

# Initial Motivations and Ideas

- **Risk Charts** for big transformative science programs now include in their top risks **the hiring of technical personnel** from industry  
(to write software, develop systems, build infrastructure, among others.)
- **Attrition** also an issue because of knowledge loss and small teams

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  - (to write software, develop systems, build infrastructure, among others.)
- **Attrition** also an issue because of knowledge loss and small teams
- **Why?**
  - ◆ Conflict between **hiring practices** in Academia vs. Industry
    - Timescales (many months vs. several weeks)
    - Supply >> Demand vs. Supply << Demand
      - a.k.a. Employer-centric vs. Employee-centric hiring environment
      - especially with industry teams adopting hybrid/remote/distributed work structures*

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→ **Why?**

◆ Conflict between **hiring practices** in Academia vs. Industry

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a.k.a. Employer-centric vs. Employee-centric hiring environment

*especially with industry teams adopting hybrid/remote/distributed work structures*

→ At the same time, **only ~1 in ~10 PhDs** will become tenure track professors

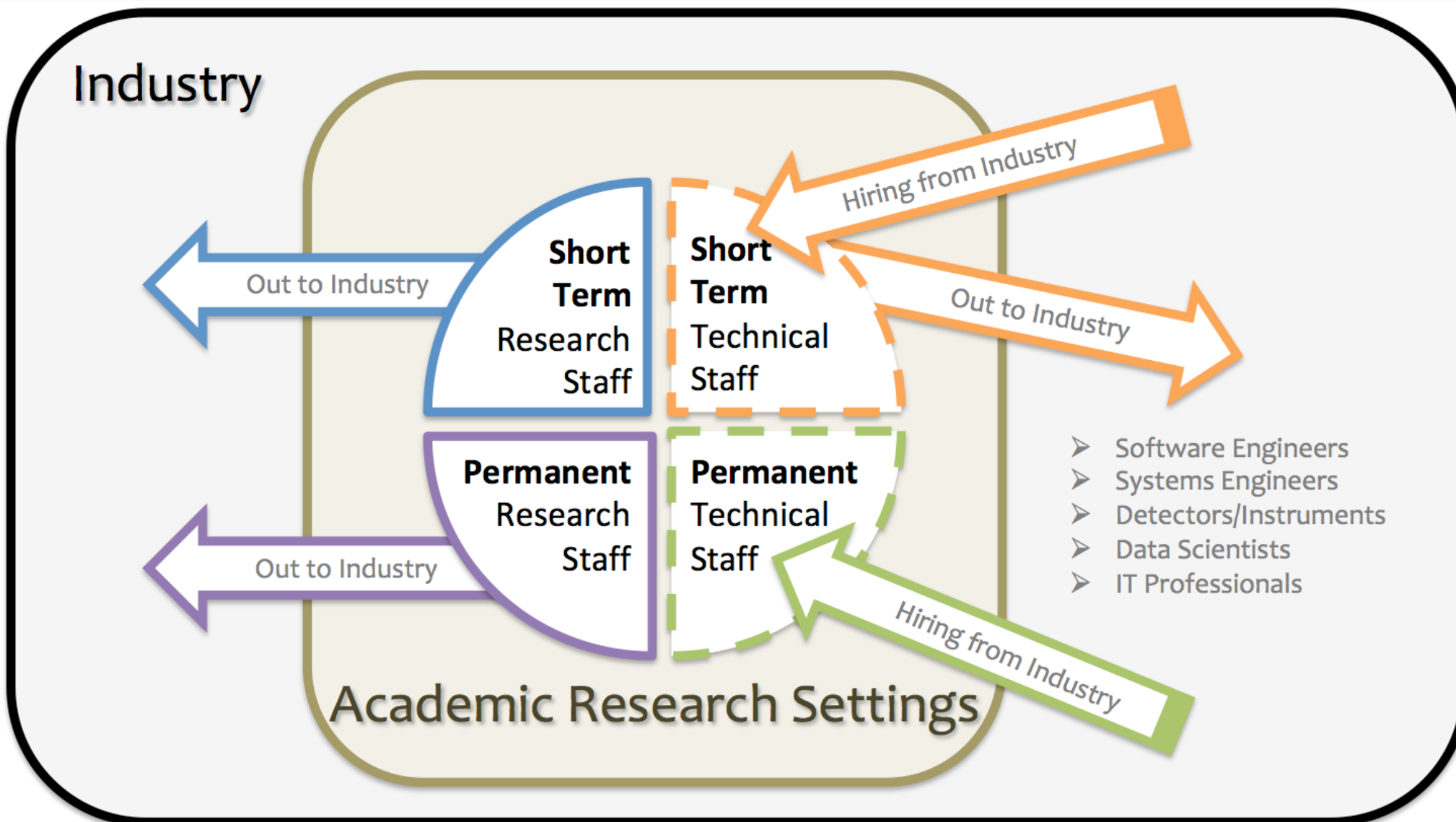
- ◆ Number of BA degrees in Astronomy up 25% from 2014-2018

- ◆ Number of Ph.D. degrees up 20% from 2014-2018

- ◆ Tenure Track in Astro Dept up 4% from 2014-2018

- ◆ **Unable to find data on technically-focused jobs, non-teaching jobs, non-university settings**

# Research Recruitment and Attrition



Very little differentiation between Industry and Academic Research Skillsets, Sense of Freedom/Choice, and other commonly raised differences.

See: <https://www.aip.org/statistics/phd-plus-10>  
 (note this data is old, but does span the late 1990's tech bubble)

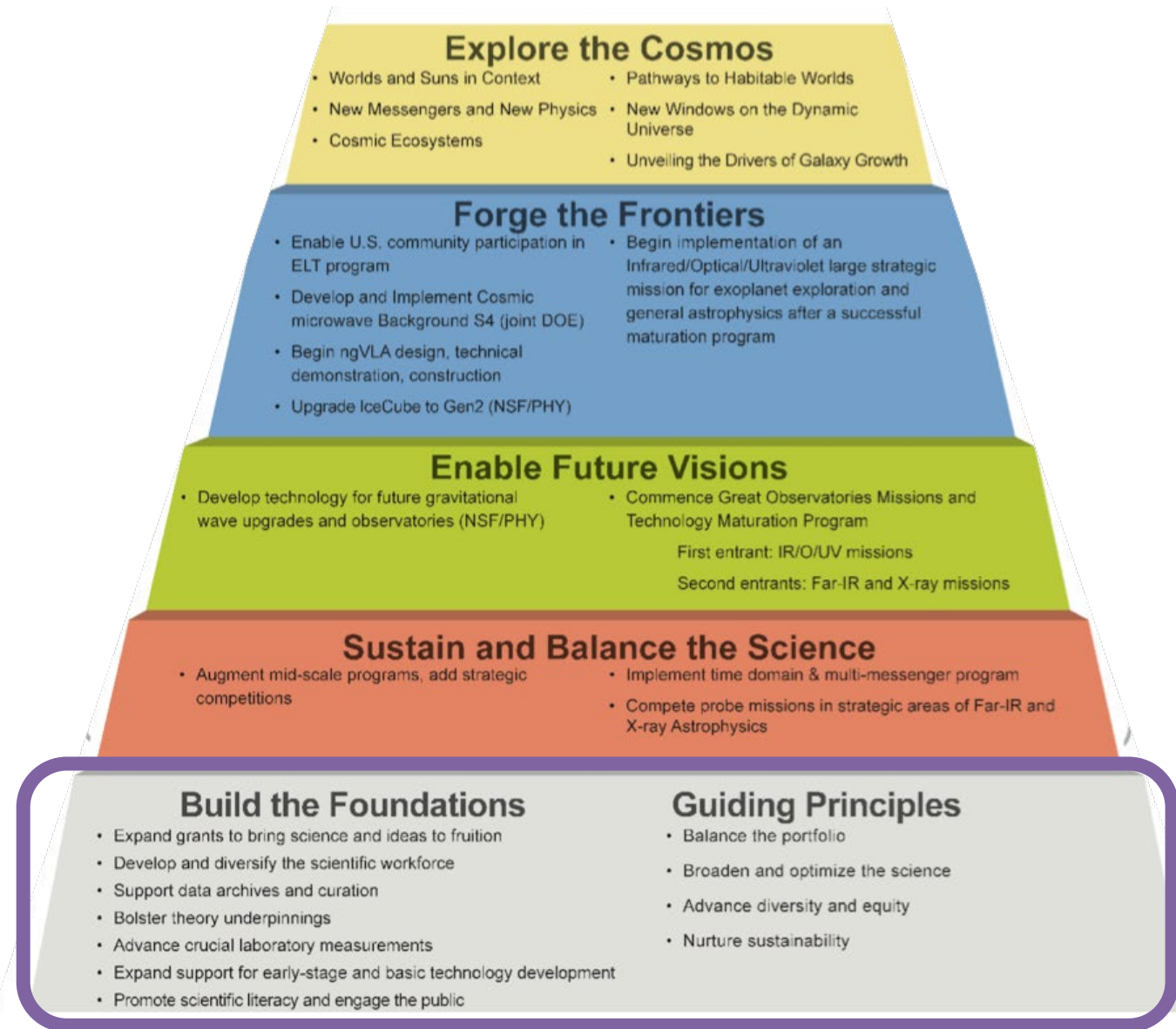
- Software Engineers
- Systems Engineers
- Detectors/Instruments
- Data Scientists
- IT Professionals

# Initial Motivations and Ideas

→ Move beyond anecdotal discussion and personal experience to understand why **highly trained** and **highly successful** researchers **leave** the field

→ Present analysis on what factors could reinforce the foundation of science:

the **people** that do science



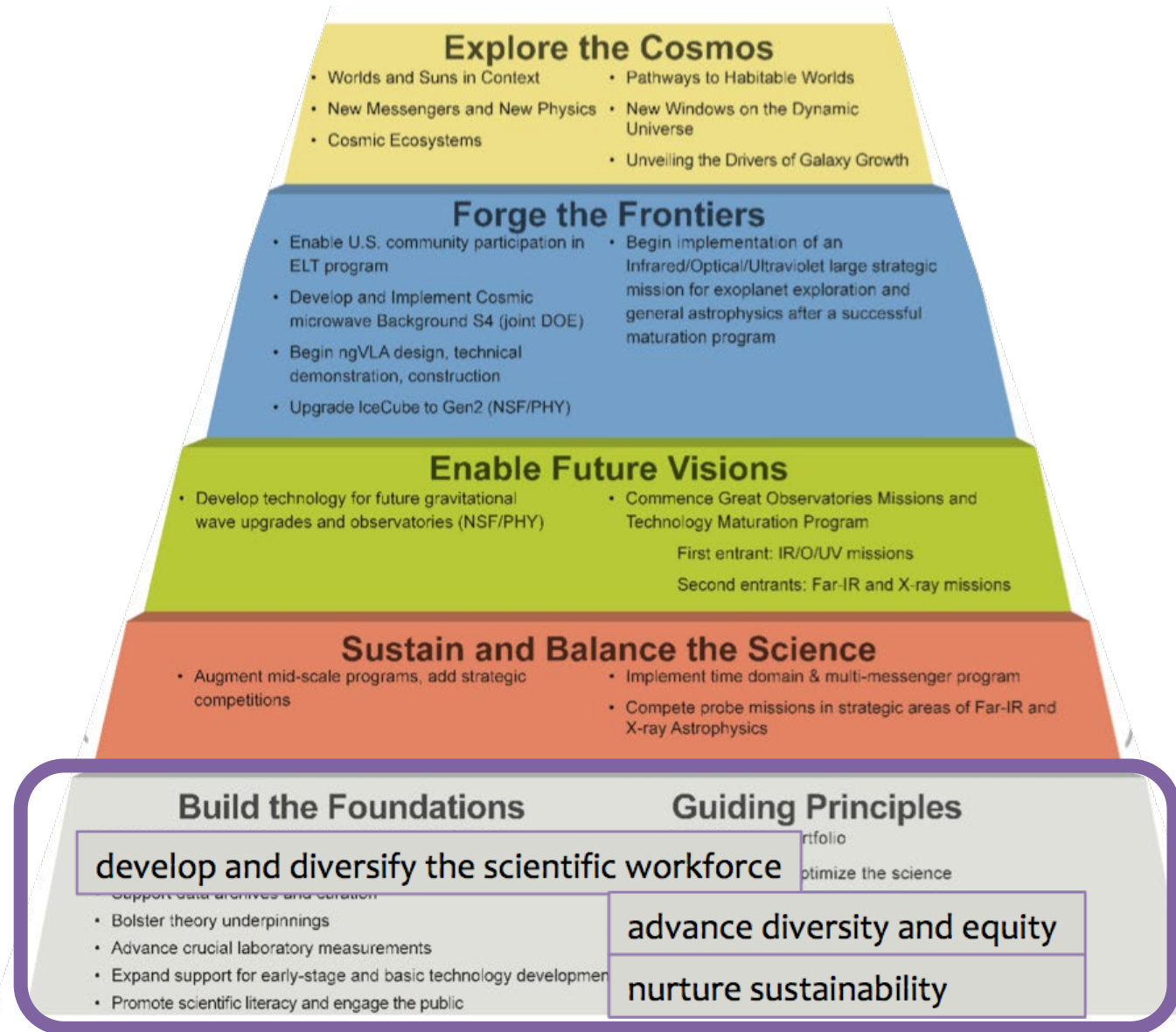


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# Why Now? What is the urgency?

- **Coming out of the pandemic scientists of all career stages are reevaluating**
  - ◆ The structural weaknesses in our community were revealed and experienced in aggregate and in full display
    - Issues related to caring for family, managing collaborations, among others have always been there but happening at the individual, rather than institutional, levels
- **We are starting to seriously examine the layers of inequity in our field**
  - ◆ NASA Inclusion Plans, AIP Team Up Report
- **Industry recruiting continues to grow**
  - ◆ Ph.D. holders are promising hires for the same reason they are promising within academia
  - ◆ Employers willing to invest in specific training for specific tasks
- **Decadal Survey has made Workforce Issues a critical component of our outlook**
  - ◆ Report of the Panel on the State of the Profession and Societal Impacts

# Initial Motivations and Ideas

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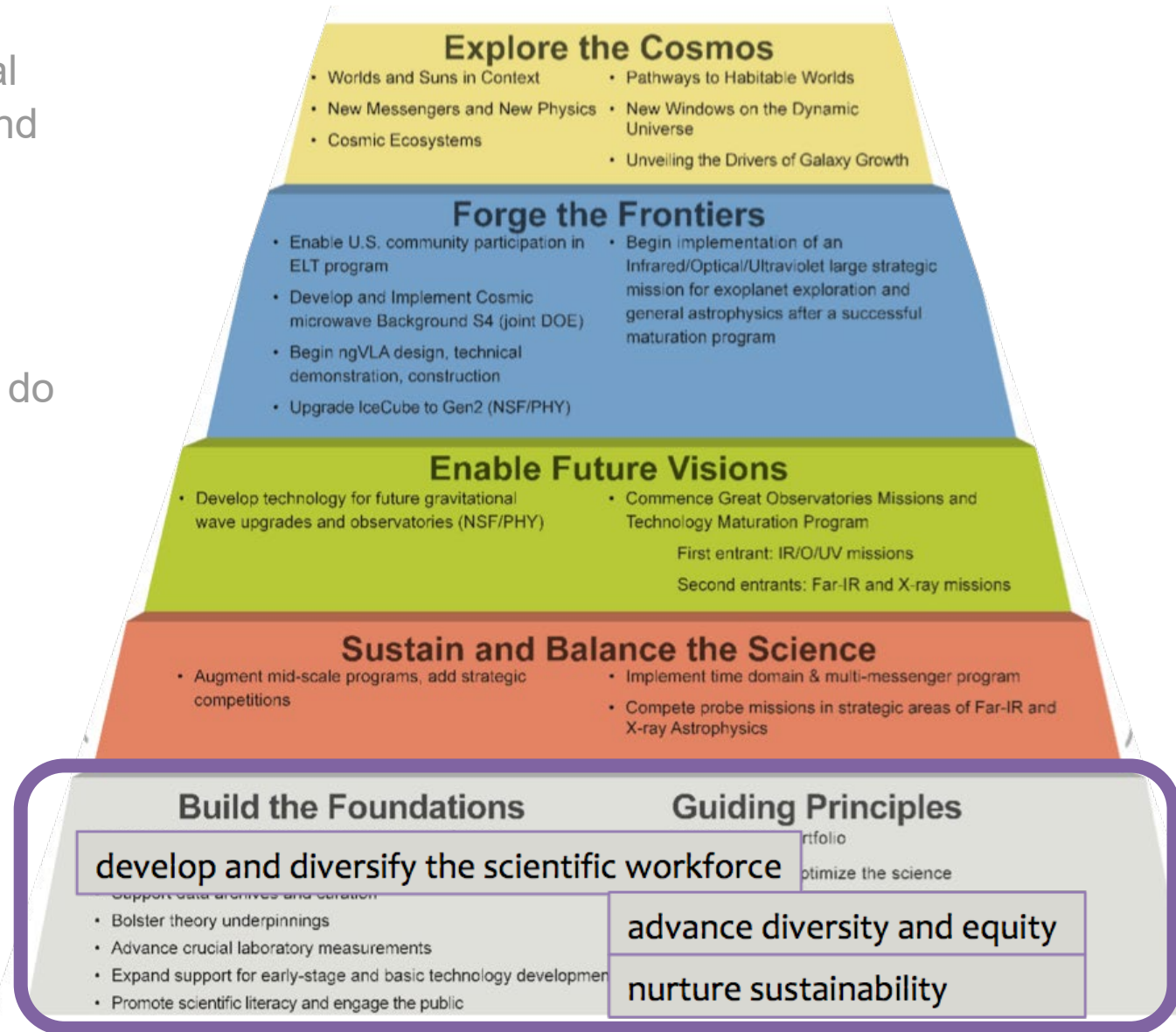
science the **people** that do science

→ **Roadblock:**

- ◆ We can't collect new data now due to Paperwork Reduction Act and limitations to our Terms of Reference

→ **Solution:**

- ◆ Use the literature, public data as motivation
- ◆ No Data on non-physics degree holders, so we will do our best to contextualize.





# Anecdotally what are the issues?

- Location
- Salary
- Long-Term Stability
- Work/Life Balance
- Lack of Support/Room for Growth

## Anecdotally what are the issues?

AAS Committee on the Status of Women in Astronomy (CSWA) has 8 years of non-academic career profiles that asked **why scientists leave** (27 from 2013 to 2021).

Source: <http://womeninastronomy.blogspot.com/2021/03/why-we-leave.html>

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- **Location** (48%)
- **Salary** (30-40%)
- **Work Environment** (19%)
- **Long-Term Stability** (48%)
- **Work/Life Balance** (37%)
- **Funding** (11%)
- **Lack of Support/Room for Growth** (41%)
- **Did not want Research Job** (33%)
- **Did not get Academic Jobs** (4%)

### Note:

This is \*my\* coding that is not fully scientific, just contextual.

This is still anecdotal in nature because there is bias in who was contacted and who responded. A systematic survey of those that stayed in academia and those that left across a variety of jobs would be more reliable.

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# Starting Salaries for Physics Bachelor's Degrees 2019 and 2020

AIP | Statistics

[aip.org/statistics](http://aip.org/statistics)

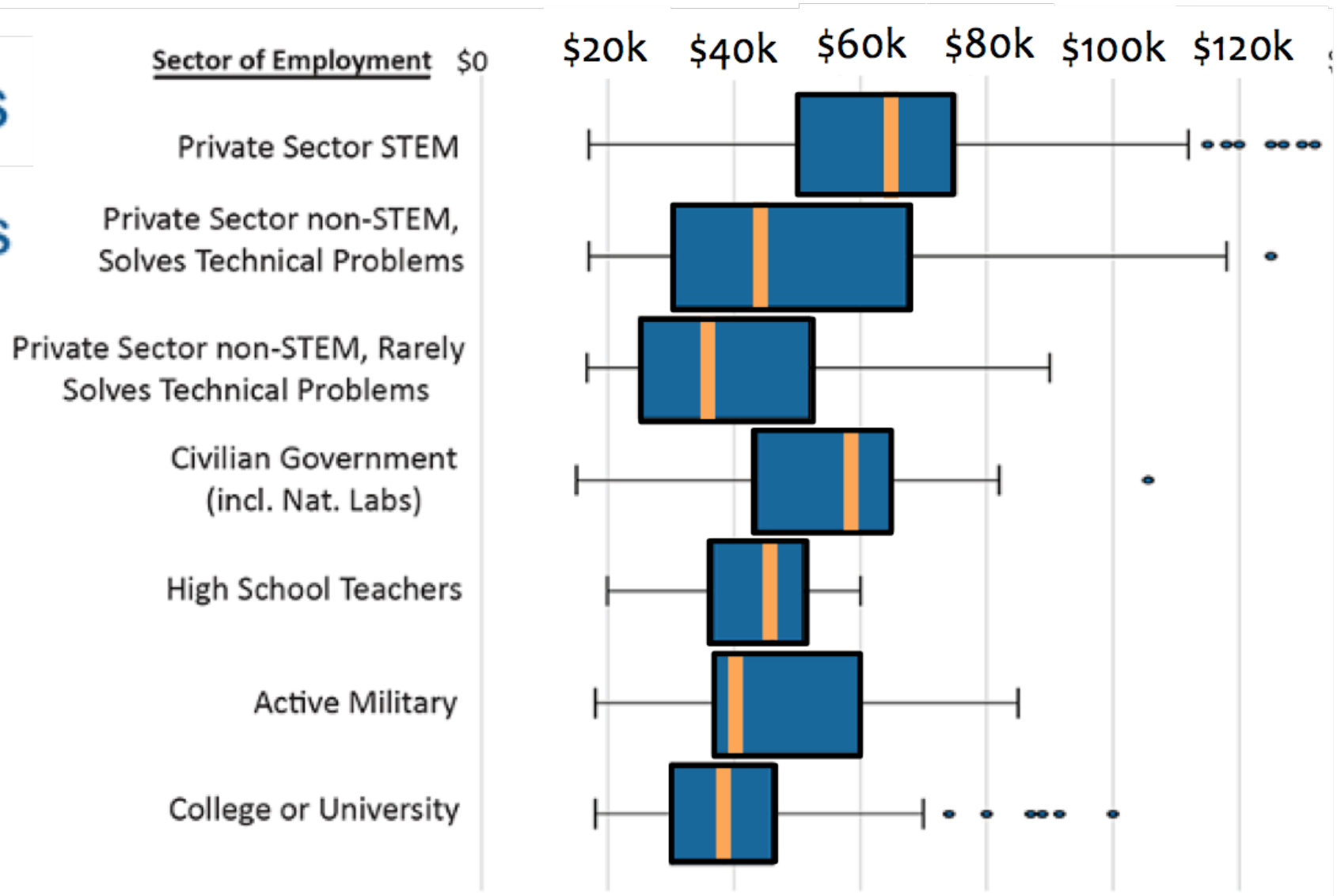


Figure adapted from:  
<https://www.aip.org/statistics/resources/initial-employment-physics-bachelors-and-phds-classes-2019-and-2020>



# Starting Salaries for Physics PhD Degrees 2019 and 2020

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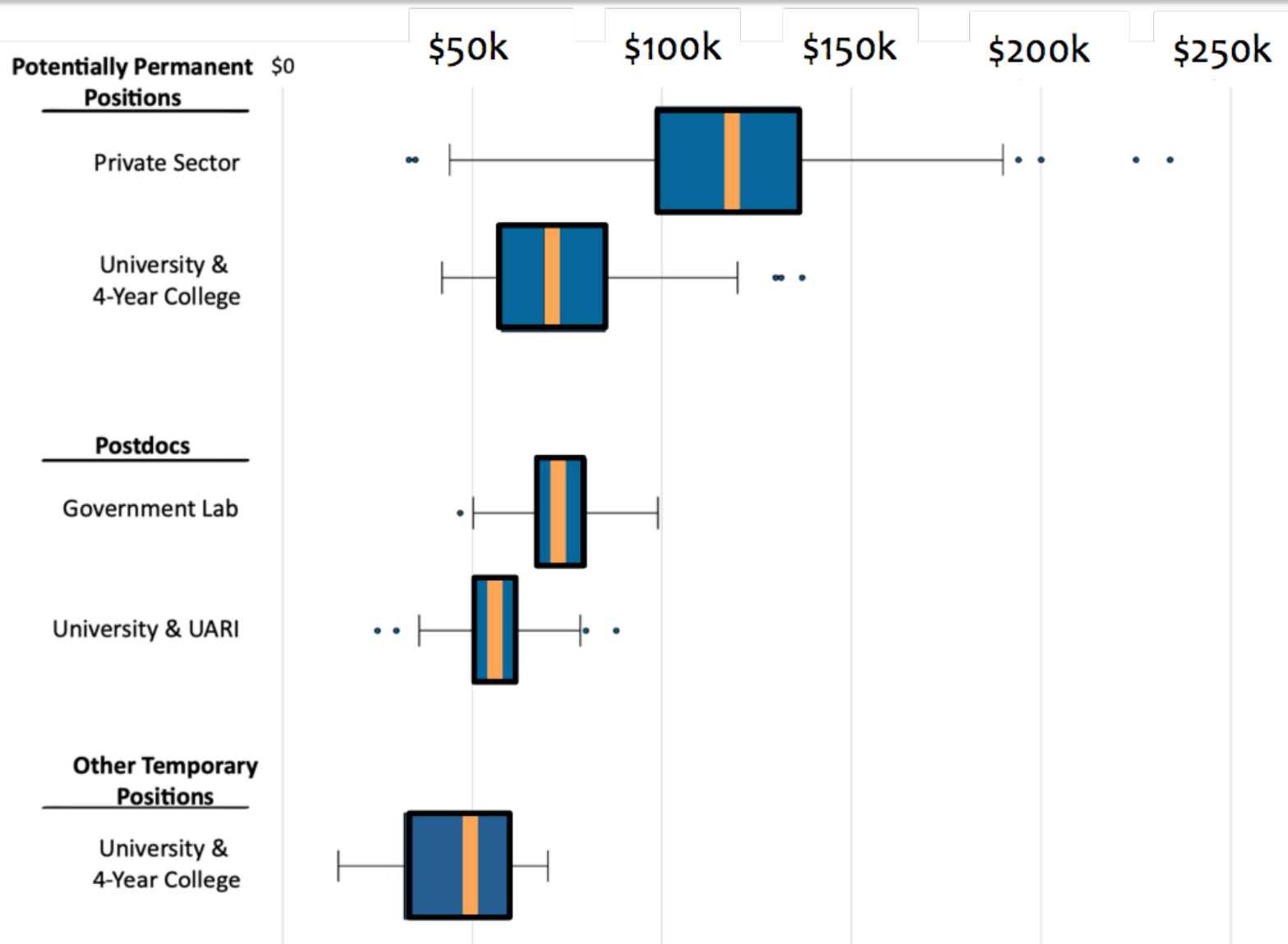


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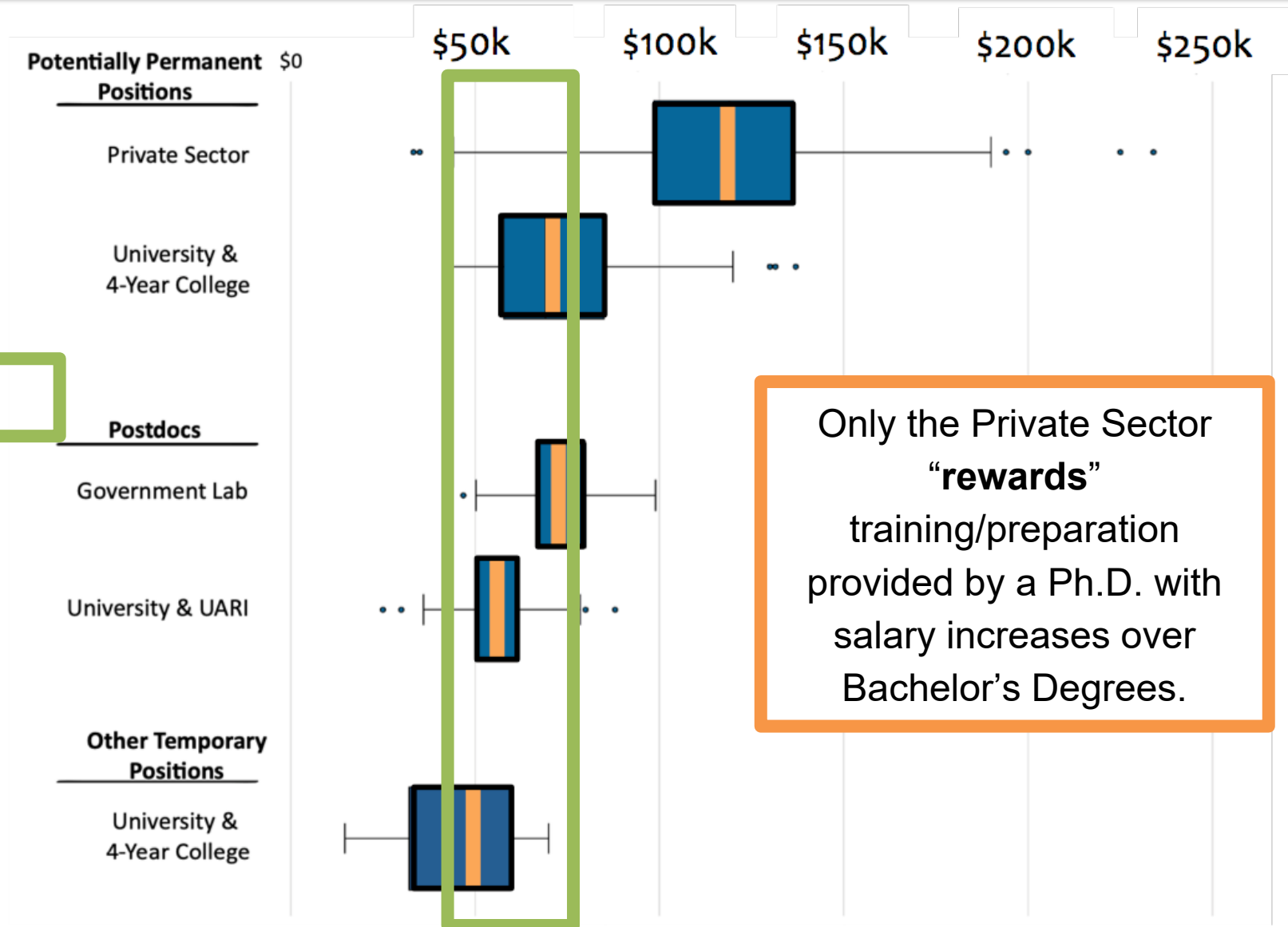
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# Starting Salaries for Physics PhD Degrees 2019 and 2020

AIP | Statistics

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IQR of All **Physics** Bachelor's Degrees



Only the Private Sector  
“rewards”  
training/preparation  
provided by a Ph.D. with  
salary increases over  
Bachelor's Degrees.

Figure adapted from:

<https://www.aip.org/statistics/resources/initial-employment-physics-bachelors-and-phds-classes-2019-and-2020>

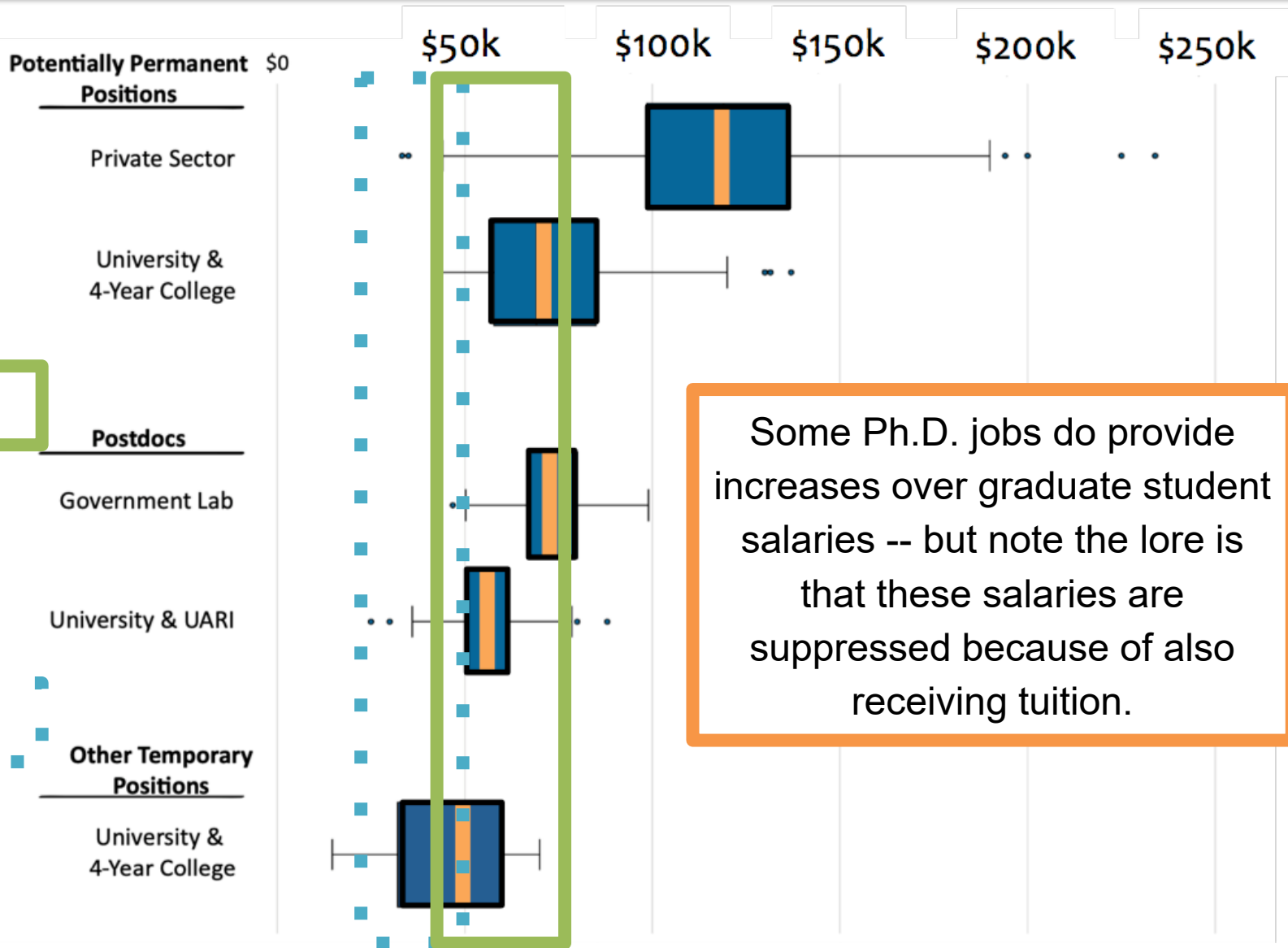
# Starting Salaries for Physics PhD Degrees 2019 and 2020

AIP | Statistics

[aip.org/statistics](http://aip.org/statistics)

IQR of All **Physics** Bachelor's Degrees

Physics Graduate Student Salaries



Some Ph.D. jobs do provide increases over graduate student salaries -- but note the lore is that these salaries are suppressed because of also receiving tuition.

Figure adapted from:

<https://www.aip.org/statistics/resources/initial-employment-physics-bachelors-and-phds-classes-2019-and-2020>

# Starting Salaries for Physics PhD Degrees 2019 and 2020

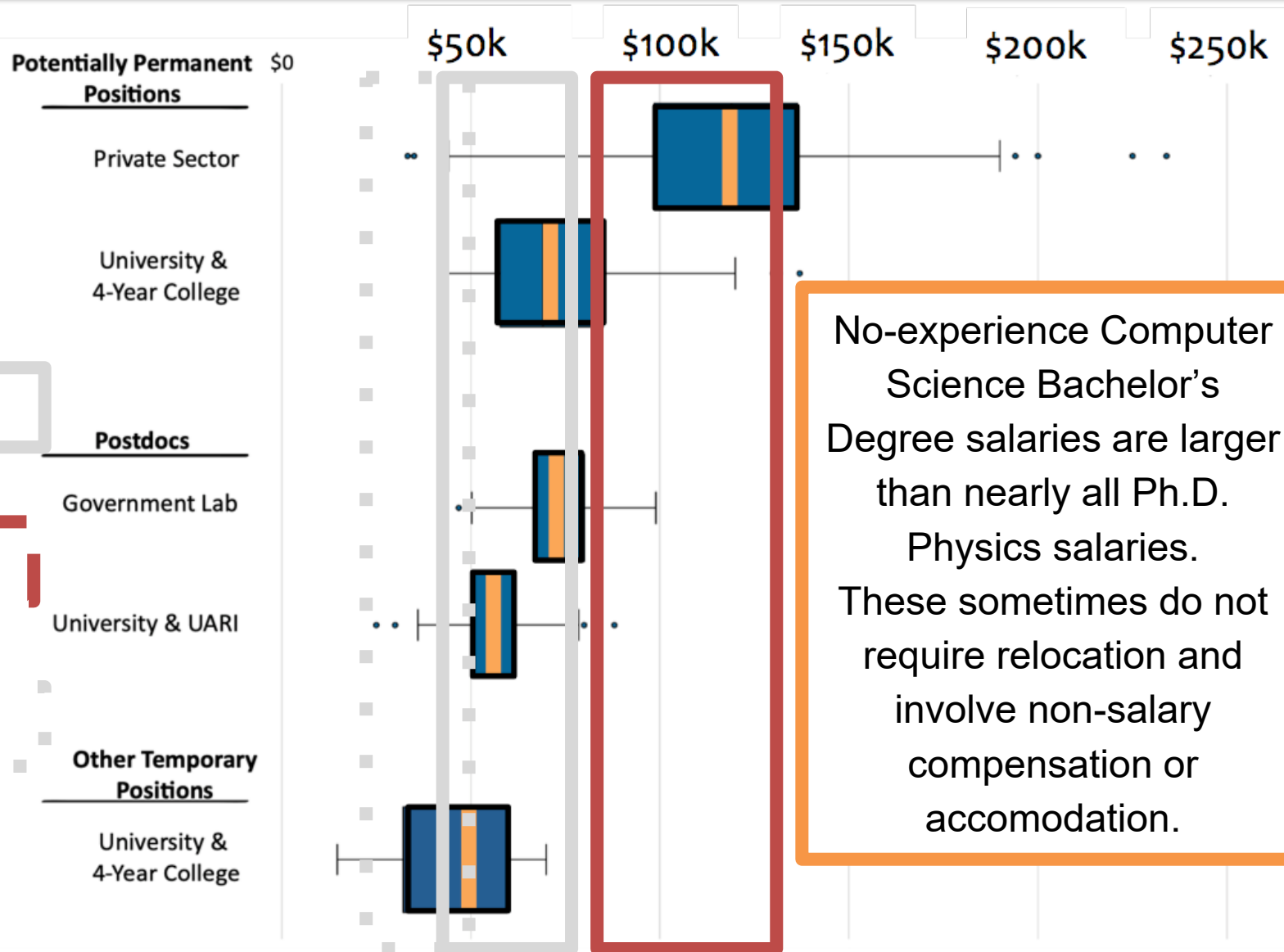
AIP | Statistics

[aip.org/statistics](http://aip.org/statistics)

IQR of All **Physics** Bachelor's Degrees

~IQR of All **CompSci** Bachelor's Degrees

Physics Graduate Student Salaries



No-experience Computer Science Bachelor's Degree salaries are larger than nearly all Ph.D. Physics salaries. These sometimes do not require relocation and involve non-salary compensation or accomodation.

Figure adapted from:

<https://www.aip.org/statistics/resources/initial-employment-physics-bachelors-and-phds-classes-2019-and-2020>

# Salaries Impact Who Can Be a Scientist

## THE STATE OF SCIENCE SALARIES

Stagnating salaries, persistent pay divides and a competitive job market are dampening scientists' optimism. **By Chris Woolston**

### Direct from the Article:

... she struggled with relatively low salaries during more than five years of postdoctoral work in the United Kingdom

...

“Postdoc salaries are OK, but it was a difficult situation for saving money. I never felt great financial security. **If something went wrong, I’d have to rely on my parents.**”

Nature | Vol 599 | 18 November 2021

Based on Nature’s 2021 salary and satisfaction survey

<https://media.nature.com/original/magazine-assets/d41586-021-03041-0/d41586-021-03041-0.pdf>



# Salaries Impact Who Can Be a Scientist

Being able to rely on family members for financial support is a privilege that most do not have. Those that face these issues without that privilege, would have to quit academic research and take a higher paying job.

## For context, from the **Economic Well-Being of US Households:**

→ 24% of households in the US are just able to pay their monthly expenses or are a single unplanned \$400 expense away from hitting this point.

This quantity has **sharp racial divides:**

- ◆ 40% of African American households
- ◆ 35% of Hispanic households
- ◆ 20% of white households
- ◆ 11% of Asian households

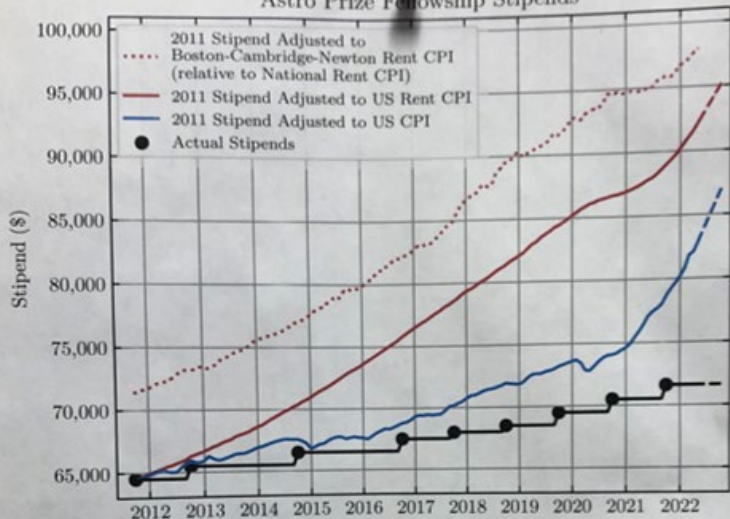
→ 27% of Americans do not have cash-on-hand to cover three months of bills

→ Lower income households (< \$50,000) **2x more likely to experience job disruption or family emergencies** than higher income households ( > \$100,000) including impacts of natural disasters.

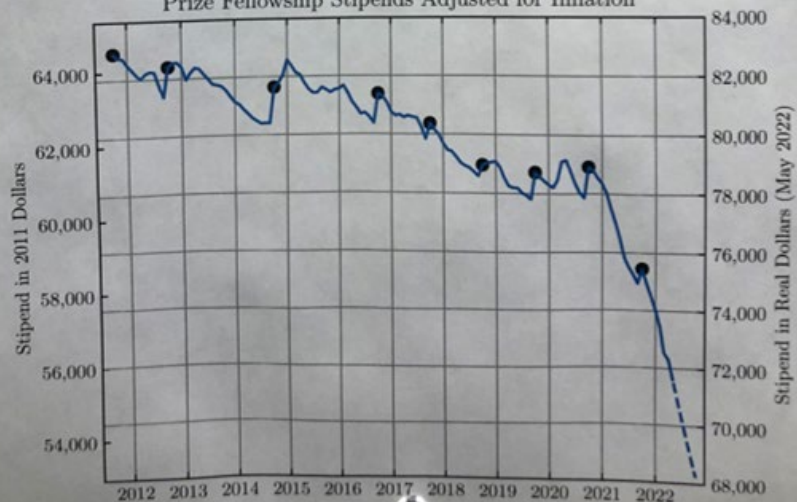
Source: <https://www.federalreserve.gov/publications/2022-economic-well-being-of-us-households-in-2021-dealing-with-unexpected-expenses.htm>

# Salaries and Cost of Living

Astro Prize Fellowship Stipends



Prize Fellowship Stipends Adjusted for Inflation

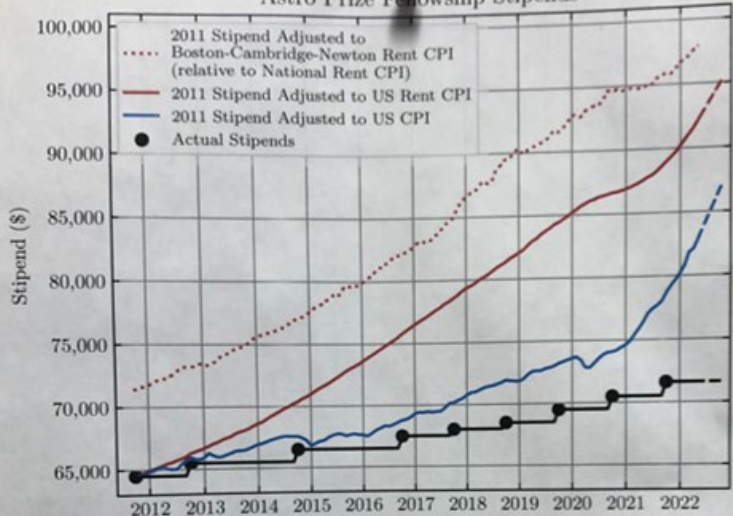


This a picture that made its way to the COPAG discussion via a telephone-of-Slack channels and is from the bulletin board of distinguished university in the Boston-Cambridge-Newton Area.

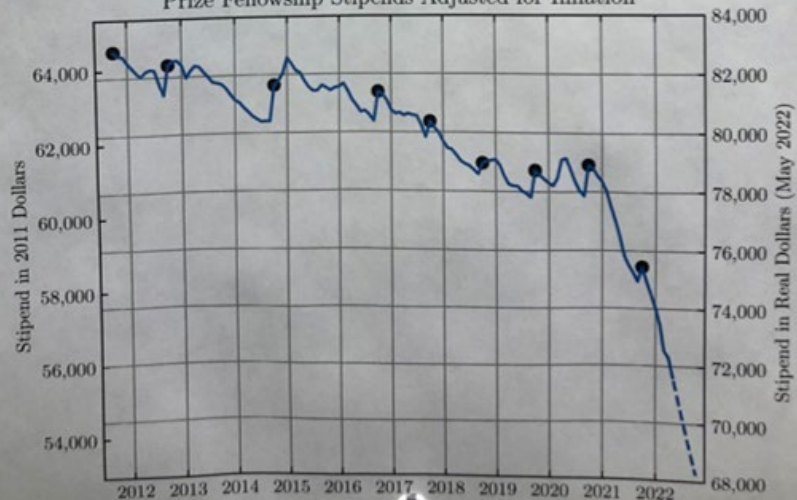
**This is an example of the type of analysis that early career researchers are motivated do on their own and distribute in their own networks when it comes to career decision making.**

# Salaries and Cost of Living

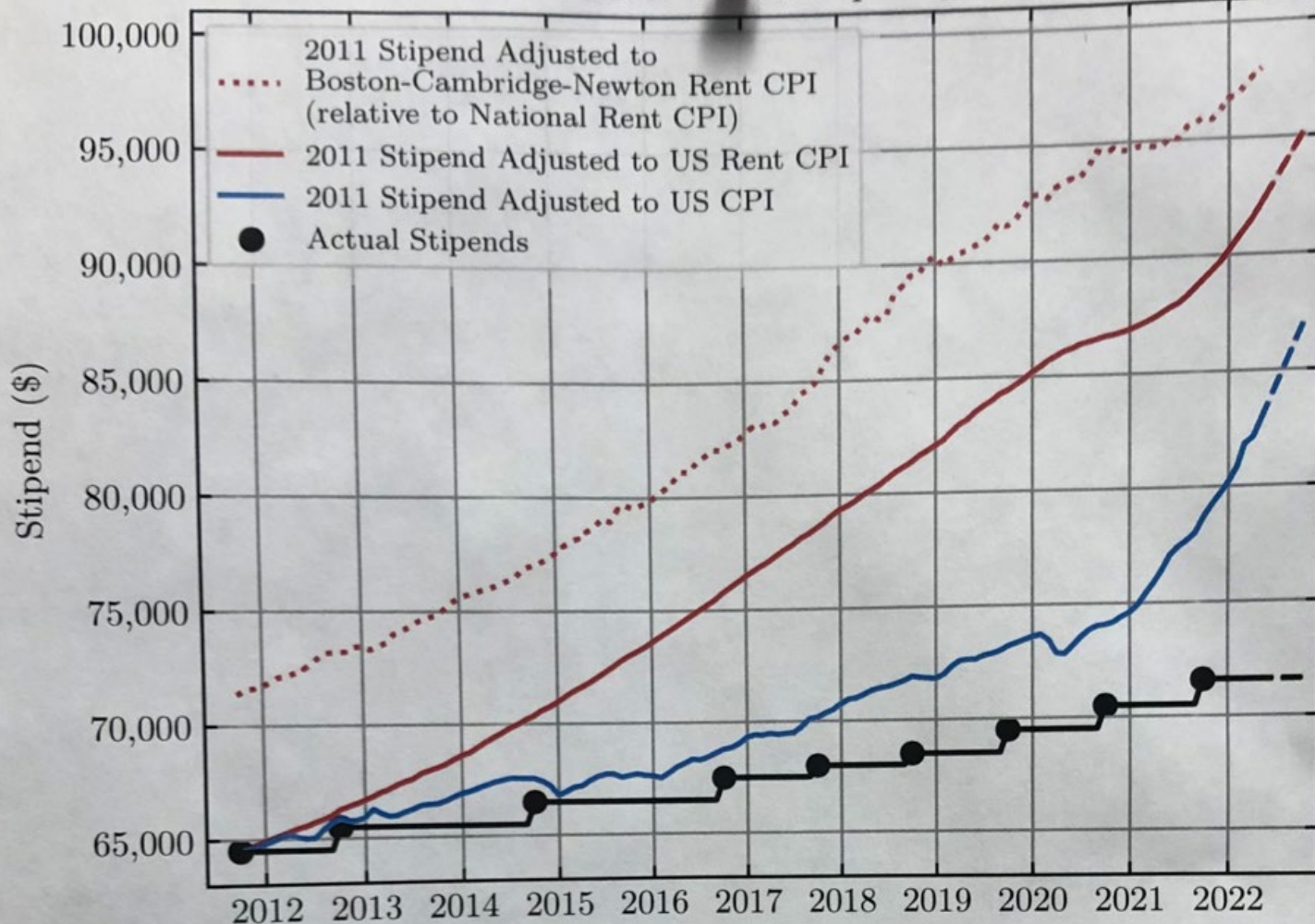
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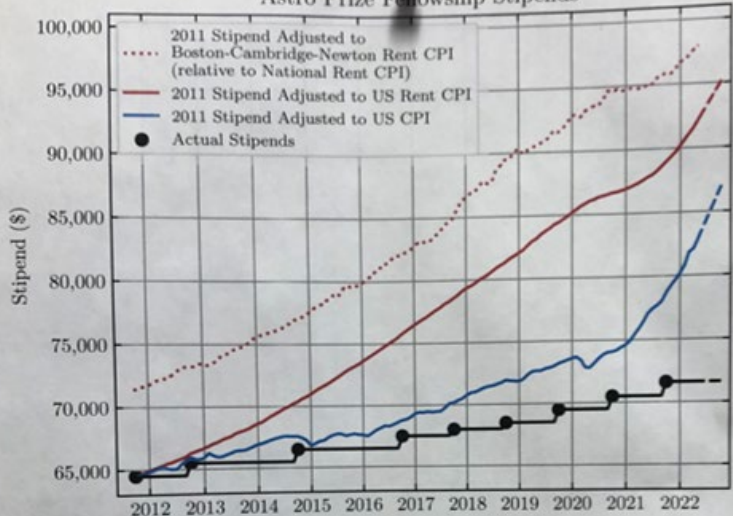
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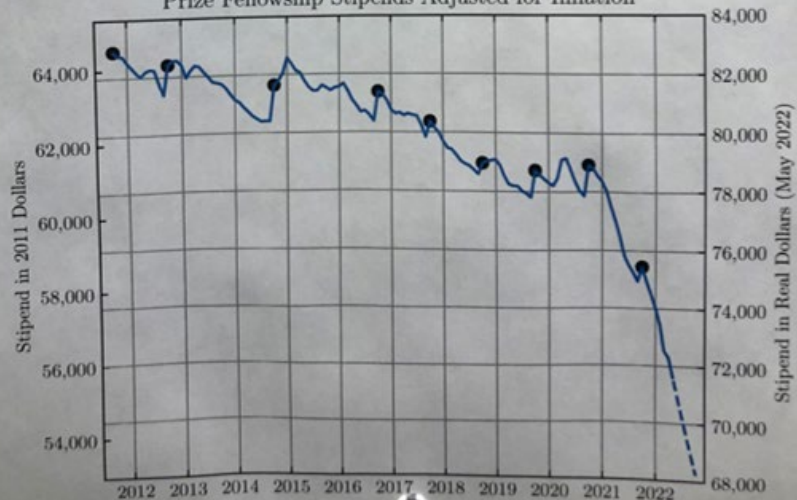


# Salaries and Cost of Living

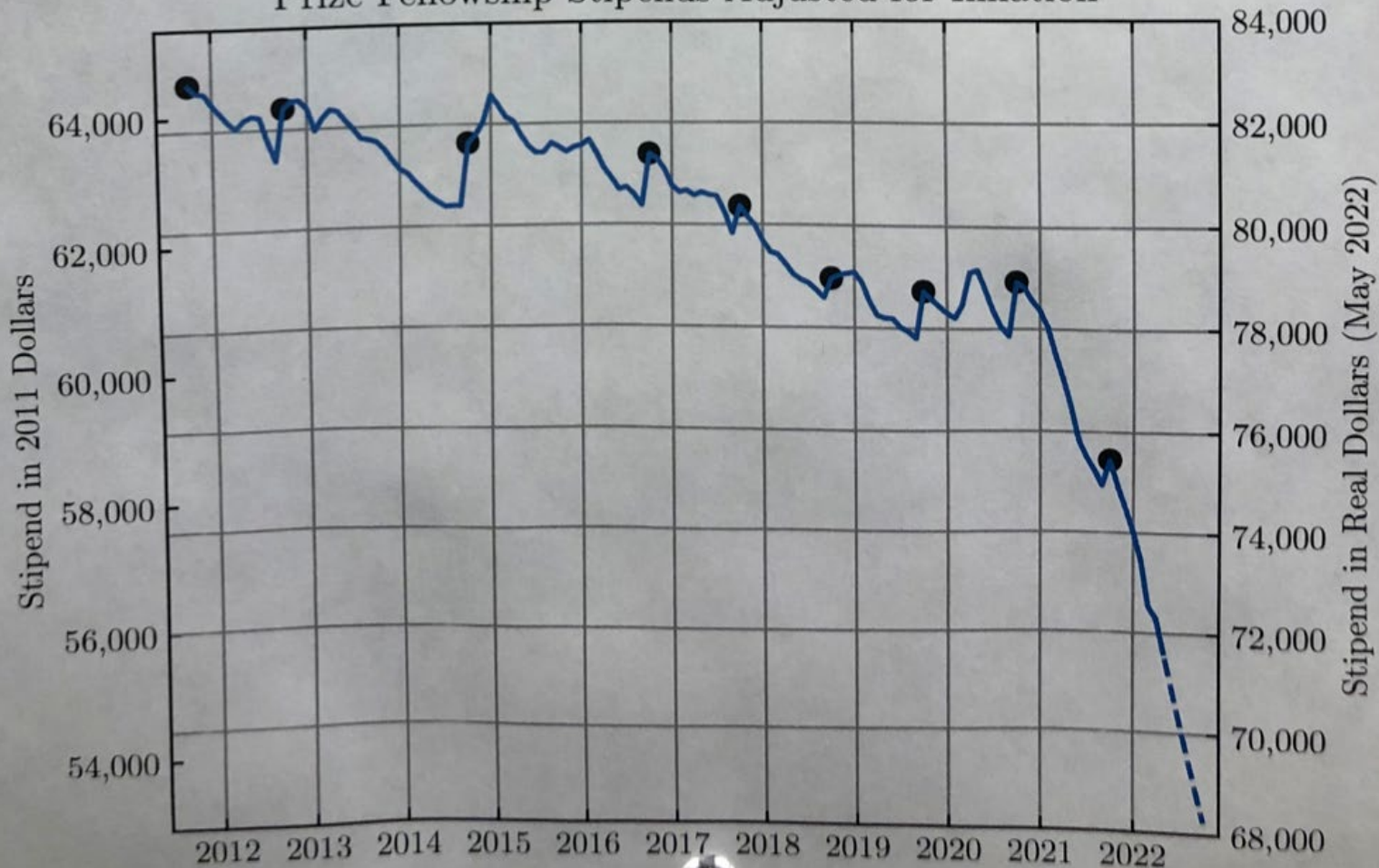
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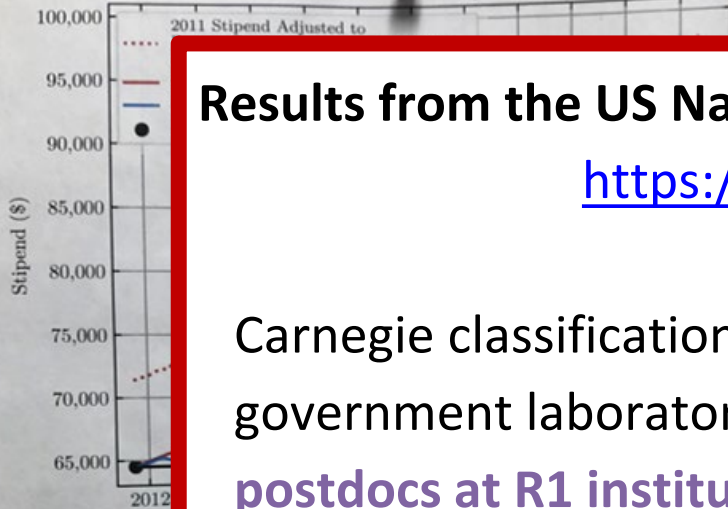


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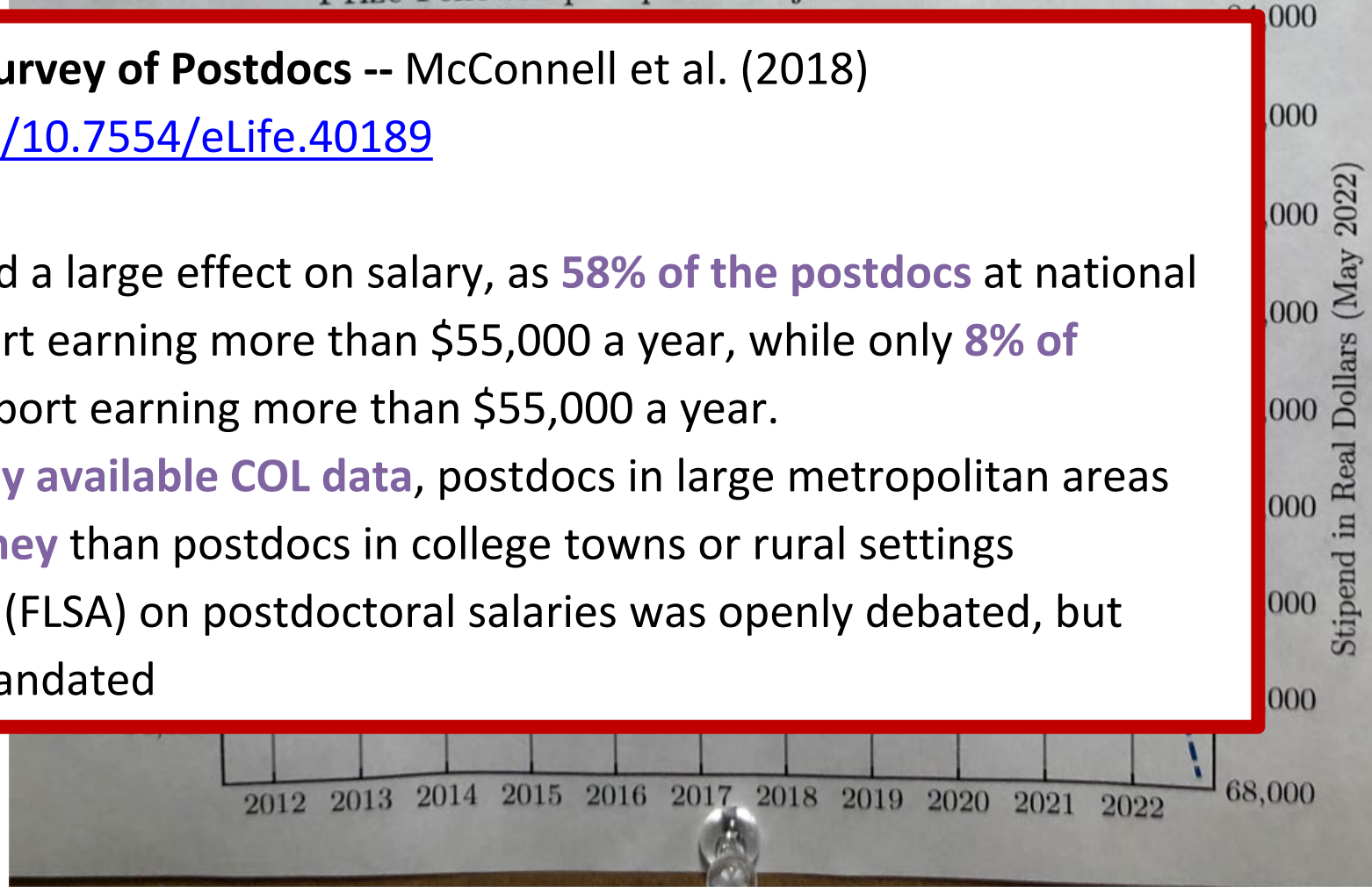


# Salaries and Cost of Living

Astro Prize Fellowship Stipends



Prize Fellowship Stipends Adjusted for Inflation



## Results from the US National Survey of Postdocs -- McConnell et al. (2018)

<https://doi.org/10.7554/eLife.40189>

Carnegie classification also had a large effect on salary, as **58% of the postdocs** at national government laboratories report earning more than \$55,000 a year, while only **8% of postdocs at R1 institutions** report earning more than \$55,000 a year.

- when adjusted to **publicly available COL data**, postdocs in large metropolitan areas earn **significantly less money** than postdocs in college towns or rural settings
- Fair Labor Standards Act (FLSA) on postdoctoral salaries was openly debated, but ultimately not federally mandated



# Salaries Impact Who Can Be a Scientist

Article | [Open Access](#) | [Published: 29 August 2022](#)

## Socioeconomic roots of academic faculty

[Allison C. Morgan](#) , [Nicholas LaBerge](#), [Daniel B. Larremore](#), [Mirta Galesic](#), [Jennie E. Brand](#) & [Aaron](#)

[Clauset](#) 

[Nature Human Behaviour](#) (2022) | [Cite this article](#)

27k Accesses | 3 Citations | 628 Altmetric | [Metrics](#)

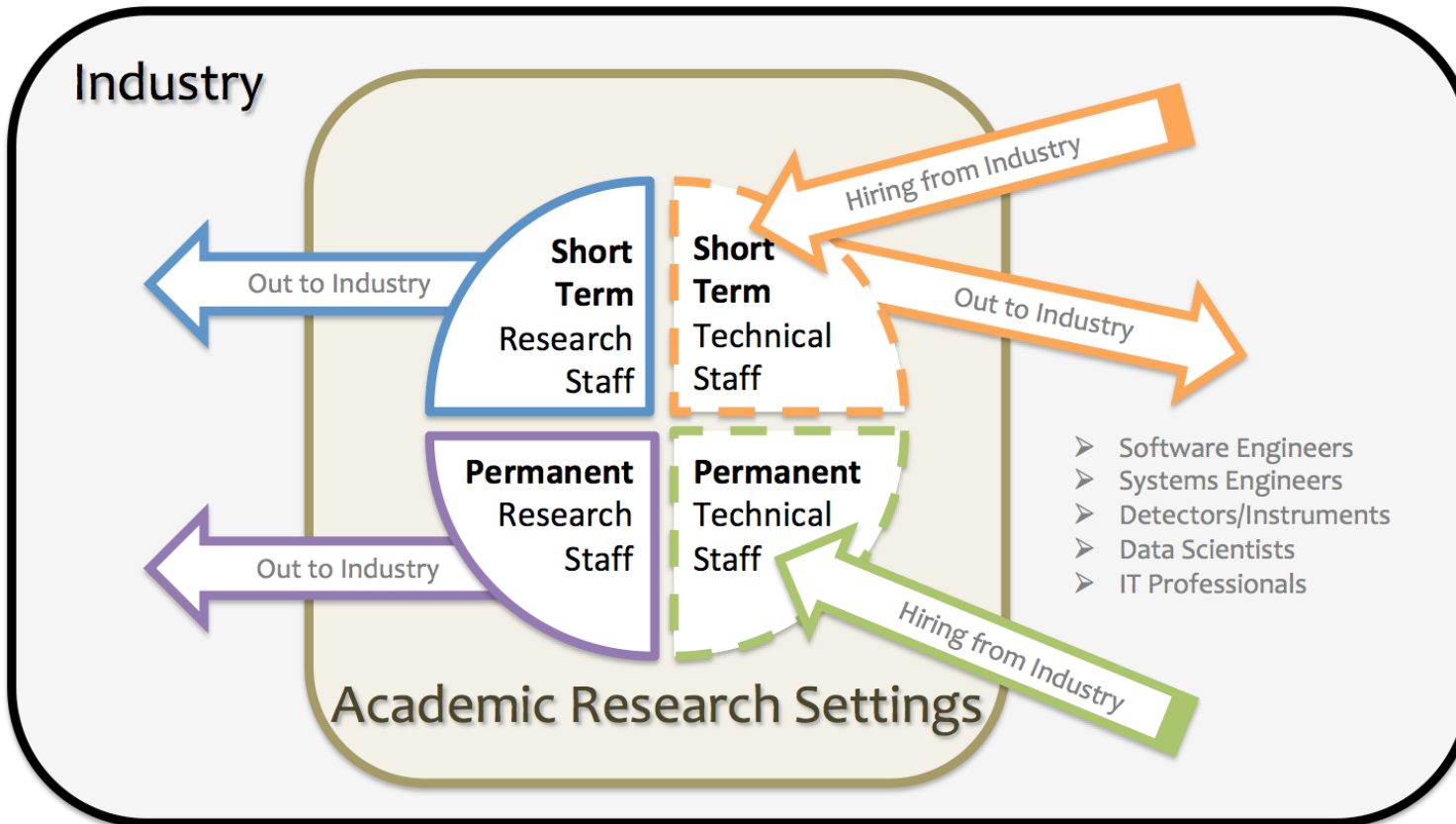
### From the article:

... we show that **faculty are up to 25 times more likely to have a parent with a Ph.D.**

Moreover, **this rate nearly doubles at prestigious universities** and is stable across the past 50 years. Our results suggest that the professoriate is, and has remained, **accessible disproportionately to the socioeconomically privileged**, which is likely to **deeply shape their scholarship and their reproduction.**

# Research Recruitment and Attrition

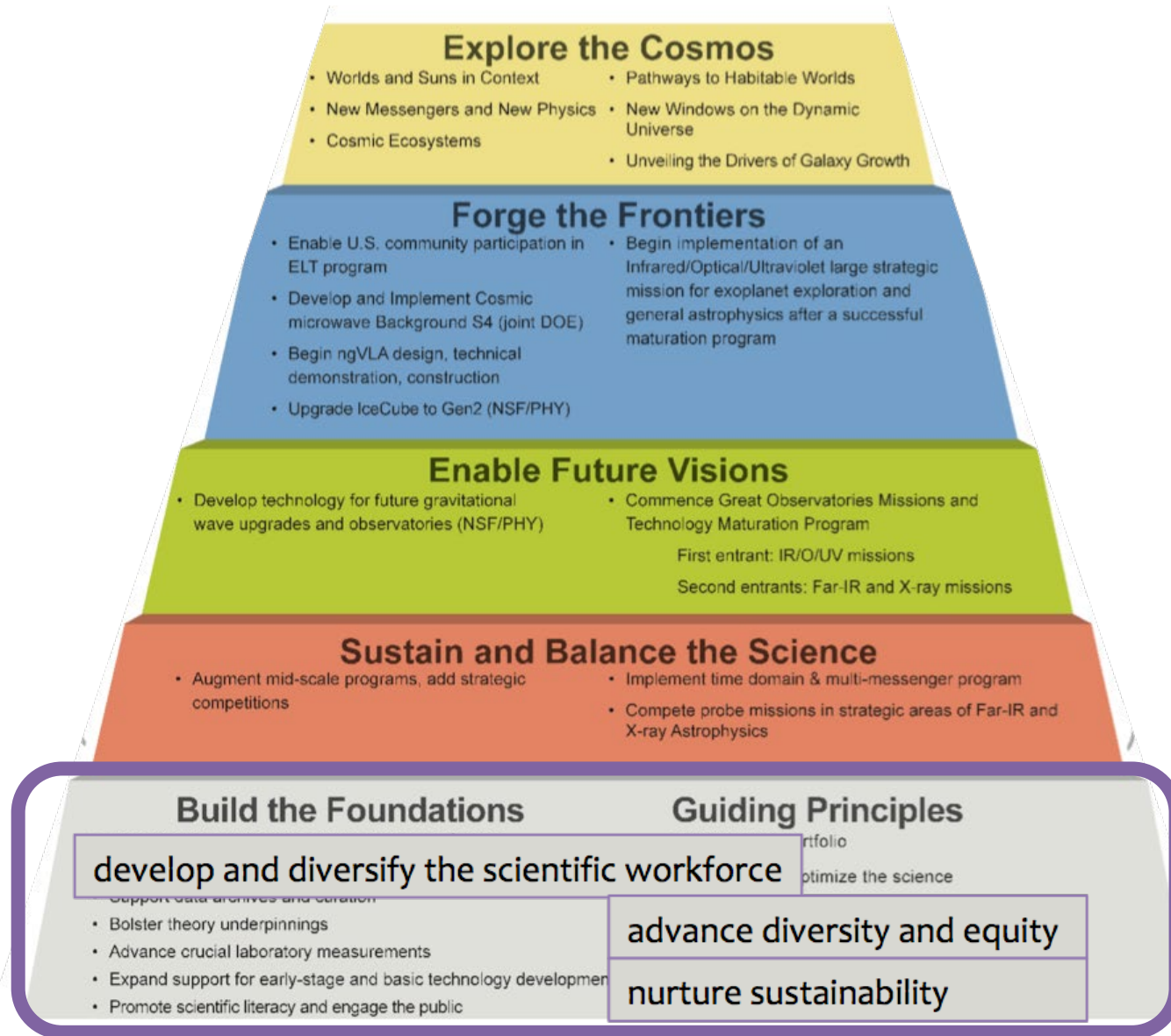
## COPAG Salary Study Summary:



- Little differentiation between Industry and Academic Research preparation and overall skillset usage in 10-year retrospective study
- Differences between how expertise and experience are compensated between Industry and Academia
- Academic salaries have not kept up with general Cost-of-Living and many are not scaled to regional Cost-of-Living differences
- Large biases in professoriate in terms of socio-economic background (correlated with other demographic axes as well).
- Data limited to research-focused jobs and Physics Degree holders. Needs expansion to cover key technical careers.

# Urgency of Going Beyond this Analysis

- Funding agencies are important for setting priorities in the scientific community
- Critical Path Employees
  - ◆ highly trained people leave because of structural problems
  - ◆ struggle to recruit highly trained people
  - ◆ existing plans/contracts may not have flexibility to retrain or to retire this risk
- Major impact on who can proceed in the Astronomy workforce
- We have only looked at one factor that could be impacting recruitment and attrition and only within Physics Ph.D. holders.



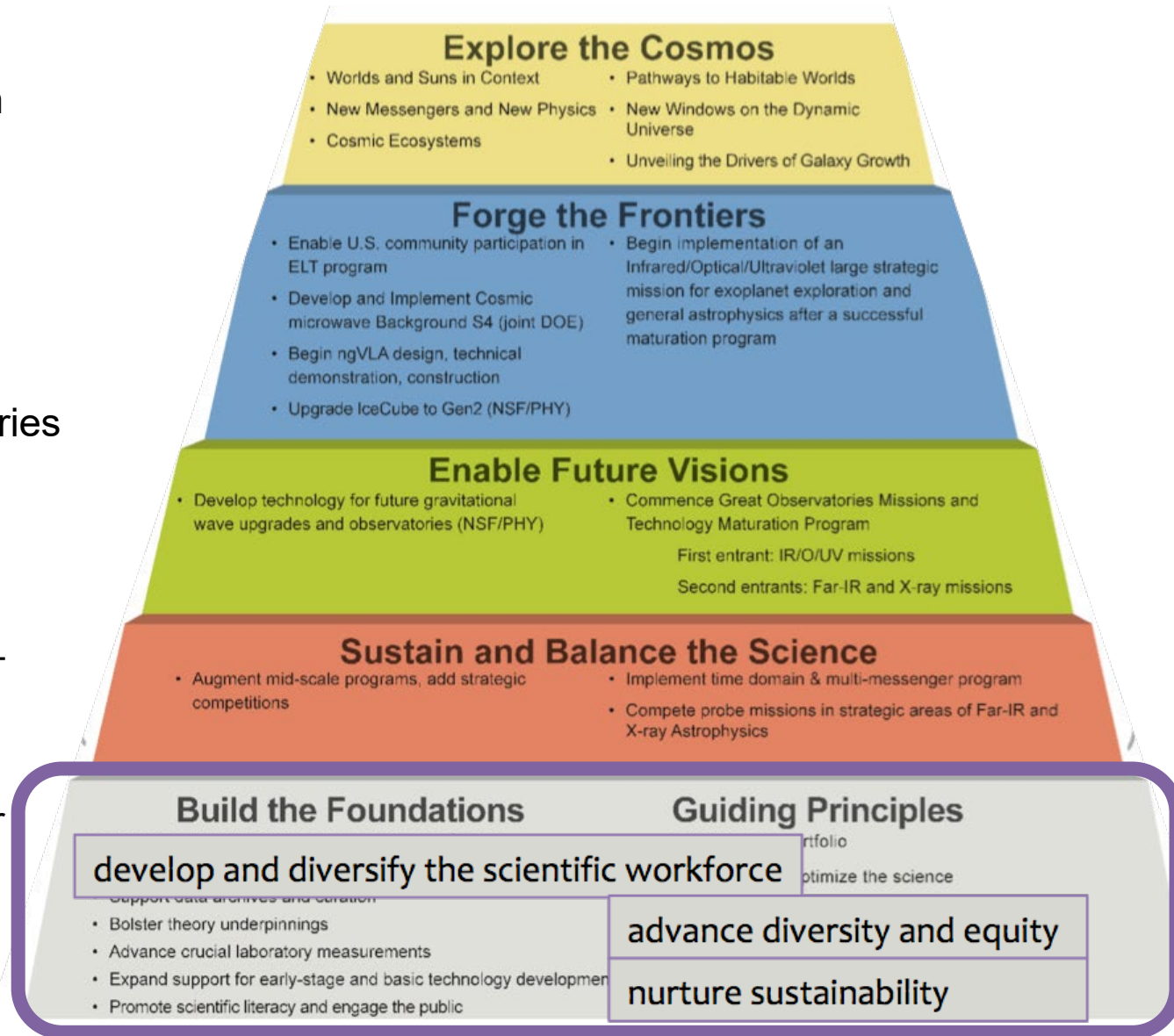
# What CAN We Do?

## → LONG TERM:

- Salaries from the bottom to more or less the top in log-N space, to go up to something meaningfully consistent with non-academic paths.
  - Incentivize institutions to raise the bar in their internal pay structures
    - ex. Athena Swan in UK
  - Funders have to enforce certifications of salaries

## → SHORT TERM:

- Allow regional adjustments to salaries that have a pre-set cost
- Require justifications for salary choices in grants – make people start thinking about it.
- Incentivize institutions to:
  - Upgrades Payroll systems to permit Hybrid or Remote work
  - Require a Cost of Living Adjustment that matches real Cost of Living Data



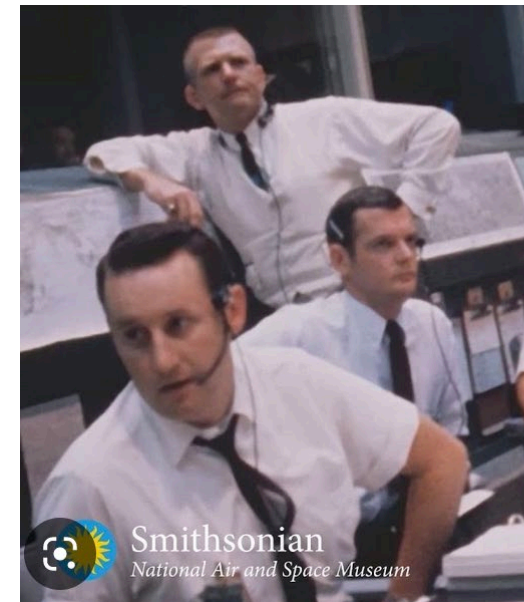


## To End:

If we can launch spacecraft of heretofore unimaginable complexity into space ...

and then use them to reveal the mysteries of the Universe 95% of which is does not produce light received by those telescopes...

we can solve this problem too.



### **Failure is Not An Option**

Gene Kranz and Mercury, Gemini,  
and Apollo Mission Control

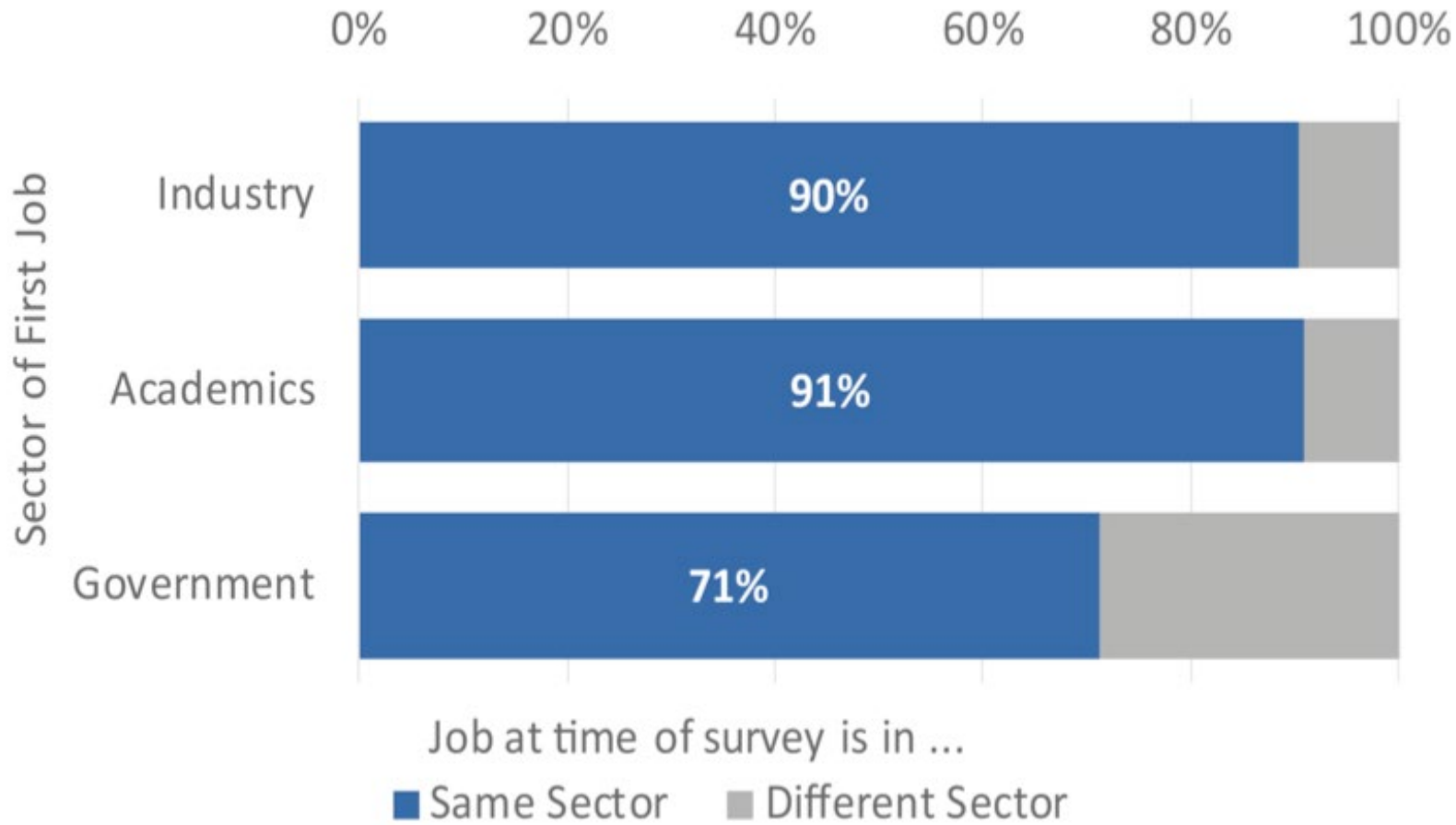


Smithsonian  
National Air and Space Museum





# Fluidity Between Industry & Academia



The categories on the y-axis are the sector of the first permanent job after earning a physics PhD and completing any Postdocs.

After the Postdoc Phase, people stay where they were hired. Slightly more movement in Government.



# Articles Just in Nature, Mostly 2021-2022:

CAREER FEATURE | 24 October 2018

## Satisfaction in science

*Nature's* survey offers a snapshot of salaries and career paths in t

Article | [Open Access](#) | [Published: 21 September 2022](#)

## Quantifying hierarchy and dynamics in US faculty hiring and retention

K. Hunter Wapman , Sam Zhang, Aaron Clauset & Daniel B. Larremore 

EDITORIAL | 01 December 2021

## Industry scores higher than academia for job satisfaction

*Nature's* salary survey finds that industry researchers are more positive about t careers. Academia must raise its game.

2022) | [Cite this article](#)

NEWS AND VIEWS | 29 September 2022

## Narrow hiring practices at US universities revealed

An analysis of faculty members employed at academic institutions in the United States reveals that most employees were trained at just a few universities. The finding provides insights into how hiring perpetuates inequalities.

CAREER FEATURE | 16 November 2021

## Stagnating salaries present hurdles to career satisfaction

Fewer than half of respondents to *Nature's* 2021 salary and satisfaction surve positive about their prospects.

CORRESPONDENCE | 14 June 2022

## Industry versus academia – a mid-life career switch

# Socio Economic Routes of Faculty

Article | [Open Access](#) | [Published: 29 August 2022](#)

## Socioeconomic roots of academic faculty

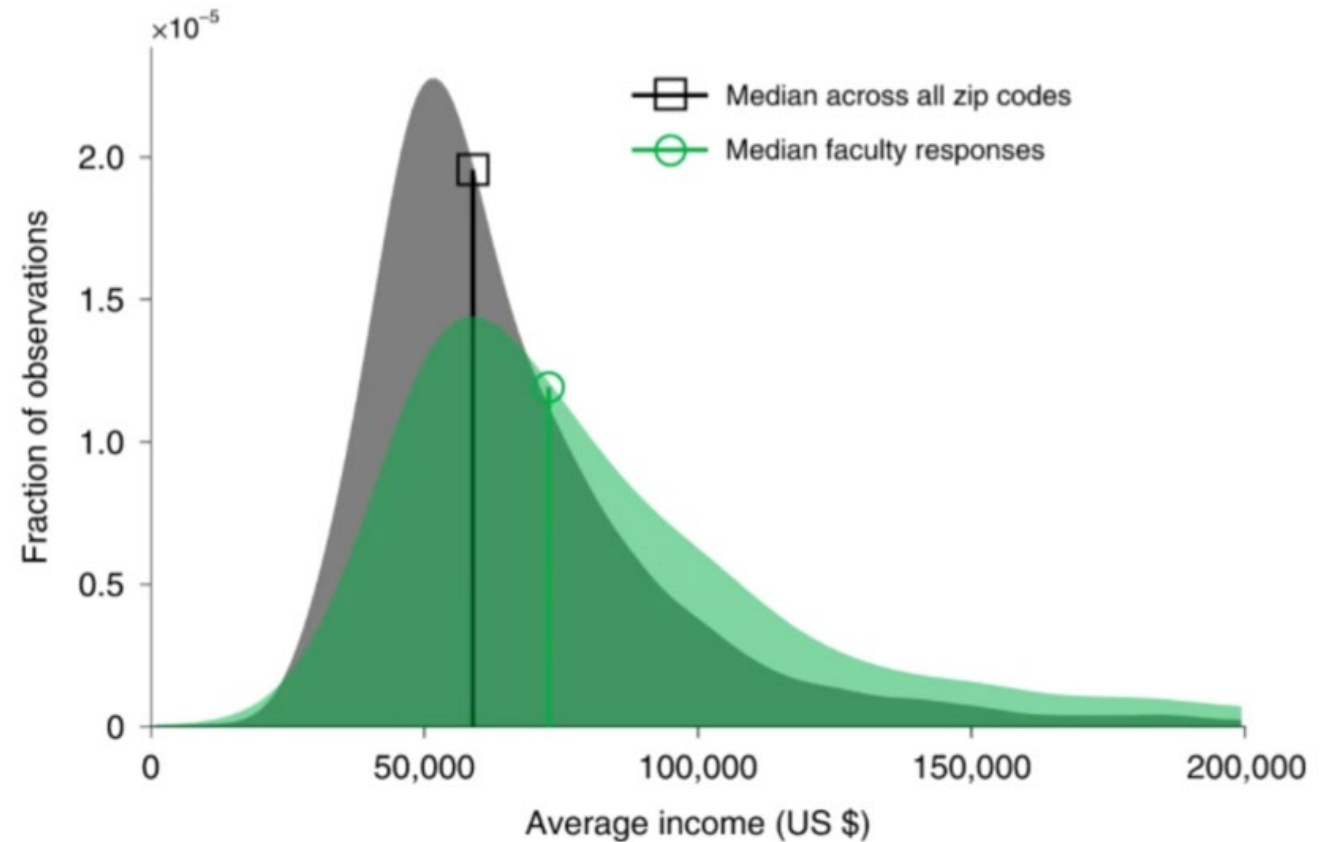
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[Nature Human Behaviour](#) (2022) | [Cite this article](#)

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Controlling for geography, the families of academic faculty are more wealthy than the distribution.

**Fig. 4: Parental income distribution.**



Average income distribution estimated using faculty members' childhood zip codes (green), compared with the income distribution across the 1998 US population (black).

# Salaries are an Inclusion Issue

## Report on the Economic Well -Being of U.S. Households in 2021 - May 2022

- This report shows **significant demographic differences** in many financial stability indicators.
- Too much to detail in this presentation, but lower income -households experience more disruption

<https://www.federalreserve.gov/publications/2022-economic-well-being-of-us-households-in-2021-executive-summary.htm>

### THE TIME IS NOW

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

#### FACTOR 4: PERSONAL SUPPORT

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

<https://www.aip.org/diversity-initiatives/team-up-task-force>

# Prestige Bias in Academic Hiring

Article | [Open Access](#) | [Published: 21 September 2022](#)

## Quantifying hierarchy and dynamics in US faculty hiring and retention

[K. Hunter Wapman](#) , [Sam Zhang](#), [Aaron Clauset](#) & [Daniel B. Larremore](#) 

[Nature](#) **610**, 120–127 (2022) | [Cite this article](#)

**79k** Accesses | **1320** Altmetric | [Metrics](#)

From the article:

Our analyses show **universal inequalities in which a small minority of universities supply a large majority of faculty** across fields, exacerbated by patterns of attrition and **reflecting steep hierarchies of prestige**.

We identify **markedly higher attrition rates** among faculty trained outside the United States or employed by their doctoral university.



# Bias in Graduate Admissions

- If where you go to graduate school predicts if you become faculty ...we, again, can find more evidence of how socio-economic, race, and gender impacts admissions.
- Faculty directly set many of these policies.

[Published: 11 June 2014](#)

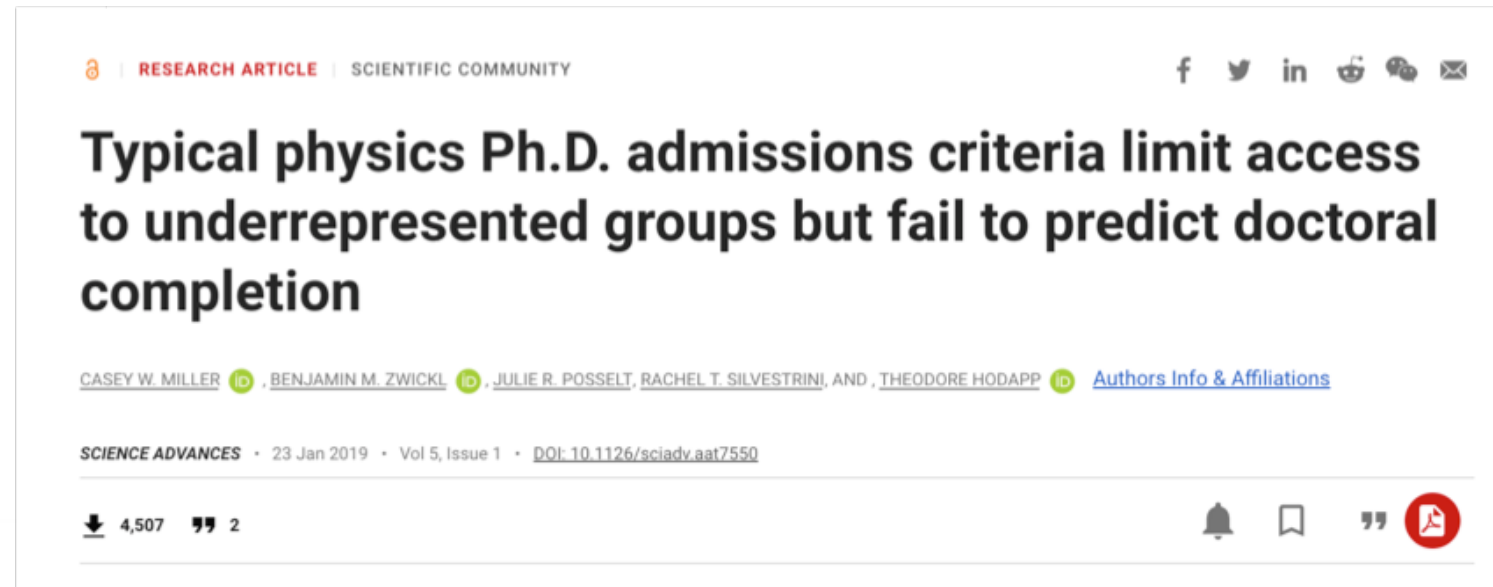
## A test that fails

[Casey Miller](#) & [Keivan Stassun](#)

[Nature](#) **510**, 303–304 (2014) | [Cite this article](#)

17k Accesses | 93 Citations | 718 Altmetric | [Metrics](#)




<https://doi.org/10.1038/nj7504-303a>



RESEARCH ARTICLE | SCIENTIFIC COMMUNITY

f t in r w e

### Typical physics Ph.D. admissions criteria limit access to underrepresented groups but fail to predict doctoral completion

CASEY W. MILLER , BENJAMIN M. ZWICKL , JULIE R. POSSELT, RACHEL T. SILVESTRINI, AND , THEODORE HODAPP  [Authors Info & Affiliations](#)

SCIENCE ADVANCES • 23 Jan 2019 • Vol 5, Issue 1 • DOI: 10.1126/sciadv.aat7550

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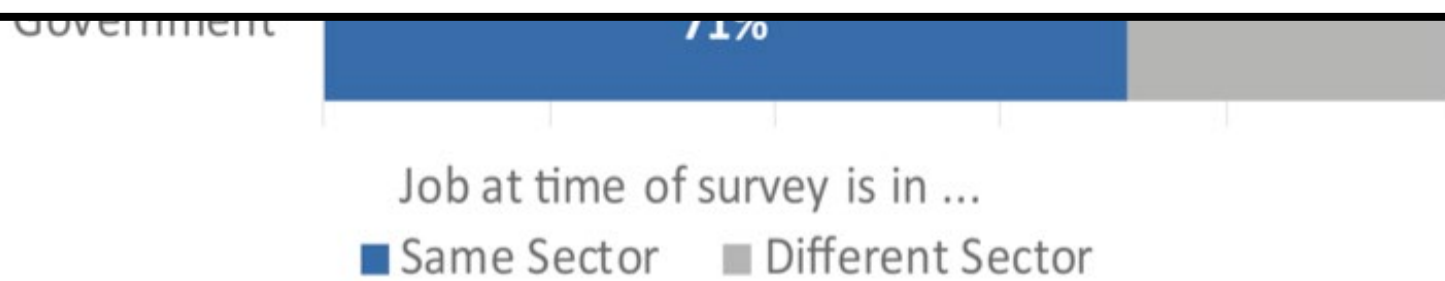
DOI: 10.1126/sciadv.aat7550

# Fluidity Between Industry & Academia

From the Article:

**The data suggest that the employment sector of the first job a physics PhD recipient takes affects his or her employment sector ten to fifteen years later.** While our data are not necessarily representative of all physics PhDs (See Survey Methodology, below.), the p-values are small enough to suggest that **the likelihood of moving across job sectors is low.** Of course, these data are taken from PhD recipients in the classes of 1996, 1997, 2000, and 2001. Graduates from later classes will not necessarily experience the same economic circumstances, and their job experiences may differ.

Sector of First Job



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# Astronomy Faculty

Estimated Total Number of Full-Time Equivalent (FTE) Faculty Members  
in Stand-Alone Astronomy Departments, 2014–2020

**4% increase**

	Year			
	2014	2016	2018	2020
Estimated Number of Full-Time Equivalent (FTE) Faculty Members	700 (38)	700 (38)	770 (39)	770 (38)
Percent Employed in Tenure or Tenure-Track Positions	76%	72%	72%	73%
Percent Employed in Temporary or Non-Tenure-Track Permanent Positions	24%	28%	28%	27%

The parentheses show the number of stand-alone departments that grant degrees in astronomy but not physics.

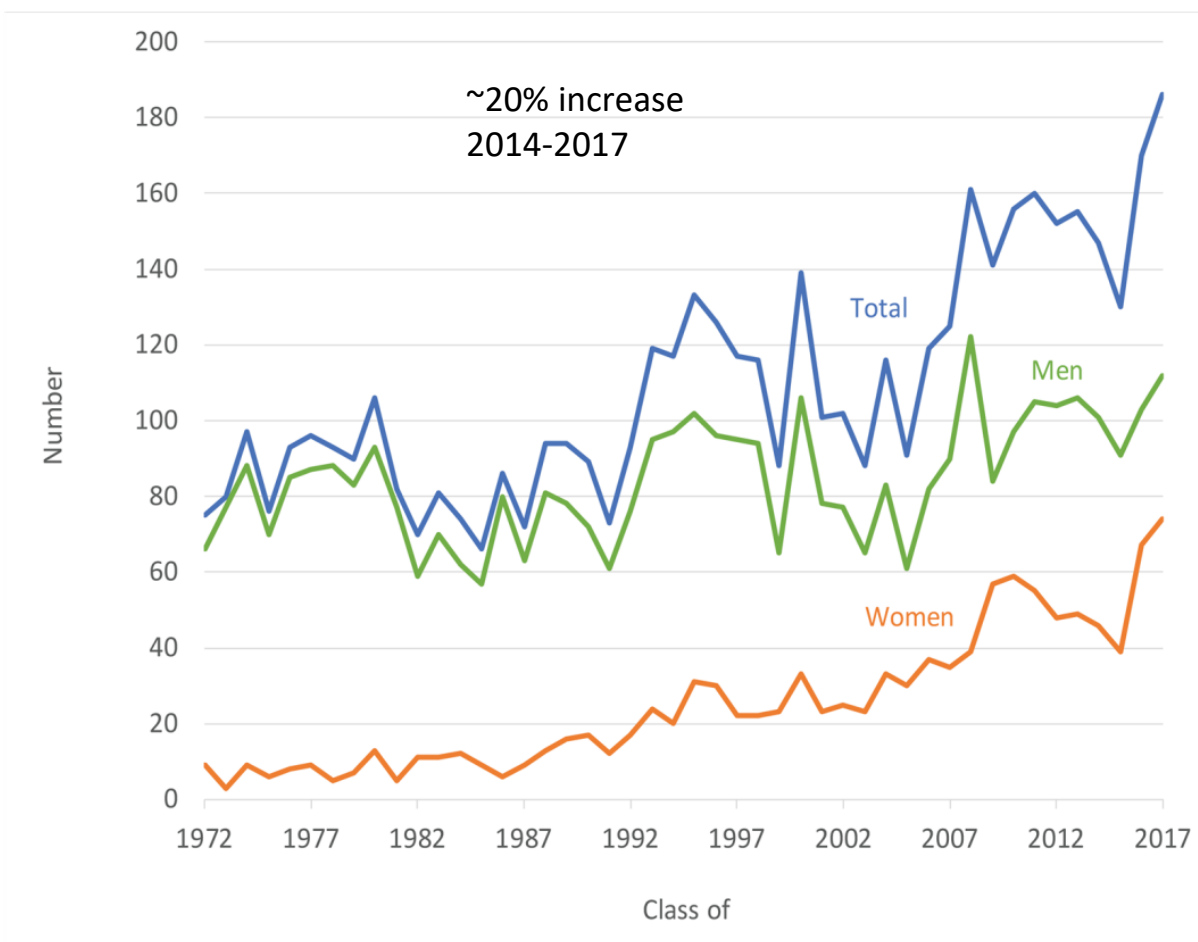
**AIP** | Statistics

[aip.org/statistics](http://aip.org/statistics)

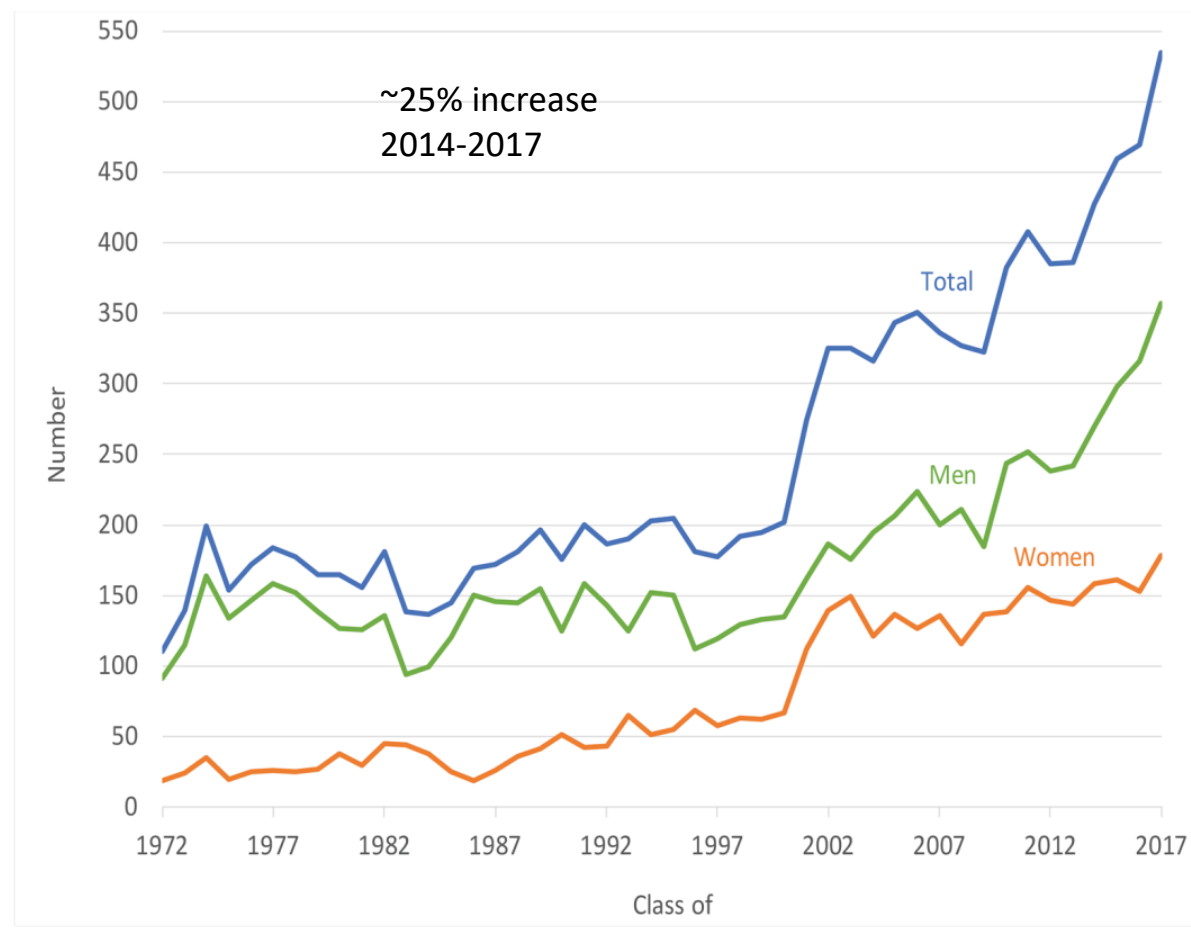
**76% of 700**  
**532**

**72% of 770**  
**554**

Number of Doctorates Earned in Astronomy.

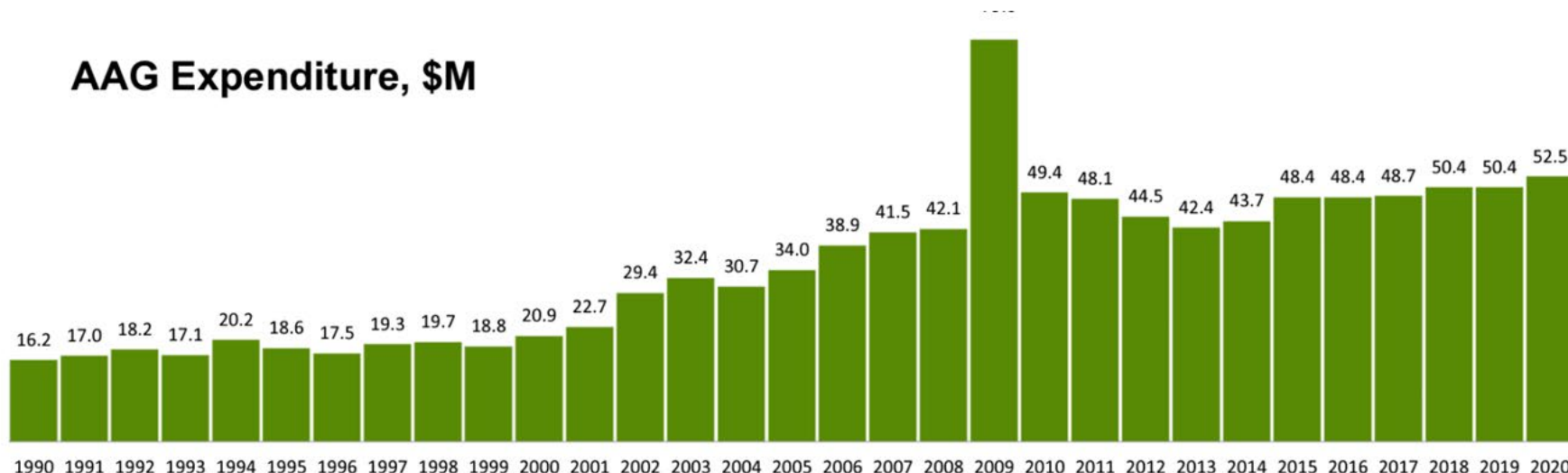


Number of Bachelor's Degrees Earned in Astronomy.



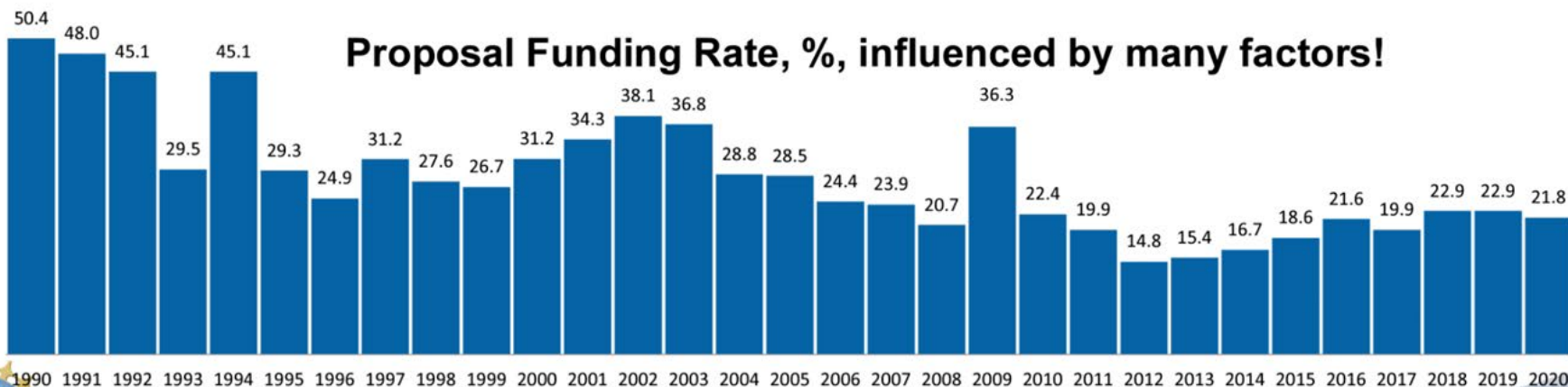
# Grant Success Rates: AAG NSF 1990 to 2020

AAG Expenditure, \$M



[https://nsf.gov/attachme nts/303934/public/5\\_NS F\\_AST\\_Program\\_Budg et\\_Update\\_Debra\\_Fisch er.pdf](https://nsf.gov/attachme nts/303934/public/5_NS F_AST_Program_Budg et_Update_Debra_Fisch er.pdf)

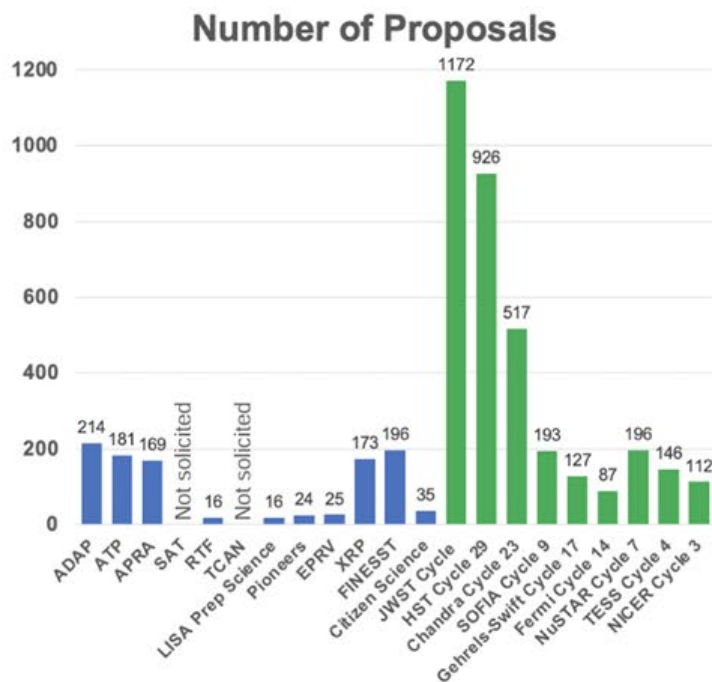
Proposal Funding Rate, %, influenced by many factors!



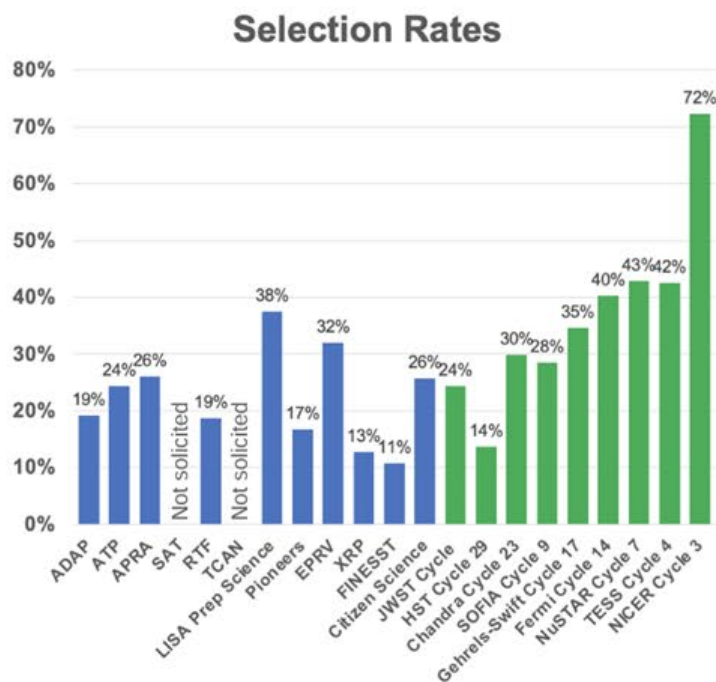


# Astrophysics R&A Proposal Status Update

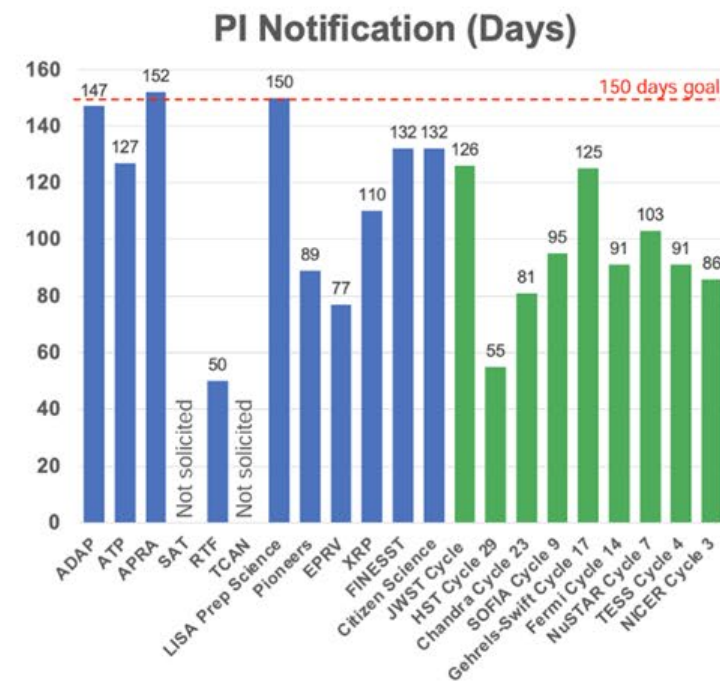
## December 2020-2021



R&A: 1,049 proposals  
 GO/GI: 3,476 proposals  
 Total: 4,525 proposals



R&A: 19%  
 GO/GI: 27%  
 Average: 25%



80% of notifications  
 R&A: 147 days  
 GO/GI: 126 days

## How can COPAG best support and inform NASA Astrophysics leadership in a **rapidly changing world and scientific landscape?**



To support NASA implementation of Astro2020

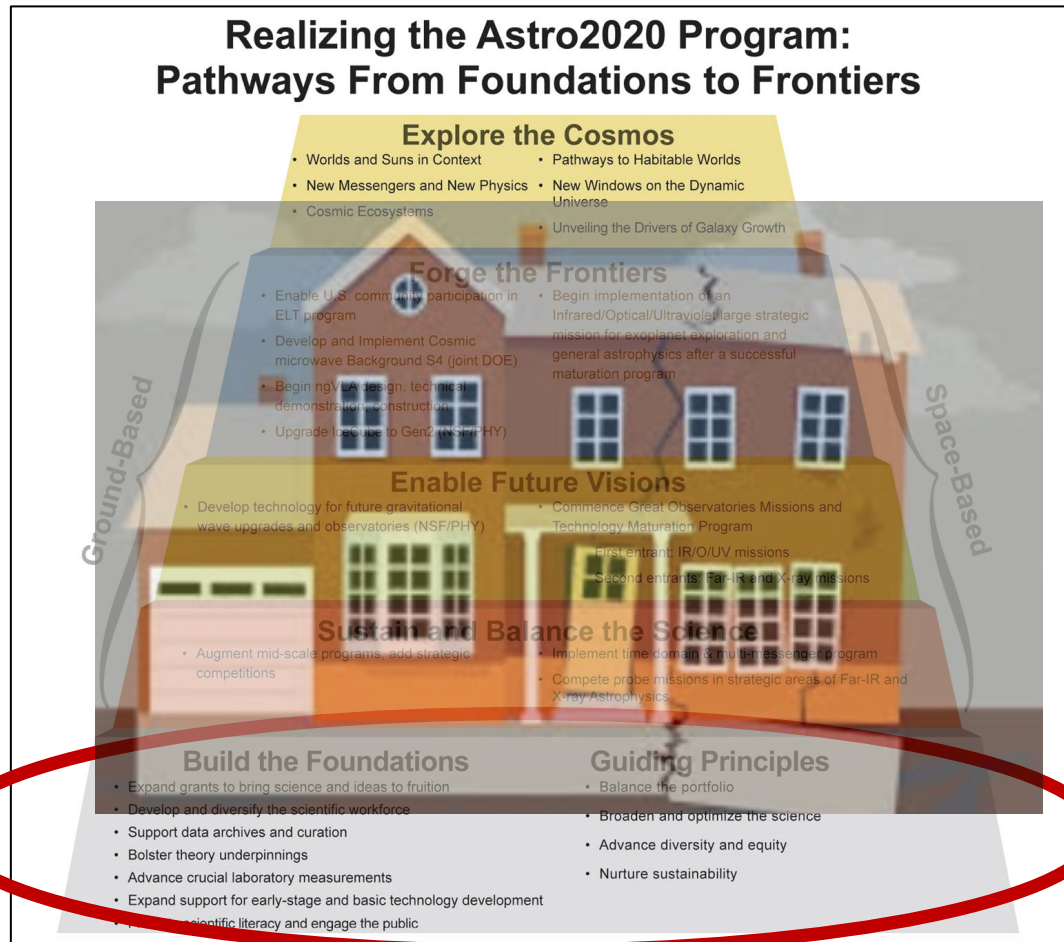
Flow inputs from SIGS/STIGS into identify "precursor science" to guide future Great Observatory architecture/trades; inform new NASA ROSES funding element;

**Precursors to Pathways: Science Enabling NASA Astrophysics Future Great Observatories**



**ensure COPAG nodes are deep, BROAD, INTEGRATED with other PAGS to enable input responsive to onslaught of new discoveries in next few years; support new cross-PAG SAGS**

## How can COPAG best support and inform NASA Astrophysics leadership in a **rapidly changing world and scientific landscape?**



Rapid changes in economics/culture/technology □ significant impacts on "Foundations" COPAG esp concerned with

- State of Profession & Workforce Issues

- Data Archives/Science

- Challenges with recruitment/retention of software engineers rising to highest levels in science center risk charts; inability to compete with tech/industry \$
- Delayed uptake in modern big data analysis techniques (machine learning/AI), gap in Astro2020
- Changes in data policies to support greater open access and sharing of higher level science products

*COPAG EC & S/TIG Leadership deliberating on community surveys and analysis to conduct and commence in ~May*



## How can COPAG best support and inform NASA Astrophysics leadership in a **rapidly changing world and scientific landscape?**

Rapid changes in economics/culture/technology  significant impacts on "Foundations" COPAG esp concerned with

### Realizing the Astro2020 Program: Pathways From Foundations to Frontiers

#### Explore the Cosmos

- Worlds and Suns in Context
- Pathways to Habitable Worlds
- New Messengers and New Physics
- New Windows on the Dynamic Cosmos

- *Retention analysis leads: Beaton & Stierwalt*
- *COPAG/NASA not allowed to perform surveys without OMB approval*
- *Will explore partnerships (e.g., with AAS) who will/may already have appropriate data for analysis with special focus on retention issues on GOMAP activities*
- *Draft ToR expected in October*

#### Build the Foundations

- Expand grants to bring science and ideas to fruition
- Develop and diversify the scientific workforce
- Support data archives and curation
- Bolster theory underpinnings
- Advance crucial laboratory measurements
- Expand support for early-stage and basic technology development
- Expand scientific literacy and engage the public

#### Guiding Principles

- Balance the portfolio
- Broaden and optimize the science
- Advance diversity and equity
- Nurture sustainability

f software  
ence center  
h/industry \$  
alysis  
n Astro2020  
ater open

access and sharing of higher level science products

*COPAG EC & S/TIG Leadership deliberating on community surveys and analysis to conduct and commence in ~May*