

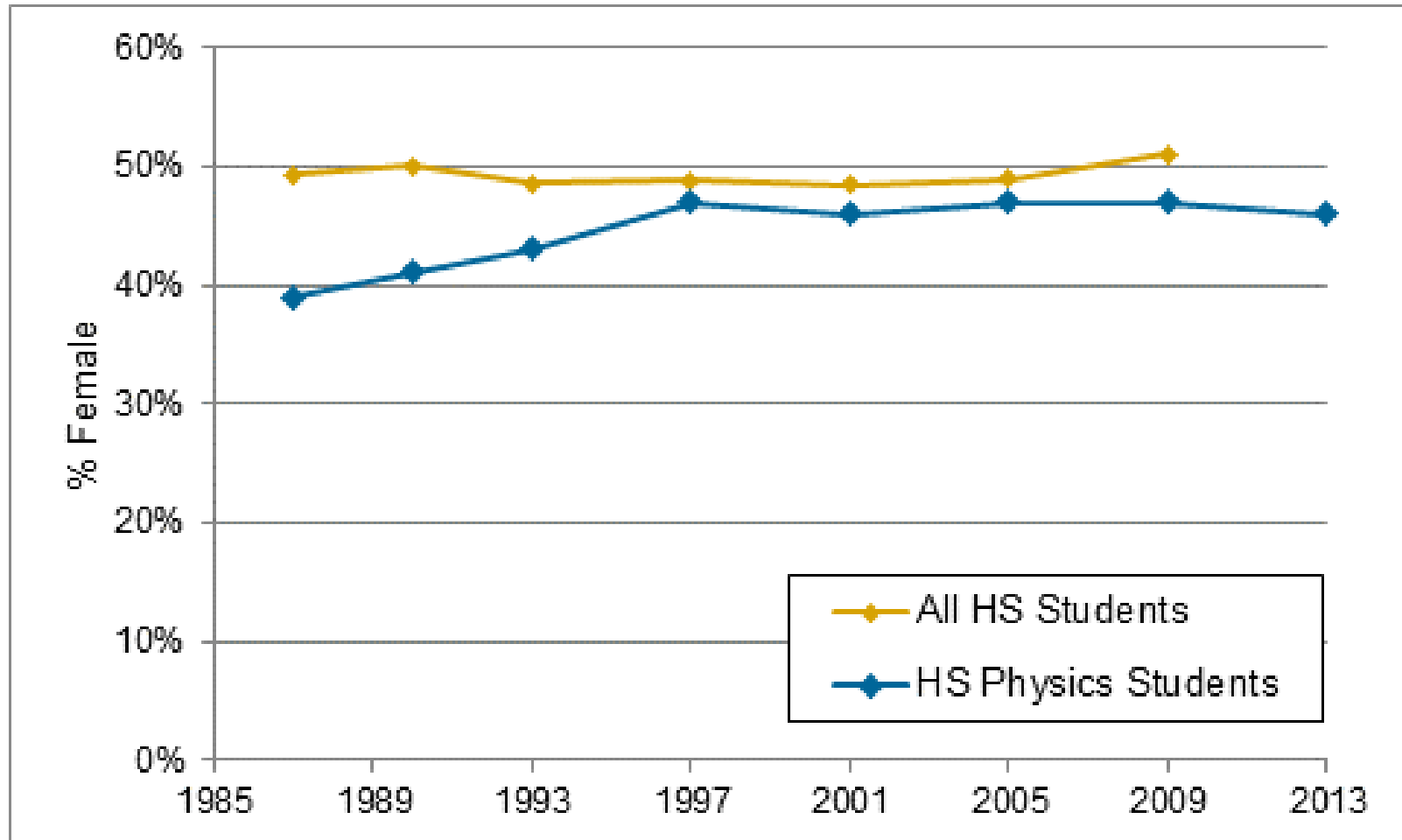
BEYOND REPRESENTATION: DATA TO IMPROVE THE SITUATION OF WOMEN AND MINORITIES IN PHYSICS AND ASTRONOMY

Rachel Ivie

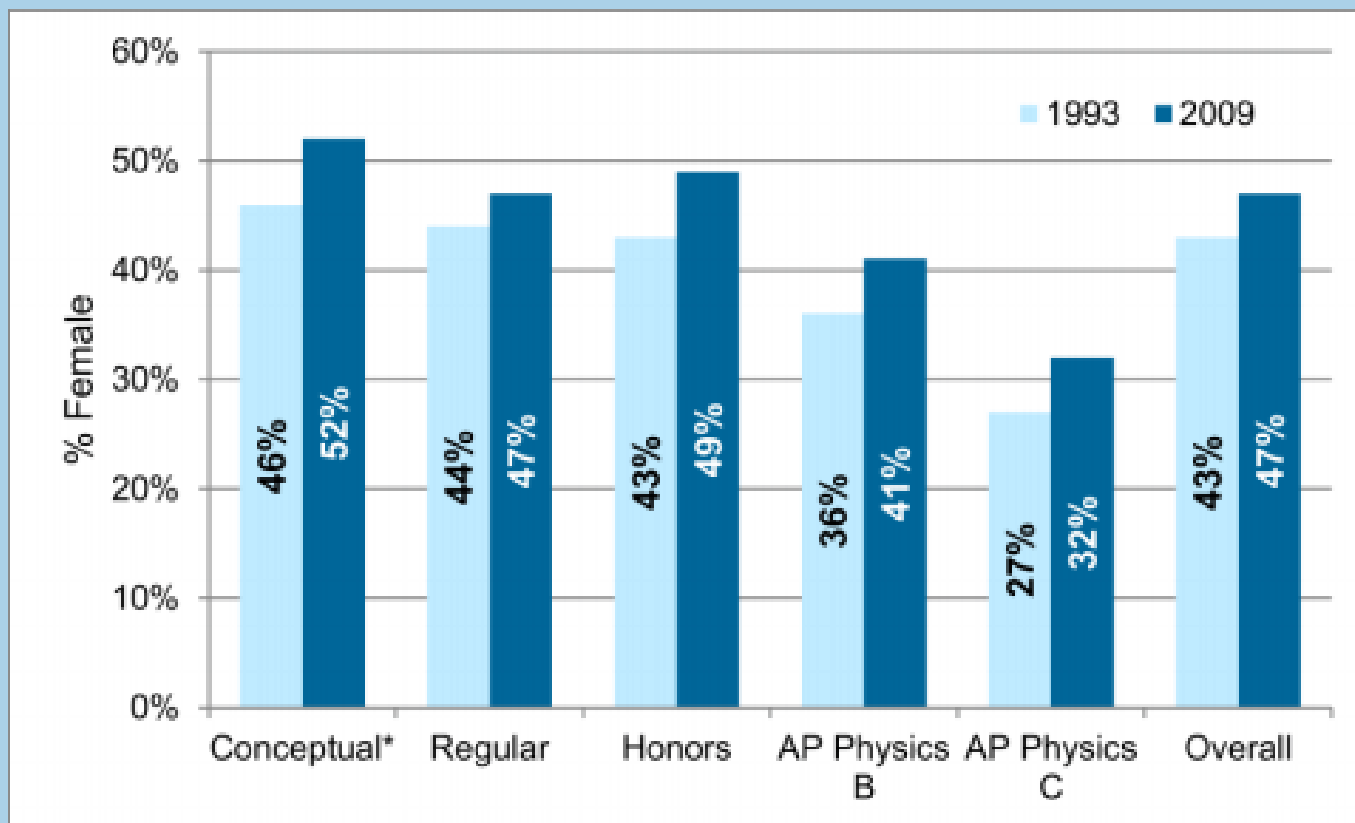
Statistical Research Center

REPRESENTATION OF WOMEN

GIRLS AS A PERCENTAGE OF TOTAL ENROLLMENT IN HIGH SCHOOL PHYSICS



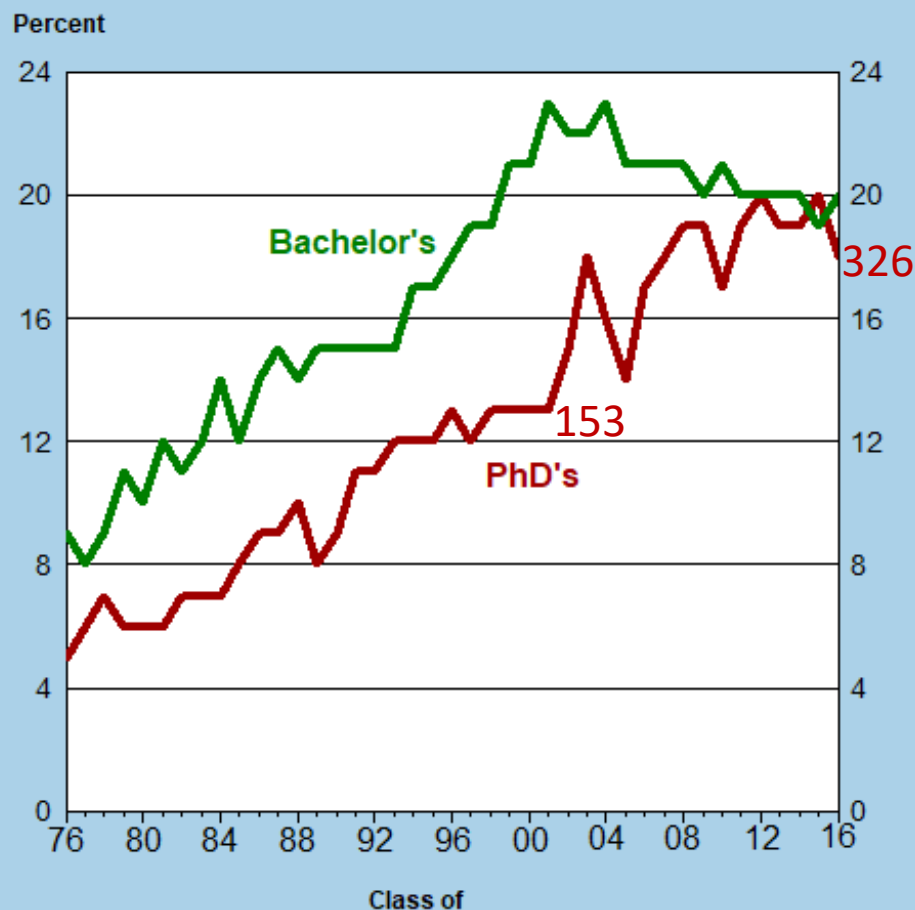
Representation of Female Students among Physics Students by Type of Course All US High Schools



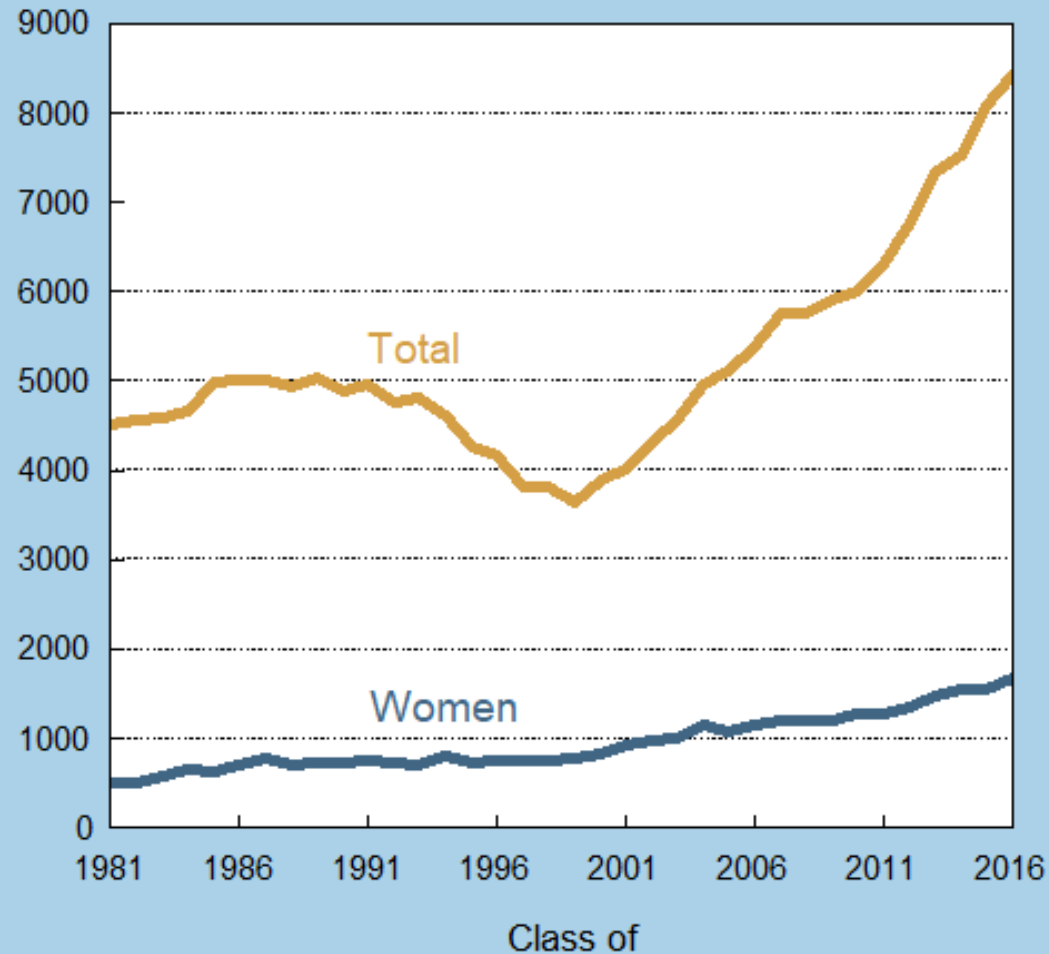
* Includes data for both Physics First and Conceptual Physics for 2009; Physics First data was not collected separately in 1993

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

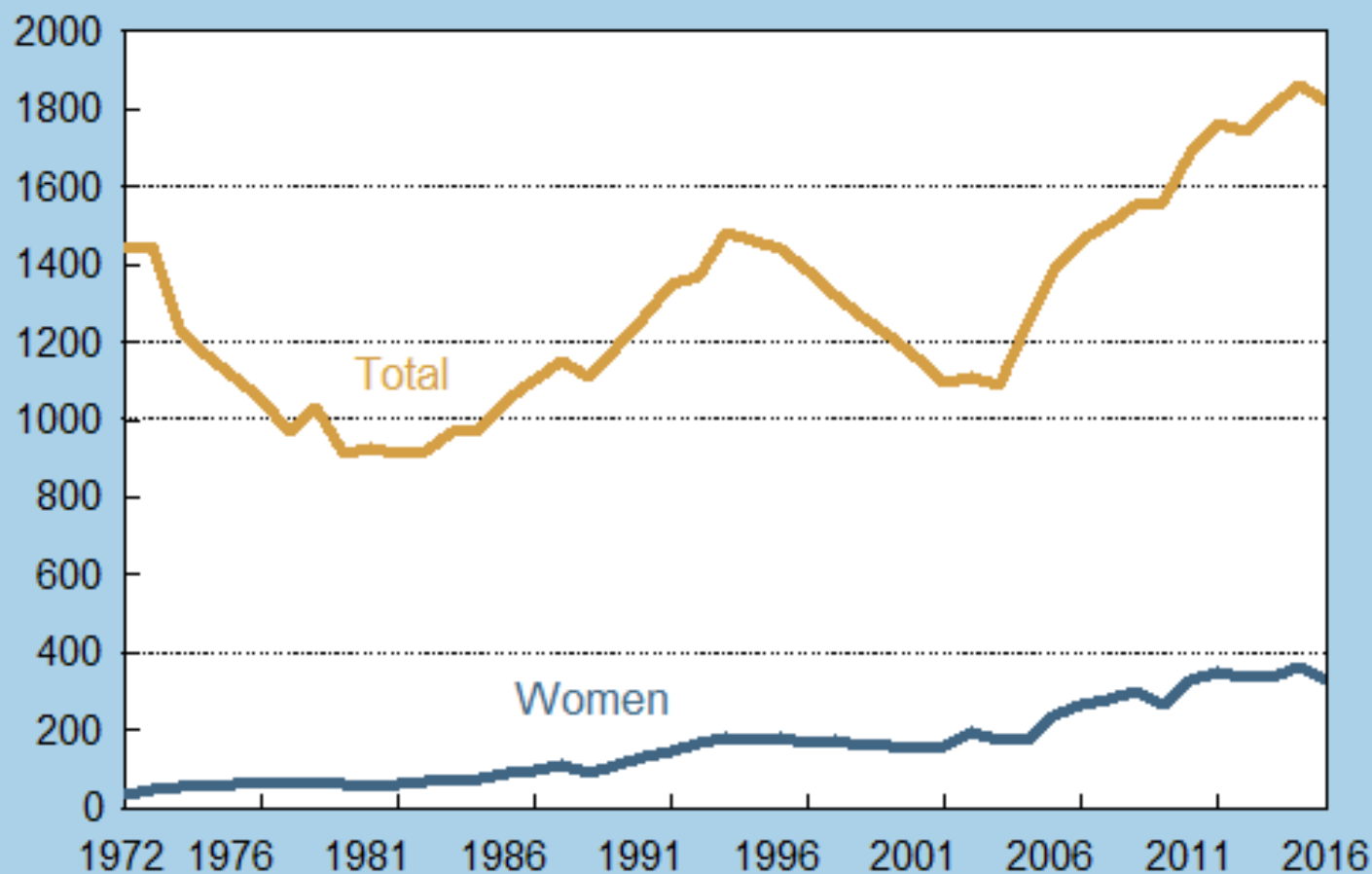
**Percent of Physics Bachelors and PhDs earned by Women,
Classes of 1976 through 2016.**



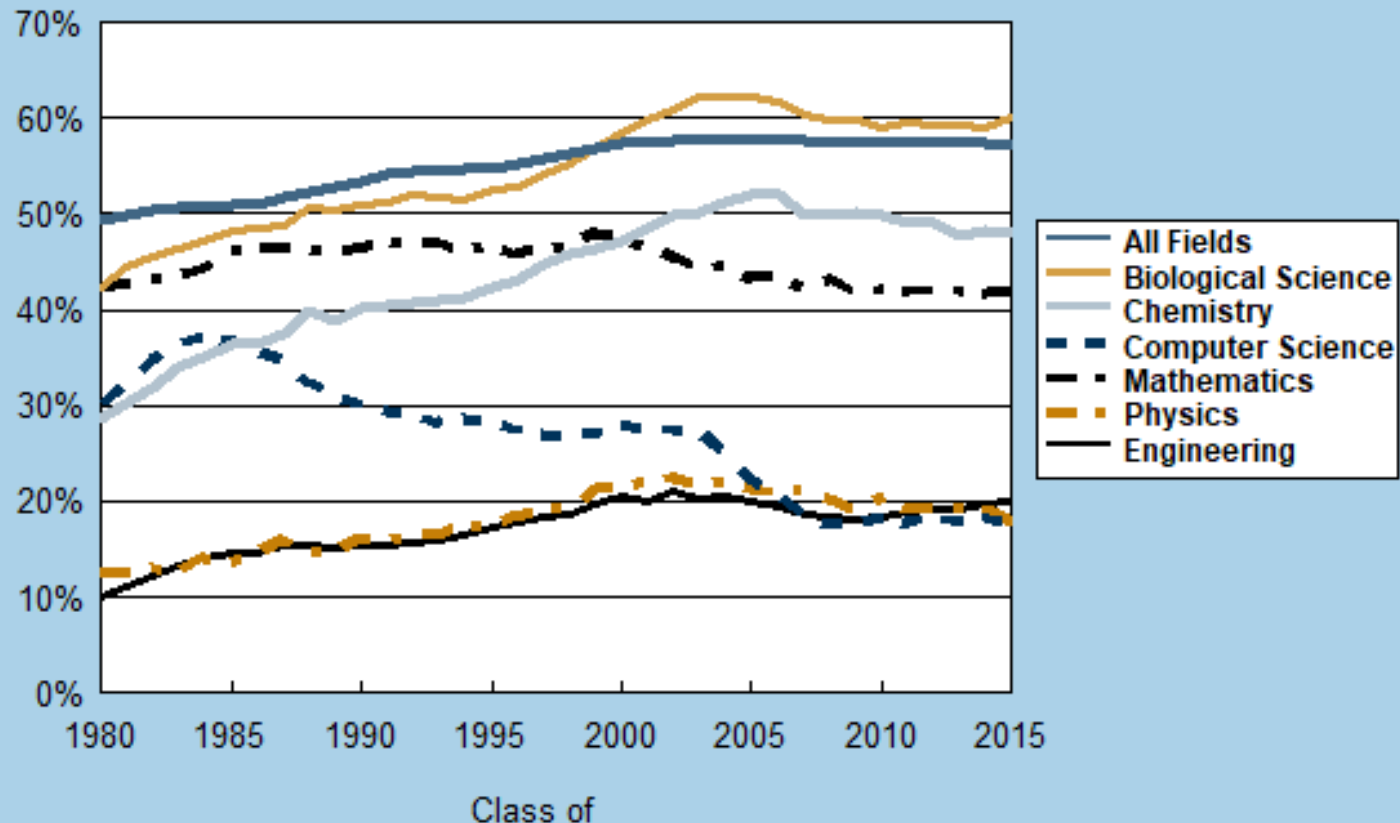
Number of Bachelor's Degrees Earned in Physics, Classes 1981 through 2016.



Number of PhDs Earned in Physics 1972 - 2016.

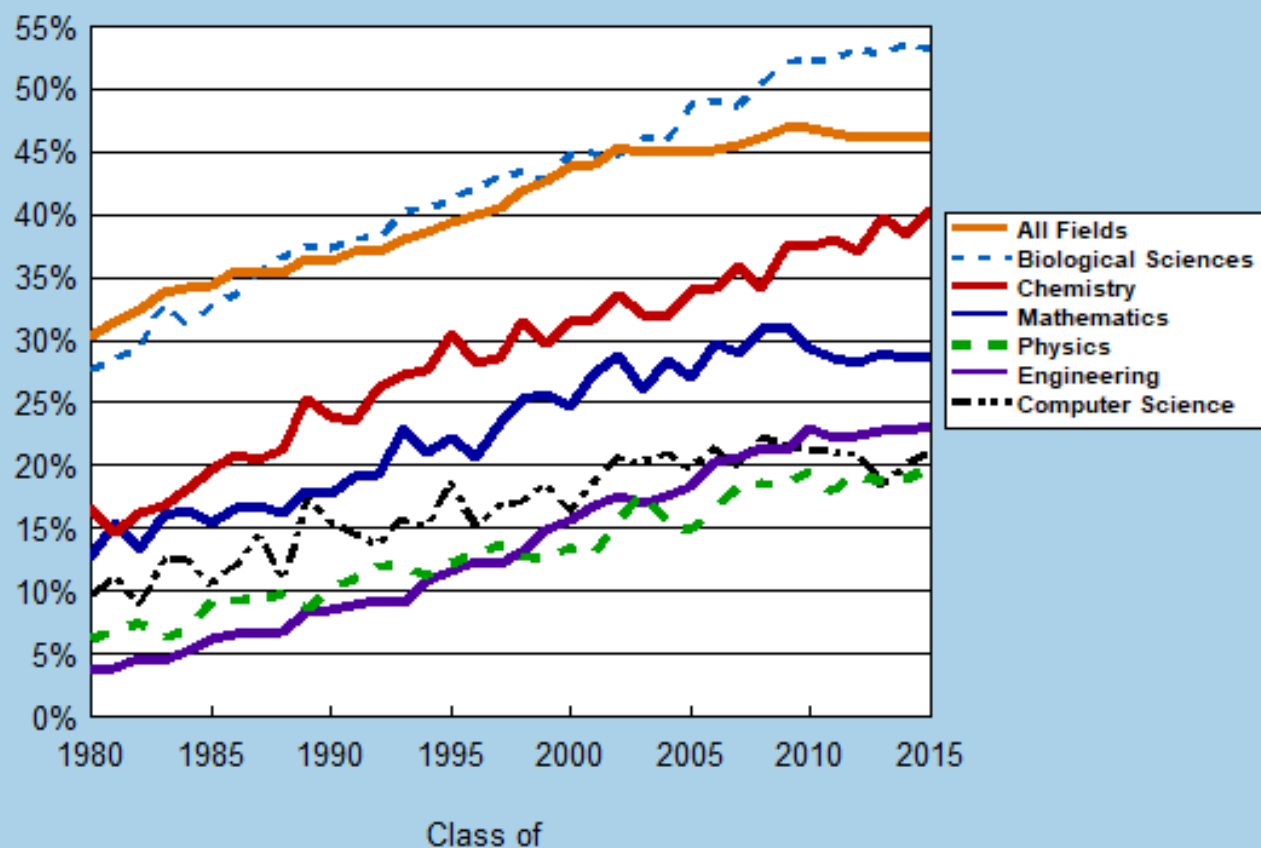


Percent of Bachelor's Degrees Earned by Women in Selected Fields, Classes 1980 through 2015.



National Center for Education Statistics. Compiled by AIP Statistical Research Center.

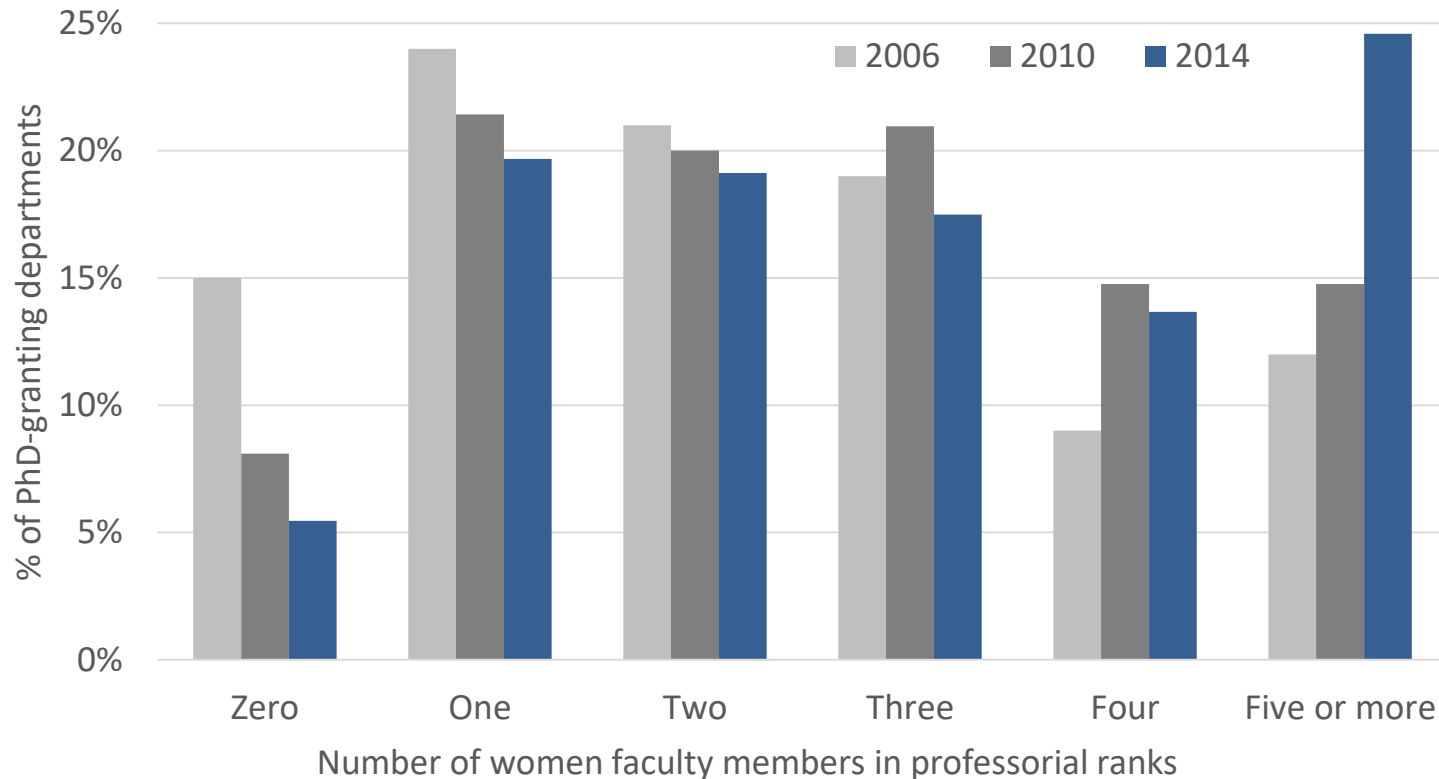
Percent of PhDs Earned by Women in Selected Fields, Classes 1980 through 2015.



PERCENTAGE OF PHYSICS FACULTY MEMBERS WHO ARE WOMEN

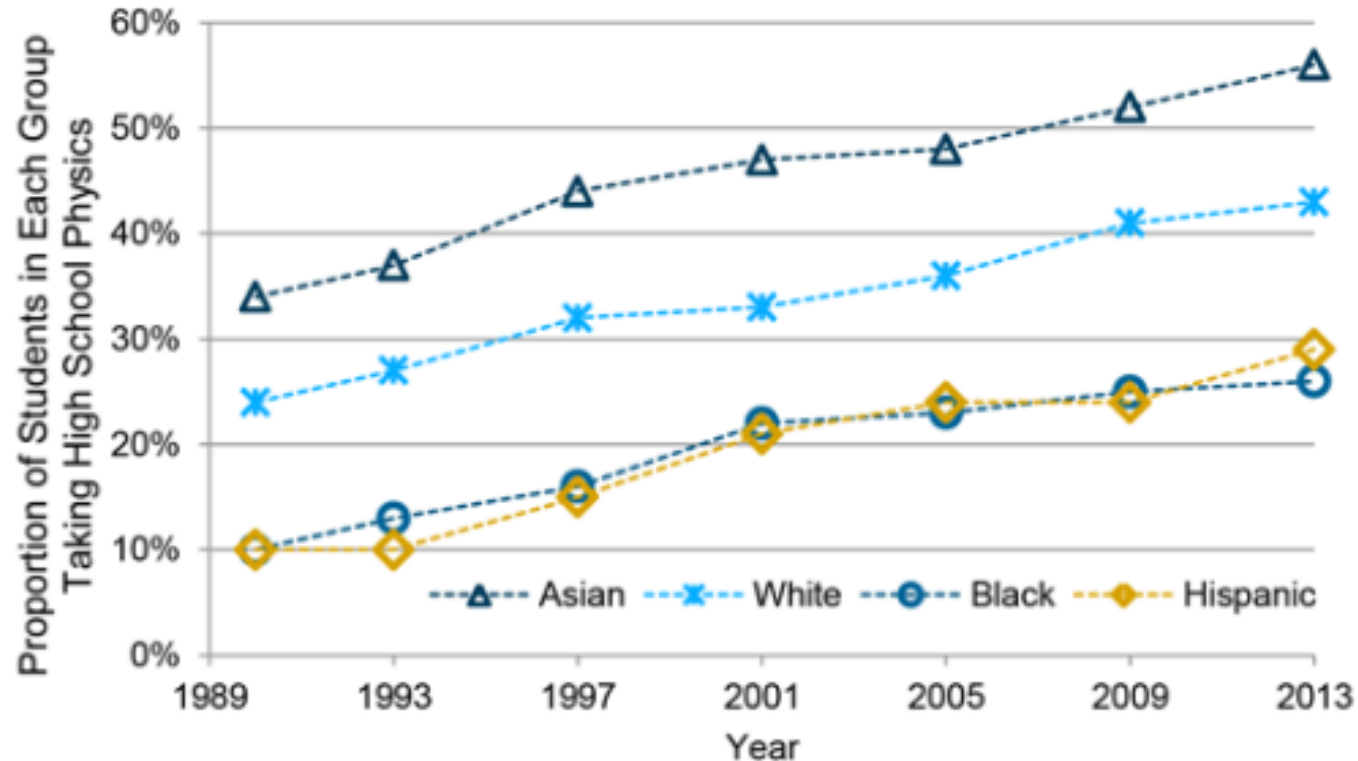
| | 2002 | 2006 | 2010 | 2014 |
|-------------------------------|-----------|-----------|-----------|-----------|
| RANK | | | | |
| FULL PROFESSOR | 5 | 6 | 8 | 10 |
| ASSOCIATE PROF | 11 | 14 | 15 | 18 |
| ASSISTANT PROF | 16 | 17 | 22 | 23 |
| INSTRUCTOR/ADJUNCT | 16 | 19 | 21 | 23 |
| OTHER RANKS | 15 | 12 | 18 | 20 |
| HIGHEST DEGREE OFFERED | | | | |
| PHD | 7 | 10 | 12 | 14 |
| MASTER'S | 13 | 15 | 15 | 18 |
| BACHELOR'S | 14 | 15 | 17 | 20 |
| OVERALL | 10 | 12 | 14 | 16 |

PHD-GRANTING PHYSICS DEPARTMENTS BY NUMBER OF WOMEN FACULTY MEMBERS IN PROFESSORIAL RANKS



UNDER-REPRESENTED MINORITIES

Proportion of Students Taking High School Physics in the US in Each Racial/Ethnic Group



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

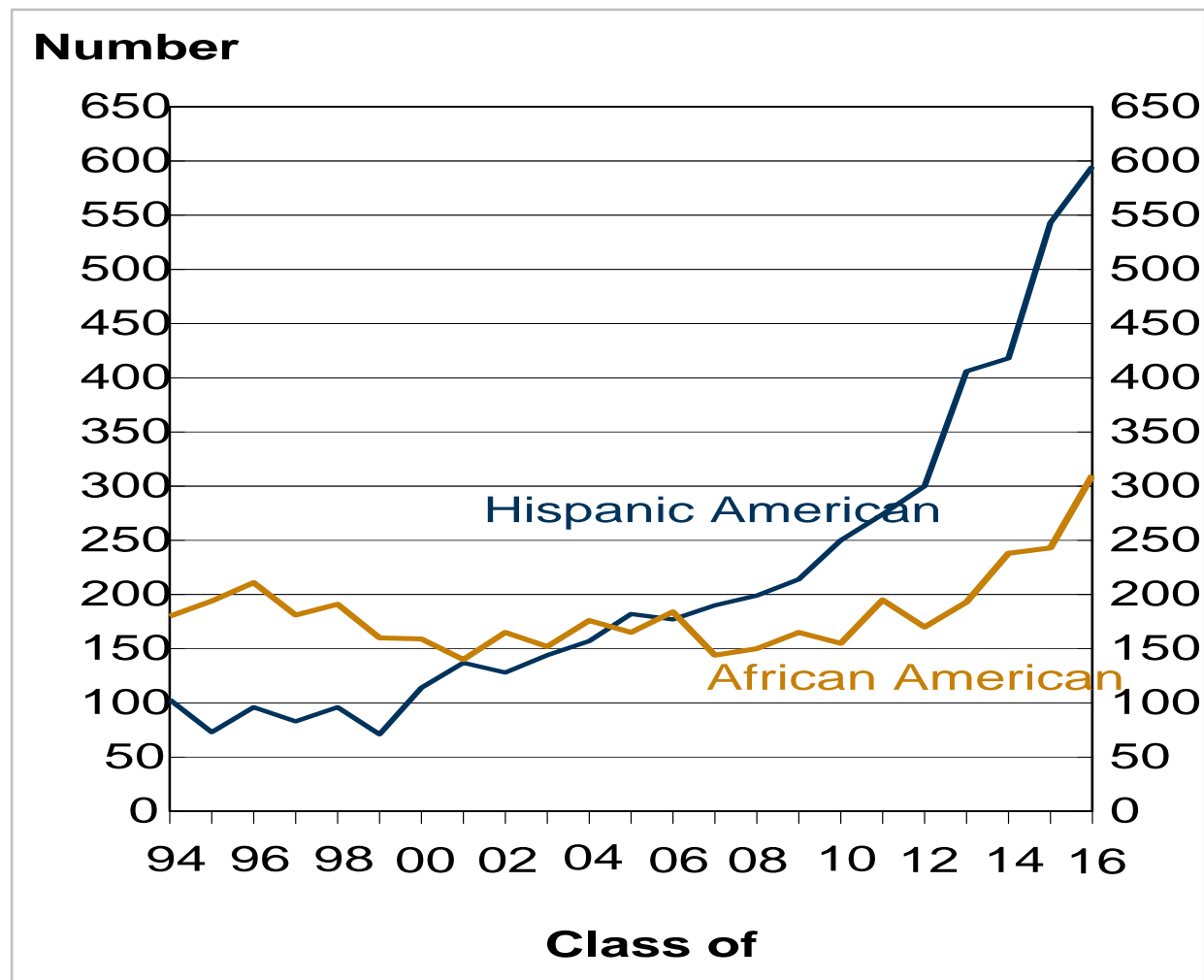
RACE AND ETHNICITY OF PHYSICS BACHELORS

CLASSES OF 2014 THROUGH 2016

(3-YEAR AVERAGE)

| | Number | Percent of all Physics Bachelors |
|-------------------|--------|-------------------------------------|
| White | 5,943 | 74 |
| Asian American | 551 | 7 |
| Hispanic American | 518 | 7 |
| African American | 253 | 3 |
| Other US citizens | 166 | 2 |
| Non-US citizens | 575 | 7 |
| Total | 8,006 | 100 |

Number of Physics Bachelor's Degrees Earned by African-Americans and Hispanic-Americans, Classes of 1994 through 2016.

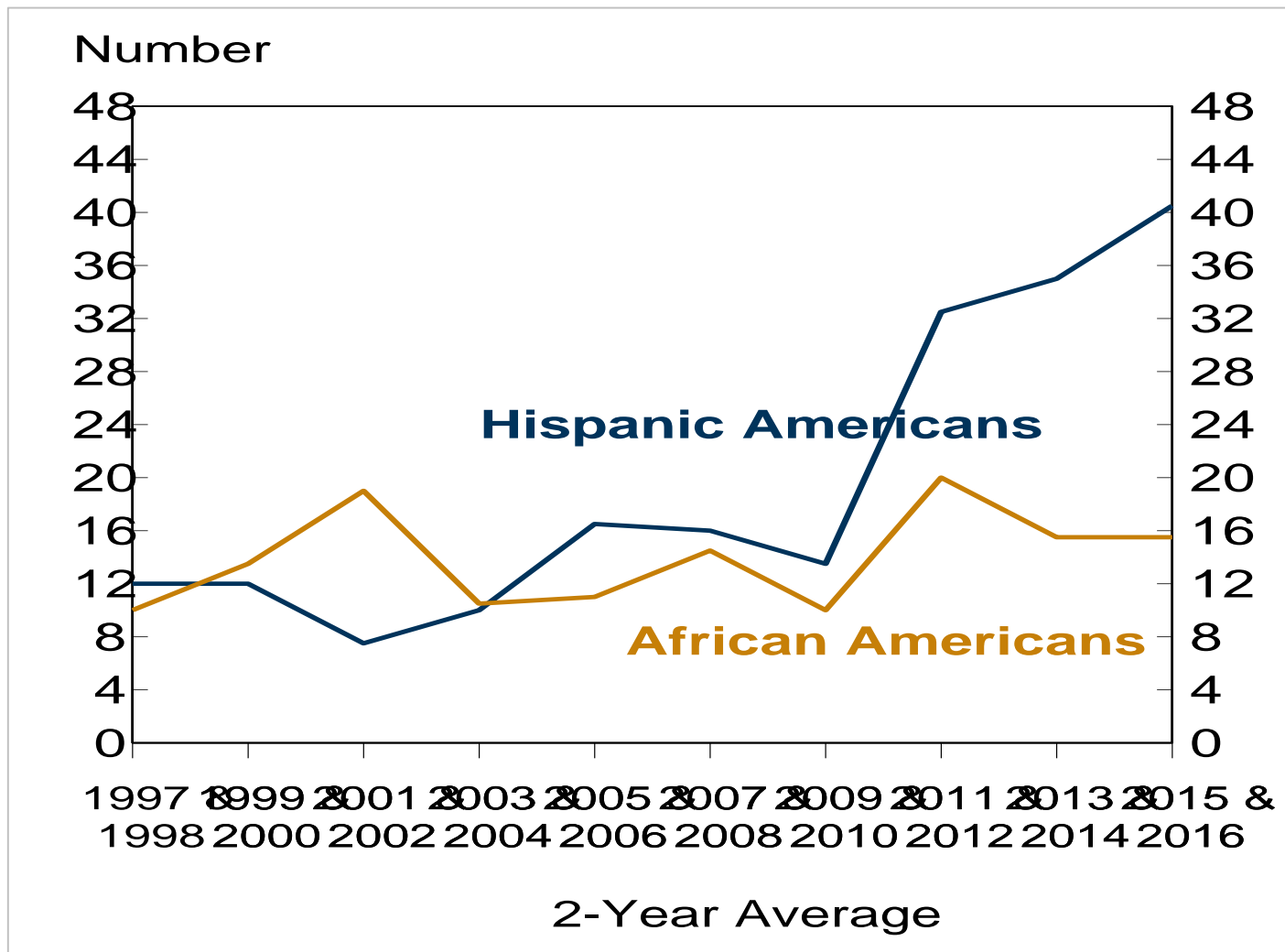


RACE AND ETHNICITY OF PHYSICS PHDS, CLASSES OF 2014 THROUGH 2016 (3-YEAR AVERAGE)

| | Number | Percent of all Physics PhDs | Percent of U.S. Physics PhDs* |
|-------------------|--------|--------------------------------|----------------------------------|
| White | 843 | 46 | 87 |
| Asian American | 57 | 3 | 6 |
| Hispanic American | 38 | 2 | 4 |
| African American | 16 | 1 | 2 |
| Other US citizens | 12 | 1 | 1 |
| Non-US citizens | 861 | 47 | - |
| Total | 1,827 | 100 | 100 |

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

Number of Physics Doctorates Earned by African-Americans And Hispanic-Americans, Classes of 1997 through 2016.

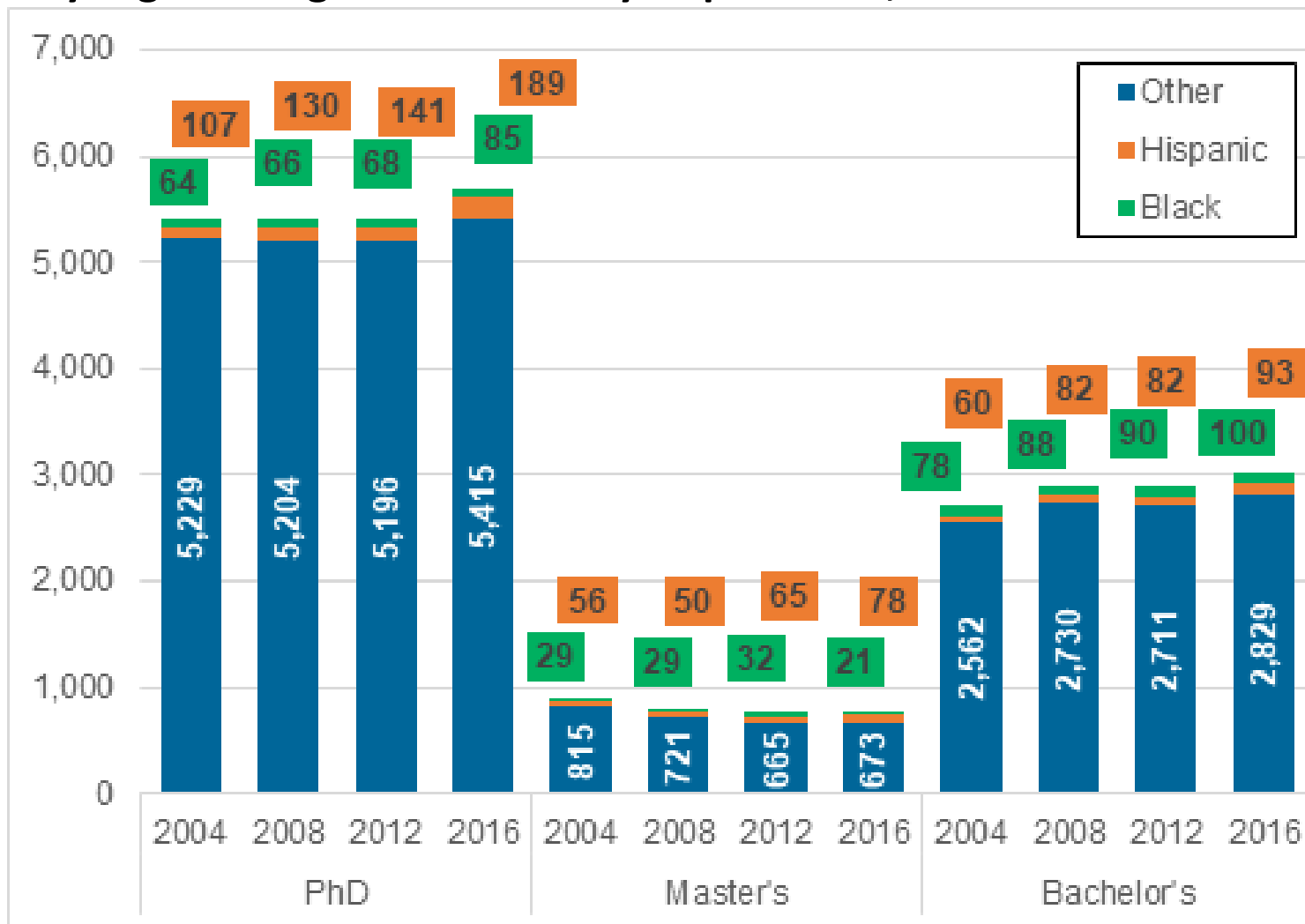


Race and Ethnicity of Physics Faculty Members, 2004-2016

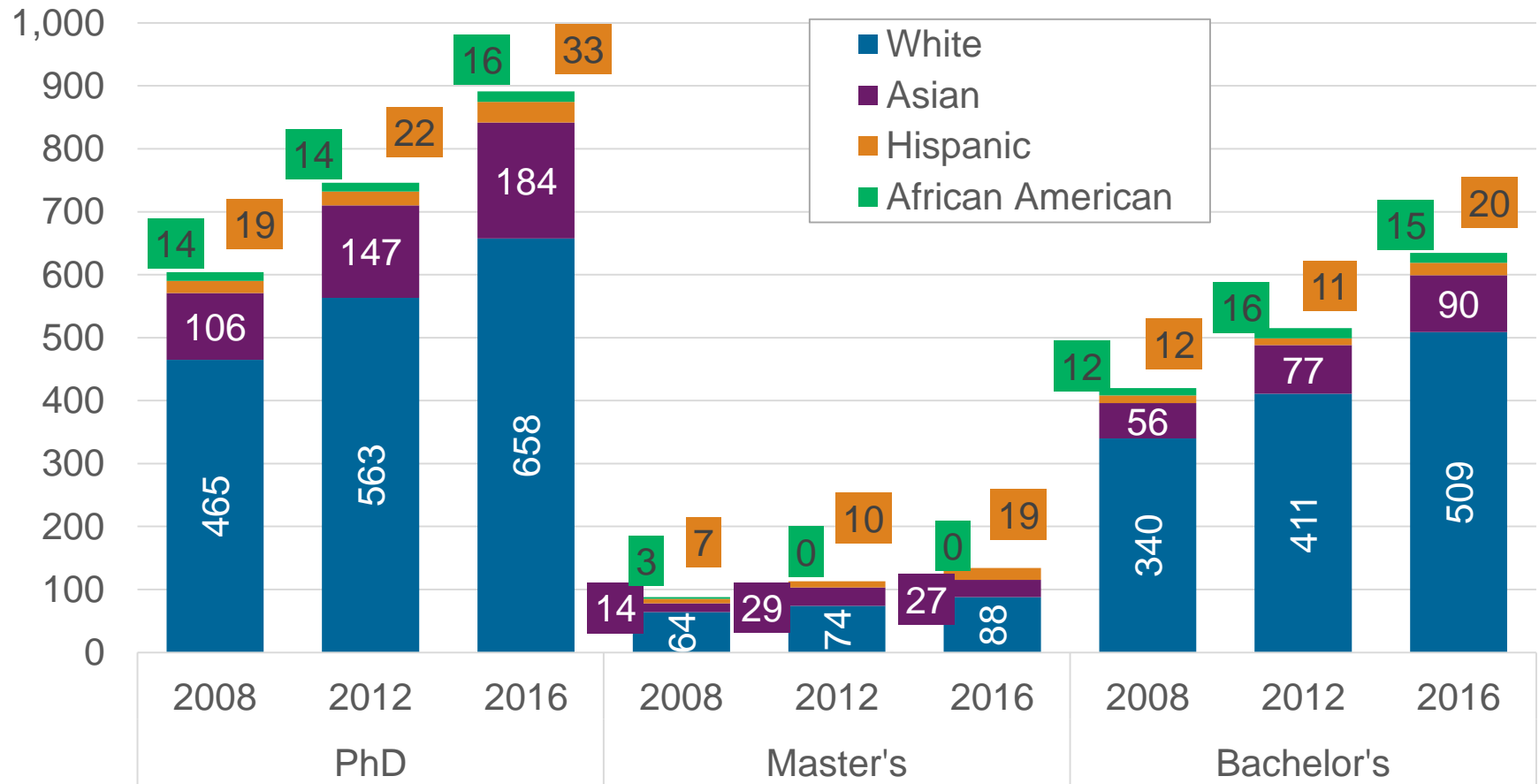
| | Physics | | | | All Disciplines* |
|-------------------------|-------------|-------------|-------------|-------------|---------------------|
| | 2004 (%) | 2008 (%) | 2012 (%) | 2016 (%) | 2015 (%) |
| African-American | 2 | 2.2 | 2.1 | 2.5 | 6 |
| Asian | 10.6 | 13.2 | 14.3 | 15.2 | 10 |
| Hispanic | 2.7 | 3.1 | 3.2 | 3.8 | 4 |
| White | 82.2 | 80 | 79.2 | 76.3 | 77 |
| Other | 2.2 | 1.5 | 1.2 | 2.3 | <2 |

*Data for all disciplines (including non-science disciplines) is located at:
<https://nces.ed.gov/fastfacts/display.asp?id=61>

Number of African-American and Hispanic Physics Faculty by Highest Degree Awarded by Department, 2004-2016



Number of Women in Physics and Astronomy Departments by Highest Degree Awarded, 2008-2016



Number of Physics Departments with African-American and Hispanic Faculty by Highest Degree Awarded, 2016

| Number of Departments that have ... | PhD | Master's | Bachelor's | Total |
|---|-----|----------|------------|-------|
| <u>Both</u> African-American and Hispanic Faculty | 25 | 7 | 3 | 45 |
| African-American Faculty and <u>no</u> Hispanic Faculty | 25 | 8 | 53 | 86 |
| Hispanic Faculty and <u>no</u> African-American Faculty | 75 | 20 | 61 | 156 |
| <u>Neither</u> African- American nor Hispanic Faculty | 76 | 22 | 365 | 463 |
| Total | 202 | 56 | 492 | 750 |

WILL INCREASING REPRESENTATION FIX EVERYTHING?

- Data should be collected on other important areas
 - Workplace environment
 - Salary
- Even with equal representation, some groups could have limited access to resources and opportunities

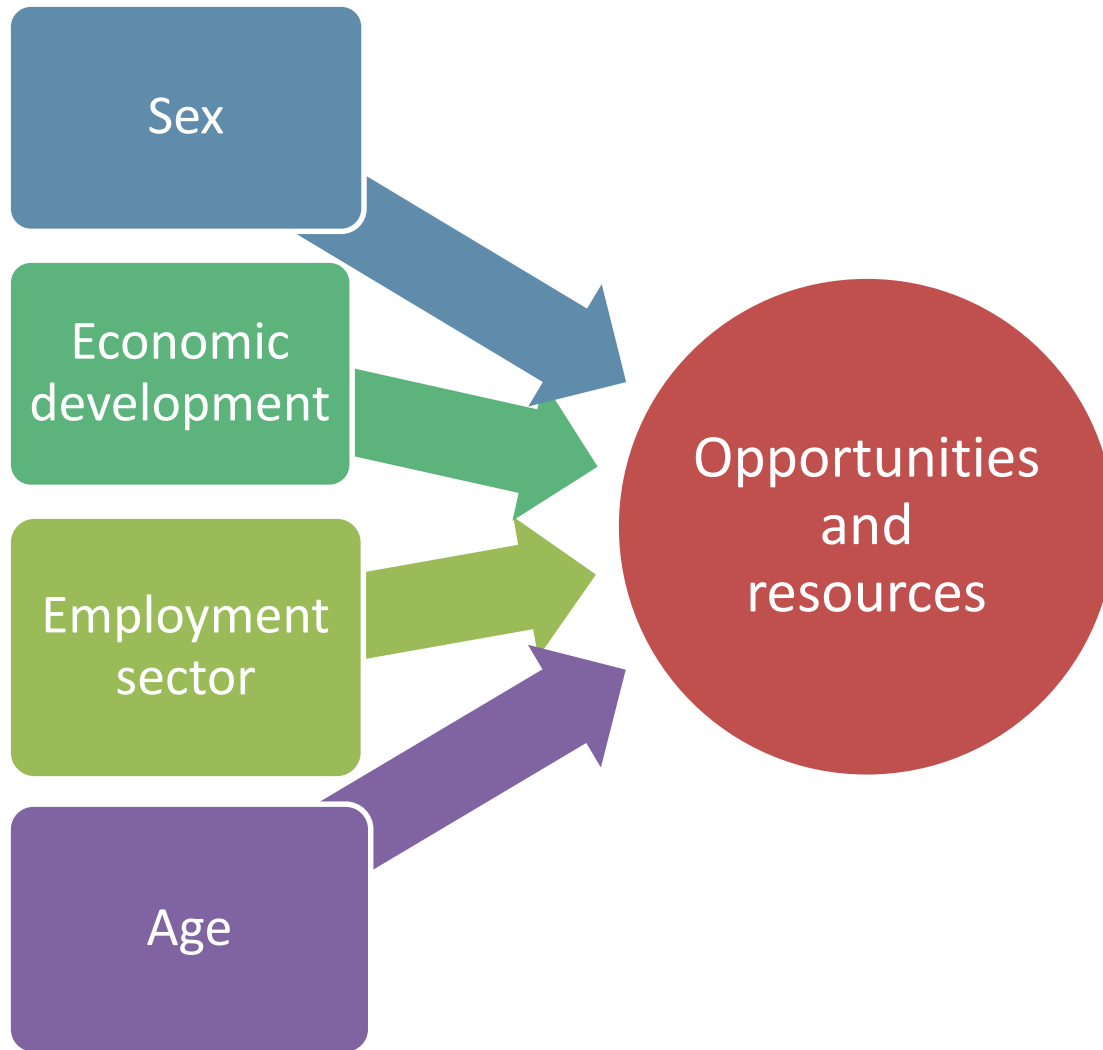
PHD+10 (TO 15) STUDY

- PhD classes of 1996, 1997, 2000, & 2001
 - Who lived in the US during 2011
 - 1,544 respondents
 - 45% response rate
- Salary regression showed that men make more than women
 - ~6% more ($p = 0.025$)
 - Controlling for employment sector, time since degree, whether respondent had stayed with same employer, whether or not respondent had take a postdoc, highest degree the department offers (academic only)

GLOBAL SURVEY OF PHYSICISTS, 2009-2010

- About 15,000 respondents from 130 countries
- Conducted in 8 languages
- Separate results for Canada

<https://www.aip.org/statistics/reports/there-land-equality-physicists>



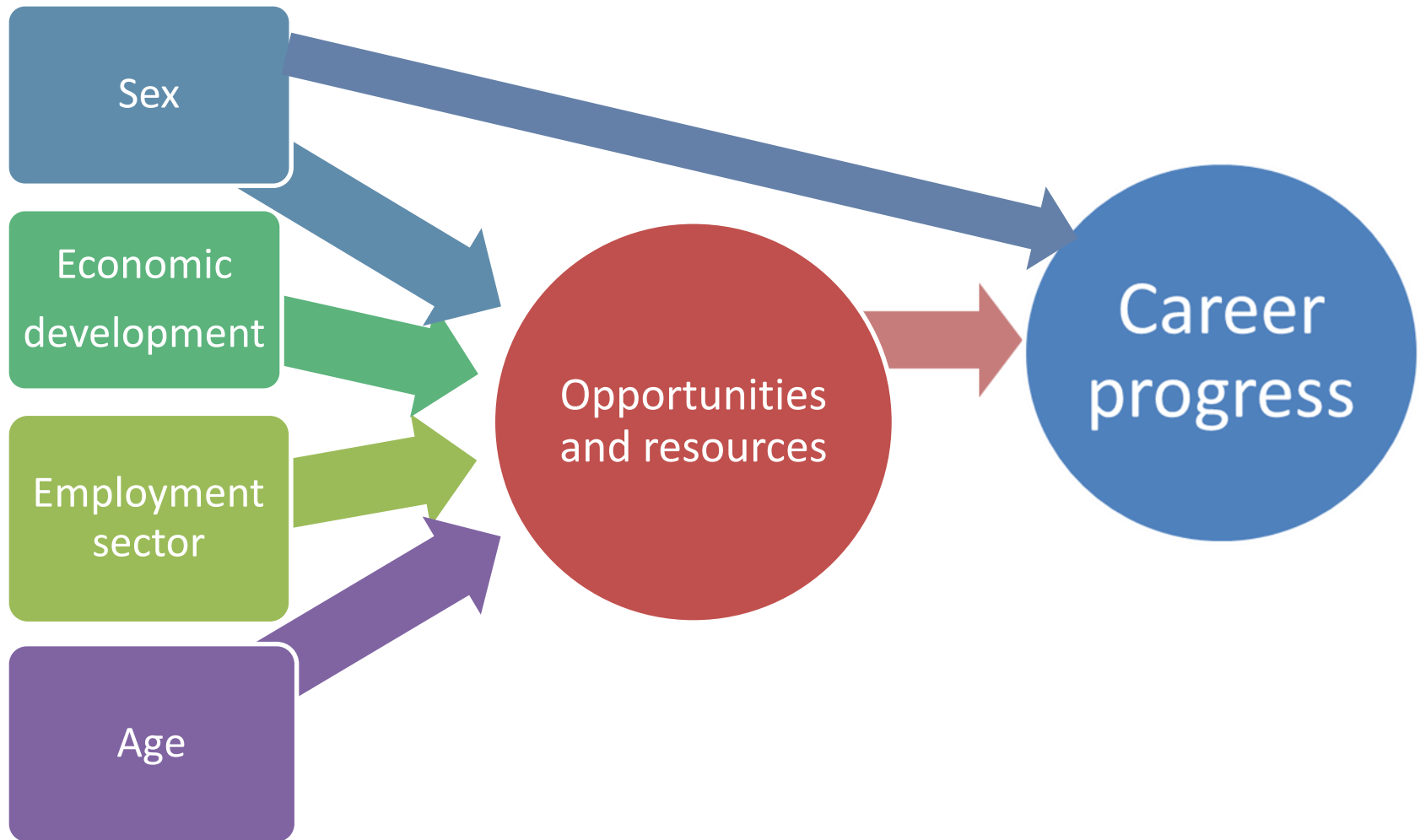
Percentage of respondents with access to key resources

| | Less Developed | | Very Highly Developed | |
|-----------------------|----------------|-----|-----------------------|-----|
| | Women | Men | Women | Men |
| Funding | 34 | 51 | 52 | 60 |
| Office space | 64 | 74 | 72 | 77 |
| Lab space | 42 | 47 | 46 | 52 |
| Equipment | 42 | 49 | 58 | 64 |
| Travel money | 31 | 47 | 57 | 64 |
| Clerical support | 22 | 38 | 30 | 43 |
| Employees or students | 42 | 53 | 33 | 43 |

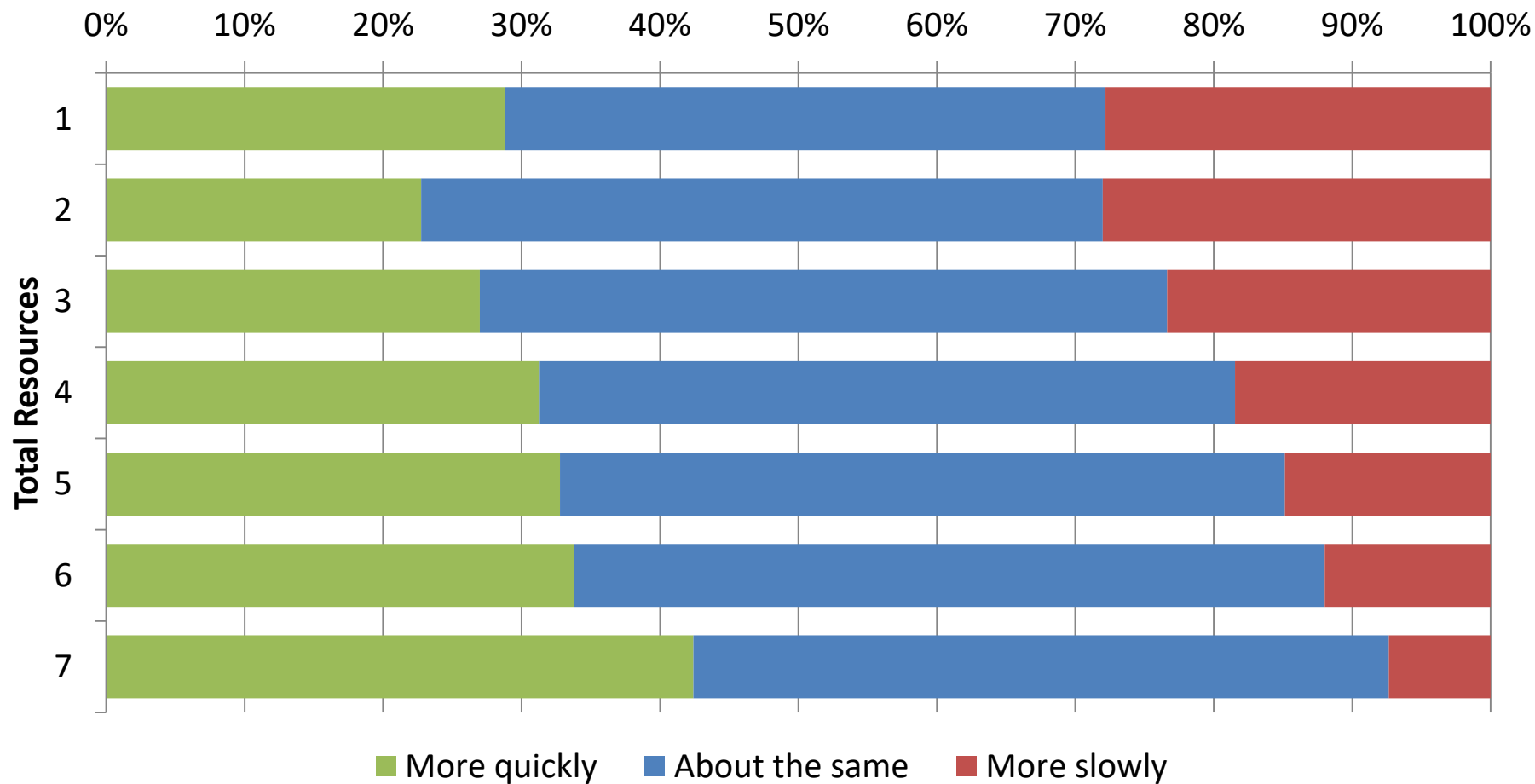
% of R's w/ career-advancing opportunities

| % Yes | Less Developed | | Very Highly Developed | |
|--|----------------|-----|-----------------------|-----|
| | Women | Men | Women | Men |
| Given a talk at a conference as an invited speaker | 51 | 67 | 58 | 73 |
| Attended a conference abroad | 75 | 81 | 83 | 87 |
| Conducted research abroad | 54 | 71 | 61 | 69 |
| Acted as a boss or manager | 38 | 53 | 46 | 61 |
| Served as editor of a journal | 16 | 24 | 11 | 19 |
| Served on committees for grant agencies | 22 | 37 | 26 | 36 |
| Served on important committees at your institute or company | 50 | 62 | 48 | 60 |
| Served on an organizing committee for a conference in your field | 48 | 59 | 48 | 55 |
| Advised undergraduate students | 82 | 84 | 69 | 74 |
| Advised graduate students | 63 | 77 | 58 | 70 |
| Served on thesis or dissertation committees (not as an advisor) | 52 | 66 | 37 | 52 |

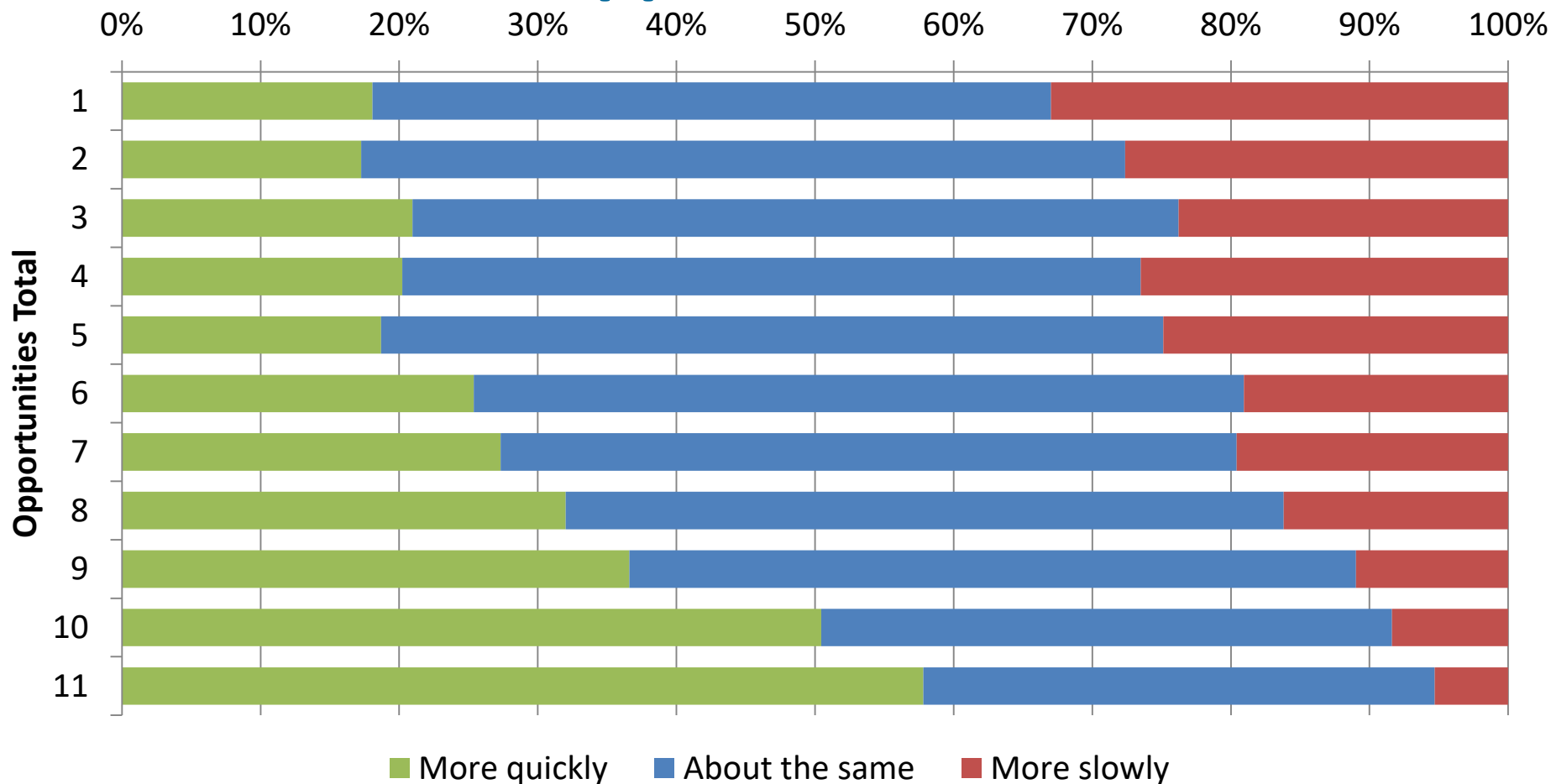
Global Survey of Physicists

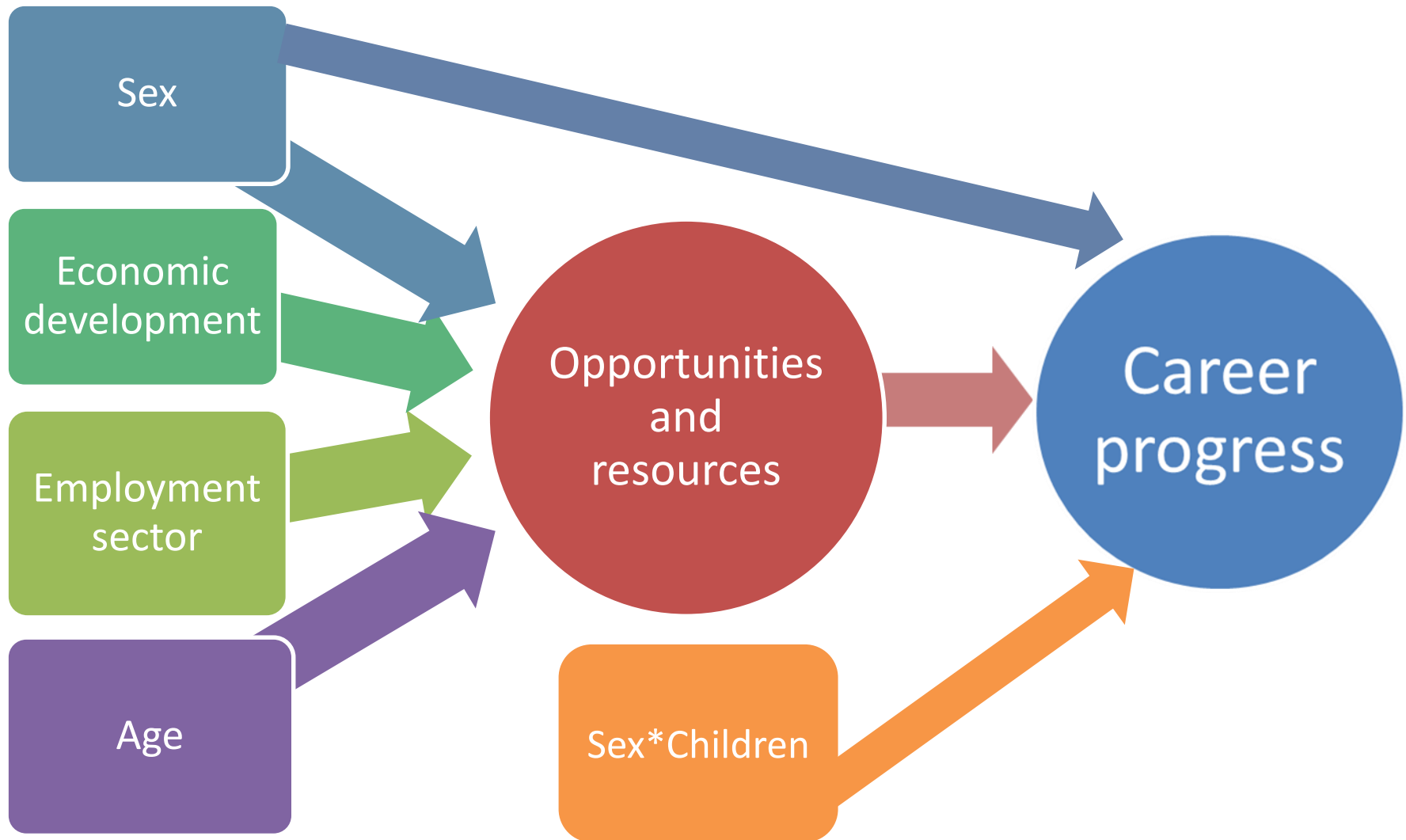


Relationship between career progress and resources

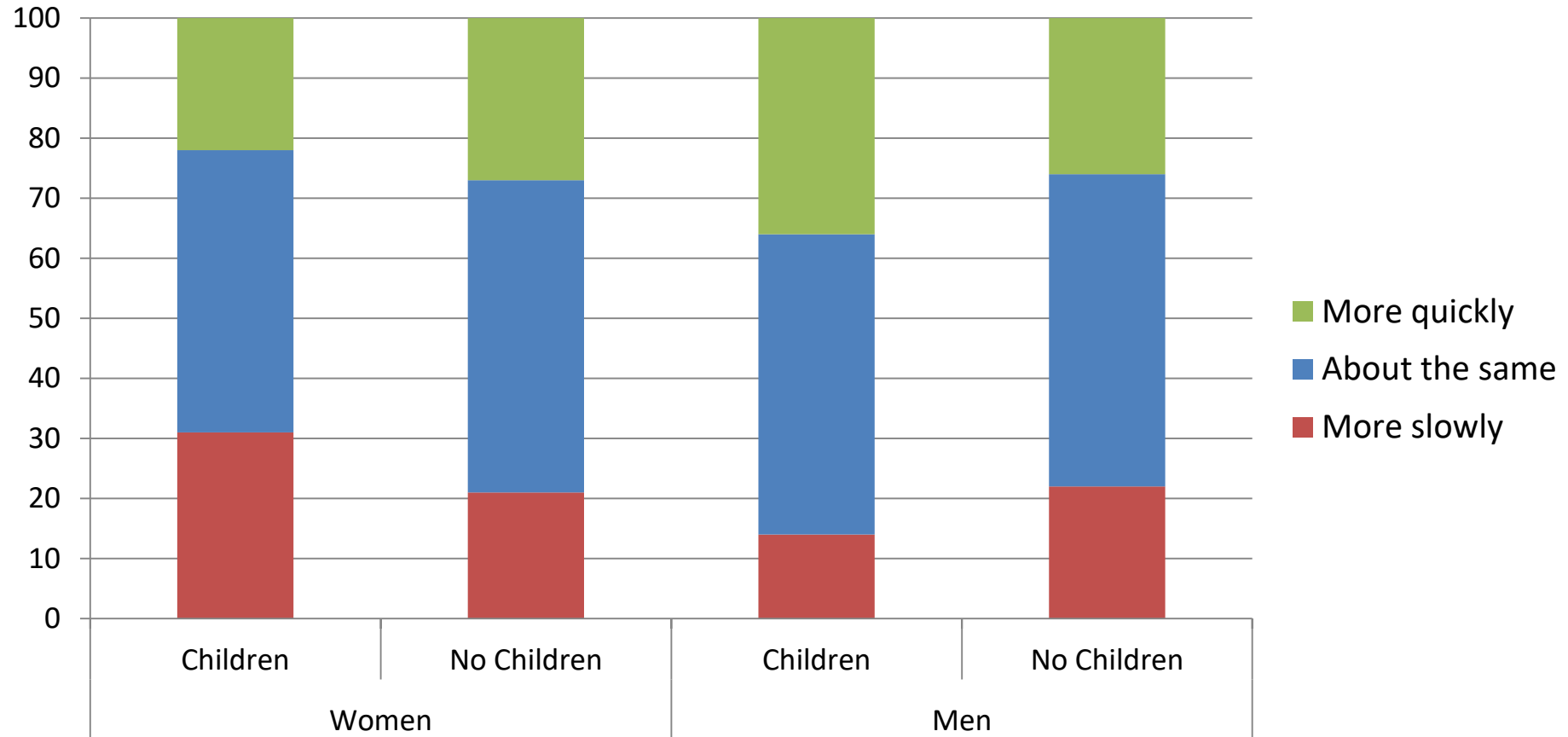


Relationship between career progress and opportunities





Compared to colleagues, how quickly have you progressed in your career?



LONGITUDINAL STUDY OF ASTRONOMY GRADUATE STUDENTS

- Result of Women in Astronomy Conference, 2003 in California, USA
- At that time, about 60% of younger members were women, and AAS wanted to know outcomes for these members.
- Would women have a higher attrition rate? Are women more likely to leave the field? If so, why?

LONGITUDINAL STUDY OF ASTRONOMY GRADUATE STUDENTS

- Partnership between American Institute of Physics and American Astronomical Society (AAS)
- Includes everyone who was in graduate school in astronomy or astrophysics in the US, 2006-07
- Data have been collected from the same cohort of people in order to document individual career paths
- Three waves of data have been collected:
 - 2007-08
 - 2012-13 *five years later*
 - 2015-16 *eight years later*

THIS ANALYSIS

- Second survey
- limited to people who
 - completed PhDs at the time of the 2nd survey
 - were not postdocs at the time of the surveys

HYPOTHESIS

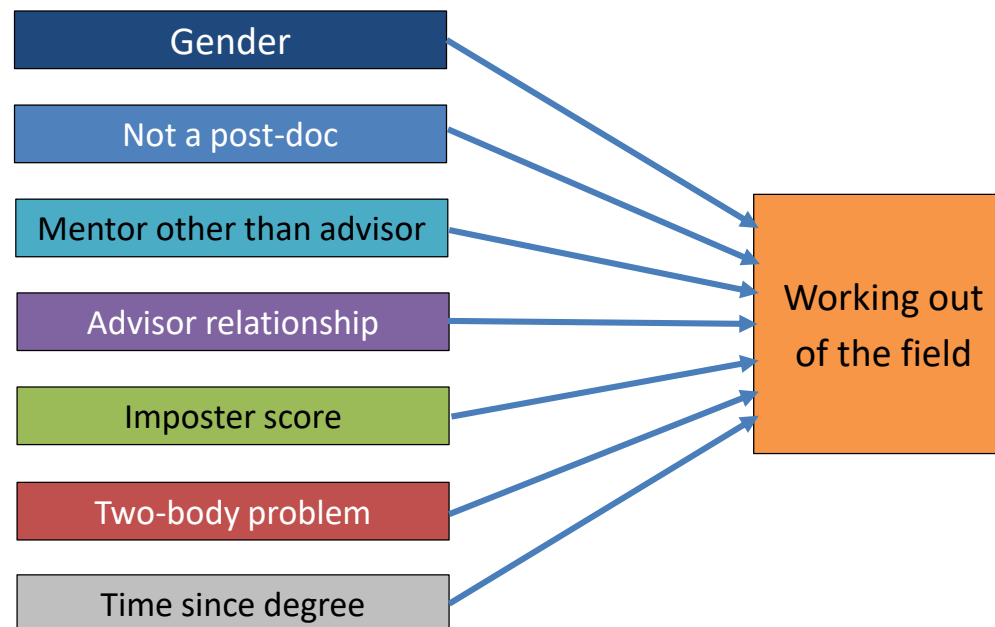
We hypothesized that women would be more likely to work outside of astronomy and physics. In other words, being female would have a *direct* effect on leaving the field, *independent* of other factors.

IS WORKING IN OR OUT OF FIELD AFFECTED BY

- Being male or female (40% female respondents)
- Taking a postdoc
- *Two-body problem* (a work/family balance problem that refers to the difficulty of finding 2 jobs in same geographic area)
- Having a *mentor other than advisor*
- *Relationship with advisor*
- *Imposter syndrome* (at time of first survey)
- Time since degree

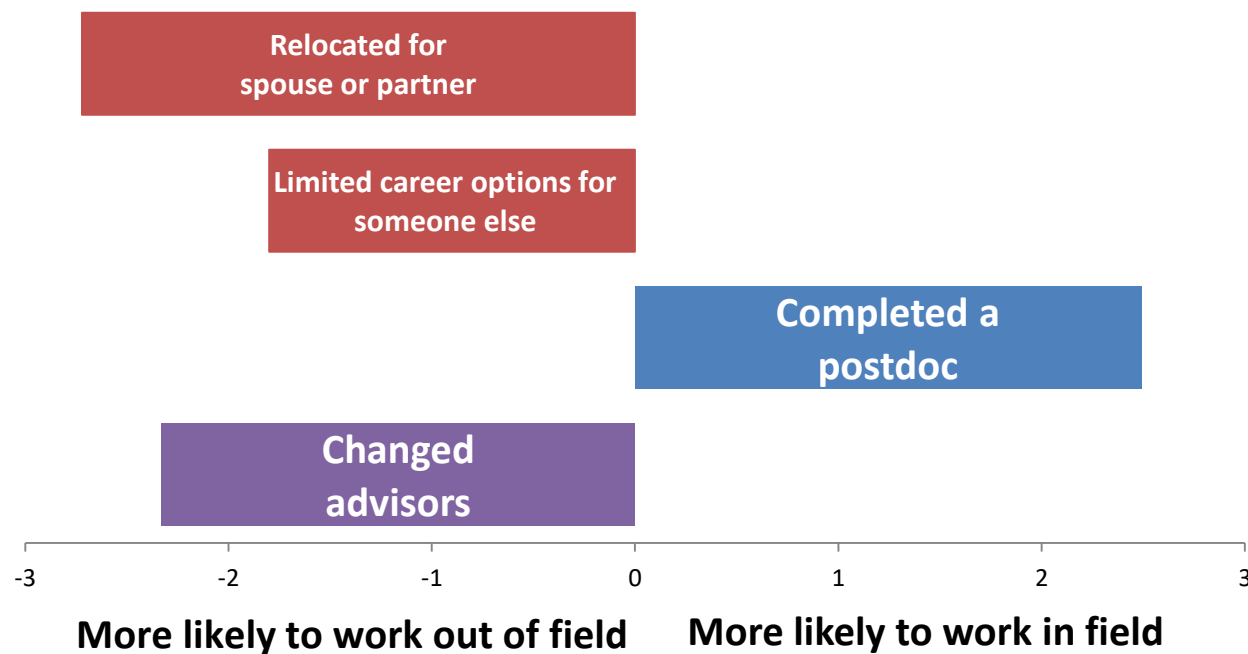
SECOND SURVEY

DOES BEING MALE OR FEMALE INDEPENDENTLY AFFECT OTHER VARIABLES IN MODEL?



SECOND SURVEY

FACTORS THAT INFLUENCE WORKING OUT OF FIELD



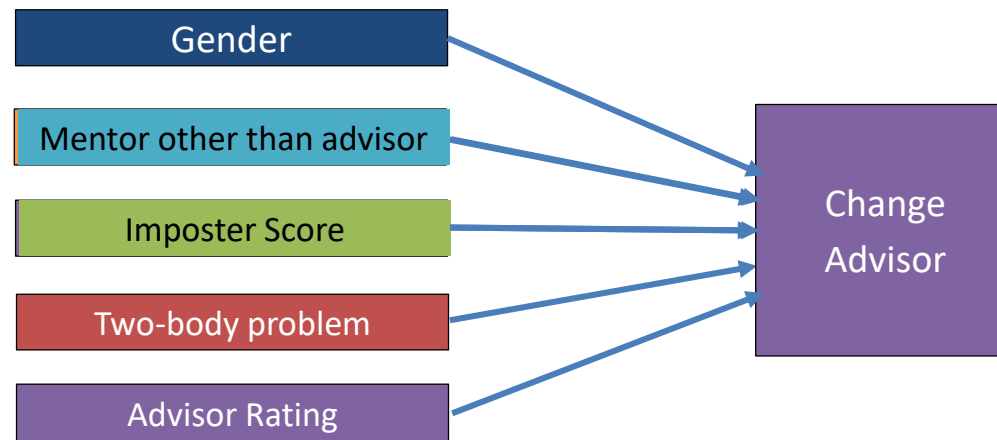
ANOTHER HYPOTHESIS

- There may be indirect effects of gender on working out of field.
- In other words, women may be more likely to have experiences that increase the likelihood of working out of field.

SECOND SURVEY

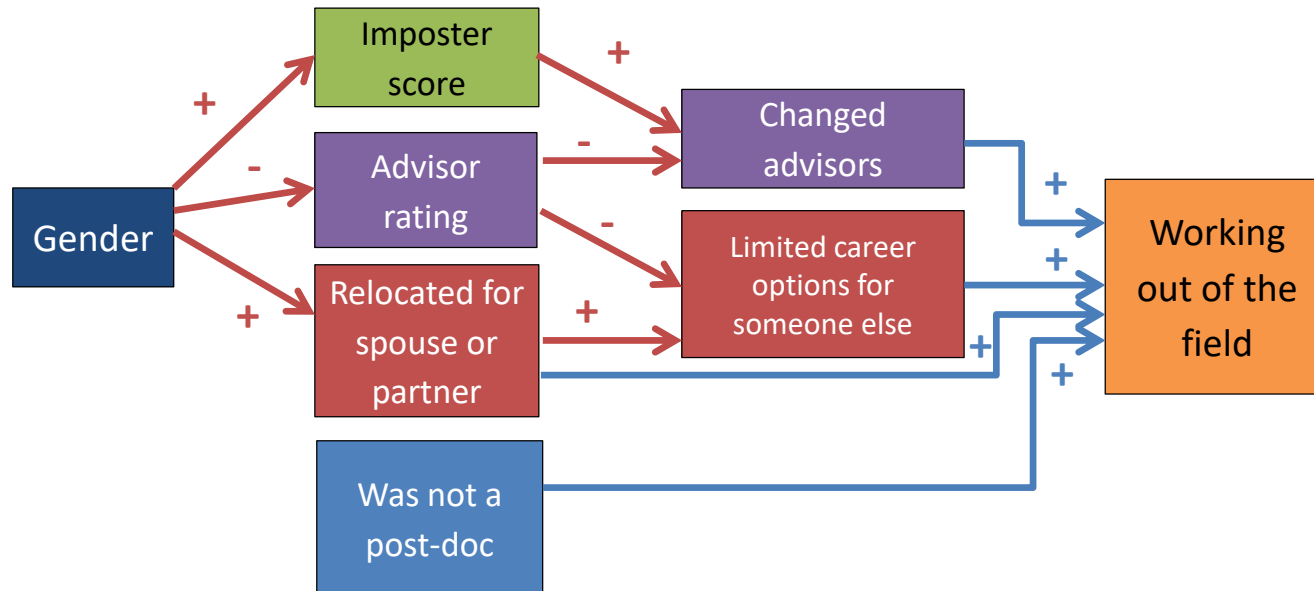
TESTING INDIRECT EFFECTS OF GENDER

EXAMPLE OF ONE MODEL



SECOND SURVEY

THE INDIRECT EFFECT OF GENDER ON WORKING OUT OF FIELD



CONCLUSIONS FROM SECOND SURVEY

- We hypothesized that women would be more likely to work outside of astronomy and physics. In other words, being female would have a direct effect on leaving the field, independent of other factors.
- However, there is no direct effect of being female on working outside the field. The effect of being female comes through other factors.
- Women may be more likely to leave astronomy because
 - Women are more likely to report less than satisfactory advising.
 - Women are more likely to report two-body problems related to the need to find two jobs in the same geographic area for a spouse or partner.

WHAT IS AIP DOING ABOUT THE REPRESENTATION OF OTHER UNDER-REPRESENTED GROUPS?

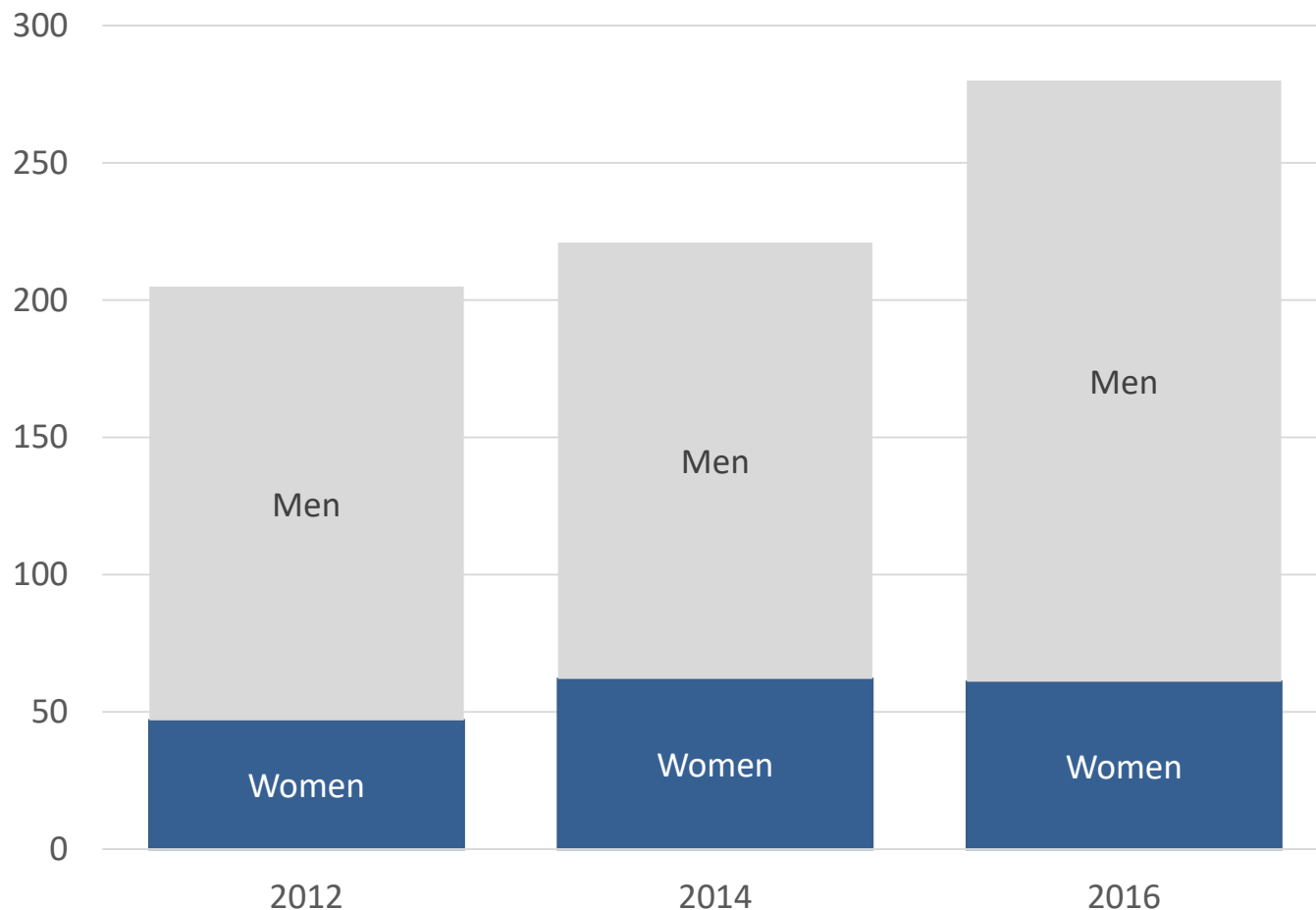
- AIP formed a task force on African Americans in undergraduate physics.
- We will be doing a survey of students, interviews, encouraging departments to collect data, site visits, and case studies.
- This will lead to recommendations for increasing the number of African Americans earning physics bachelor's degrees.

Thanks to my colleagues
Susan White and Patrick Mulvey

For more information

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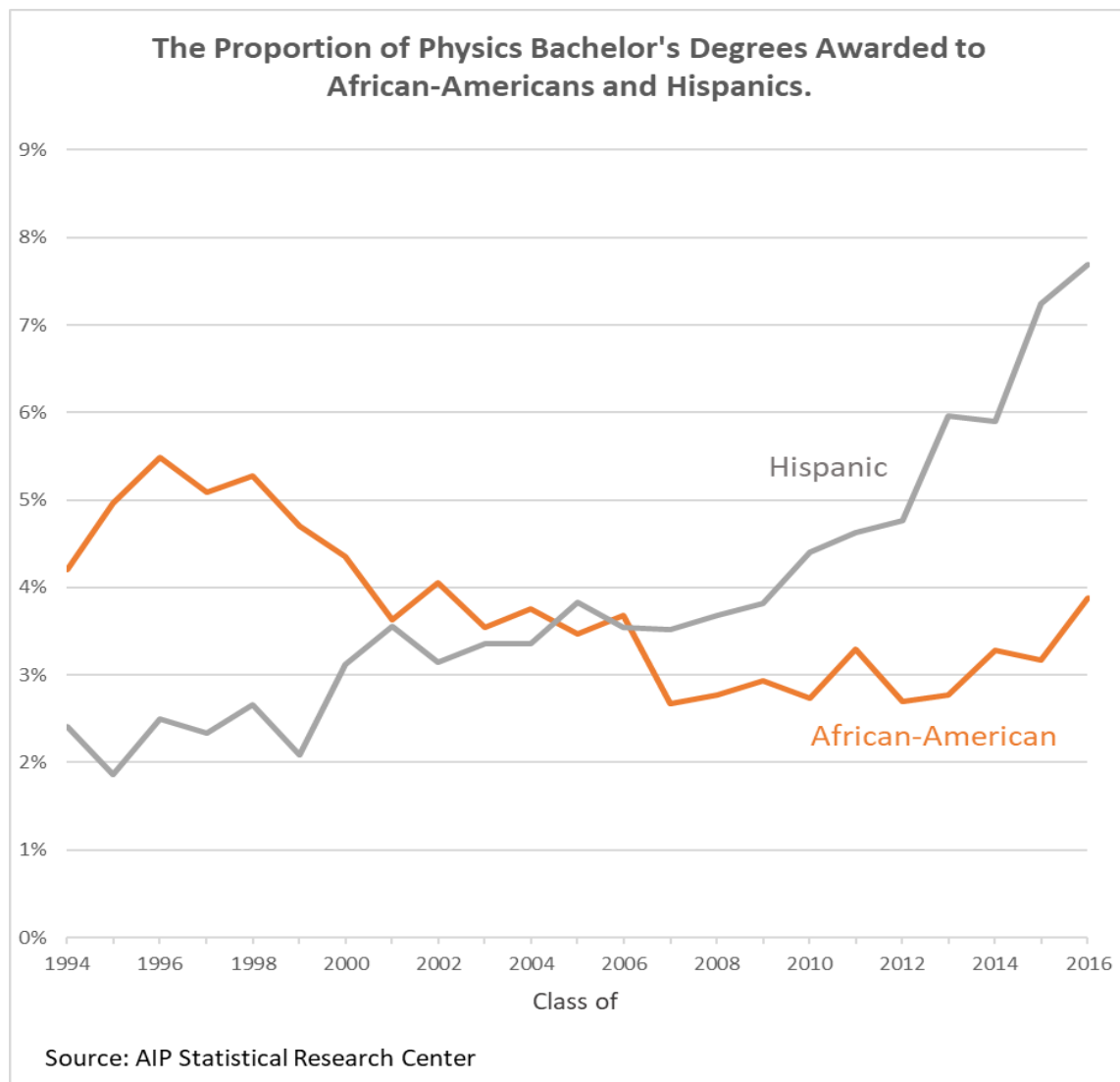
NEWLY-HIRED TENURE-TRACK FACULTY MEMBERS IN PHYSICS DEPARTMENTS



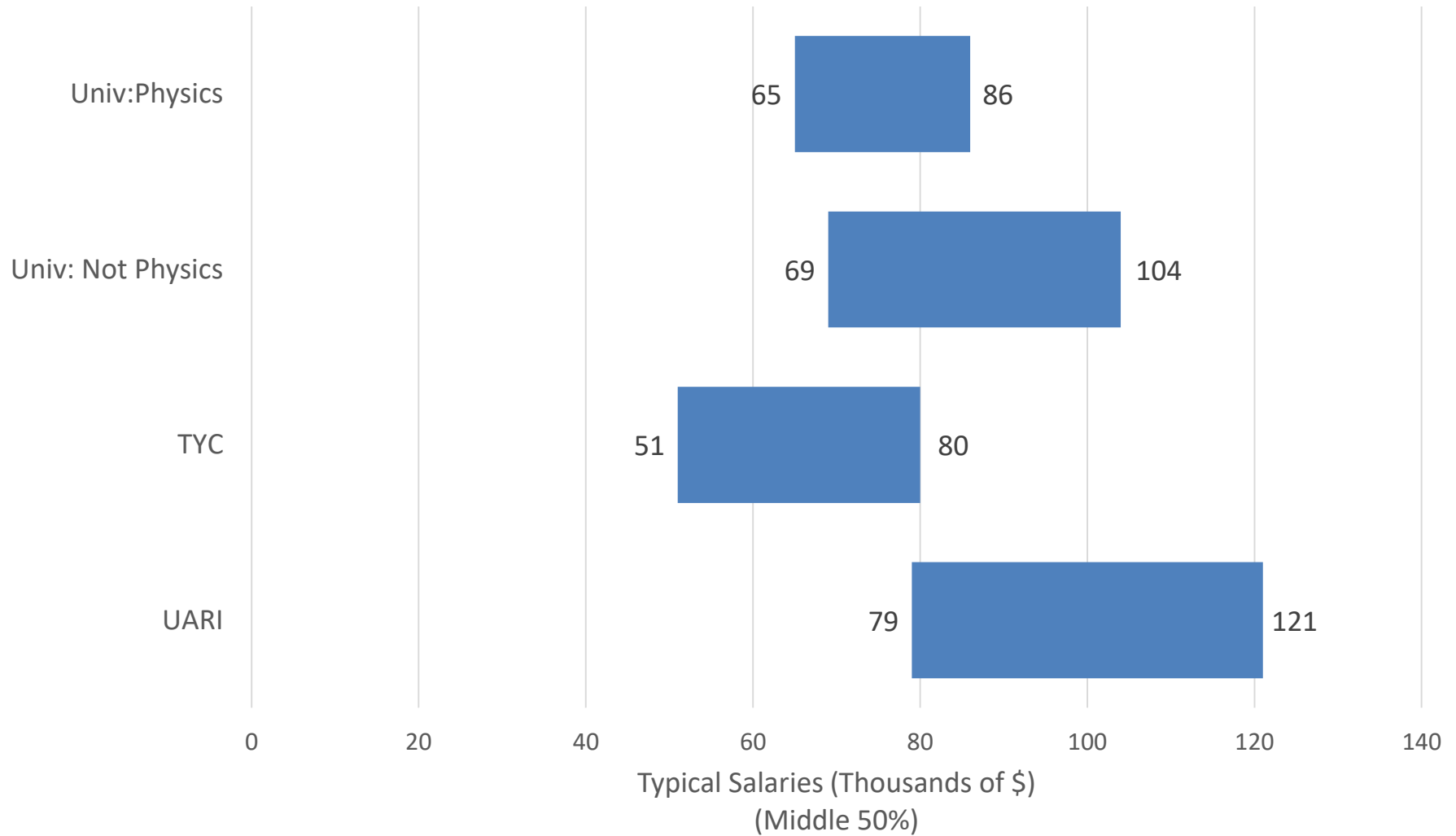
DEPARTMENTS AVERAGING 3 OR MORE AFRICAN-AMERICAN PHYSICS BACHELORS PER YEAR, CLASSES OF 2014 THROUGH 2016

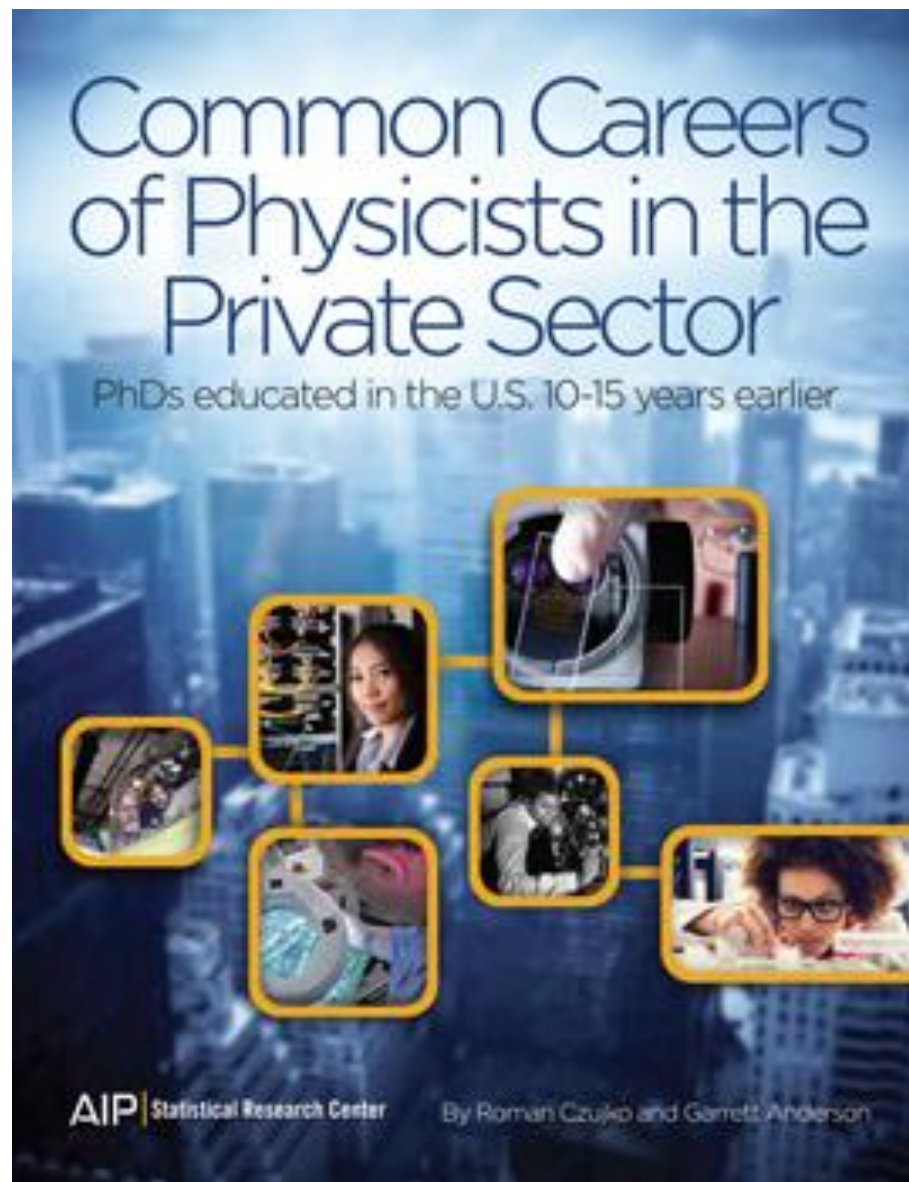
| | Annual Average |
|-----------------------------|----------------|
| Morehouse College (GA)* | 8 |
| U of Maryland, College Park | 6 |
| Delaware State U* | 5 |
| Dillard U (LA)* | 5 |
| Howard U (DC)* | 4 |
| Jackson State U (MS)* | 4 |
| North Carolina A&T State U* | 4 |
| Spelman College (GA)* | 4 |
| Tuskegee U (AL)* | 4 |
| Xavier U (LA)* | 4 |
| Florida A&M U* | 3 |
| Hampton U (VA)* | 3 |
| Norfolk State U (VA)* | 3 |
| | |

*Historically Black College and University. List includes only those departments that contributed degree data for all 3 years.



Academic Salaries



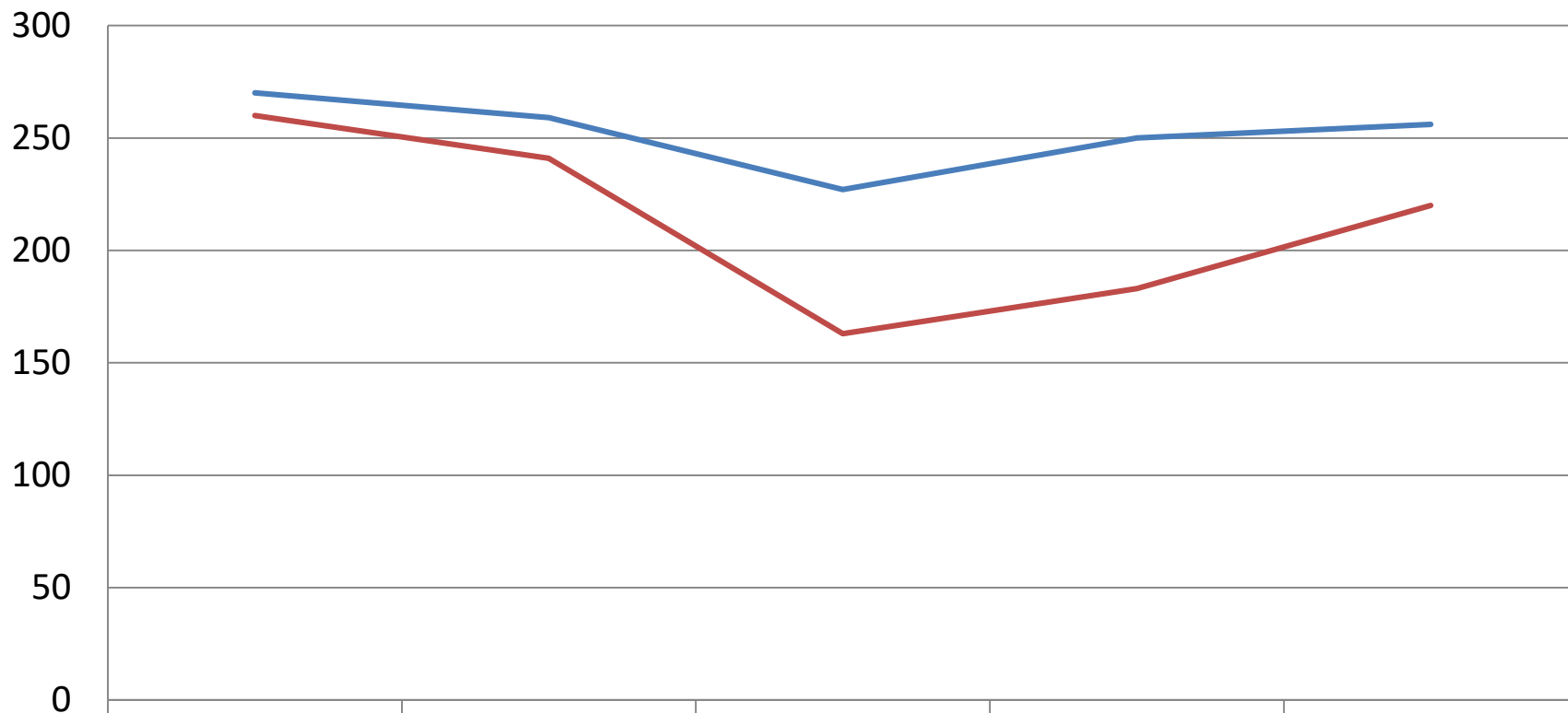


PRIMARY TYPES OF CAREERS IN PRIVATE SECTOR

Top eight primary types of careers that mid-career physicists chose to pursue in the private sector:

- self-employed
- finance
- government contractors,
- primarily engaged in engineering
- primarily engaged in computer science
- primarily engaged in physics
- primarily engaged in other STEM fields
- not working in a STEM field.

Number of New Hires in Physics Departments



| | 2006 | 2008 | 2010 | 2012 | 2014 |
|--------------|------|------|------|------|------|
| — Bachelor's | 270 | 259 | 227 | 250 | 256 |
| — PhD | 260 | 241 | 163 | 183 | 220 |

Salaries

