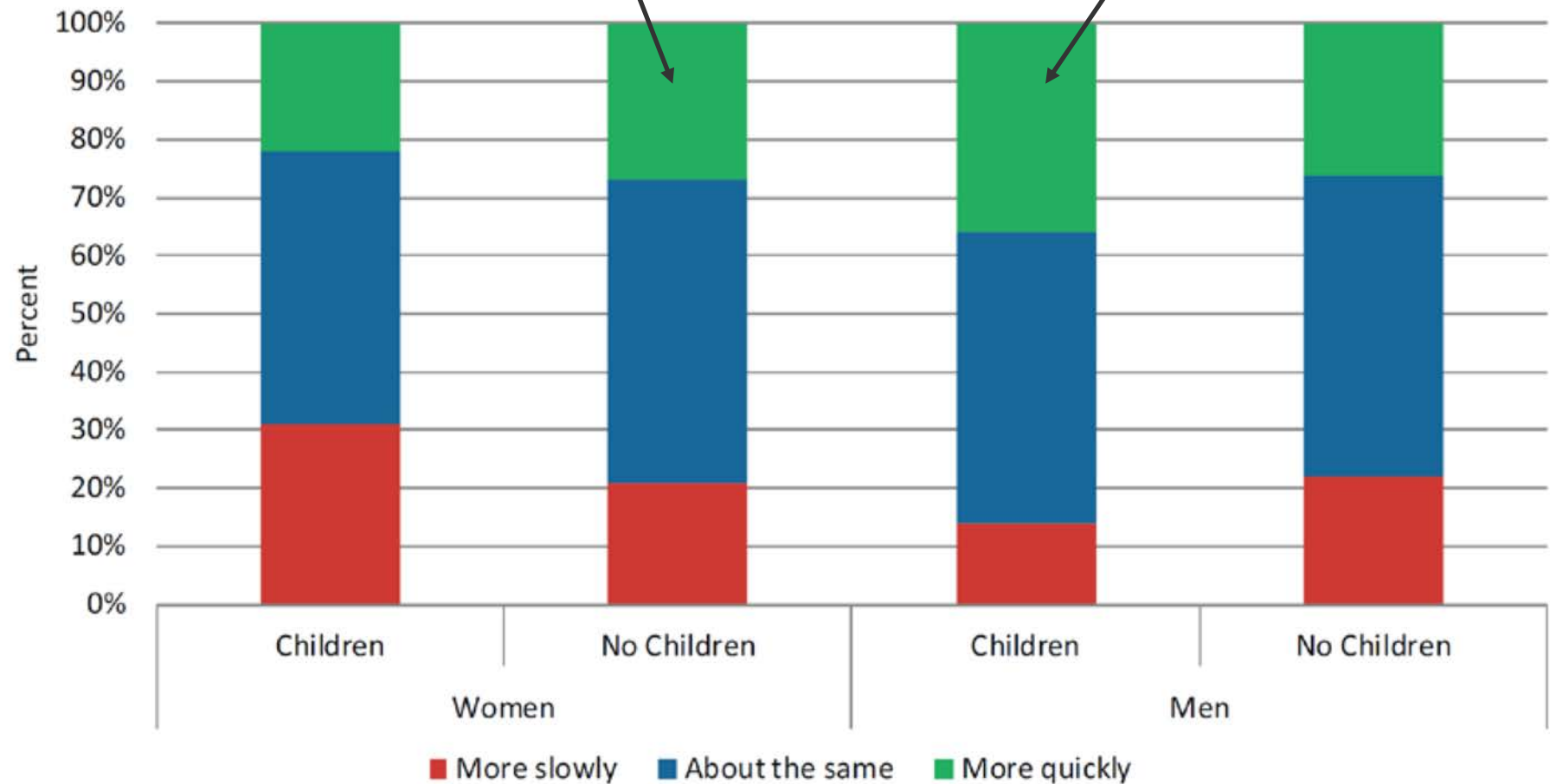
Gender Differences in Career Compromises for Family Reasons

Career Compromises	Survey Source	Gender Difference
Relocated for a spouse	Longitudinal Study of Astronomy Graduate Students, 2007–2016	Women were 204% more likely
Declined job for a spouse	PhD Plus 10 Survey, 2011	Women were 346% more likely
Had a career break for family reasons	Global Survey of Physicists, 2010	Women were 400% more likely
Became a stay-at-home parent	Global Survey of Physicists, 2010	Women were 463% more likely
Chose a less demanding or more flexible schedule	Global Survey of Physicists, 2010	Women were 111% more likely
Changed employers or field of employment	Global Survey of Physicists, 2010	Women were 40% more likely
Spent less time at work	Global Survey of Physicists, 2010	Women were 104% more likely

Women progress (a little) faster without children

Men progress faster **with** children

Gender Differences in Perceived Career Progression by Parental Status, 2010

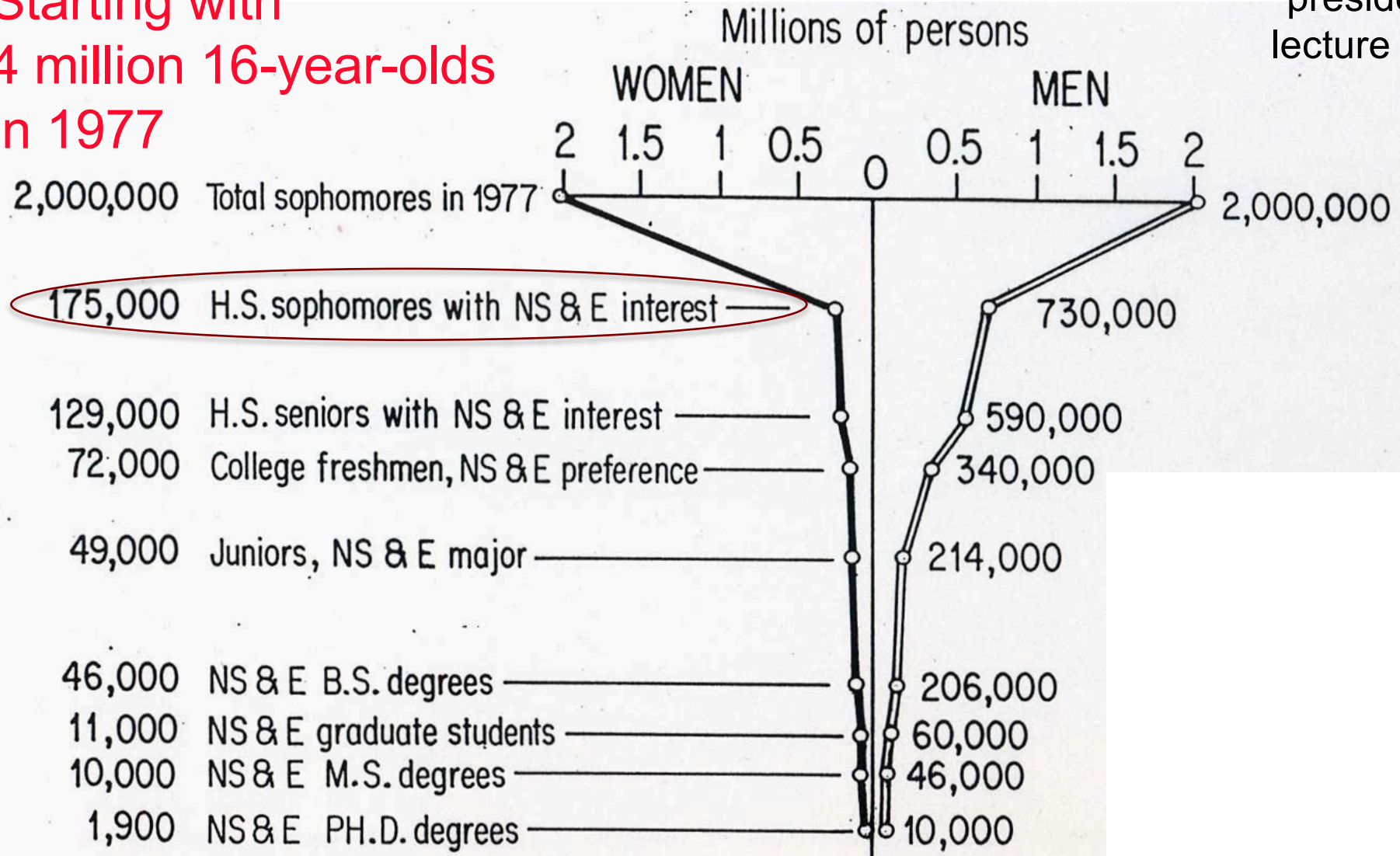


Source: AIP Statistical Research Center, 2010 Global Survey of Physicists.

"The Leaky Pipeline"

Shiela Widnall
AAAS
presidential
lecture 1988

Starting with
4 million 16-year-olds
in 1977

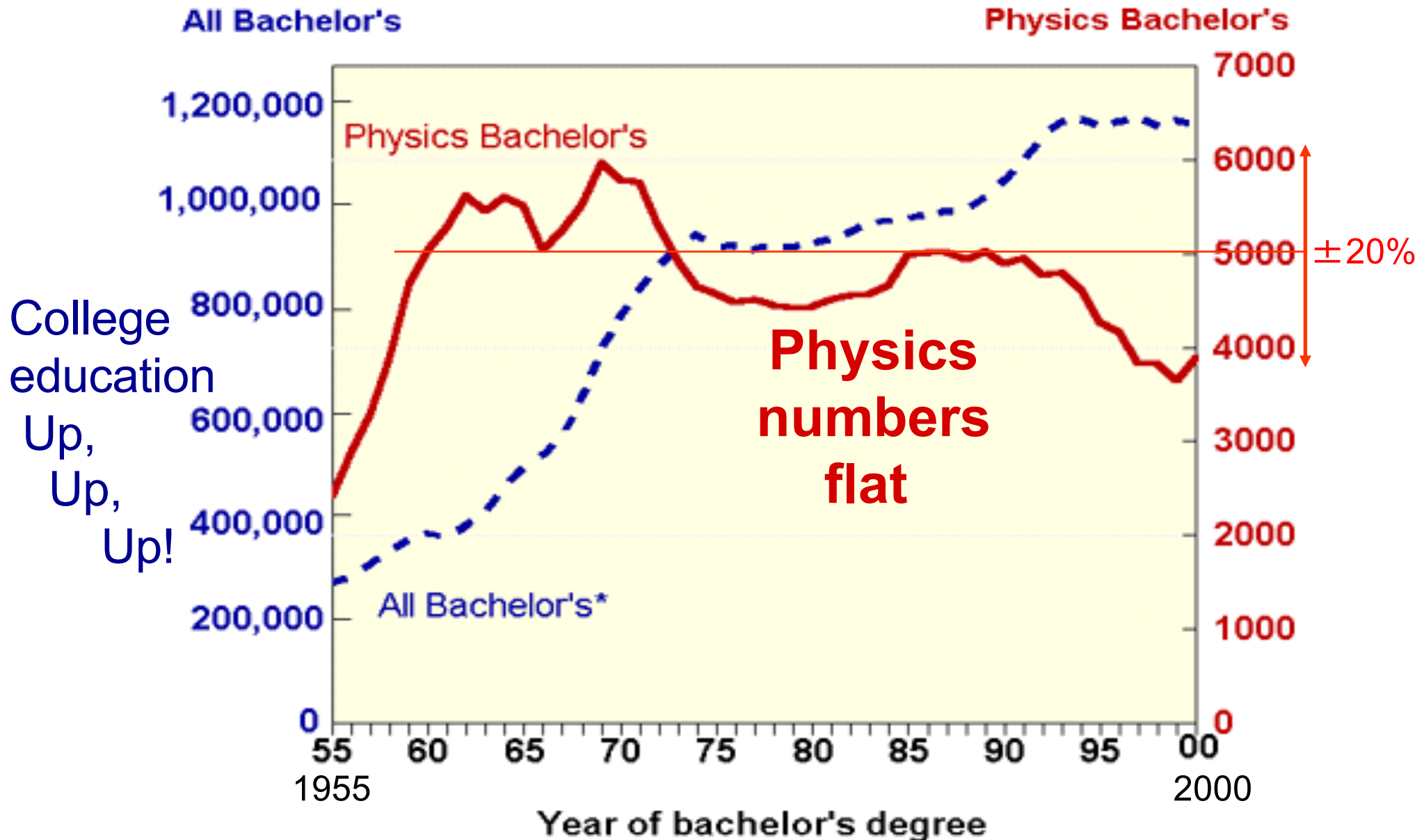


1 in 1000 women obtained
Ph.D.s in Nat. Sci. & Eng.

5 in 1000 men obtained
Ph.D.s in Nat. Sci. & Eng.

National

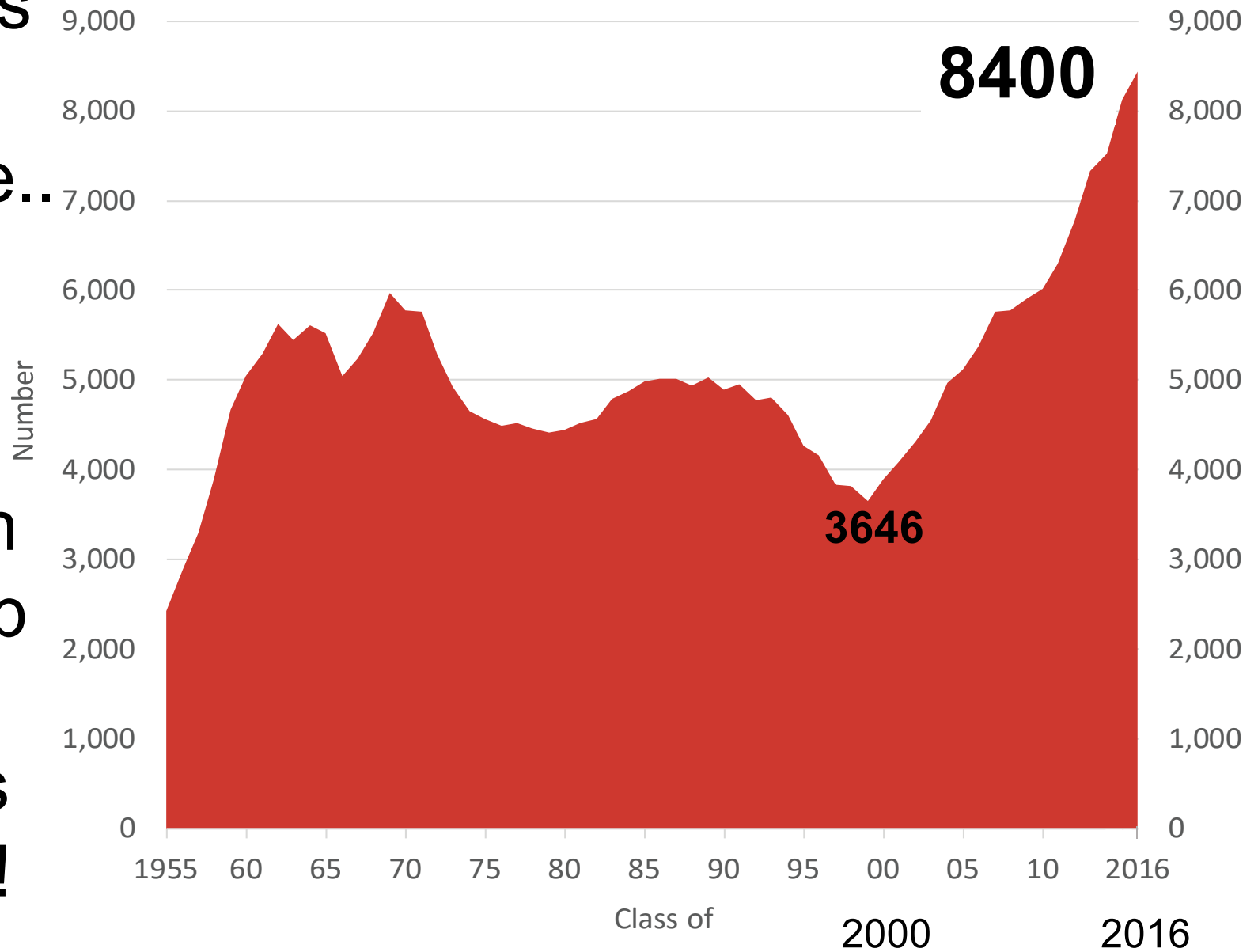
Physics Education – input to our profession



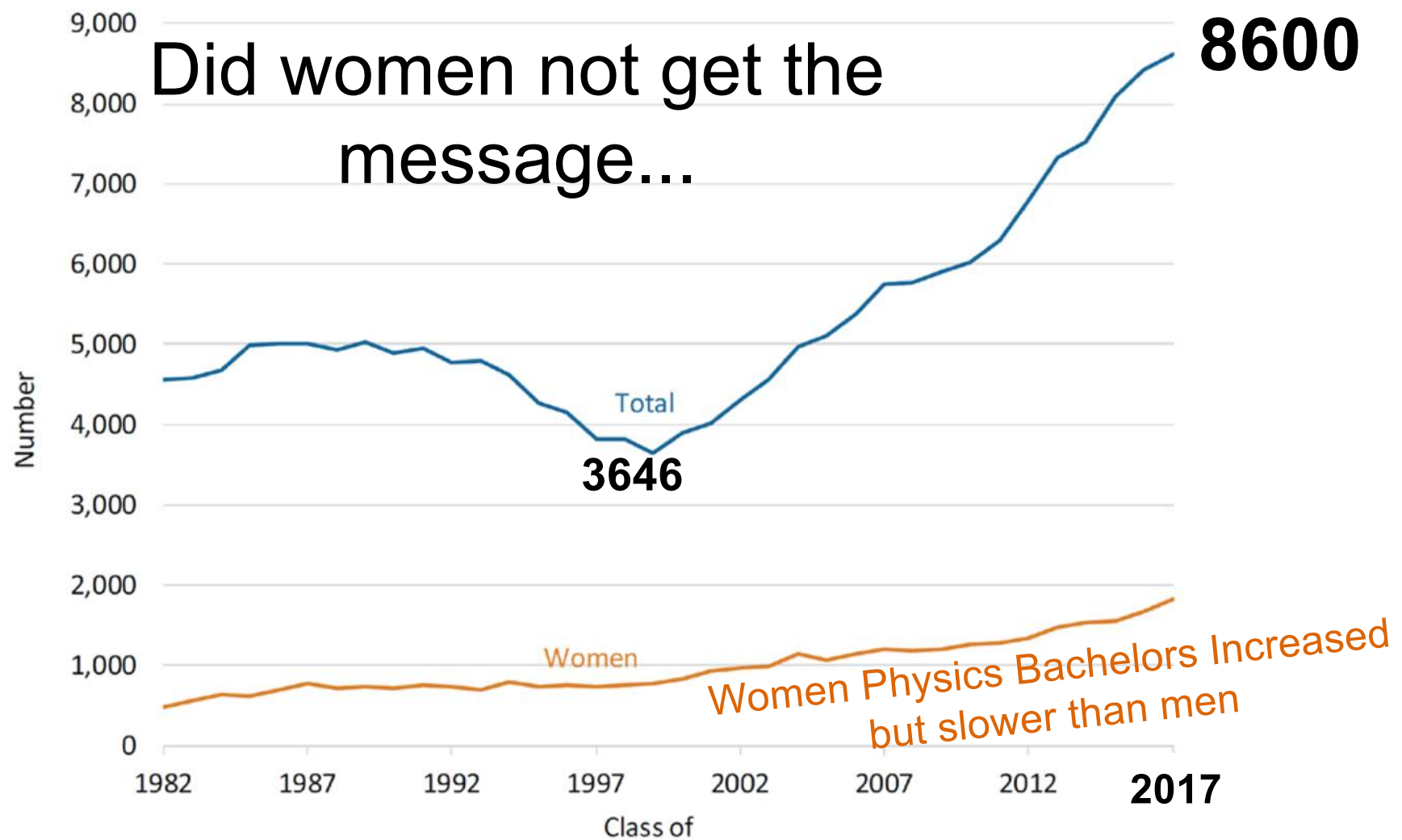
Physics Bachelor's Degrees Awarded.

Students
got the
message..

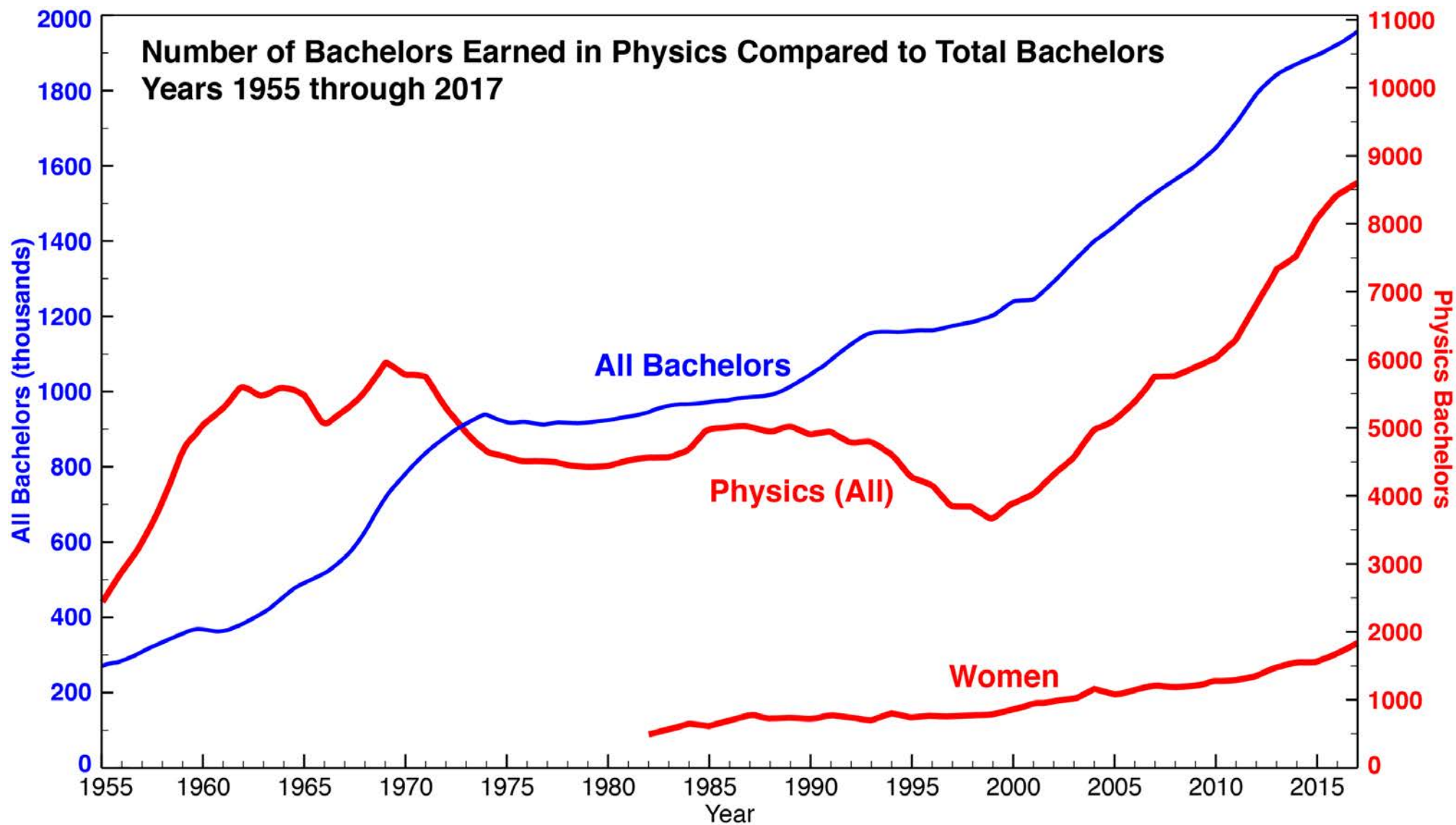
You can
get a job
with a
physics
degree!



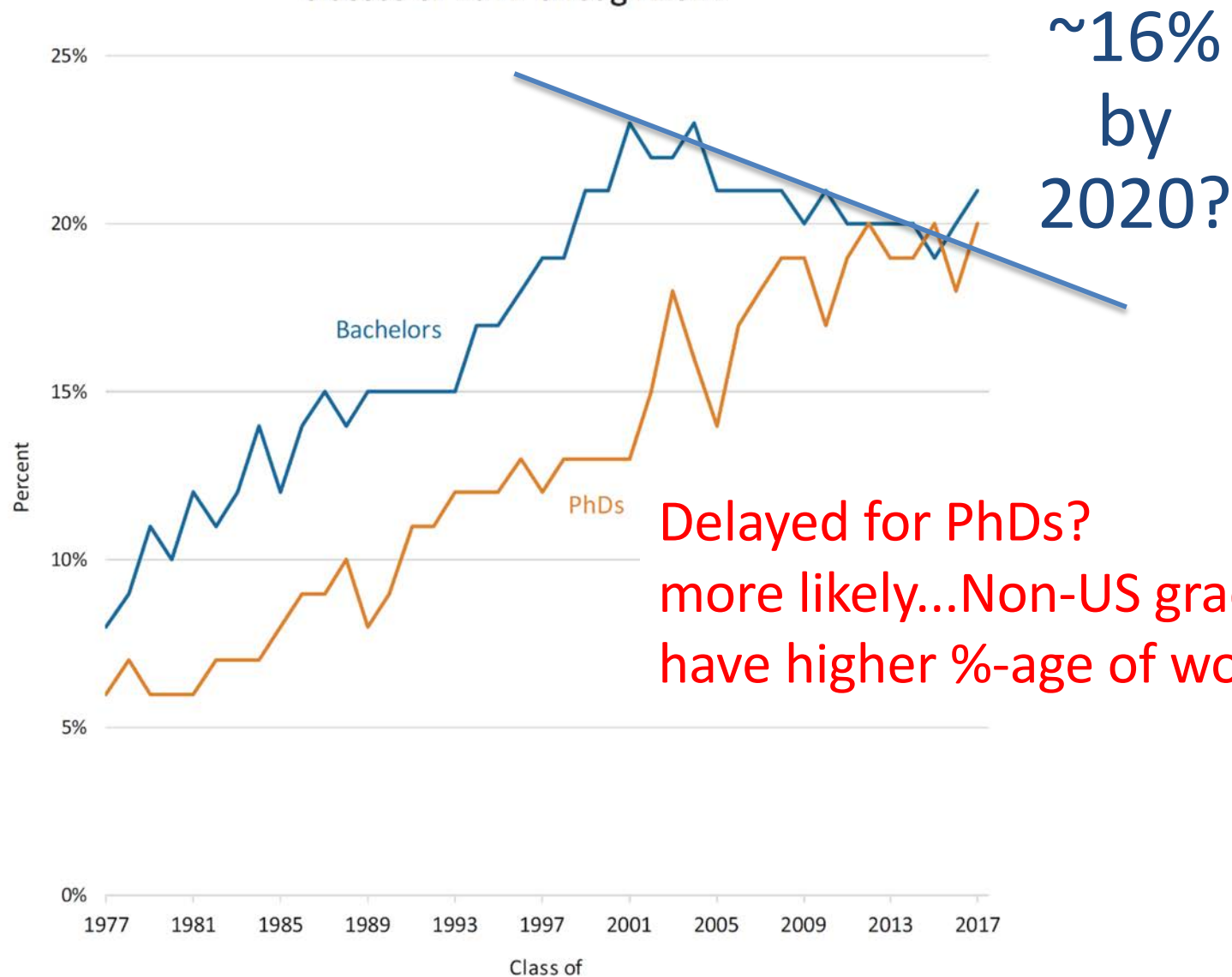
Number of Bachelor's Degrees Earned in Physics, Classes 1982 through 2017



Source: AIP Statistical Research Center, Enrollments and Degrees Survey.

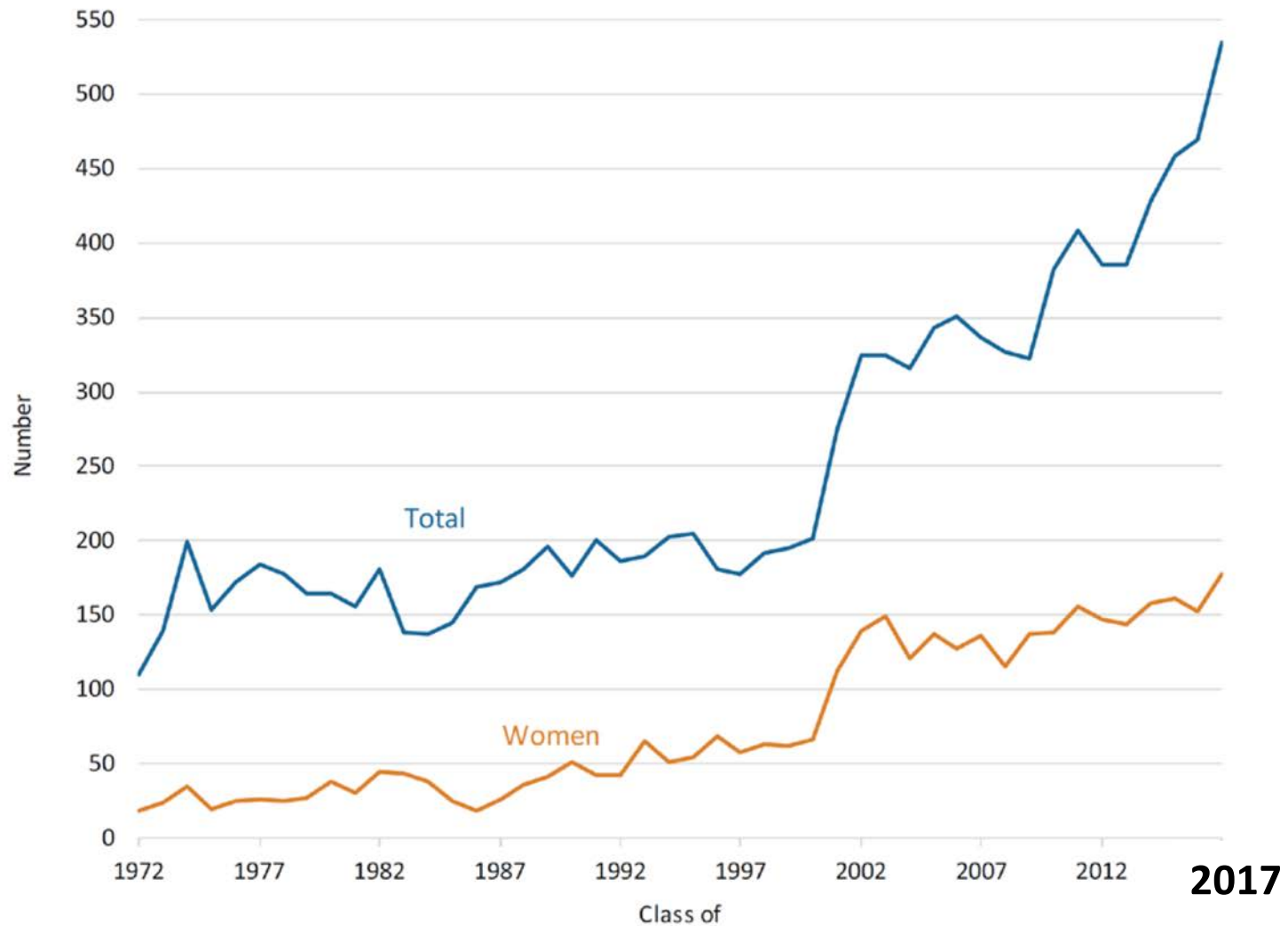


Percent of Physics Bachelors and PhDs Earned by Women, Classes of 1977 through 2017



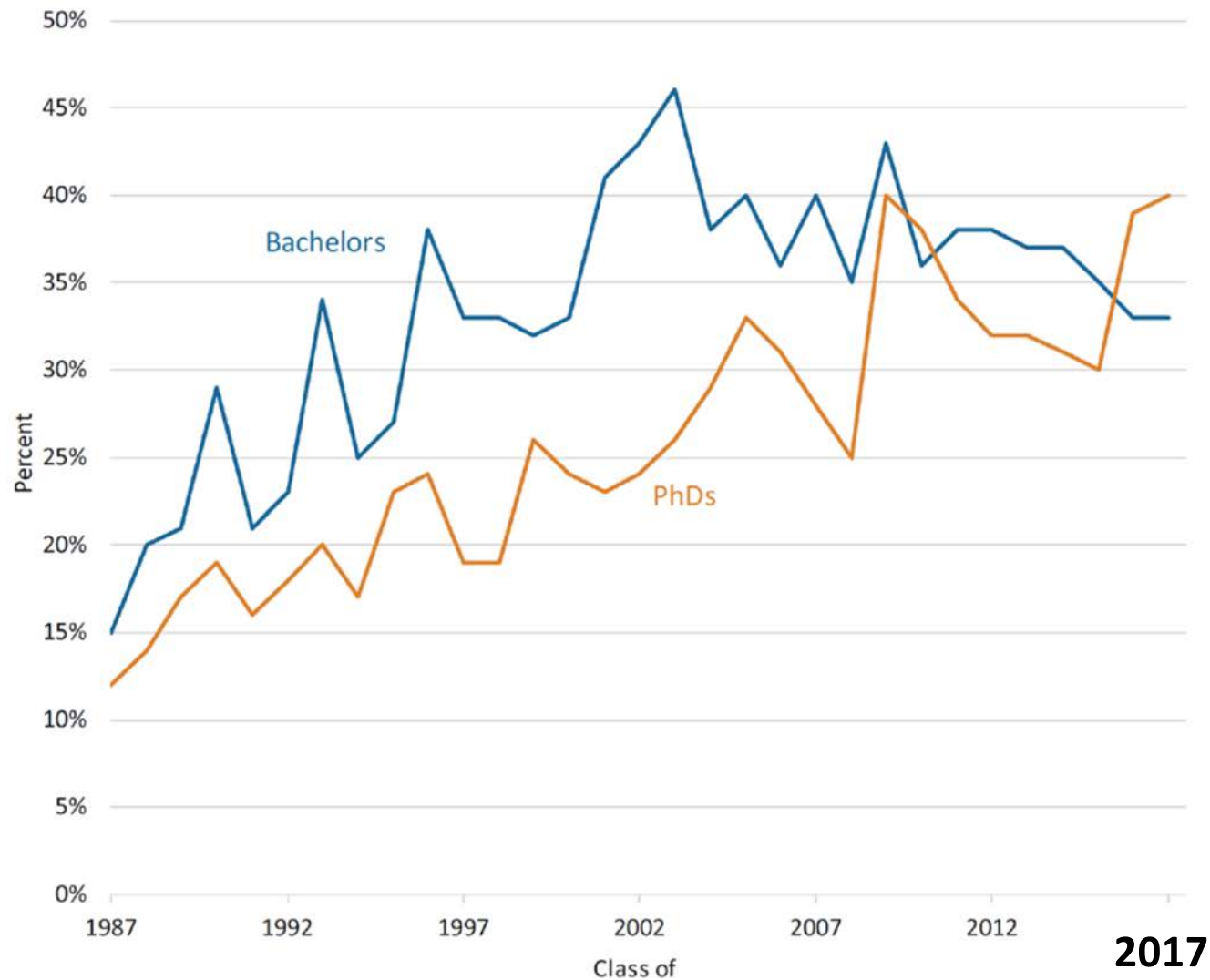
Source: AIP Statistical Research Center, Enrollments and Degrees Survey.

Number of Bachelor's Degrees Earned in Astronomy, Classes of 1972 through 2017



Source: AIP Statistical Research Center, Enrollments and Degrees Survey.

Percent of Astronomy Bachelors and PhDs Earned by Women, Classes of 1987 through 2017



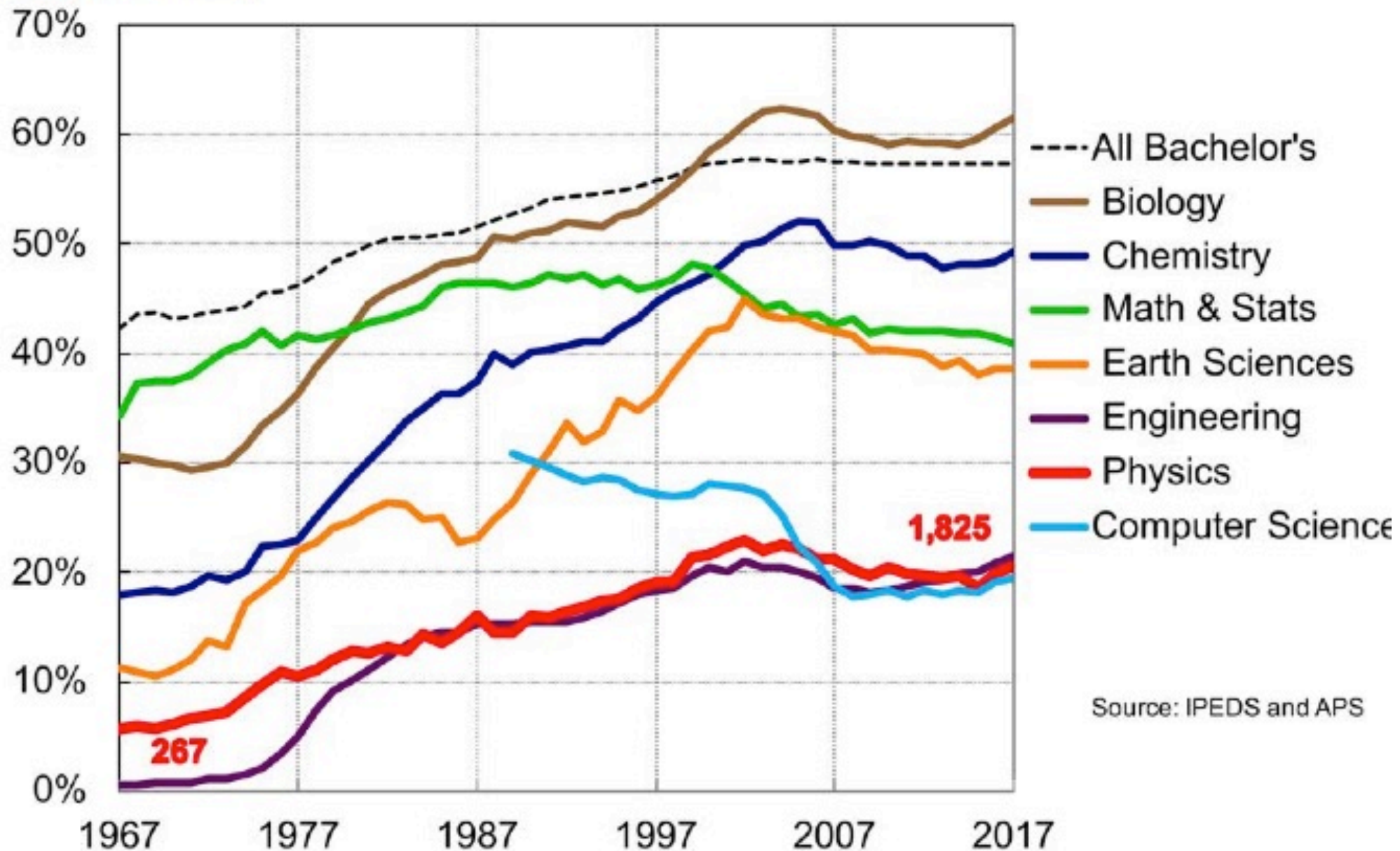
Source: AIP Statistical Research Center, Enrollments and Degrees Survey.

Fraction of college (BA/BS) degrees to women

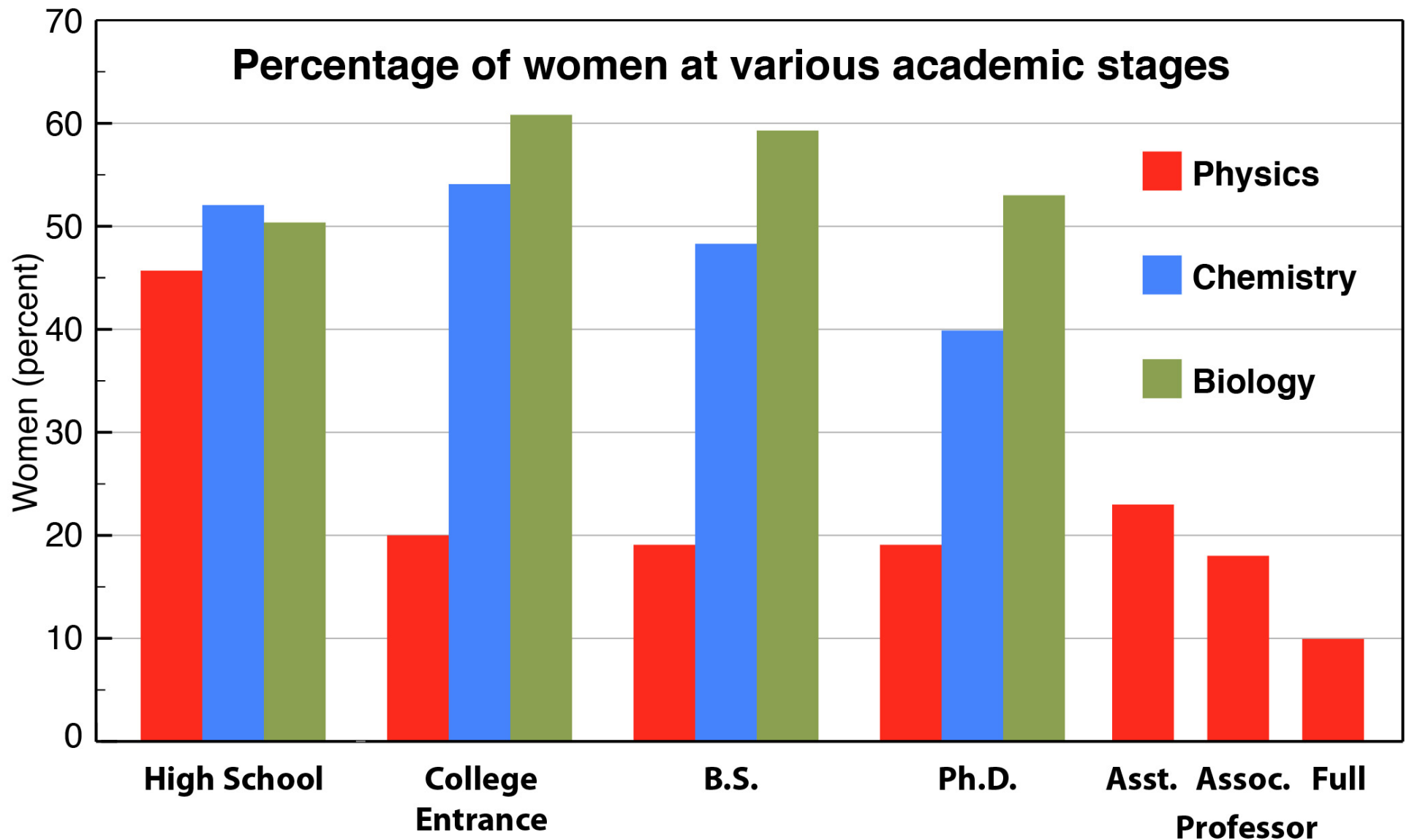


Education
& Diversity

Bachelor's Degrees Earned by Women



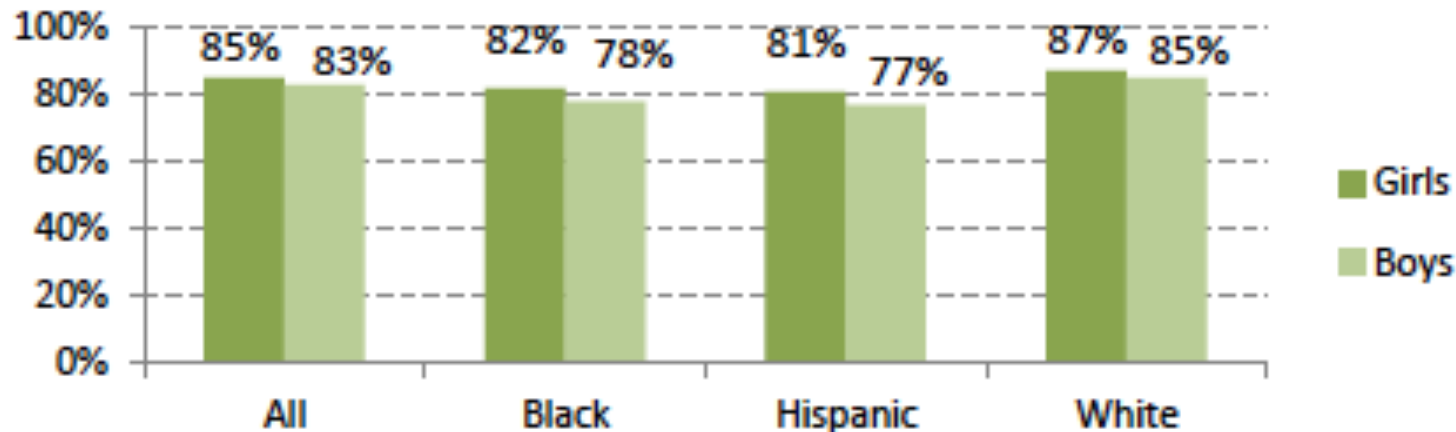
Compared to Other Sciences



Percentage of students in physics, chemistry, and biology who are women at various academic stages. Source: AIP, HERI, & IPEDS

US Dept of Education - 2012 – High School

Algebra I Pass Rates: Grades 7 or 8

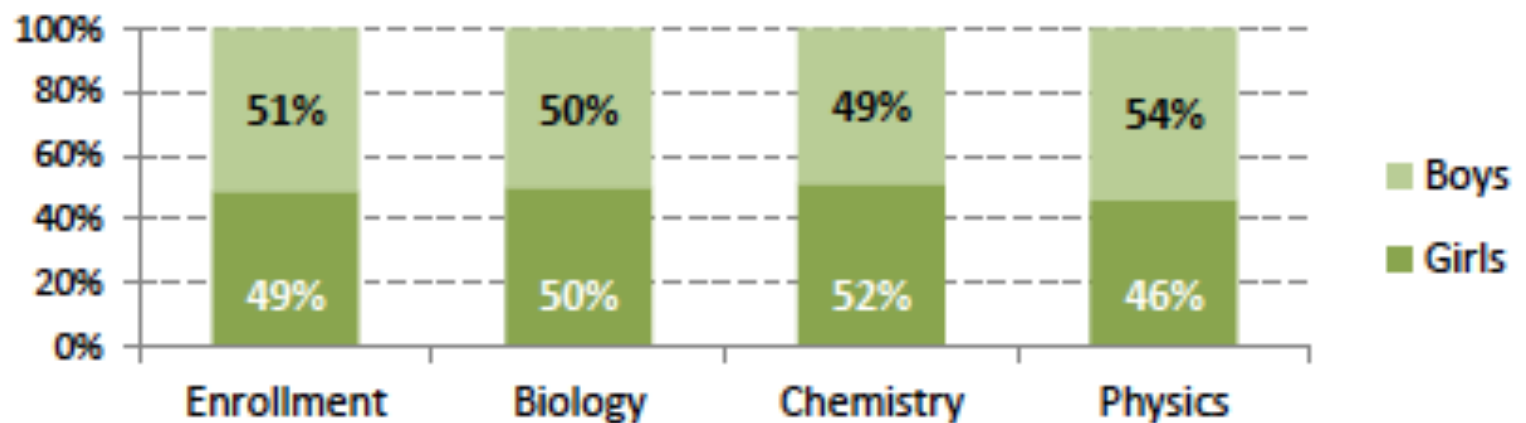


Source: Civil Rights Data Collection, 2009-10.

Girls more than keep up in math!

But there is still a small difference in Physics – but not much

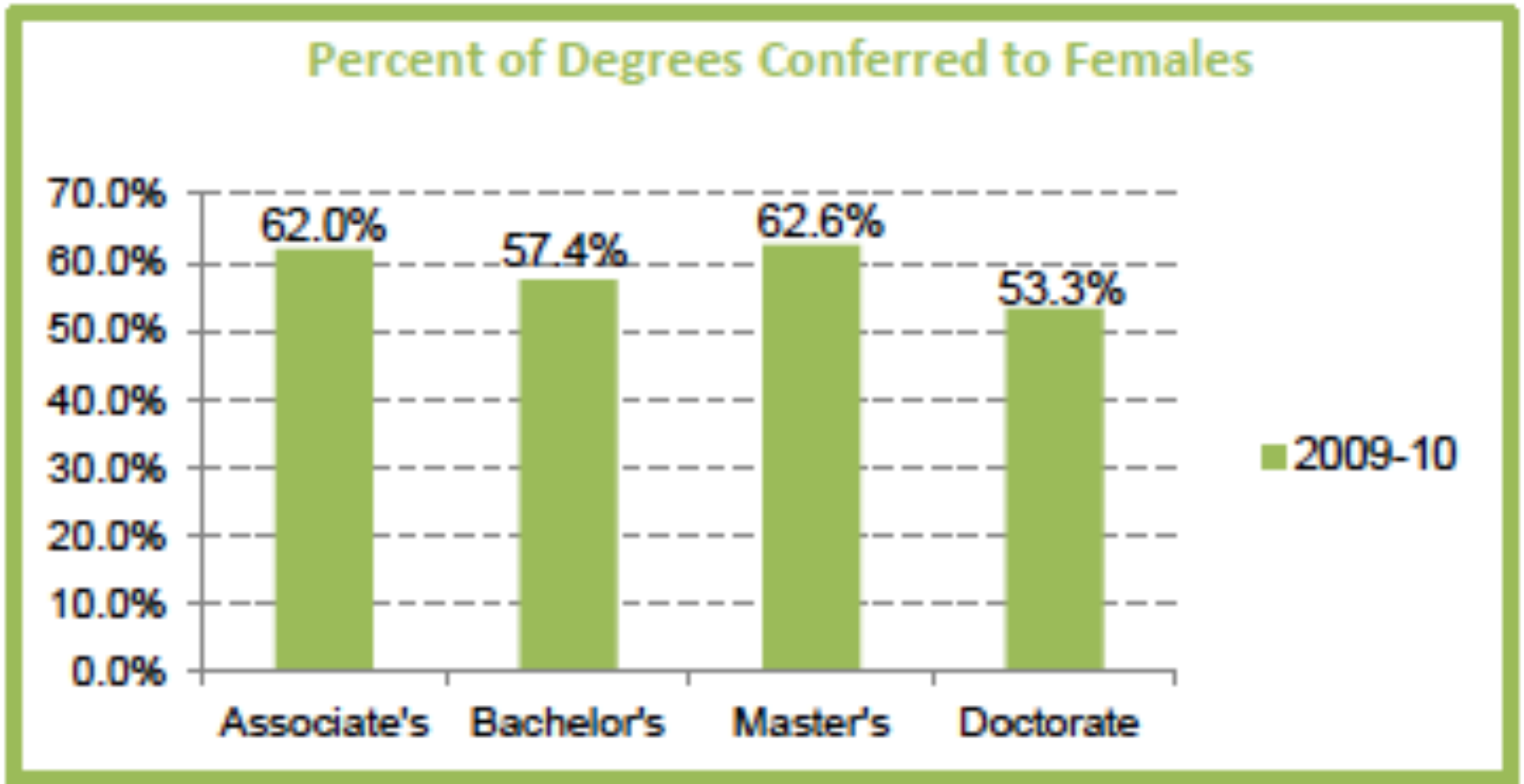
Enrollment in Science Courses



Source: Civil Rights Data Collection, 2009-10.

US Dept of Education - 2012

Overall education.... across all fields... women are doing



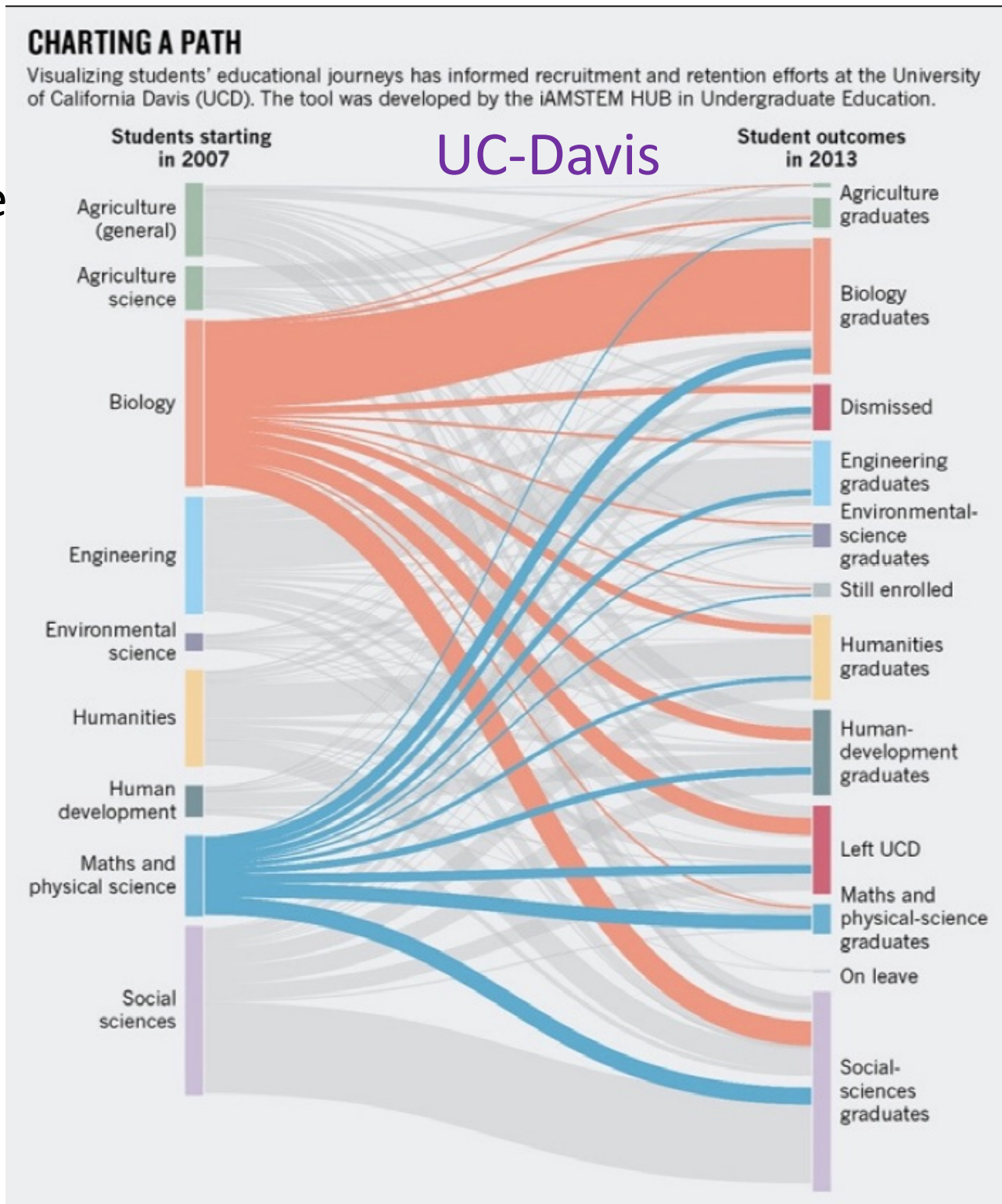
Source: Condition of Education, Table A-47-2

How about in Math/Physics/Engineering

Where majors start-end

- What does this look like separated by years?
- When do students move? Why?
- Gender? Minorities?
- **What does this look like at your institution?**

Let's do the research



It's not just about grades....

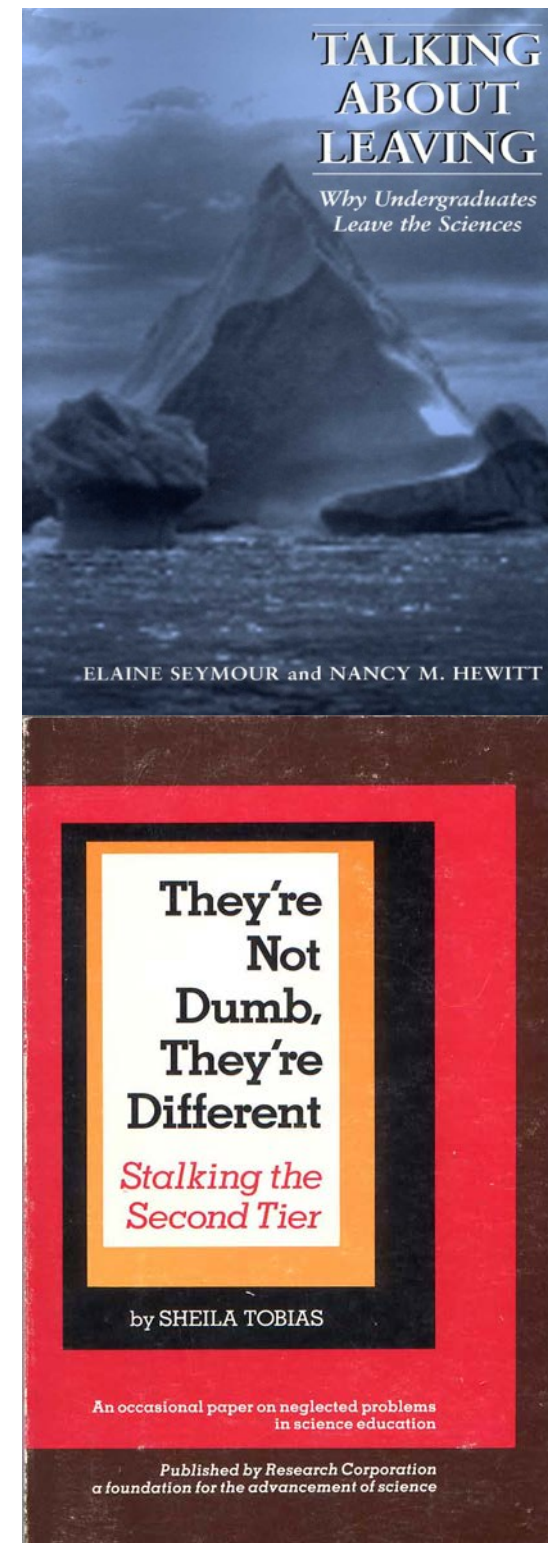
- women and men equally likely to change their major in response to poor grades
- Women more likely to switch out of male-dominated STEM majors in response to poor performance compared to men

still

Is this true at your institution?
^
Got the stats?

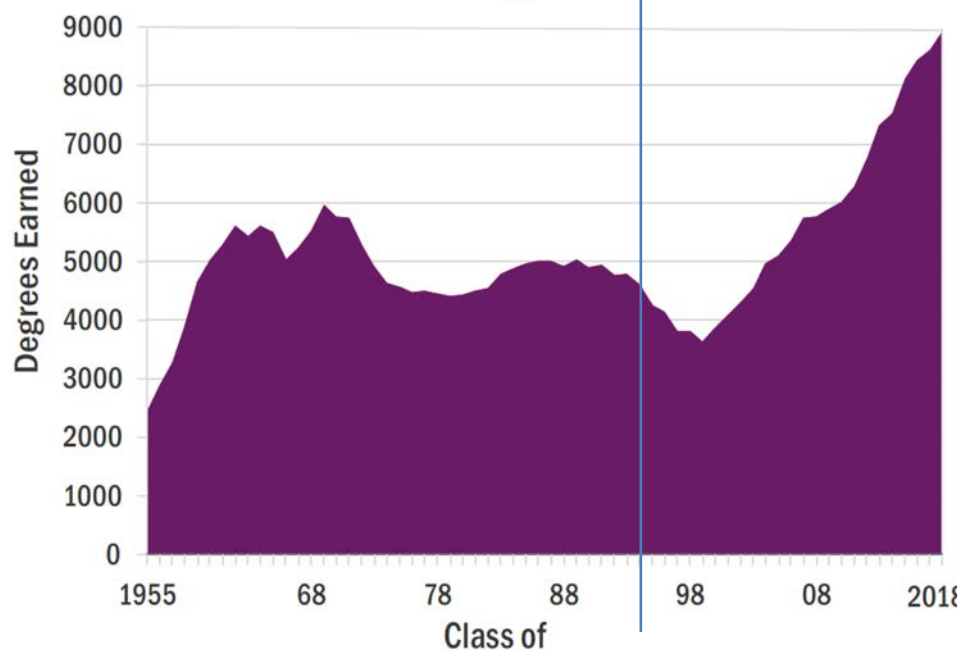
NATIONAL BUREAU OF ECONOMIC RESEARCH

Kugler et al. 2017 <http://www.nber.org/papers/w23735>

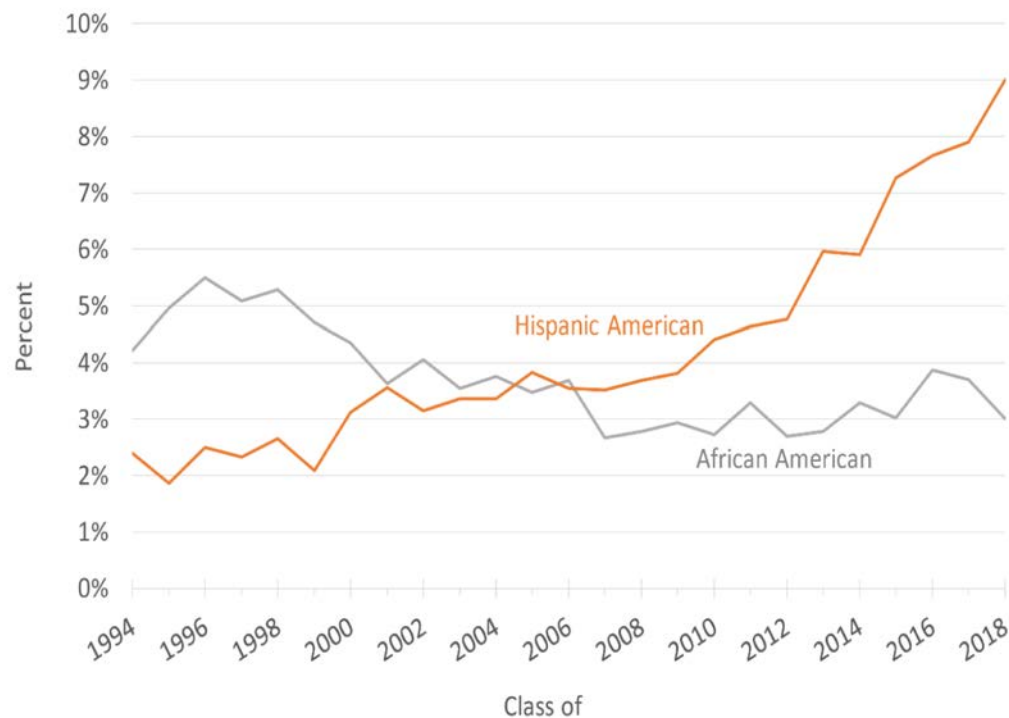


Under-Represented Minorities

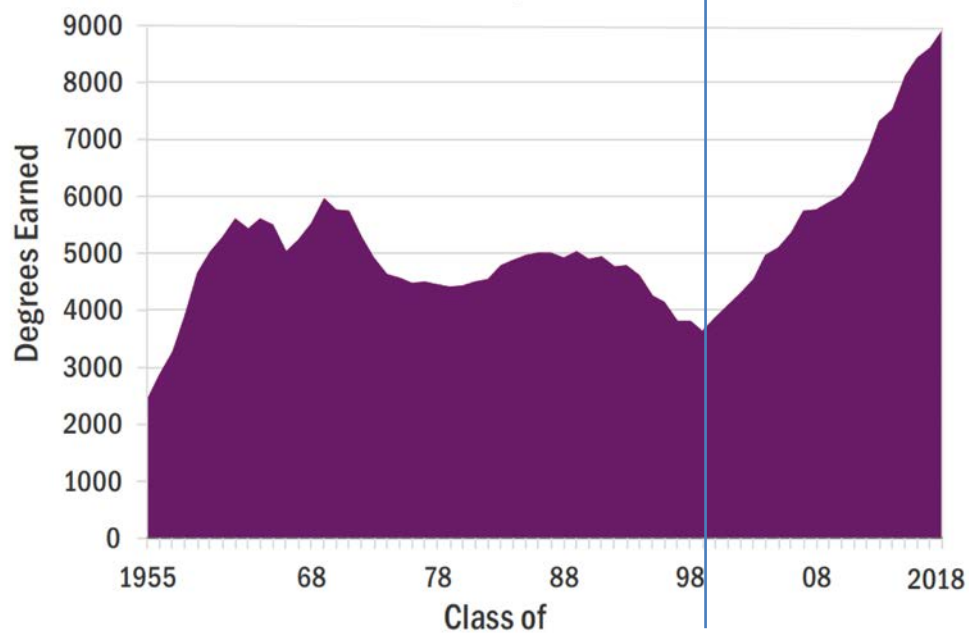
Number of Bachelor's Degrees Earned in Physics
1955 through 2018



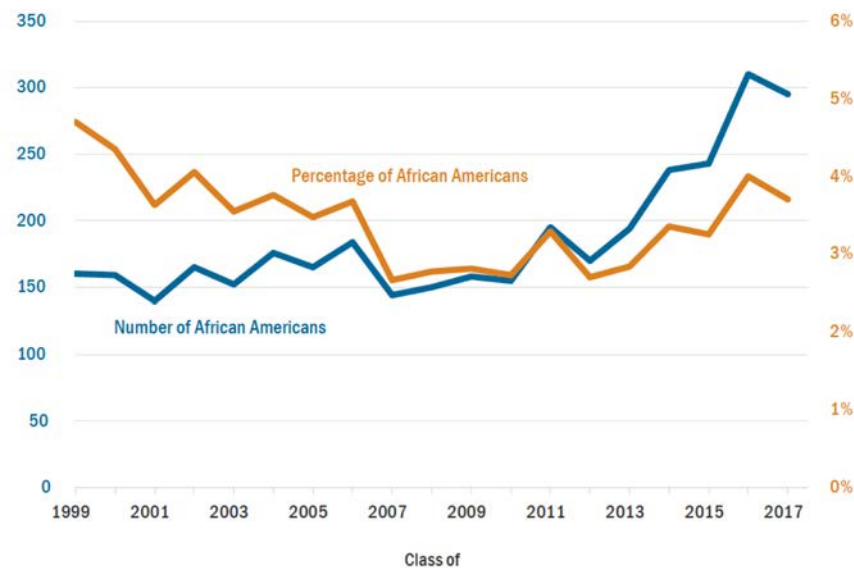
**The Proportion of Physics Bachelor's Degrees Awarded to
African Americans and Hispanic Americans**



Number of Bachelor's Degrees Earned in Physics
1955 through 2018



Number and Percentage of Physics Bachelor's Degrees Earned by African Americans



The percentage of degrees awarded to African-Americans is based on US citizens only. Typically between 5% and 8% of physics bachelors are awarded to non-US citizens.

Past 6 months –
organizations are making
statements, delivering
webinars, doing studies,
publishing reports,



Eight Deliberate Steps AGU is Taking to Address Racism in our Community

Robin Bell, AGU President and Susan Lozier, AGU President-elect

AIP

American Institute
of Physics

TEAM-UP REPORT

**THE TIME
IS NOW**

Systemic Changes to Increase African
Americans with Bachelor's Degrees in
Physics and Astronomy

HBCUs:

*America's
Innovative
Asset*

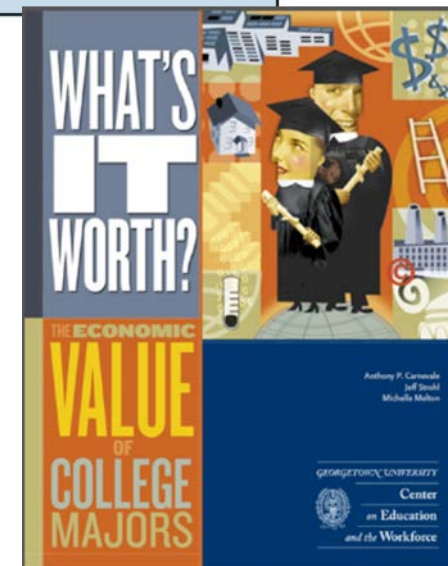
16 July 2020
Victor McCrary, PhD
VP for Research
victor.mccrary@udc.edu
202-274-7443

UNIVERSITY OF
THE
DISTRICT OF
COLUMBIA
1851

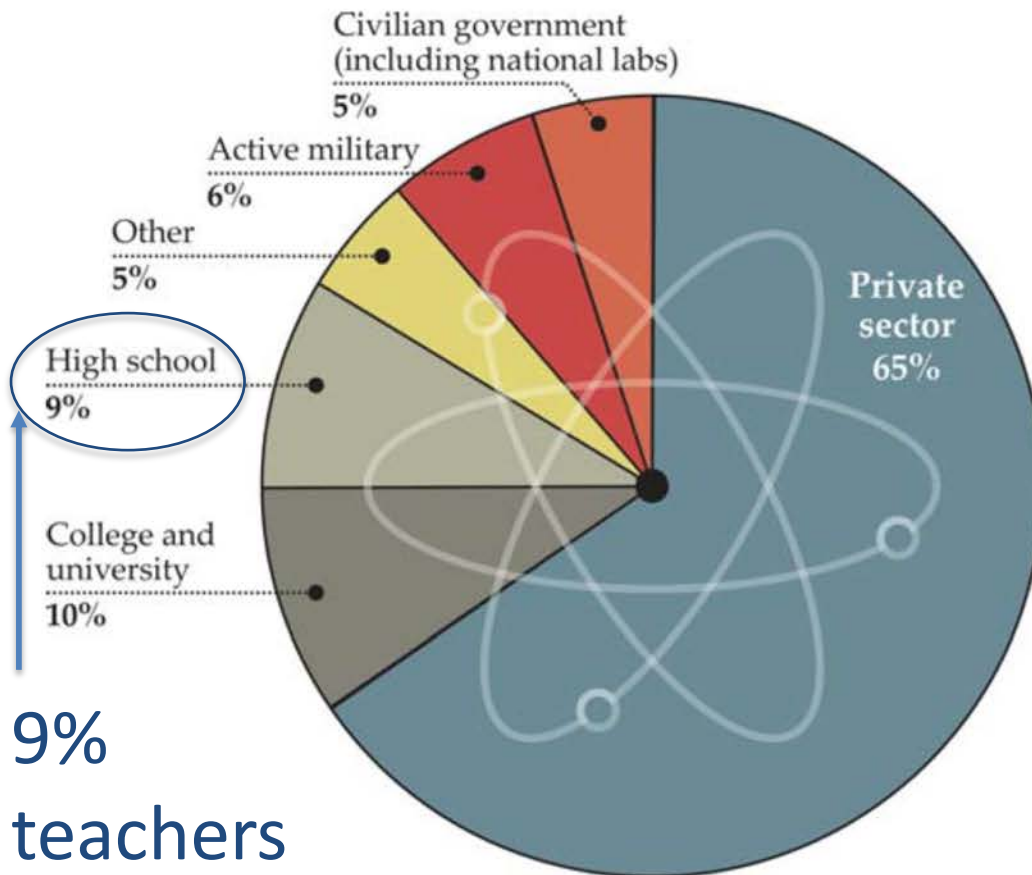
Top 10 Majors by Concentration of African-American Bachelor's Degrees

	Percent White	Percent African-American	Percent Hispanic	Percent Asian	Percent Other Races & Ethnicities
School Student Counseling	56	38	<0.5	6	<0.5
Human Services and Community Organization	65	21	11	1	2
Counseling Psychology	72	20	3	5	1
Health and Medical Administrative Services	71	18	6	5	1
Public Administration	67	18	10	4	2
Social Work	71	16	9	3	1
Miscellaneous Social Sciences	77	16	3	4	<0.5
General Medical and Health Services	71	15	7	6	1
Public Policy	72	15	6	7	1
Community and Public Health	73	14	4	7	1

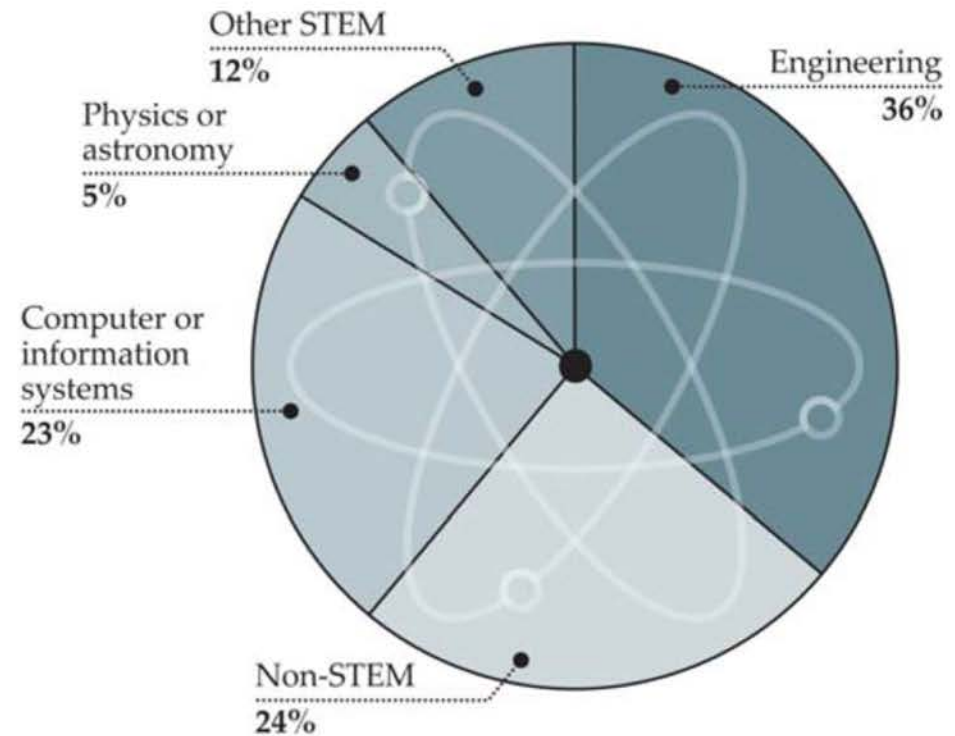
Doing good things for society...
not the best paid



46% of Physics Bachelors enter the workforce on graduation



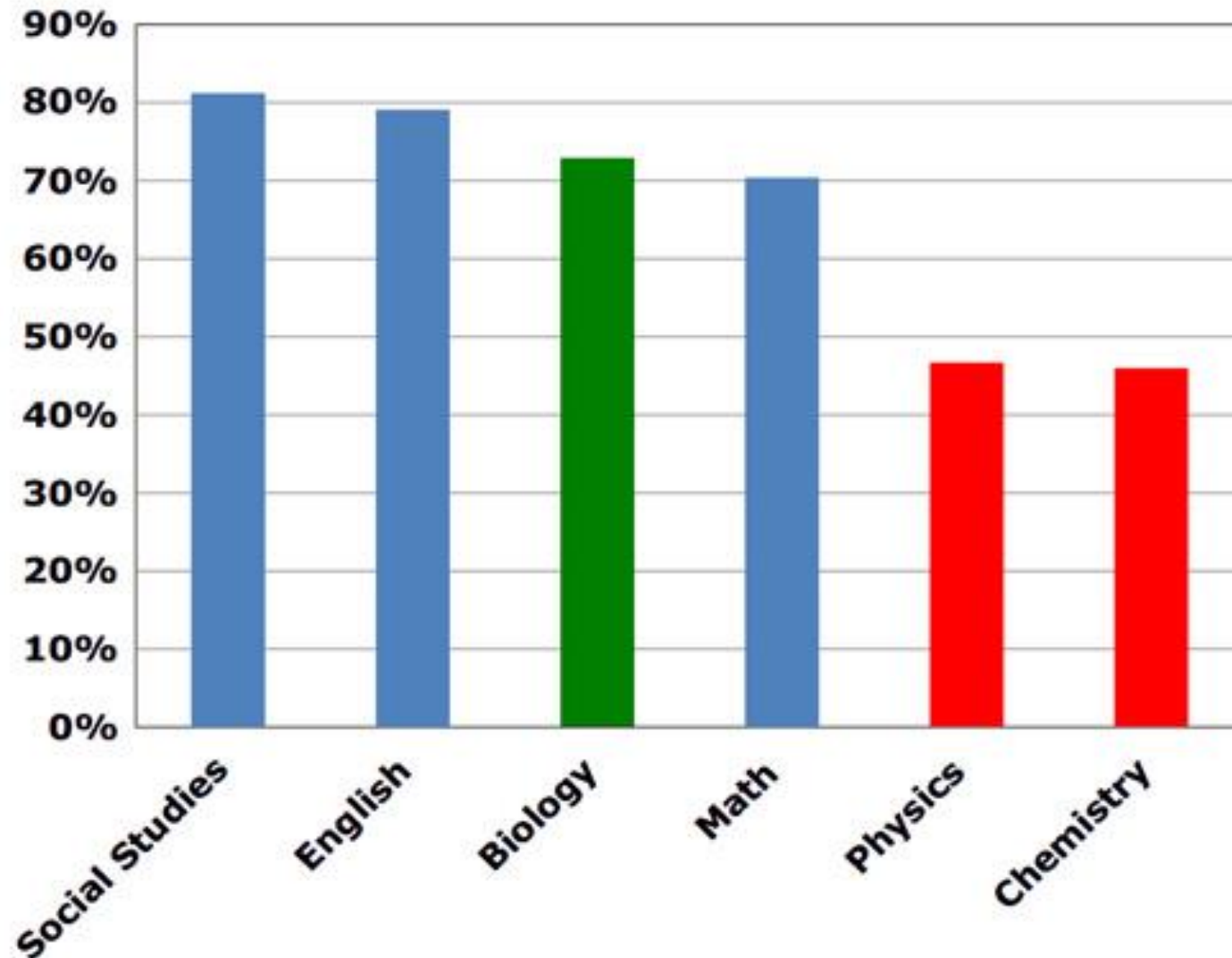
Initial employment sectors
of physics bachelors



Field of employment for physics
bachelors in the private sector

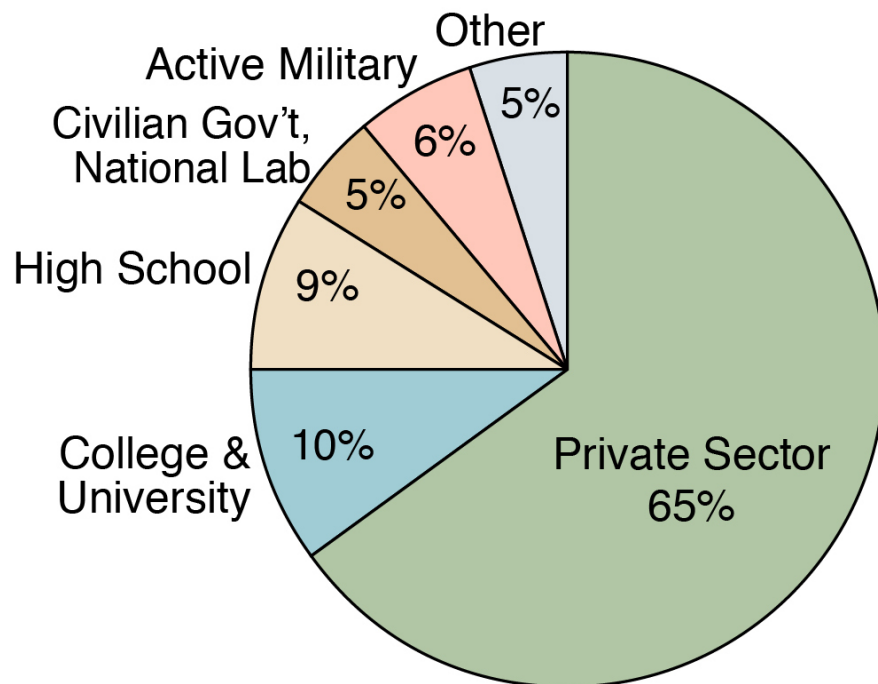
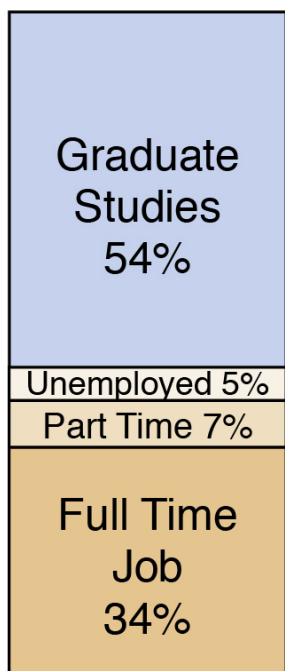
*Of these, 65% go into the private sector
Let's get them the right skills & career advice!*

High School Teachers with a Physics Degree

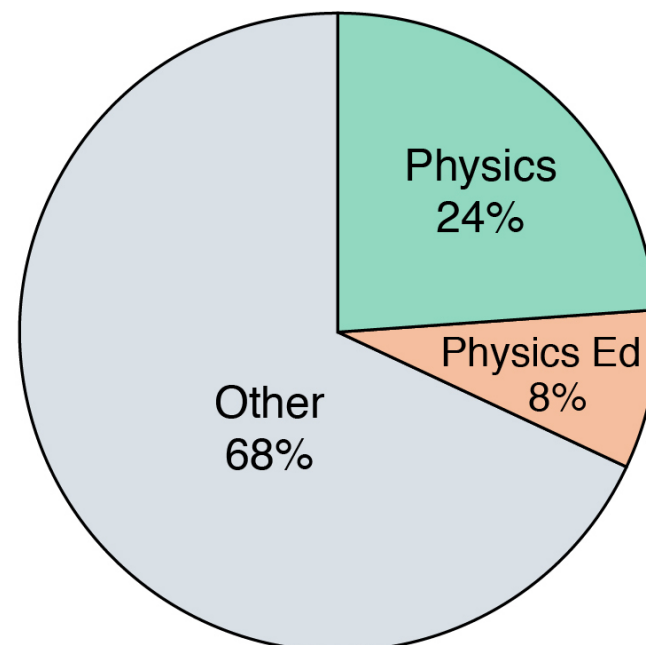


Only 47% of physics classes are taught by a teacher with a degree in the subject, compared with 73% of biology classes and about 80% of humanities classes.

**Initial Employment Sectors
Physics Bachelors 2013 & 2014**



**Degrees of Physics High
School Teachers in 2013**



Thought Experiment:

What would it take to put a teacher with a physics bachelor in every high school in the US?

- 45,000 high schools
15 years "Typical career length" – survival span (optimistic)
= 3000 Physics bachelors per year going into teaching
- Currently 9% of 8000 = 720
- Crank up production another factor 4
- Incentivize? Pay better?
- Change "Physics" to "Natural Sciences"?
- Placement at local schools?

Think Globally
Act Locally

Solutions - 1

– Keep the UGs going

- A – More interactive classes – less "chalk&talk"
- B – Affirmation exercises (they're cheap!)
- C – The Sophomore Roadbump
 - provide undergraduate "study buddies"
 - don't put most traditional teachers in E&M 1!
- D – Socialize (safe) study spaces – university wide
- E – Invite Physics Education Researchers to give a Dept. Seminar
- F – Dept/AGU/AAS/APS needs to provide more advice on non-academic careers

Got Stats?

Let's do the research

**Think Globally
Act Locally**

Solutions – 2 Grad School

Recruitment:

- what are the realistic predictors of success in grad school?
- cast a broad net – makes a better environment

Program

- set fair, consistent, expectations
- design a program that supports and encourages a broad spectrum
- evaluate and articulate progress in a fair, consistent manner – so students know where they are early & often

Non-academic career advice

***– get people from the real world out there to come
give advice on real-world careers***

**Think Globally
Act Locally**

Solutions – 3 - Family

- A society that puts generous resources into educating women - and should make a major effort to benefit from the investment on the long term
- Institutions need to develop policies and resources
 - Dual Careers Recruitment Office, Family Support, "stop the tenure clock", etc;
 - be flexible, adapt to specific cases/needs
- Think long-term – 2 years of supporting "re-entry stipend" pays off over 25-30 year career (e.g. to pay for post-doc to keep research going)

Think Globally
Act Locally

Solutions – 4 - Culture

- Don't blame the women.
Telling women to become more like men is not the solution.
- Change the institutional environment
BUT don't just ask women faculty/researchers to "fix" the problem
- Hire more women faculty/researchers - it's non-linear
- But it is as much CULTURE that drives women away
 - *Women are less content with their work environment*
 - *2-body problems, family issues*
 - *But also hostile environment - many subtle obstacles*
- *Leadership - from the very top - is critical*

Physics Education – the input to our profession....

Total Physics Degrees Academic Year 2012-2013	
Bachelor's	7,329
Exiting Master's	801
Enroute Master's	1,039
PhDs	1,743

Total Physics Enrollments Fall 2013	
Juniors	10,229
Seniors	12,855
1 st Yr Grad	3,159
Total Grad	15,532

Number of Departments by Highest Degree Offered Academic Year 2012-2013	
Bachelor's	497
Master's	57
PhD	198
Total Departments	752

.... and service teaching = bread and butter

Solutions – 5 - National

- Sponsor AIP to do the demographic surveys – SMD-wide – in time for next Decadal Surveys
 - How are numbers changing?
 - What fraction of researchers are non-US to meet needs of the field?
 - How is the field changing?
 - What workforce is needed for next decade?
- Urge APS/AGU/AAS to provide career advice
- Make physical science education a priority – high school, college, graduate
 - *surely we can do better than 8600 physics majors out of 300 million people!*

Demographics Surveys – 1

Across NASA-SMD

- Goal: Is the workforce in the US meeting the needs of SMD? How is the workforce evolving?
- There are significant **overlaps** between areas (e.g. growing field of exoplanets, solar/stellar physics, planetary magnetospheres). How large are these overlaps? Until they are measured we do not know the population served by SMD.
- **Similarities & best practices** - AIP have many years of experience in running demographics surveys. It will be important to follow their best practices as well as ask (at least some) same questions across surveys.
- **Efficiency of scale** - AIP gathers email databases from AGU, AAS, APT, etc, counting and eliminating duplicates.
- **Survey fatigue** - AIP gets a good ~60% response to their surveys but if multiple, uncoordinated surveys are sent out for each sub-area by different organizations the community will likely quickly stop responding.

Demographics Surveys – 2

Across NASA-SMD

Approaches - the Decadals are offset by 2 years.

1 - Do a single, cross-SMD demographics survey every, say, 6 years. The data for a field could be up to 6 years old.

2 - Do separate demographics surveys for each Division, coordinating questions and cross-comparing data.