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

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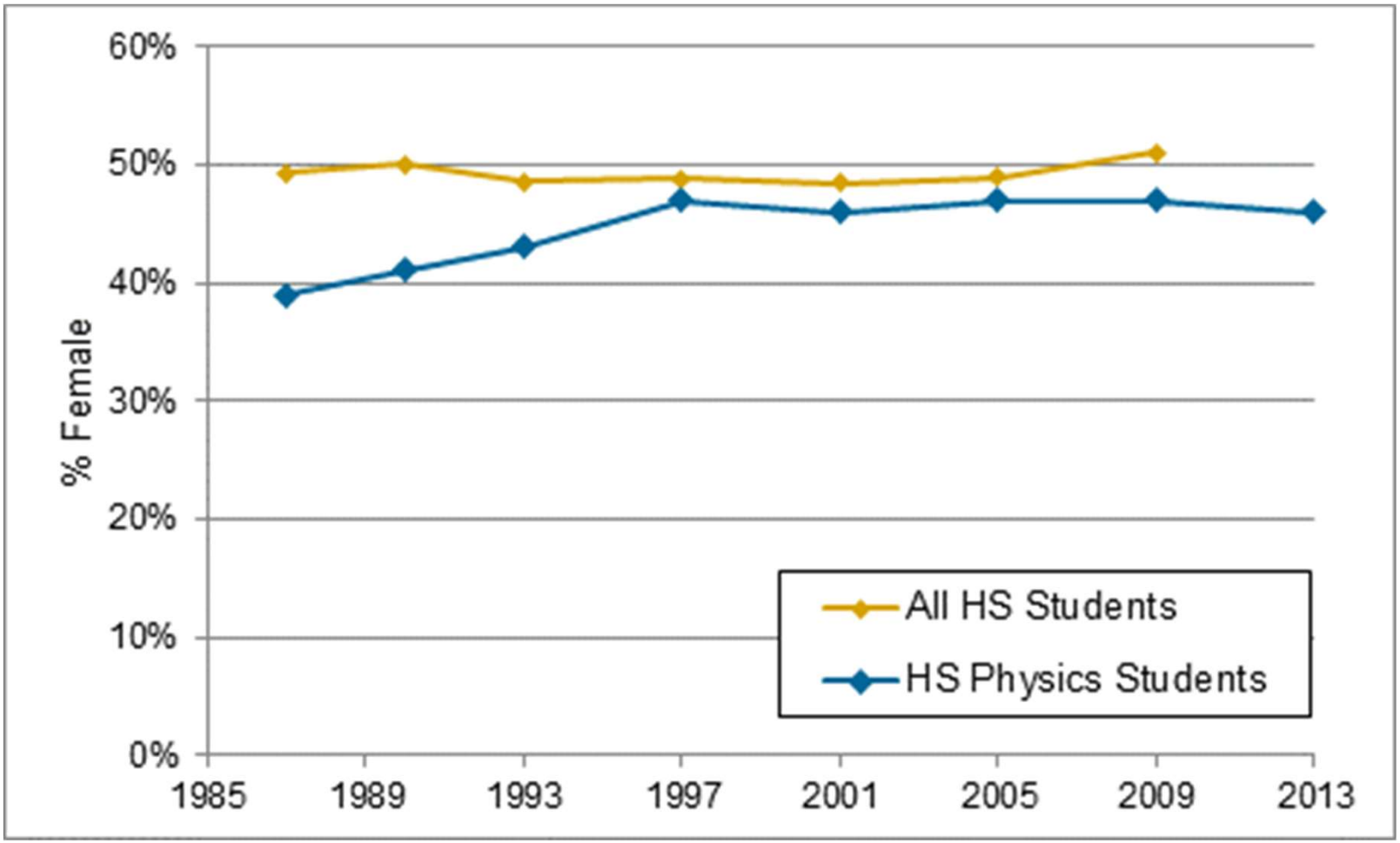
Statistical Research Center

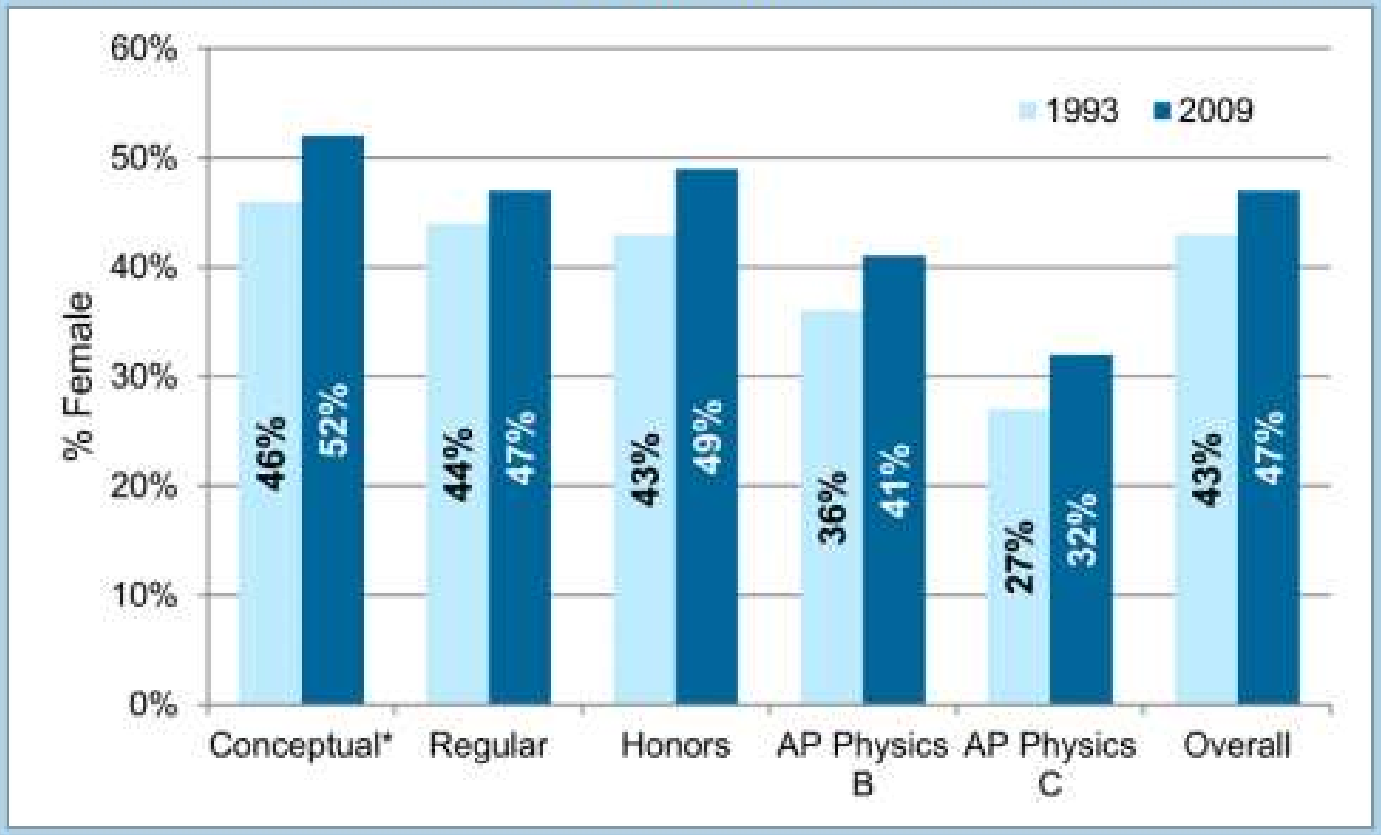
REPRESENTATION OF WOMEN

GIRLS AS A PERCENTAGE OF TOTAL ENROLLMENT IN HIGH SCHOOL PHYSICS



Representation of Female Students among Physics Students by Type of Course

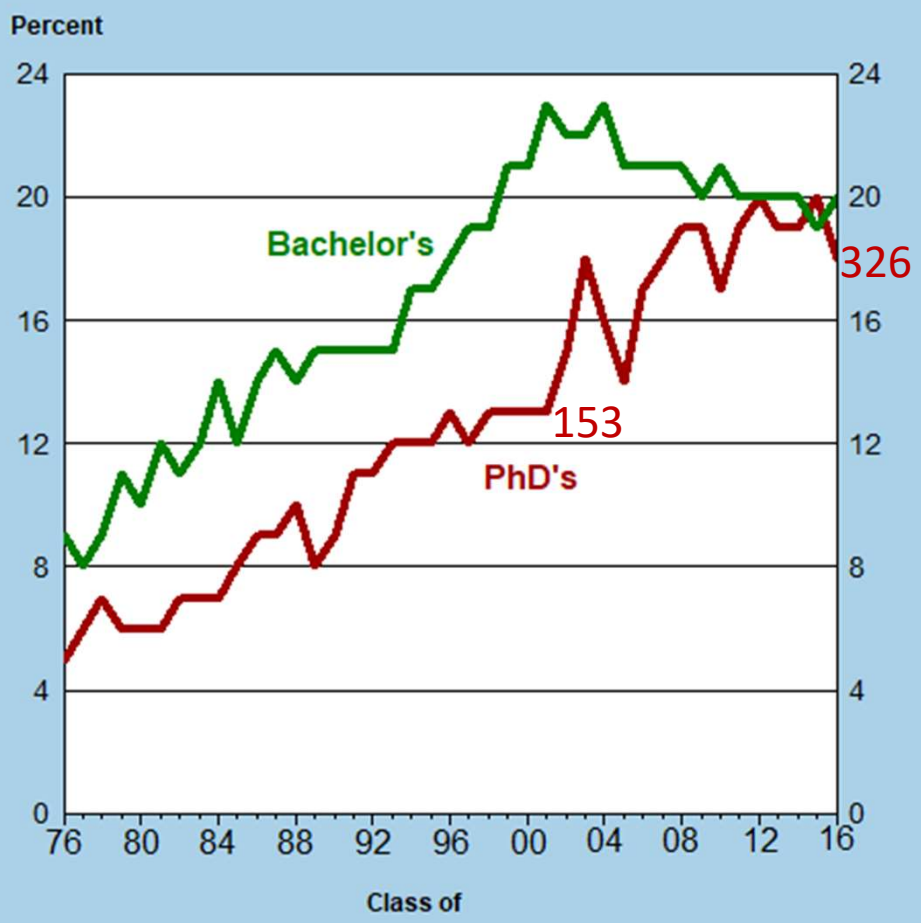
All US High Schools



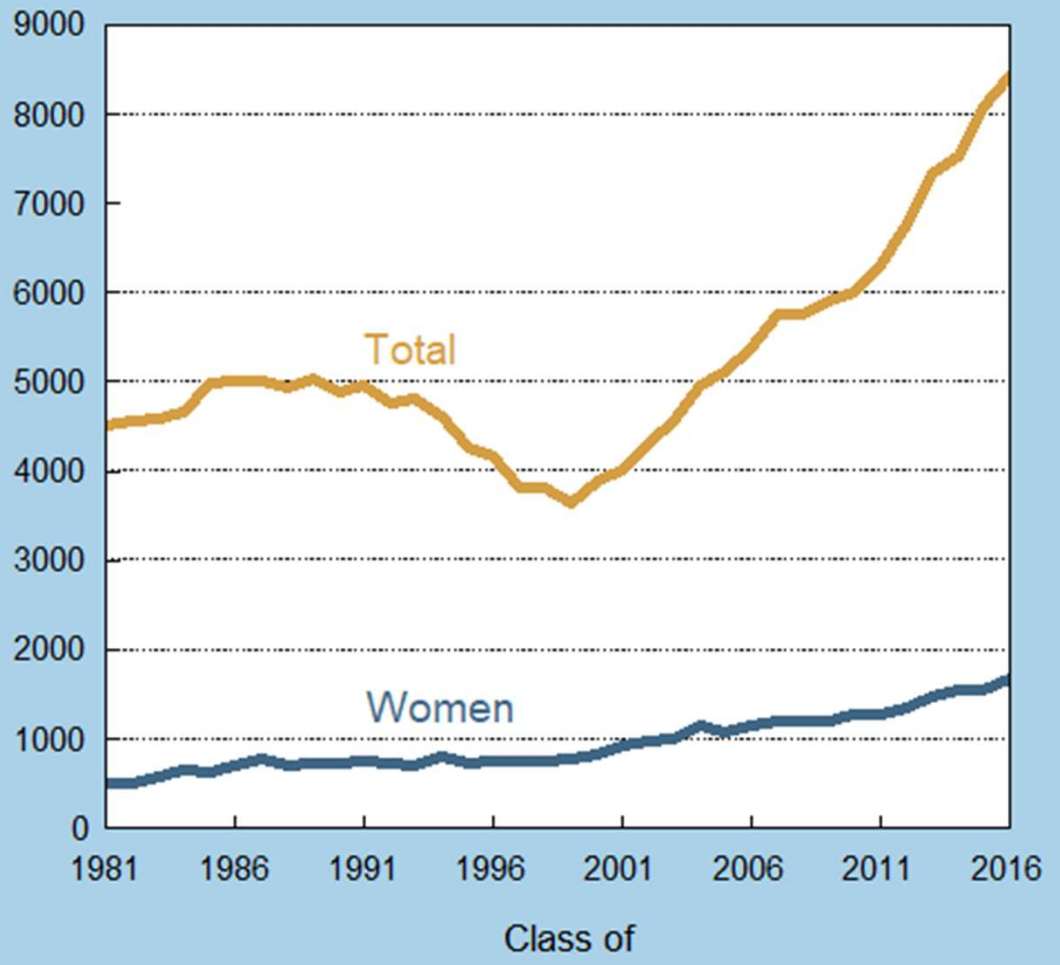
* Includes data for both Physics First and Conceptual Physics for 2009; Physics First data was not collected separately in 1993

http://www.aip.org/statistics

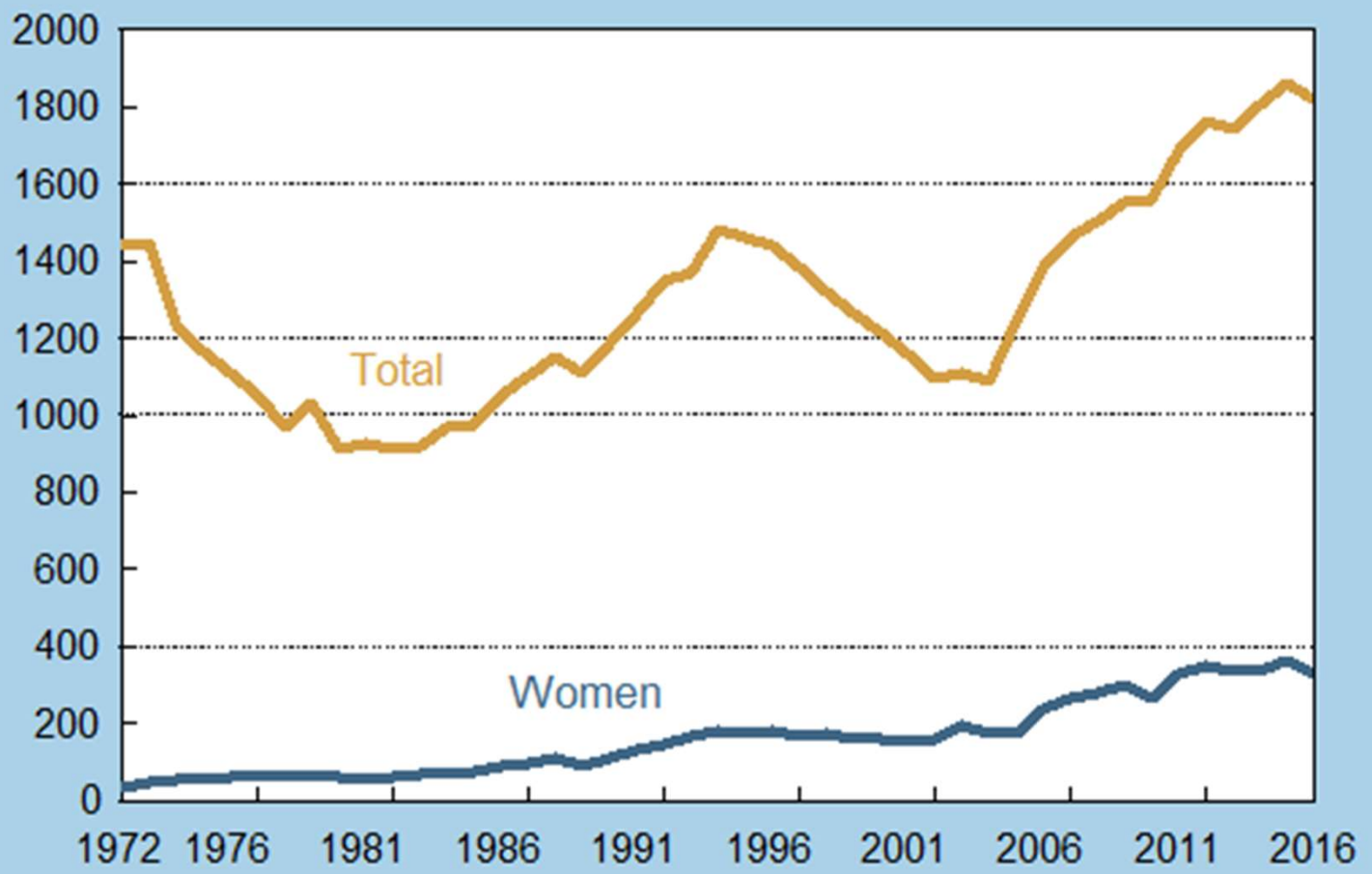
Percent of Physics Bachelors and PhDs earned by Women, Classes of 1976 through 2016.



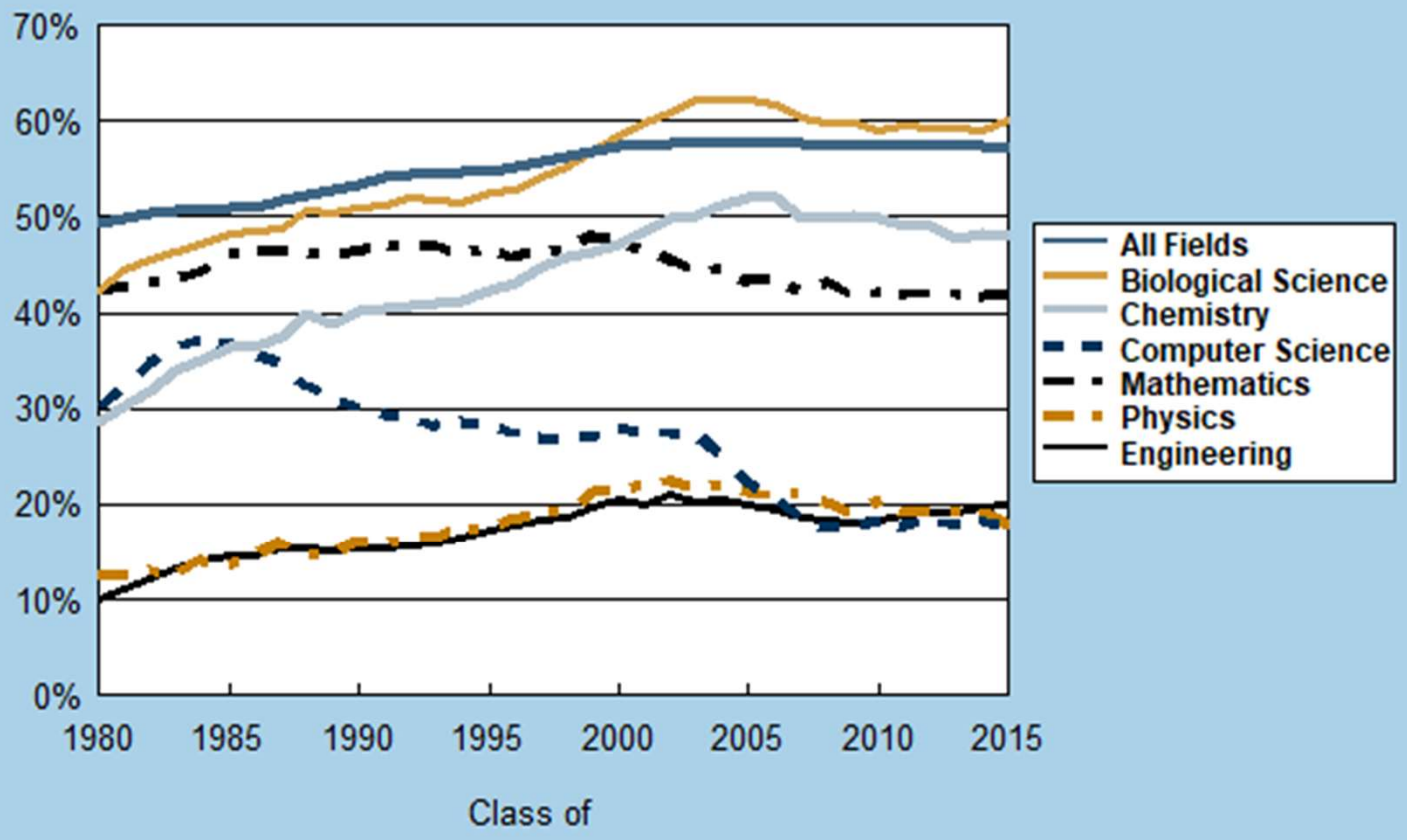
Number of Bachelor's Degrees Earned in Physics, Classes 1981 through 2016.



Number of PhDs Earned in Physics 1972 - 2016.

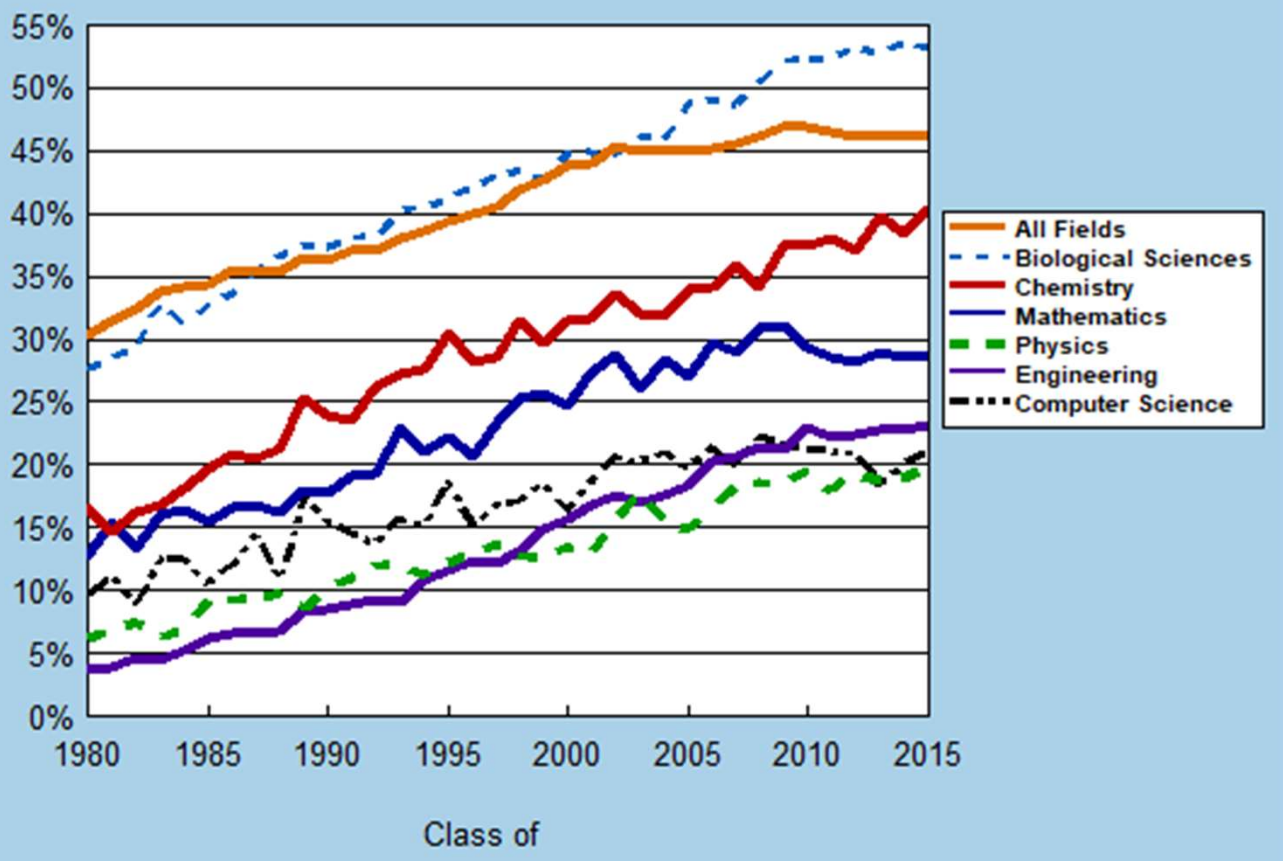


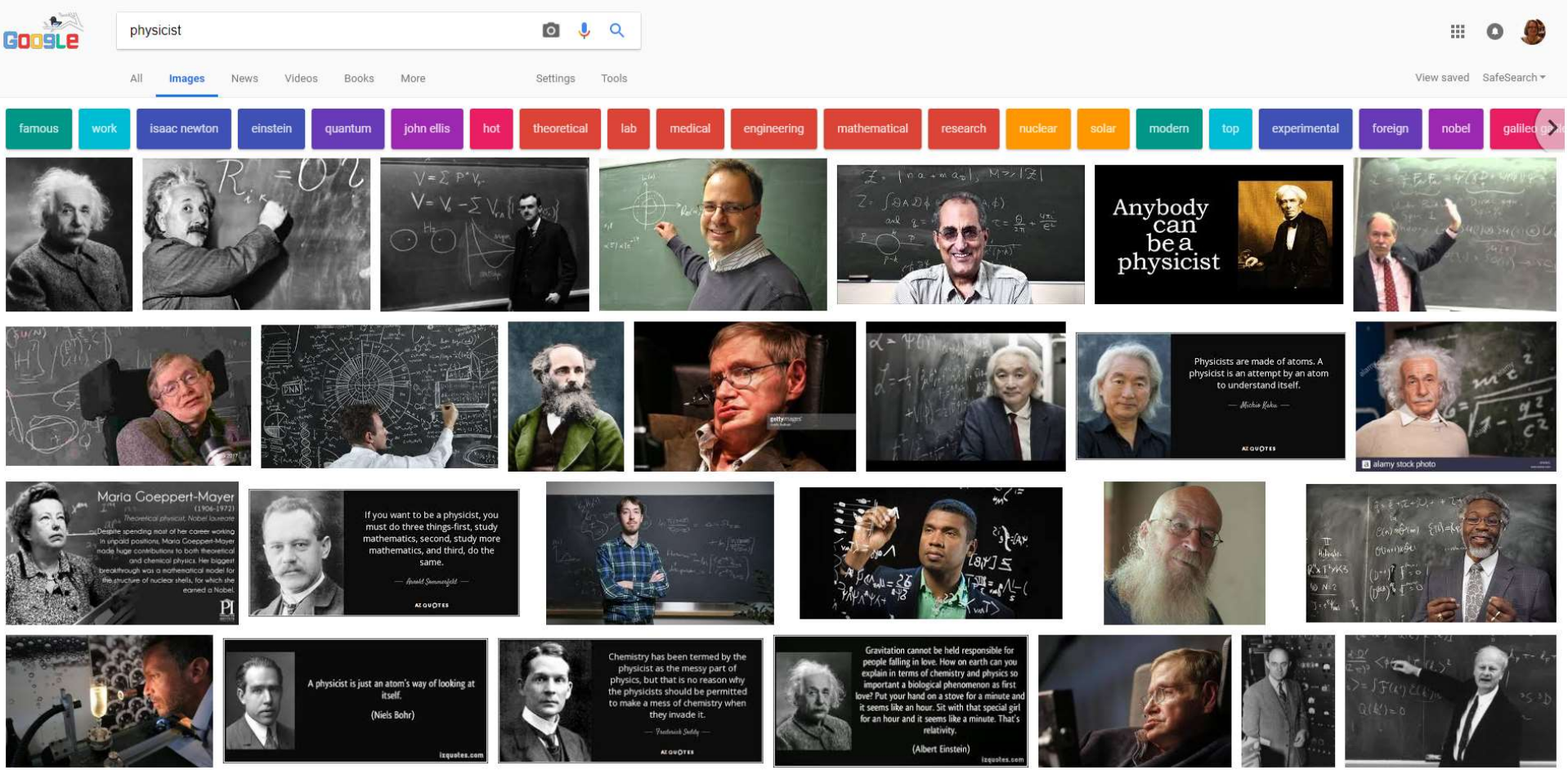
Percent of Bachelor's Degrees Earned by Women in Selected Fields, Classes 1980 through 2015.



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

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

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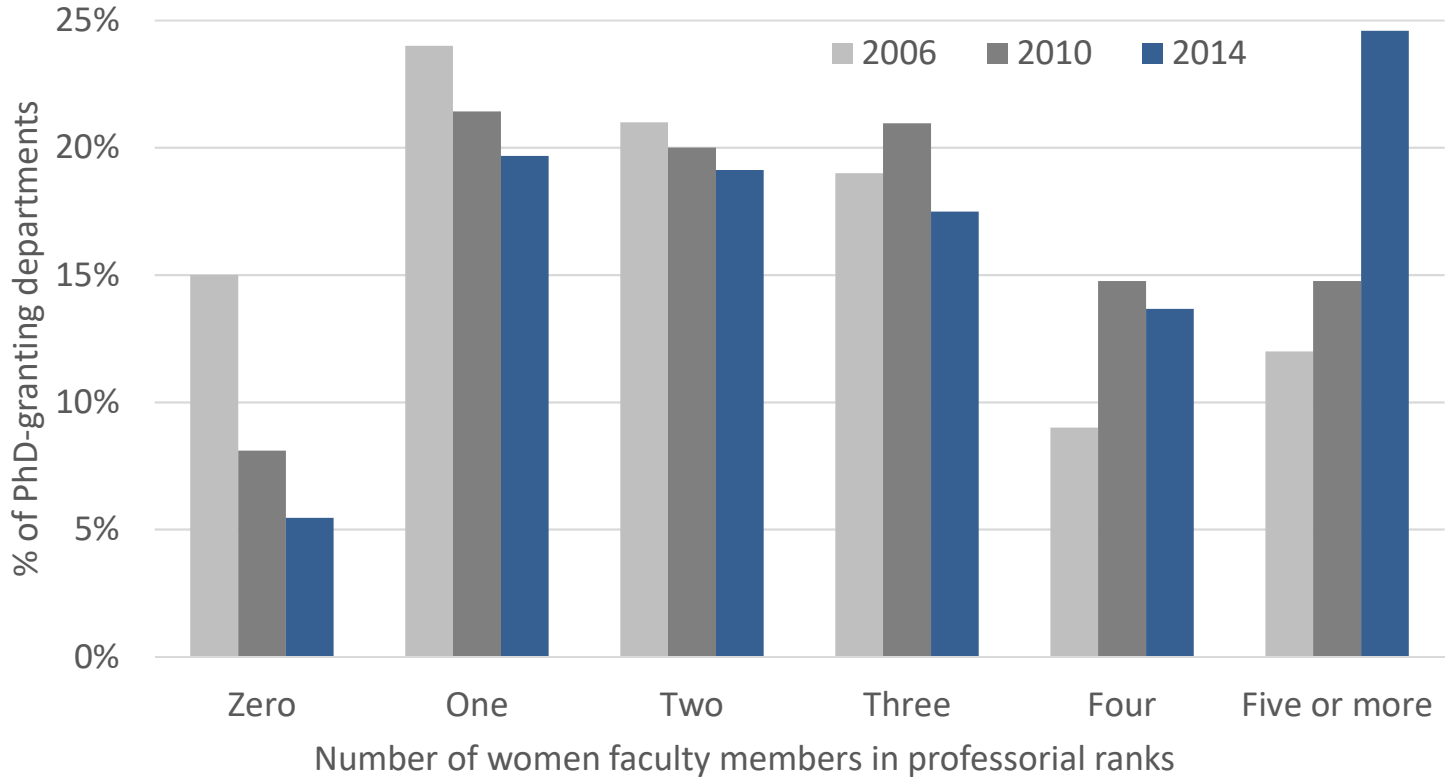
john ellis
hot
theoretical
lab
medical
engineering
mathematical
research
nuclear
solar
modern
top
experimental
foreign
nobel
Anybody can be a physicist
Physicists are made of atoms. A physicist is an attempt by an atom to understand itself.
— Michio Kaku —
AZ QUOTES
alamy stock photo
Maria Goeppert-Mayer
(1906-1972)
Theoretical physicist. Nobel laureate
Despite spending most of her career working in unpaid positions, Maria Goeppert-Mayer made huge contributions to both theoretical and chemical physics. Her biggest breakthrough was a mathematical model for the structure of nuclear shells, for which she earned a Nobel.
If you want to be a physicist, you must do three things-first, study mathematics, second, study more mathematics, and third, do the same.
— Arnold Sommerfeld —
AZ QUOTES
A physicist is just an atom's way of looking at itself.
(Niels Bohr)
izquotes.com
Chemistry has been termed by the physicist as the messy part of physics, but that is no reason why the physicists should be permitted to make a mess of chemistry when they invade it.
— Frederick Soddy —
AZ QUOTES
Gravitation cannot be held responsible for people falling in love. How on earth can you explain in terms of chemistry and physics so important a biological phenomenon as first love? Put your hand on a stove for a minute and it seems like an hour. Sit with that special girl for an hour and it seems like a minute. That's relativity.
(Albert Einstein)
izquotes.com

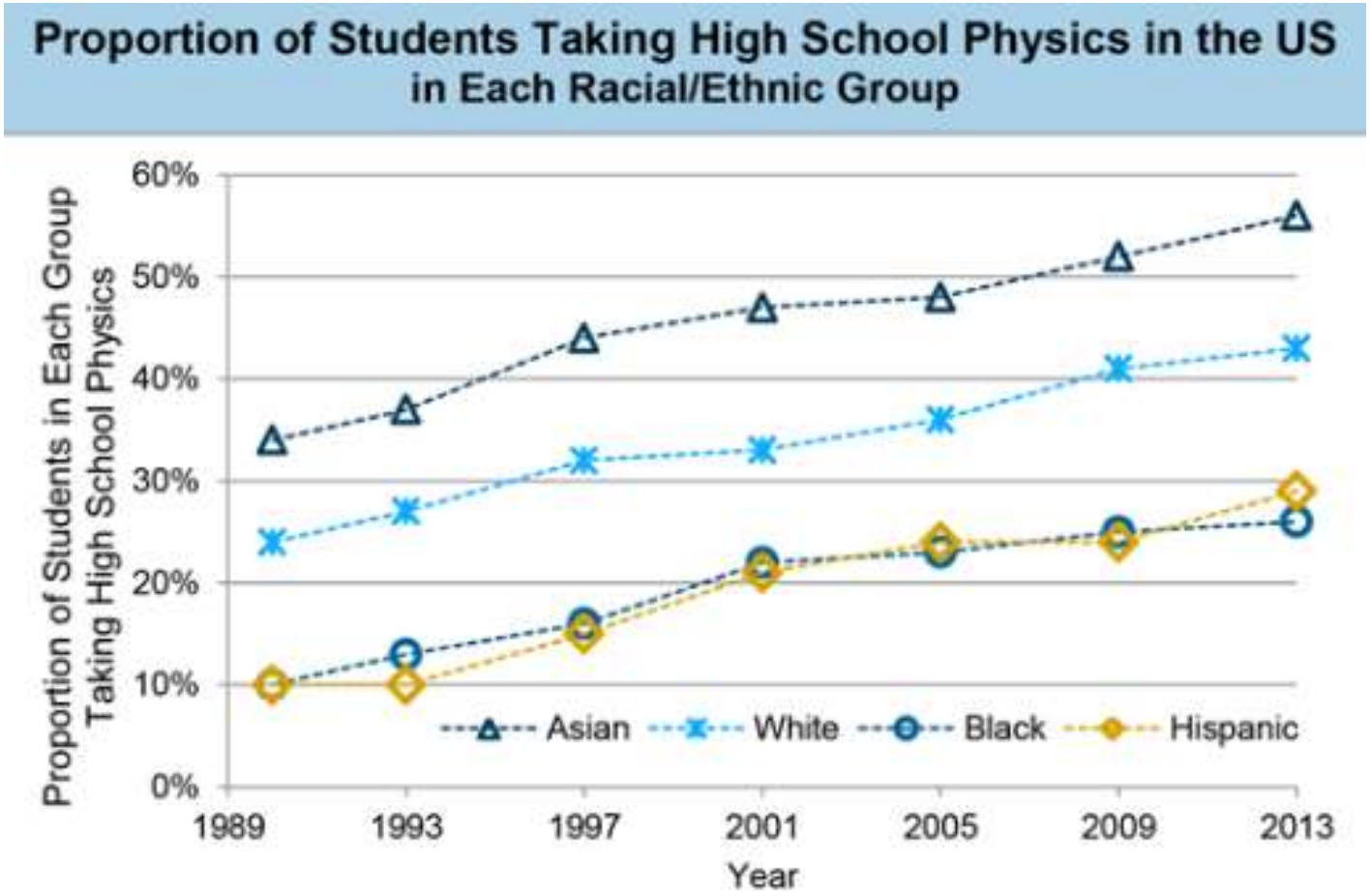
PERCENTAGE OF PHYSICS FACULTY MEMBERS WHO ARE WOMEN

	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

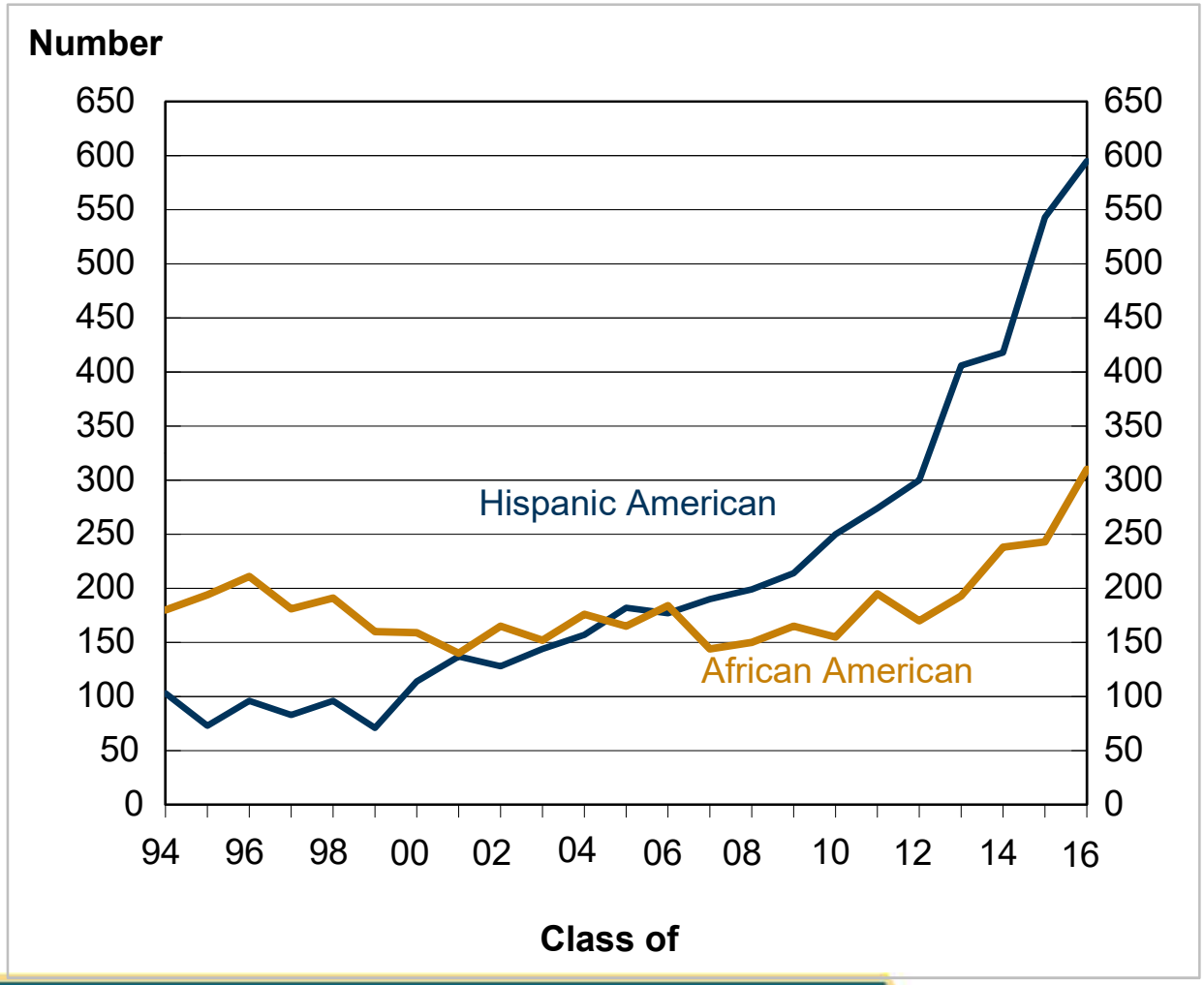


A closer examination of the data reveals that these differences are likely driven more by socioeconomic factors than by race.

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

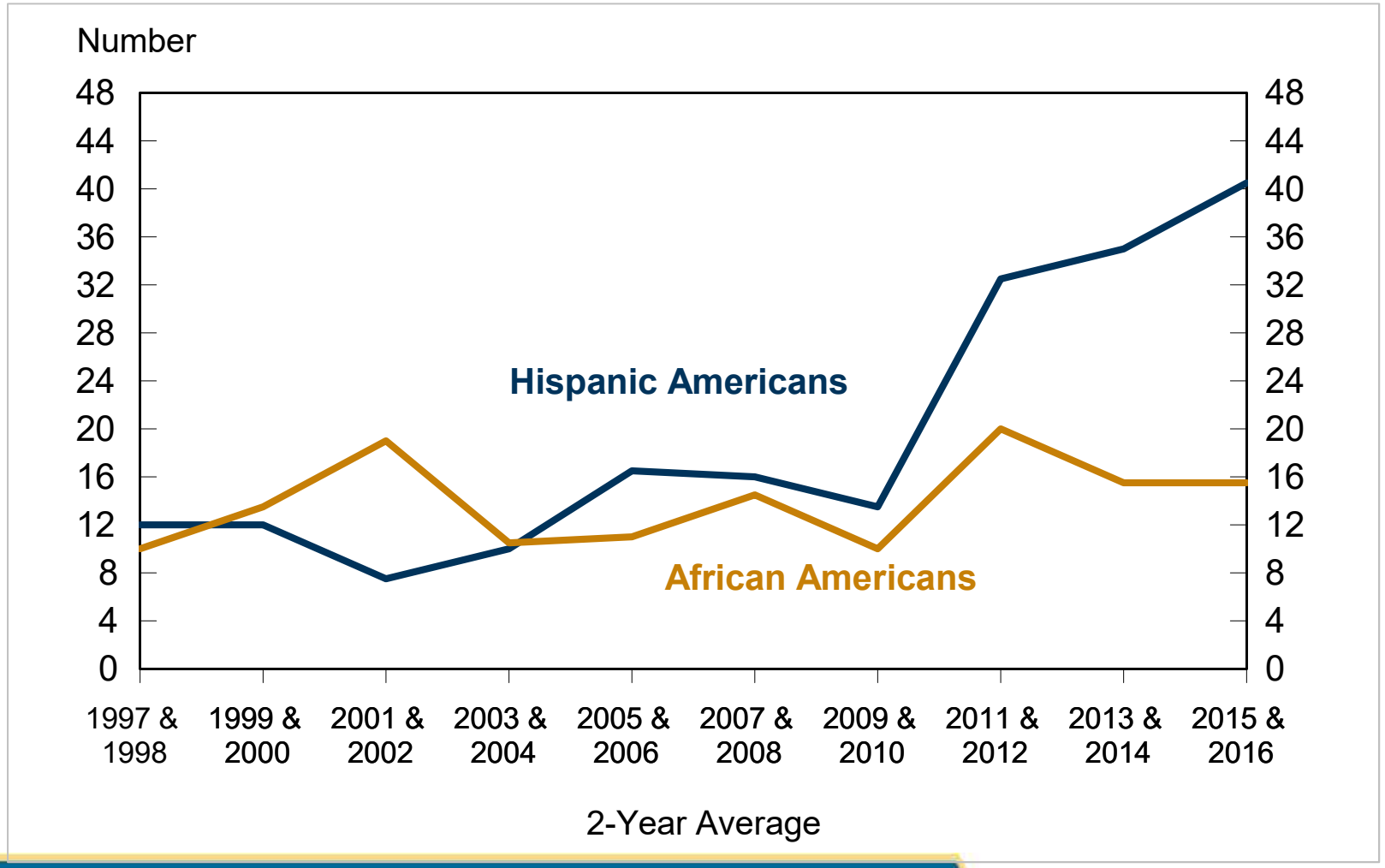


RACE AND ETHNICITY OF PHYSICS PHDS, CLASSES OF 2014 THROUGH 2016 (3-YEAR AVERAGE)

	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

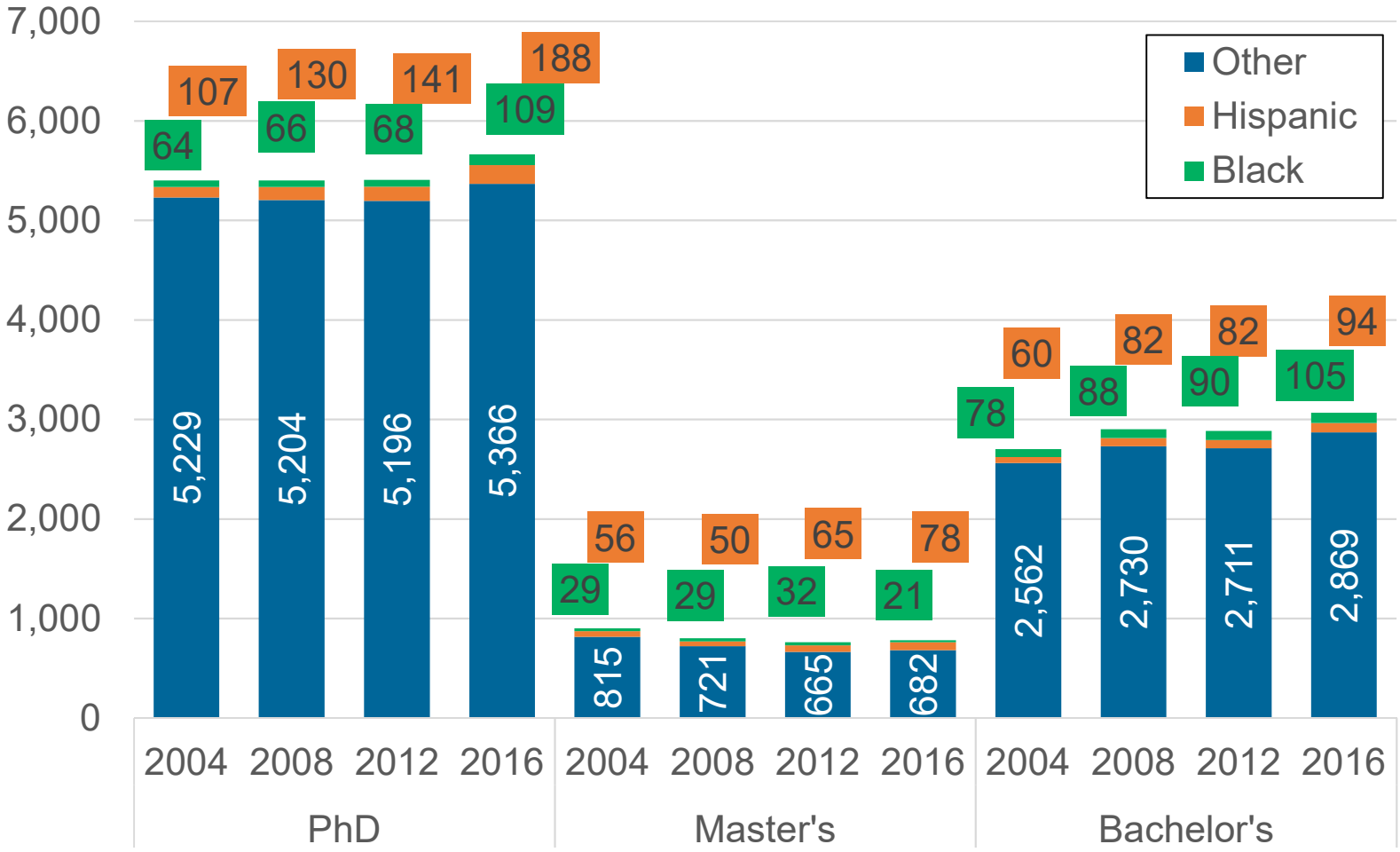


RACE AND ETHNICITY OF PHYSICS FACULTY MEMBERS

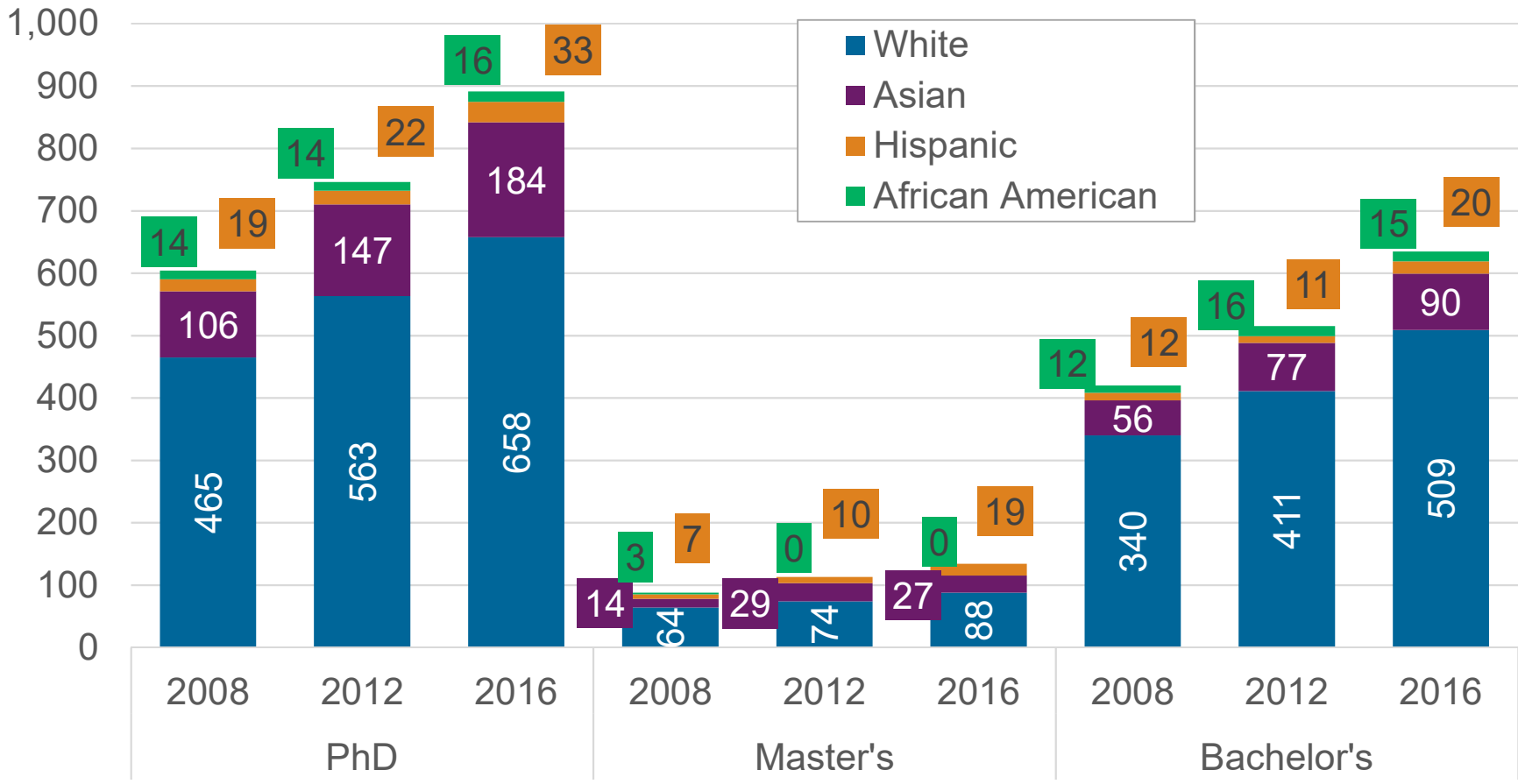
	Physics				All Disciplines*
	2004 (%)	2008 (%)	2012 (%)	2016 (%)	2015 (%)
African-American	2	2.2	2.1	2.5	6
Asian	10.6	13.2	14.3	15.2	10
Hispanic	2.7	3.1	3.2	3.8	4
White	82.2	80	79.2	76.3	77
Other	2.2	1.5	1.2	2.3	<2

*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



NUMBER OF WOMEN IN PHYSICS AND ASTRONOMY DEPARTMENTS BY HIGHEST DEGREE AWARDED



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
Both African-American and Hispanic Faculty	25	7	3	45
African-American Faculty and no Hispanic Faculty	25	8	53	86
Hispanic Faculty and no African-American Faculty	75	20	61	156
Neither 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

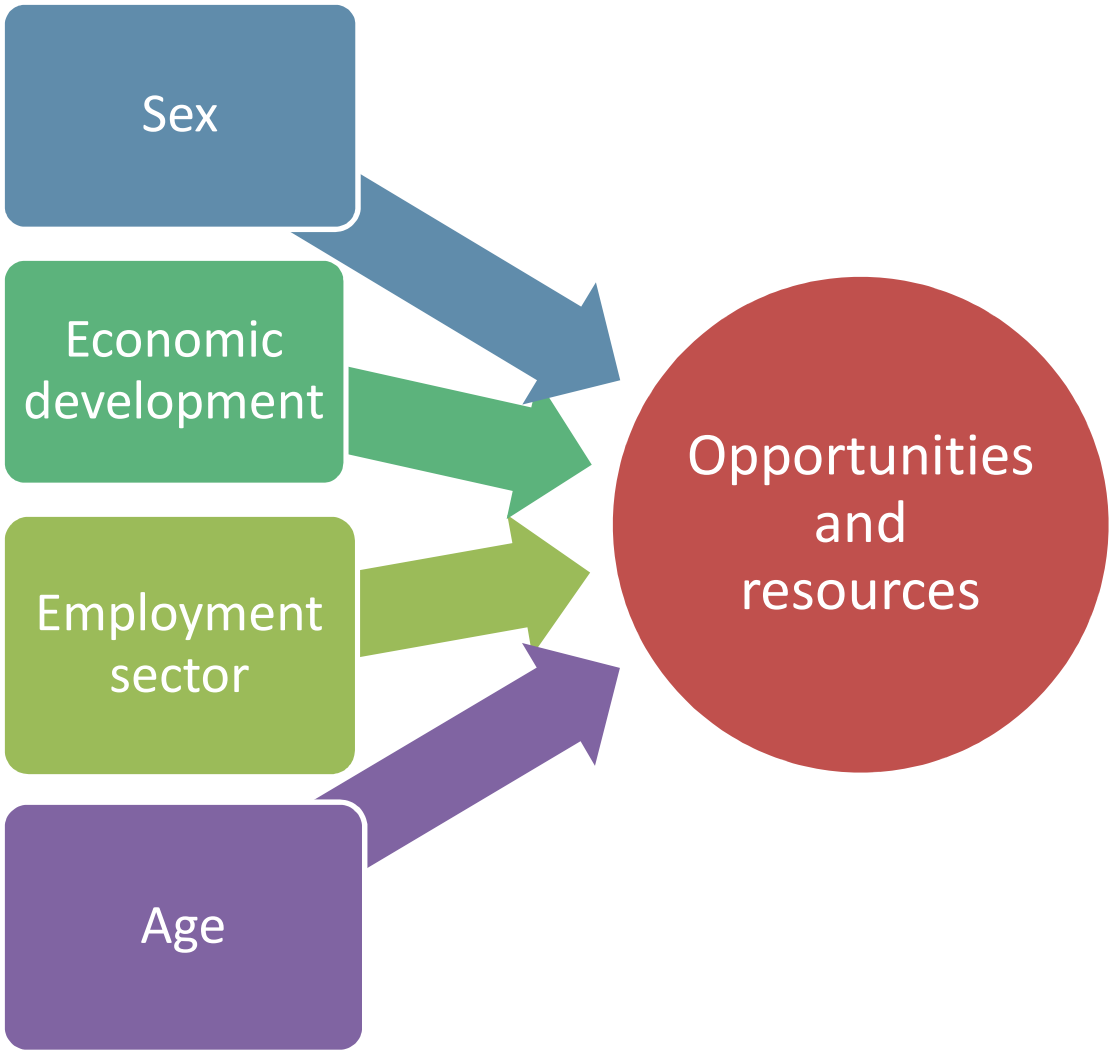
PHD+10 (TO 15) STUDY

- 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


Sex
Economic development
Employment sector
Age
Opportunities and resources

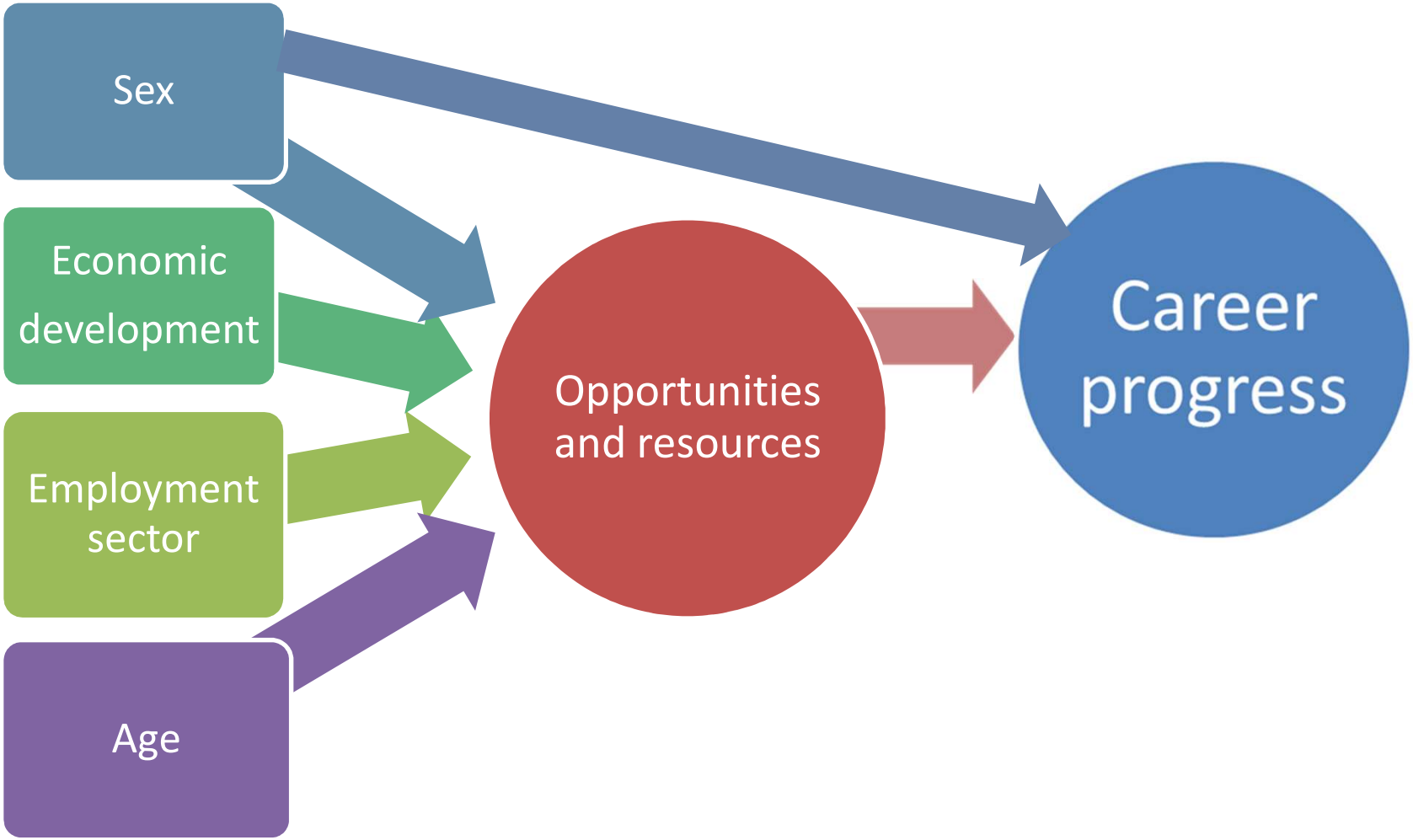
Percentage of respondents with access to key resources

	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

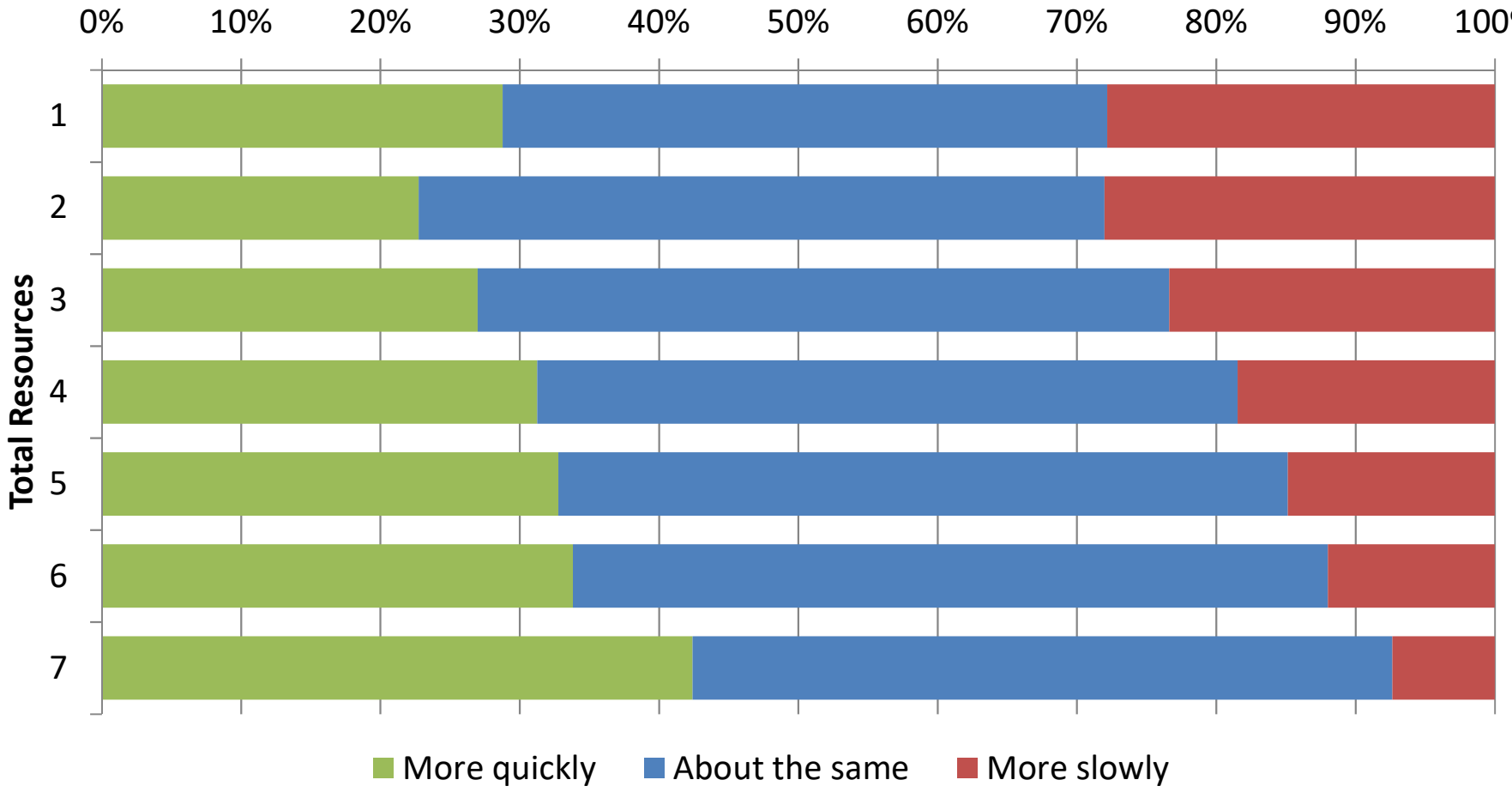
% of R's w/ career-advancing opportunities

% 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

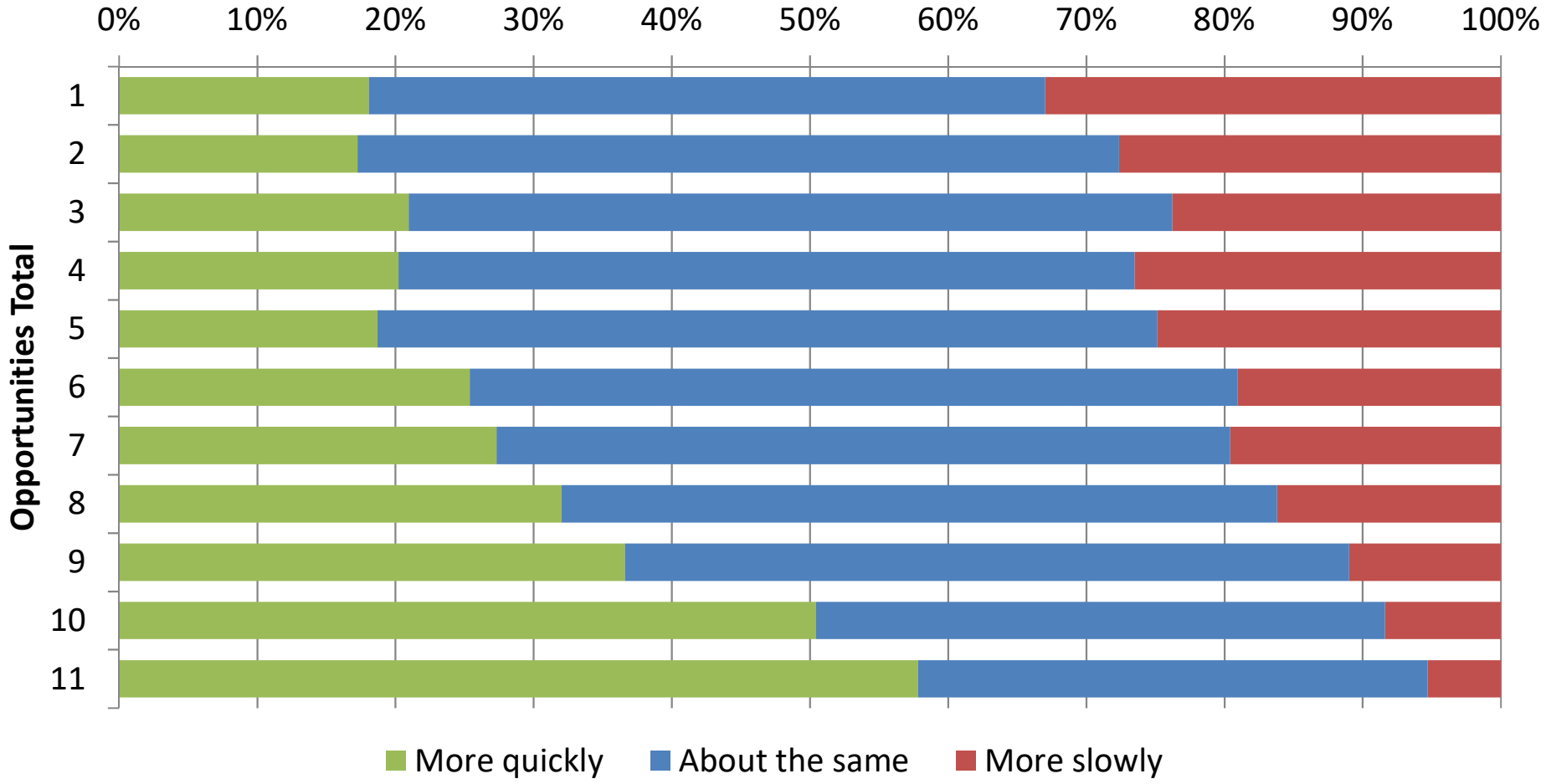
Global Survey of Physicists

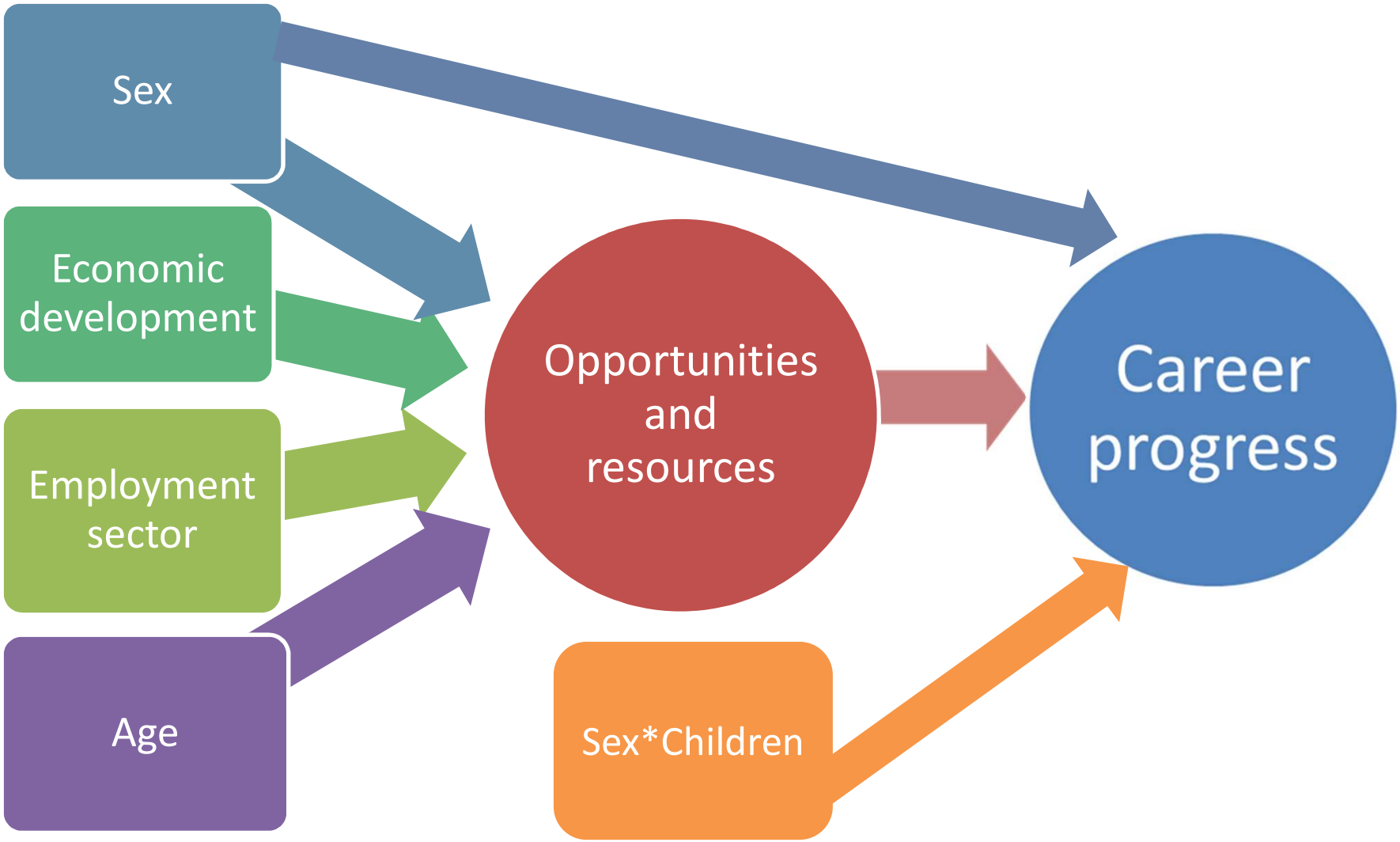


Relationship between career progress and resources

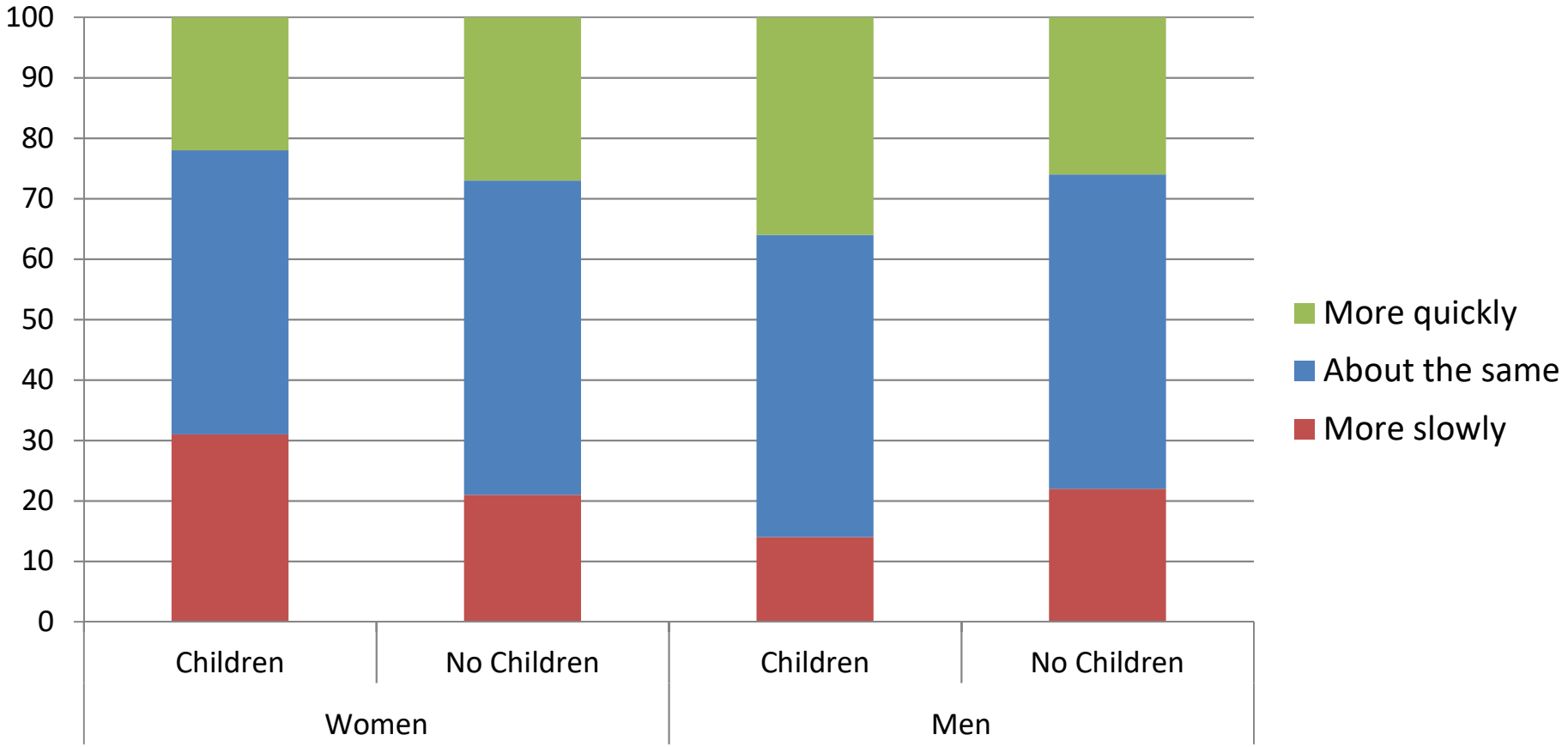


Relationship between career progress and opportunities




Sex
Economic development
Employment sector
Age
Opportunities and resources
Sex*Children
Career progress

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



IMPORTANCE

Documenting gender differences in salaries and access to opportunities and resources can result in policy changes.

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

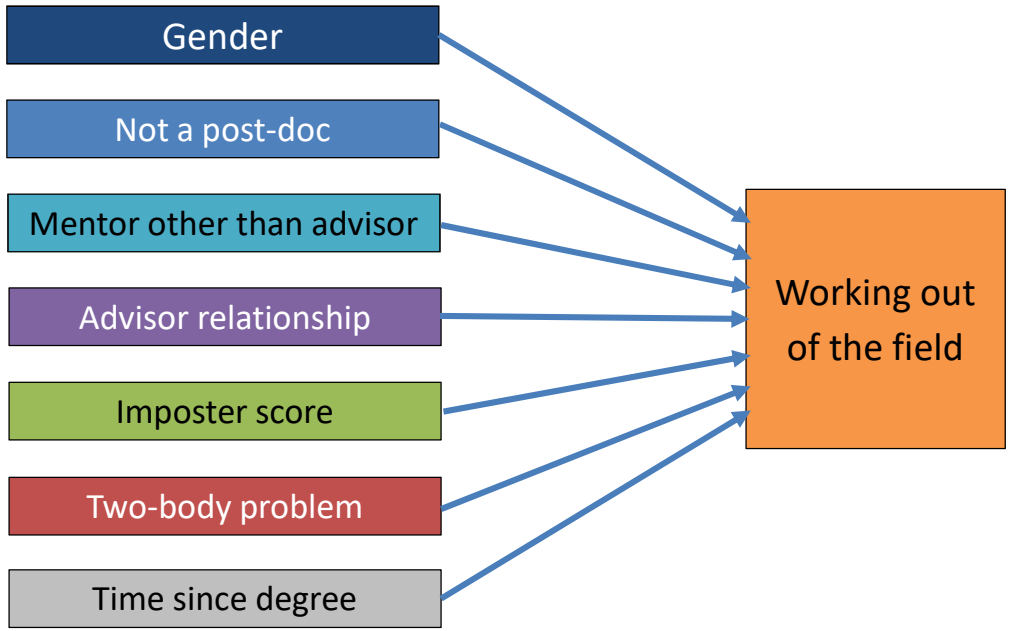
HYPOTHESIS

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.

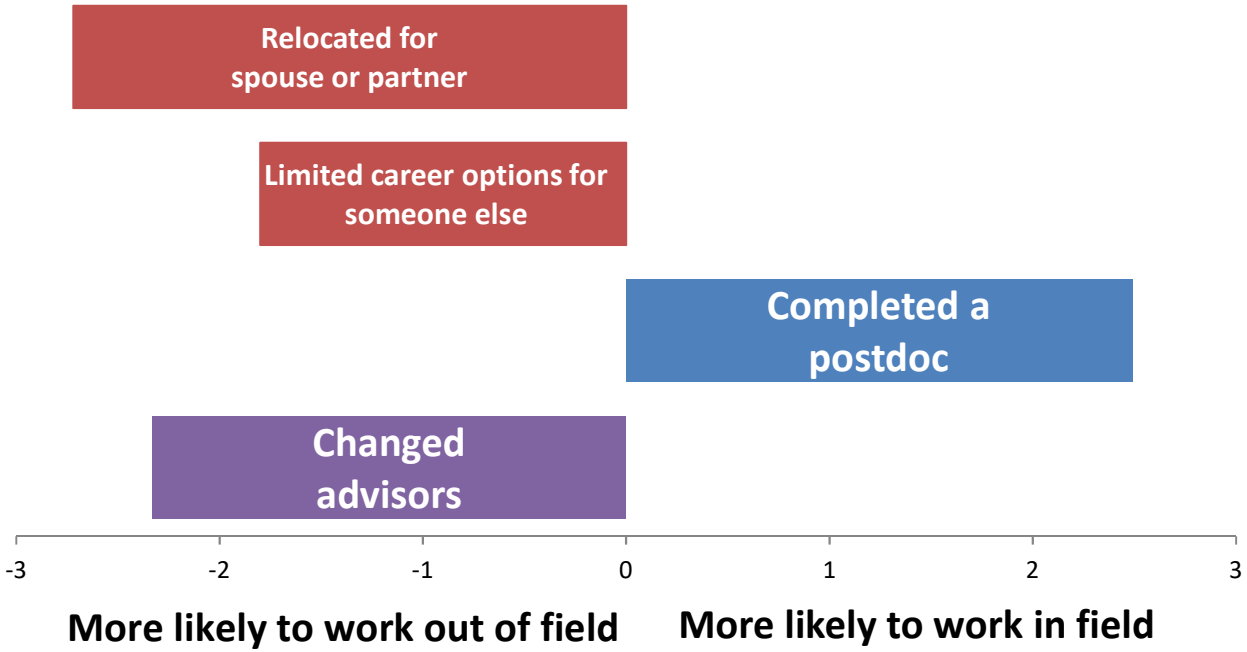
IS WORKING IN OR OUT OF FIELD AFFECTED BY

- 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?



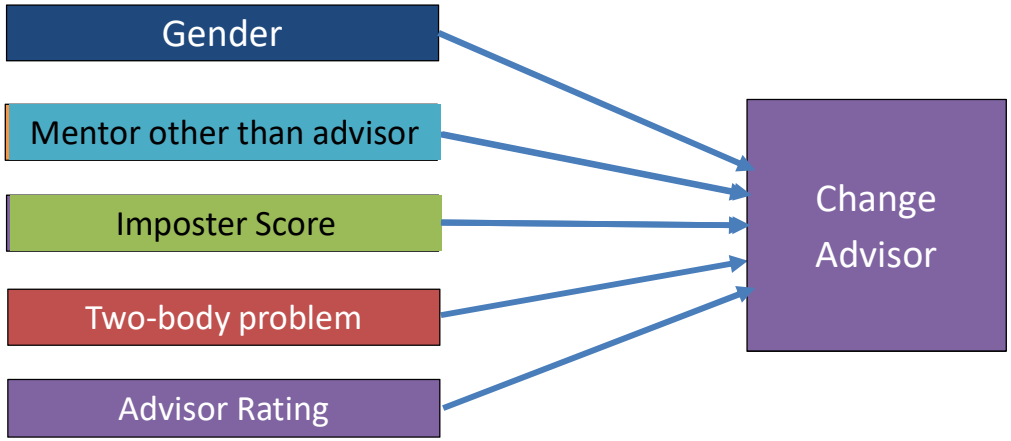
SECOND SURVEY
FACTORS THAT INFLUENCE WORKING OUT OF FIELD



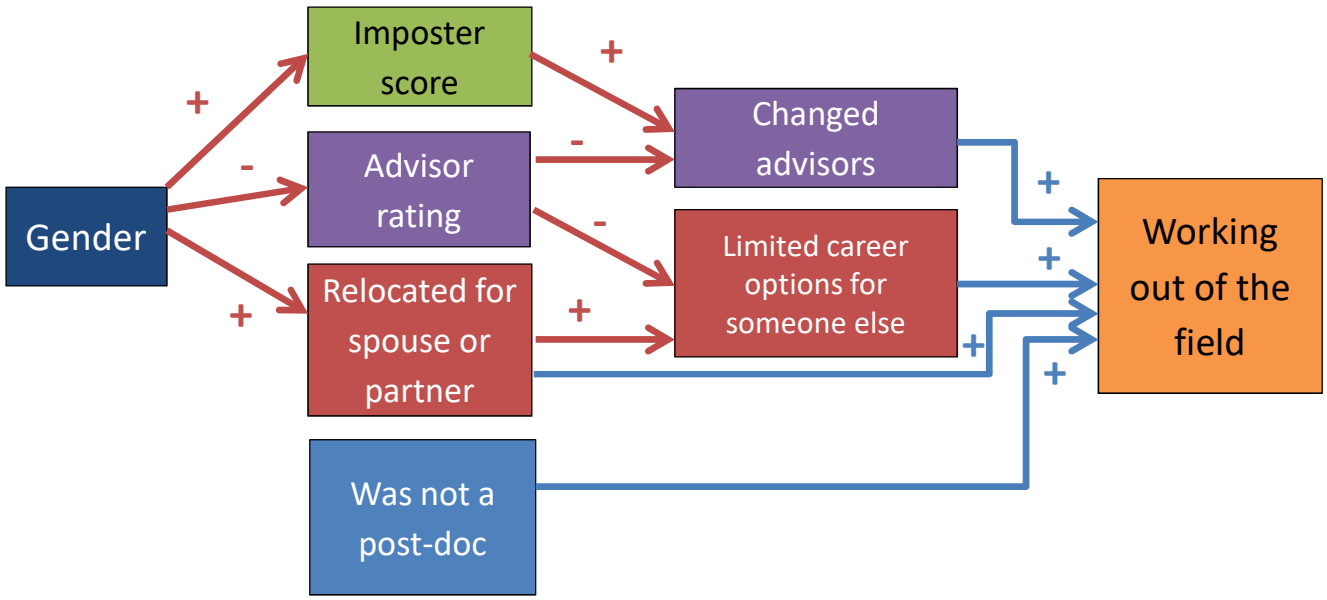
ANOTHER HYPOTHESIS

- 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.

Thanks to my colleagues Susan White and Patrick Mulvey

For more information

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