

# Diversity and Equity in the Multimessenger Era

Ellen Bechtol

University of Wisconsin–Madison, WIPAC

# About Me

- Education & Outreach for Wisconsin IceCube Particle Astrophysics Center and IceCube Collaboration.
- Community Manager for Multimessenger Diversity Network
- Equity, Diversity, and Inclusion working group convener for IceCube
- Work at UW-Madison, in the USA.

# Definitions

- Diversity – all the ways that people are different and the same at the individual and group levels. Even when people appear the same, they are different.
- Equity – the fair and just treatment of all members of a community.
- Inclusion – the intentional, ongoing effort to ensure that diverse individuals fully participate in all aspects of organizational work. It also refers to the ways that diverse participants are valued and respected members of an organization or community.
- Accessibility – giving equitable access to everyone along the continuum of human ability and experience.

[Adapted from the American Alliance of Museums](#)

# Why do we need diversity in multimessenger astronomy?



# Why do we need diversity in multimessenger astronomy?

*A moral imperative* AND better science

*While it is true that the physics community as a whole loses when it routinely bars certain demographics from entering and contributing, what matters here is that **black women deserve a seat at the table for no reason other than they have an interest they want to pursue.** BIPOC people deserve to be welcomed to and respected in the physics space, and any space they may choose to inhabit.*

From "Policing and Gatekeeping in STEM: Safety, Security & Sanctity" by A.K. Hodari, S.B. Krammes, C. Prescod-Weinstein, B.D. Nord, J.N. Esquivel, and K.A. Assamagan. [arXiv:2203.11508](https://arxiv.org/abs/2203.11508)

# Who Has Access to Multimessenger Astronomy?

- Multimessenger Astronomy is an incredibly exciting field!
- Advances require increasingly large and sophisticated instrument/facilities.
- It takes many people and a lot of resources to make these big projects work.
- Many people are now part of a large collaboration, or more than one.




# International Diversity

Multimessenger collaborations rely on international participation, but *who is missing?*

# THE ICECUBE COLLABORATION

 **AUSTRALIA**  
University of Adelaide

 **BELGIUM**  
UCLouvain  
Université libre de Bruxelles  
Universiteit Gent  
Vrije Universiteit Brussel


 **CANADA**  
SNOLAB  
University of Alberta–Edmonton

 **DENMARK**  
University of Copenhagen


 **GERMANY**  
Deutsches Elektronen-Synchrotron  
ECAP, Universität Erlangen-Nürnberg  
Humboldt-Universität zu Berlin  
Karlsruhe Institute of Technology  
Ruhr-Universität Bochum  
RWTH Aachen University  
Technische Universität Dortmund  
Technische Universität München  
Universität Mainz  
Universität Wuppertal  
Westfälische Wilhelms-Universität  
Münster

 **ITALY**  
University of Padova


 **JAPAN**  
Chiba University

 **NEW ZEALAND**  
University of Canterbury

 **SOUTH KOREA**  
Sungkyunkwan University

 **SWEDEN**  
Stockholms universitet  
Uppsala universitet

 **SWITZERLAND**  
Université de Genève

 **TAIWAN**  
Academia Sinica

 **UNITED KINGDOM**  
University of Oxford

 **UNITED STATES**  
Clark Atlanta University  
Columbia University  
Drexel University  
Georgia Institute of Technology  
Harvard University  
Lawrence Berkeley National Lab  
Loyola University Chicago  
Marquette University  
Massachusetts Institute of Technology  
Mercer University

Michigan State University  
Ohio State University  
Pennsylvania State University  
South Dakota School of Mines  
and Technology  
Southern University  
and A&M College  
Stony Brook University  
University of Alabama  
University of Alaska Anchorage  
University of California, Berkeley  
University of California, Irvine  
University of Delaware  
University of Kansas

University of Maryland  
University of Nevada, Las Vegas  
University of Rochester  
University of Texas at Arlington  
University of Utah  
University of Wisconsin–Madison  
University of Wisconsin–River Falls  
Yale University

## FUNDING AGENCIES

Fonds de la Recherche Scientifique (FRS-FNRS)  
Fonds Wetenschappelijk Onderzoek-Vlaanderen  
(FWO-Vlaanderen)

Federal Ministry of Education and Research (BMBF)  
German Research Foundation (DFG)  
Deutsches Elektronen-Synchrotron (DESY)

Japan Society for the Promotion of Science (JSPS)  
Knut and Alice Wallenberg Foundation  
Swedish Polar Research Secretariat

The Swedish Research Council (VR)  
University of Wisconsin Alumni Research Foundation (WARF)  
US National Science Foundation (NSF)



icecube.wisc.edu



# International Diversity

Scientists often come from richer countries where there is greater access to opportunities for studying physics/astronomy, mentoring, and access to funding.

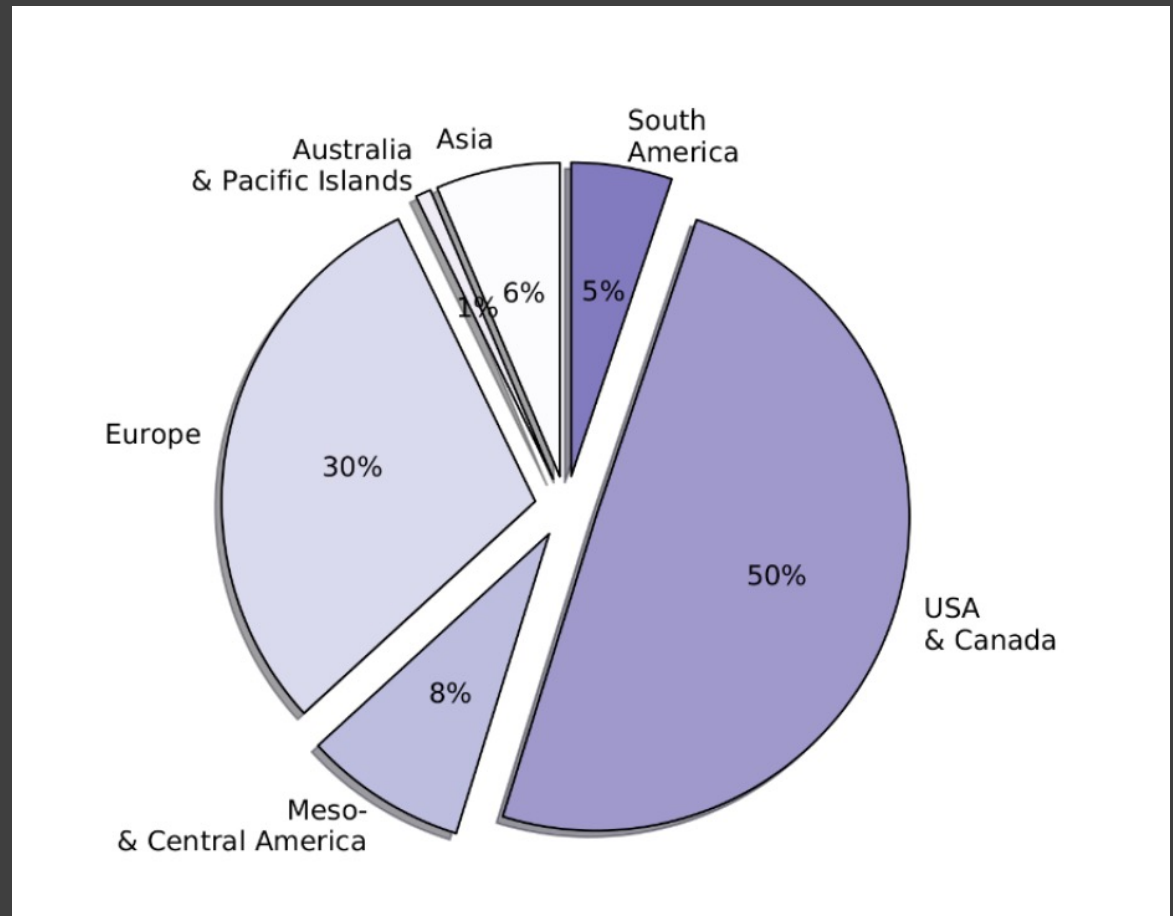


# International Diversity

Respondents to the Sloan Digital Sky Survey (SDSS)-IV demographic survey in 2015 were mostly from USA & Canada, or Europe.

[arXiv: 1505.06199](https://arxiv.org/abs/1505.06199)

SDSS-IV Survey Respondents by Geographic Area



# International Diversity

*What perspectives and ideas are missing* from our work because of the disparities?



# National/Regional Diversity

## Bias is everywhere

- Groups and individuals impacted can be different depending on location.
- In society at large, people are marginalized based on gender identity and sexual orientation; race and ethnicity; disability (both visible and invisible); socioeconomic status; immigration status; veteran status; status as a first-generation college student. [arXiv:2206.01849v2](#)

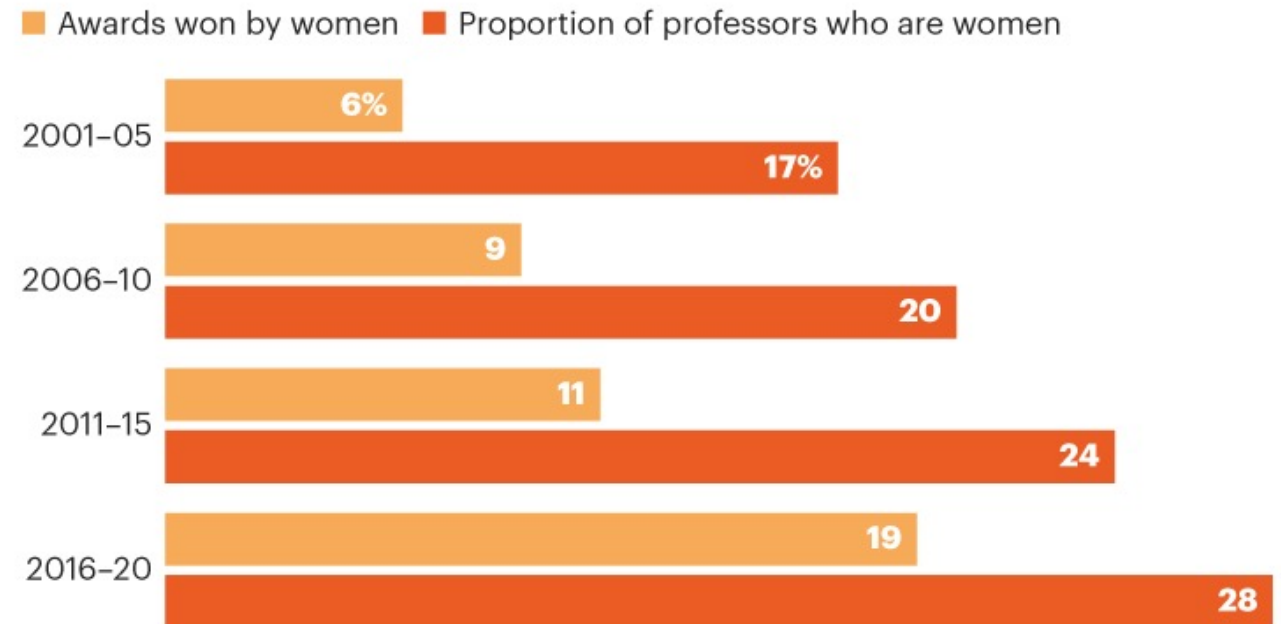
# Gender Bias

- Wide-spread bias favoring men.
- Time allocation for the Hubble Space Telescope disproportionately awarded to Male PIs for over a decade.
- Women are less likely to win prestigious science research awards, despite gains in number of professorships.

[Nature article](#)

## CLOSING THE GAP

Although the proportion of professors who are women has increased in recent decades, the percentage of top research prizes going to women still lags behind.



©nature

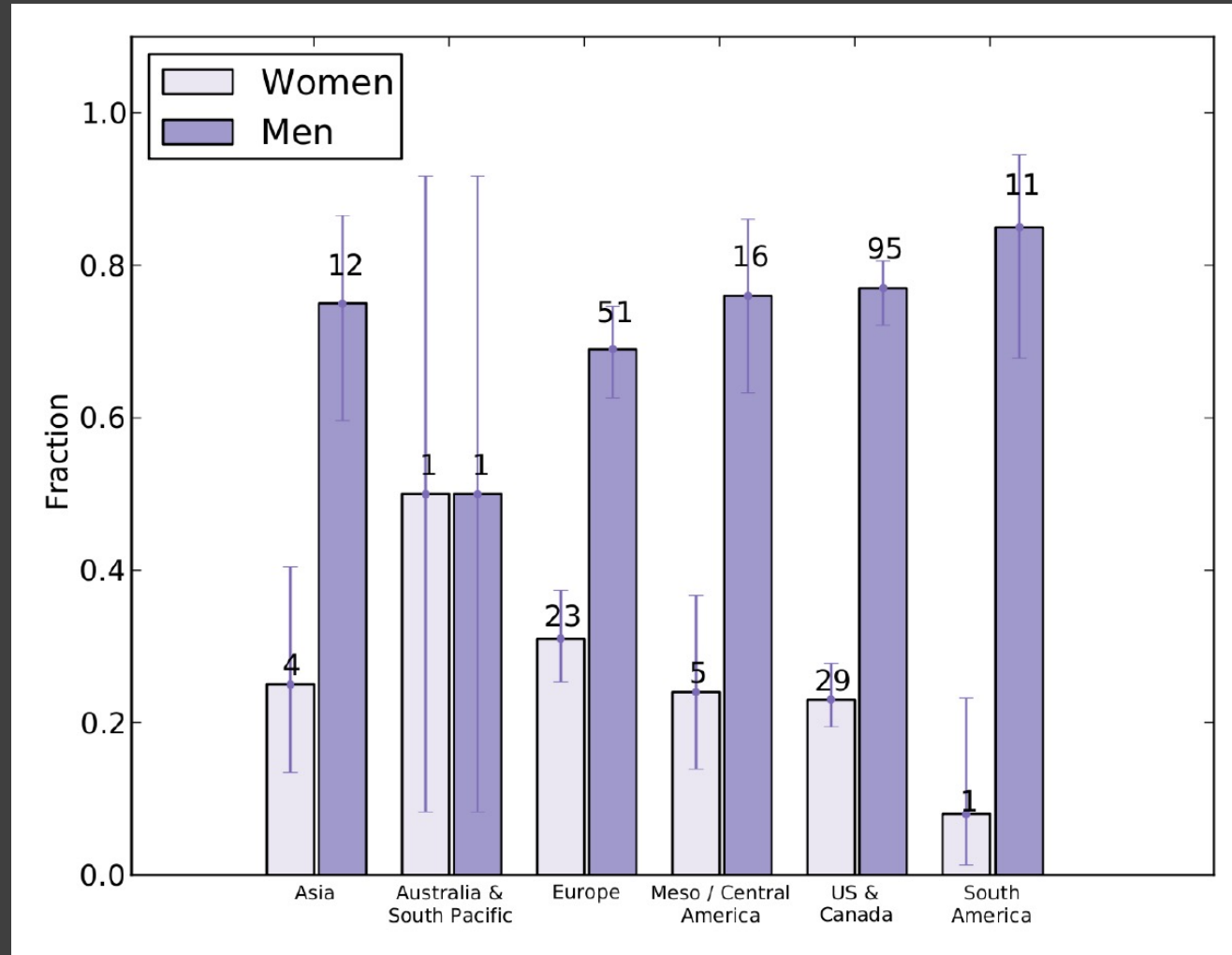
# Gender Diversity

The gender distribution of SDSS-IV survey respondents by geographic region.

With one exception, there are more men than women respondents in all regions.

[arXiv: 1505.06199](https://arxiv.org/abs/1505.06199)

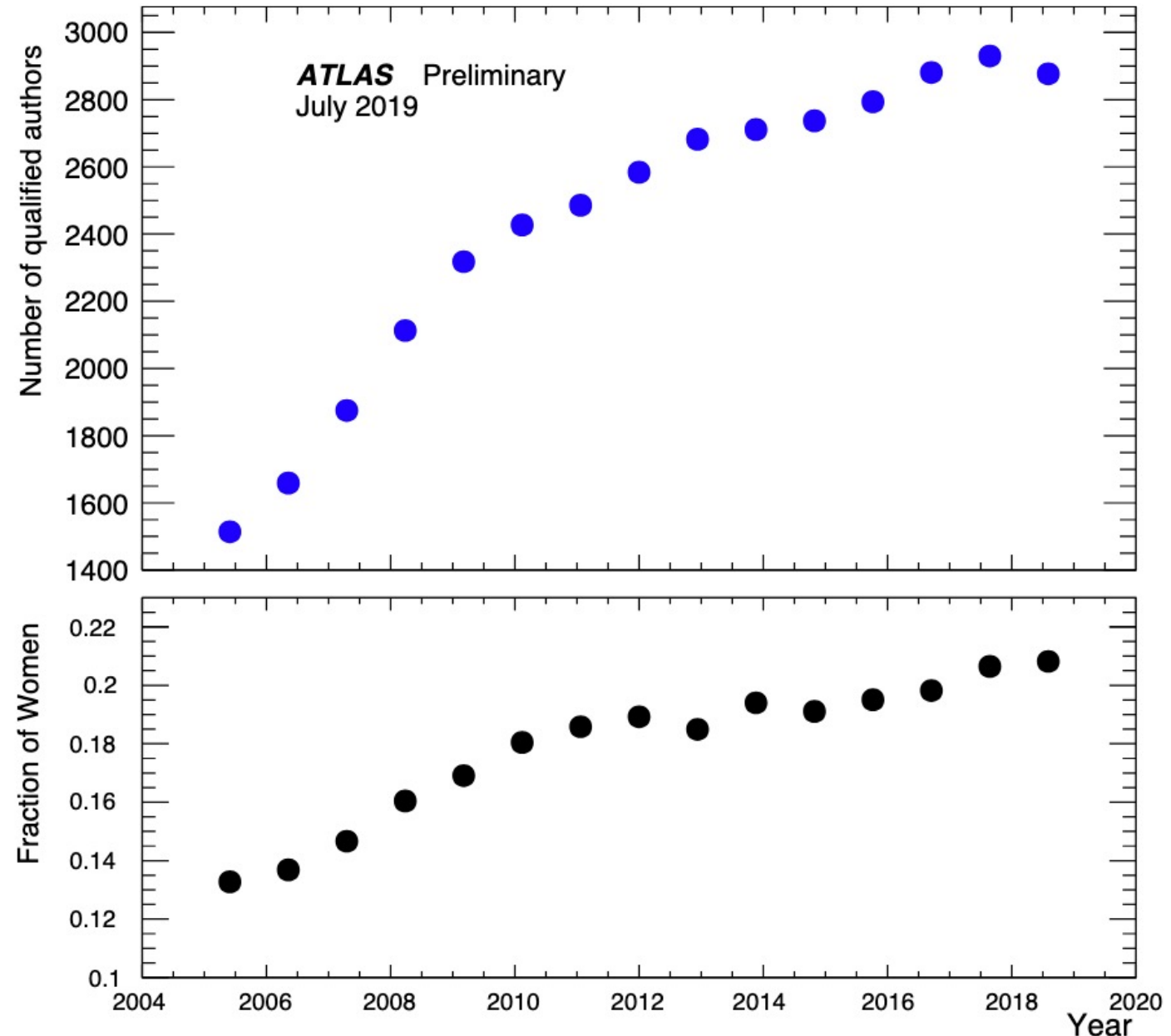
SDSS-IV Gender Distribution as Fraction of Geographic Region



# Gender Diversity

The fraction of women in the ATLAS collaboration at CERN, from 2005-2019. In 2019, 21% of ATLAS members were women with 17% of women being 35 years or older.

<https://cds.cern.ch/record/2689492/files/ATL-OREACH-PROC-2019-005.pdf>



# USA: Physics PhDs

American Institute of Physics (AIP) has tracked and documented who earns physics and astronomy degrees for years.

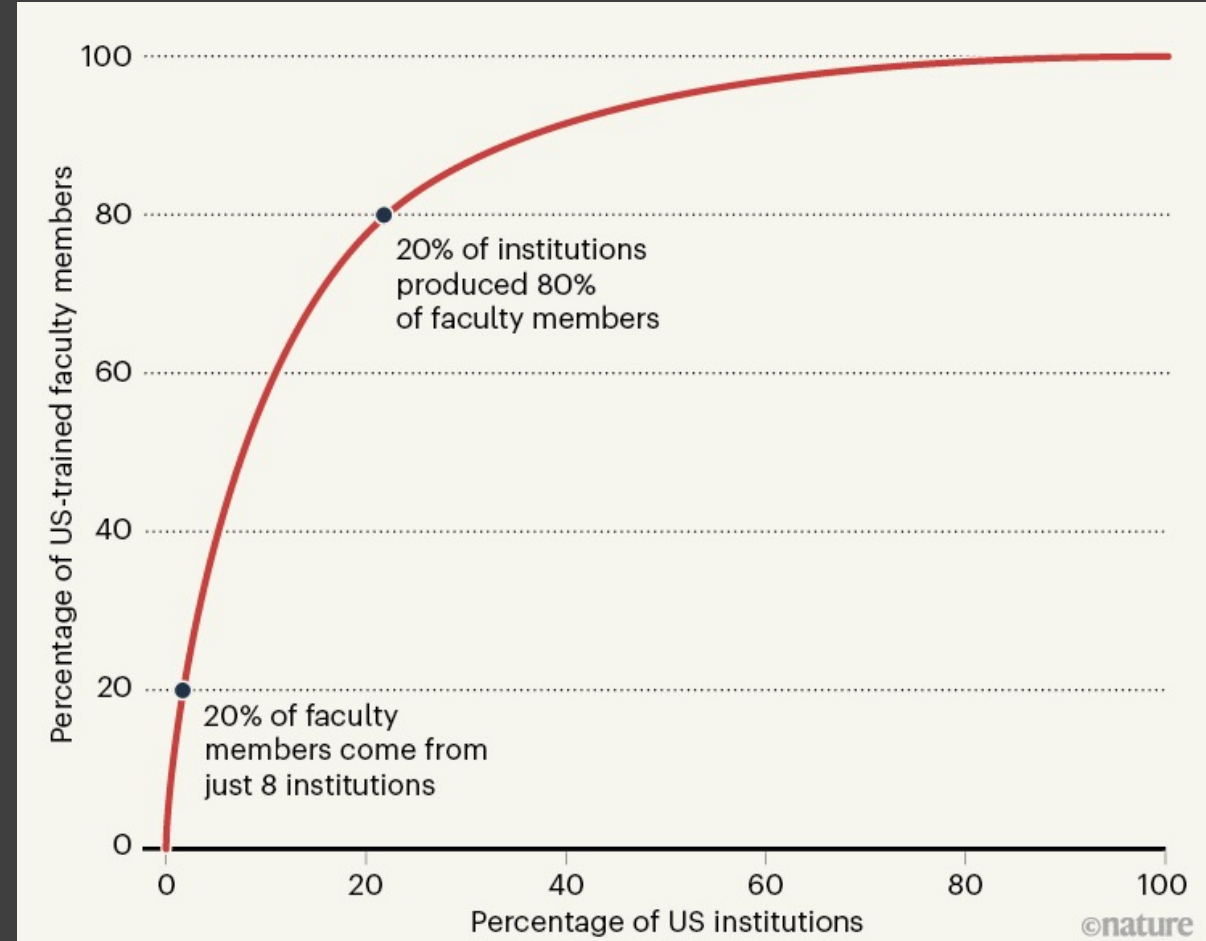
- The percentage of women earning a Physics PhD in 2019 was 19%, a percentage that has held flat for about a decade. [AIP](#)
- The *number* of Physics PhDs earned in 2019 by American Indian or Native American, Black or African American, and Native Hawaiian or Other Pacific Islander men or women was in the single digits for each of these groups. [AIP](#)

# USA: Institutional Hiring Practices

- University hiring practices perpetuate academic inequities.
- 20% of faculty members were granted their PhD from just 8 institutions (almost 14% of those from 5 institutions).
- The study included over 295,000 faculty members in over 10,000 departments at 368 institutions.

[Nature article](#)

A few universities produce the most faculty members



# USA: Sexual Orientation

NEWS | 05 July 2022

## **Revealed: the pay bump for being a straight, white man in US science**

“Straight, white men without disabilities received at least an extra US\$32,000 each year compared with queer people of colour who had the same level of experience, tenure, hours worked, family responsibilities, education and other factors, Cech found.”

<https://www.nature.com/articles/d41586-022-01851-4>

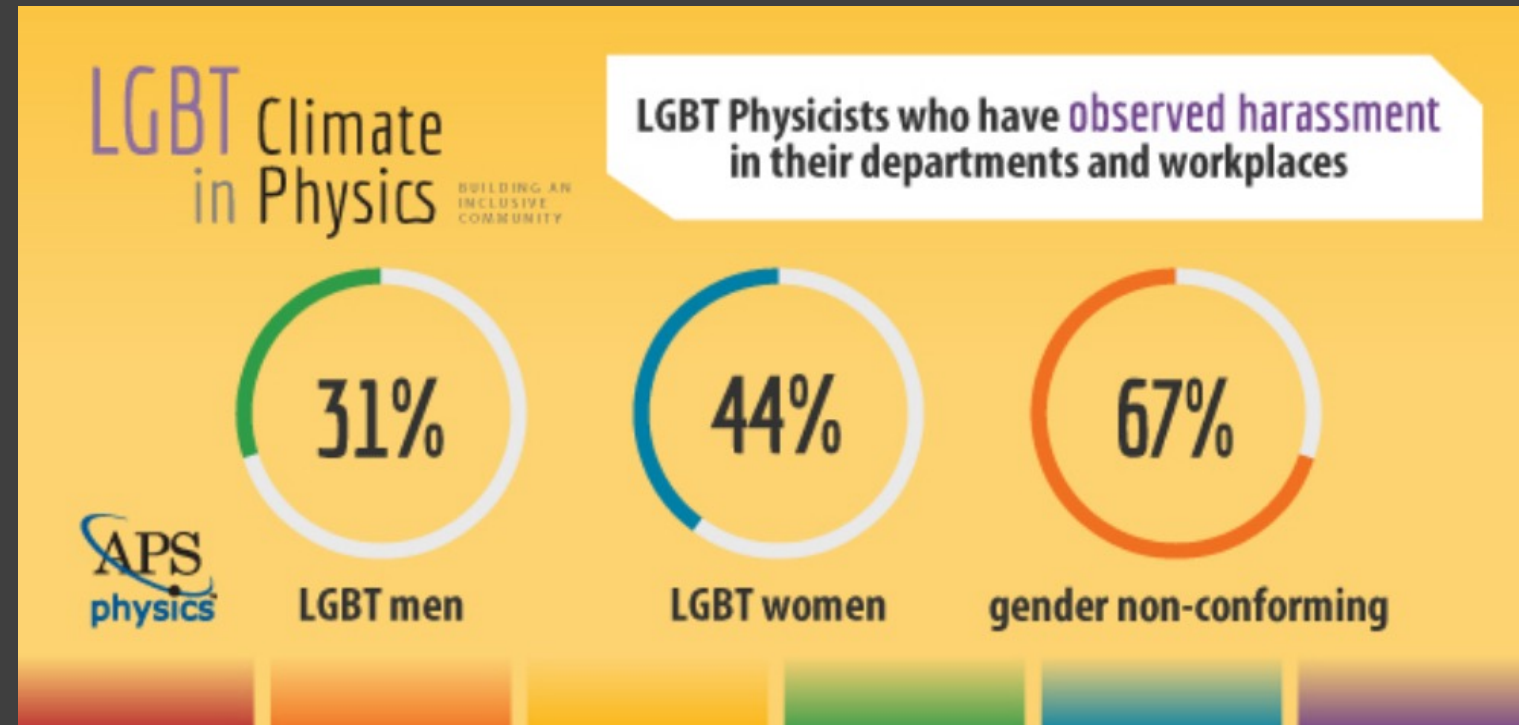


# USA: Sexual Orientation

In a 2015 study of LGBTQ physicists sponsored by the American Physical Society, over 20% of respondents reported experiencing exclusionary behavior in the last year due to their gender identity or sexual orientation. Over 40% reported observing such behavior due to sexual orientation or identity.

LGBT Climate in Physics: Building an Inclusive Community

Press Conference Slides





# Why do we need diversity in multimessenger astronomy?

*A moral imperative* AND better science

# Science of Team Science

- Diverse and inclusive working environments = more effective work teams
- Diversity of discipline, diversity of individuals
- Large teams experience decreased productivity as the group becomes more homogenous.

National Academies Press

“Scientific excellence is achieved by people, and people are at their best when they are treated well. The only way to ensure our scientific community reaches its full potential is to ensure that *every single one* of its members has equal access to resources, education, and career opportunities.”

From “Building a Culture of Equitable Access and Success for Marginalized Members in Today’s Particle Physics Community.” by K.A. Assamagan, O.M Bitter, M-C Chen, A. Choi, J. Esquivel, K. Jespen, T.R. Lewis, A Muronga, F. Psihas, L. Walkowicz, and Y. Zhang. [arXiv: 2206.01849v2](https://arxiv.org/abs/2206.01849v2)

# Efforts to Improve Equity and Diversity in Multimessenger Astronomy

(A non-exhaustive sample)


# Planning Processes in the USA

- Astro2020 Decadal Survey (astronomy community)
  - “State of the Profession and Societal Impacts” included as an official panel for the first time
  - <https://www.nationalacademies.org/our-work/astro2020-panel-on--stateof-the-profession-and-societal-impacts>
- Snowmass Planning Process (physics community)
  - “Community Engagement Frontier” included as an official section for the first time.
  - <https://snowmass21.org/community/start>

# Physics Without Frontiers

- Works to inspire and train physics and math students worldwide.
  - Posters in South African high schools
  - Focus on role models and visibility
  - In partnership with Working with Sahal Yacoob, Organisation of Women in Physics in South Africa, University of Cape Town, and the ICTP.

[Physics Without Frontiers website](http://www.womenphysicistsinsouthafrica.com)





My grandfather used to take me to the library every week. And I always made sure that at least one of the books I took was a science book.

**Riona Ramraj**  
Astronomy, University of Cape Town

Originally from Pietermaritzburg, Riona Ramraj is a PHD candidate from the University of Cape Town working on the details of the light emitted from the brightest part at the centre of a galaxy (the Active Galactic Nucleus) in order to determine their nature and evolution.

[www.womenphysicistsinsouthafrica.com](http://www.womenphysicistsinsouthafrica.com)

Some information about the project, maybe an internet website and other details details details

# Inclusive and Equitable Conferences



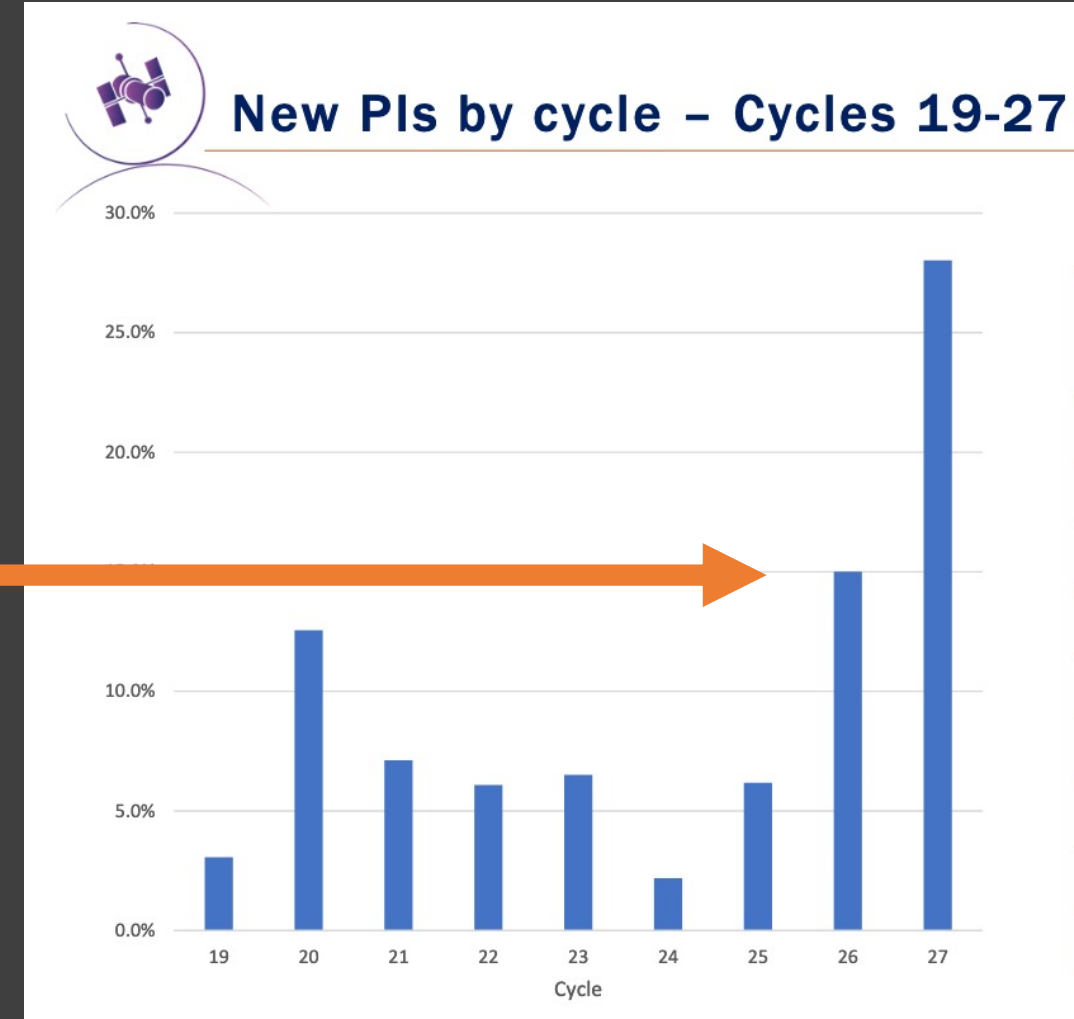
The virtual conference “A Rainbow of Dark Sectors” is an example of how to intersperse equity, diversity, inclusion, and accessibility talks with science talks.



# Dual-anonymization of telescope time allocation applications.

- Many NASA telescope programs now require dual-anonymized application and review process, including *Fermi* GI program.
- The number of new PIs to HST increased substantially with the dual anonymized system, cycles 26 & 27.

STSCI

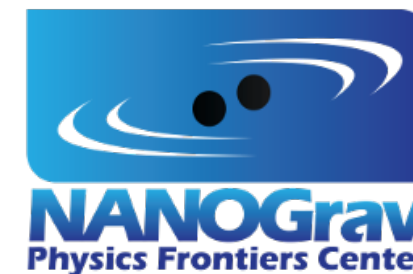
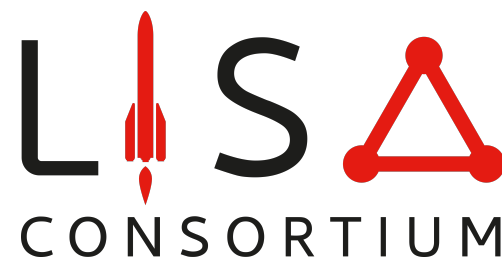
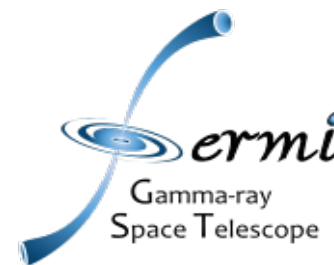




# Multimessenger-specific: Multimessenger Diversity Network

- Formed in late 2018
- NSF INCLUDES funding
- 7 founding collaborations -> 13 current collaborations
- Applies principles of collaboration and cooperation from multimessenger astronomy to equity, diversity, inclusion, and accessibility.





## Opportunity

*to go beyond individual accomplishments*

## Structure

*through organizational principles and tools*

## Legitimacy

*in broadening participation efforts*



## Training

*for members of the network*

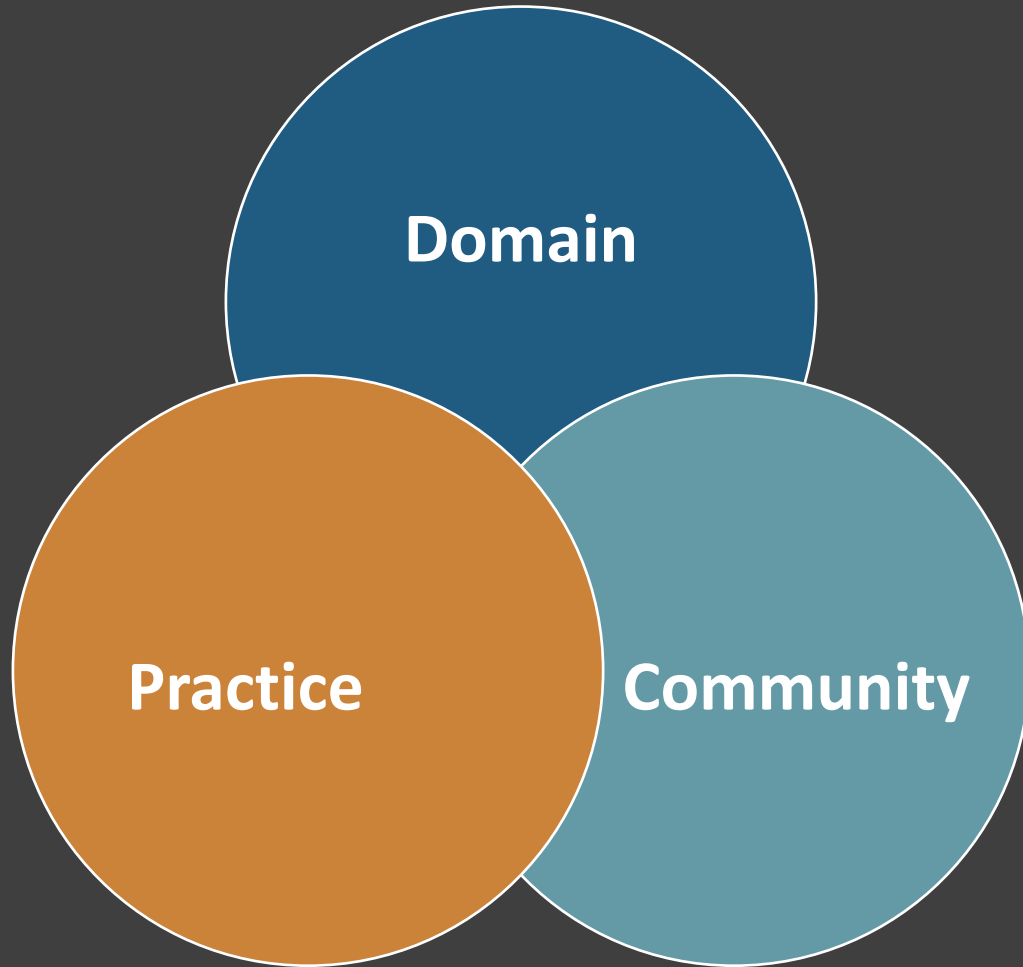
## Presence

*at conferences, on websites and media outlets*

## Support

*from each other and for current and future STEM professionals*

# Community of Practice



**Domain:** Subject of focus

**Community:** group of individuals who care about the same subject.

**Practice:** activities and efforts the group engages in.

# Community of Practice



**Domain:** DEIA in multimessenger collaborations

**Community:** representatives from participating collaborations

**Practice:** monthly meetings, sharing experiences/efforts

# MDN – what we’ve done together

- Community engagement lead training
- Astro2020 Decadal Survey

Astro2020 - State of the Profession White Paper

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**Pursuing diversity, equity, and inclusion  
in multimessenger astronomy  
collaborations over the coming decade**

arXiv:1907.06970v1 [astro-ph.IM] 16 Jul 2019

**The Multimessenger Diversity Network - E. Bechtol\*** (WIPAC - UW-Madison, WI), **K. Bechtol** (Physics Dept. - UW-Madison, WI), **S. BenZvi** (Dept. of Physics and Astronomy - Univ. of Rochester, NY), **B. Cenko** (NASA Goddard Space Flight Center, MD), **L. Corlies** (LSST EPO, AZ), **P. Couvares** (LIGO - Caltech, CA), **A. Furniss** (Dept. of Physics - CSU East Bay, CA), **E. Hays** (NASA Goddard Space Flight Center, MD), **C. M. Hui** (NASA Marshall Space Flight Center, AL), **D. L. Kaplan** (Dept. of Physics - UW-Milwaukee, WI), **J.S. Key** (Physical Sciences Div. - UW-Bothell, WA), **J. Madsen** (Dept. of Physics - UW-River Falls, WI), **M. McLaughlin** (Dept. of Physics and Astronomy- West Virginia Univ., WV), **F. McNally** (Dept. of Physics - Mercer Univ., GA), **R. Mukherjee** (Dept. of Physics and Astronomy- Barnard College, NY), **M. Santander** (Dept. of Physics and Astronomy- Univ. of Alabama, AL), **S. Vigeland** (Dept. of Physics - UW-Milwaukee, WI), **J. Zuniga-Paiz** (WIPAC - UW-Madison, WI).

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- Community engagement lead training
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- IDWGS campaign

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\*contact author: ellen.bechtolt@icecube.wisc.edu



## International Day of Women & Girls in Science 2022



**8,225 Impressions**  
**139 Engagements**  
61 likes, 17 Retweets  
**1.7% Engagement rate**

**Liked, Retweeted from:**  
@EGO\_Virgo, @DESISurvey, @DESY,  
@Fermilab, @LIGO, @ICC\_UB, @Nikhef,  
@TRIUMFLab, @CTA\_Observatory,  
@PhysicsNews, @AugerObs, @ICEHAP1,  
@PolarTREC, @NASA



**1,540 Impressions**  
**56 Interactions**  
416 views, 48 likes, 5 shares, 1 comment  
**3.6% Engagement rate**

**1,330 Accounts Reached**  
727 followers, 603 non-followers  
= 45% of viewers were new  
+15 new followers from 2/11-2/12



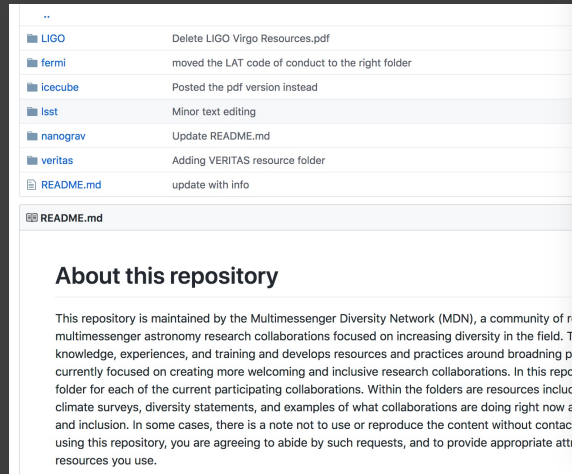
**3,941 Accounts reached**  
**85 Interactions**  
63 Reactions, 7 comments, 16 shares  
**2.2% Engagement rate**



- Reached more viewers than **91%** of 50 most-recent posts  
- More interactions than **75%** of 50 most-recent posts




# MDN – what we’ve done together

- Community engagement lead training
- Astro2020 Decadal Survey
- IDWGS campaign
- Website
- Resources







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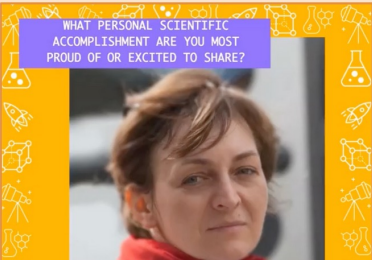
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**- More interactions than 75% of 50 most-recent posts**



**WHAT PERSONAL SCIENTIFIC ACCOMPLISHMENT ARE YOU MOST PROUD OF OR EXCITED TO SHARE?**

The most exciting scientific experience of my life was participating in the first detection of gravitational waves in 2015 and the discovery that the signal was generated by coalescing binary black holes, GW150914.

**DOROTA GONDEK-ROSINSKA** | Virgo-LIGO Collaboration

## Astro2020 - State of the Profession White Paper

### Pursuing diversity, equity, and inclusion in multimessenger astronomy collaborations over the coming decade

16 Jul 2019 astro-ph.IM

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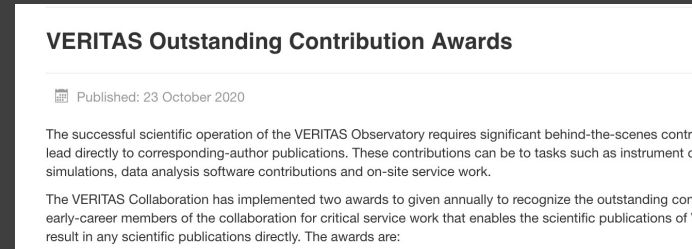
Lead author: [ellen.bechtol@icecube.wisc.edu](mailto:ellen.bechtol@icecube.wisc.edu)



# Impact: Programs

## Awards

- VERITAS inspired by IceCube



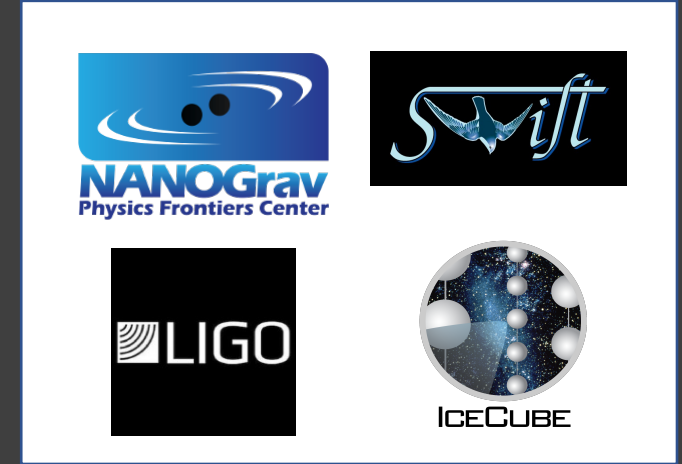
## Mentoring

- *Fermi*-LAT program directly informed IceCube program
- DESI program inspired by DES, SDSS, Supernova Foundation



# Impact: Policies

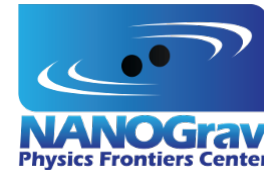
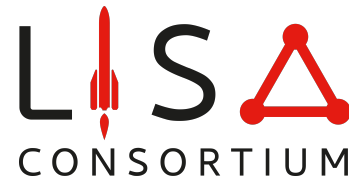
- Ombuds Programs
  - IceCube learned from NANOGrav and LIGO
  - Swift Observatory inspired to develop a program
  
- Code of Conducts
  - DESI
  - Pierre Auger
  - Swift



# Impact: Gravitational Wave Panel

Gravitational wave panel at the National Diversity in STEM Conference:

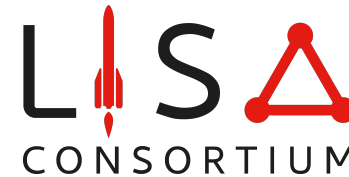
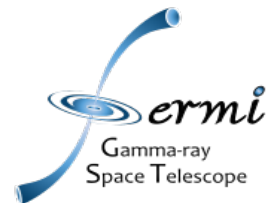
October 27-29, 2022 in San Juan, Puerto Rico



# Impact: Field-wide Mental Health Survey

LIGO-Virgo-KAGRA Mental Health Survey expansion to include the broader multimessenger community.

Participating groups currently include:



# Impact: Reports, Surveys, and Inspiration

- Many groups have exchanged lessons learned and inspired or informed questions for climate surveys.
- Input and lessons learned went into the IAU report “International Coordination of Multi-Messenger Transient Observations in the 2020s and Beyond: Kavli-IAU White Paper” [arXiv:2007.05546](https://arxiv.org/abs/2007.05546)
- Special speakers and collaboration session ideas have been inspired by participation in MDN.

“However, welcoming and respecting must be the first steps taken, not the only steps.”

From “Policing and Gatekeeping in STEM: Safety, Security & Sanctity” by A.K. Hodari, S.B. Krammes, C. Prescod-Weinstein, B.D. Nord, J.N. Esquivel, and K.A. Assamagan. [arXiv:2203.11508](https://arxiv.org/abs/2203.11508)

# Thank you!

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# Extra Slides

# Stage of Community

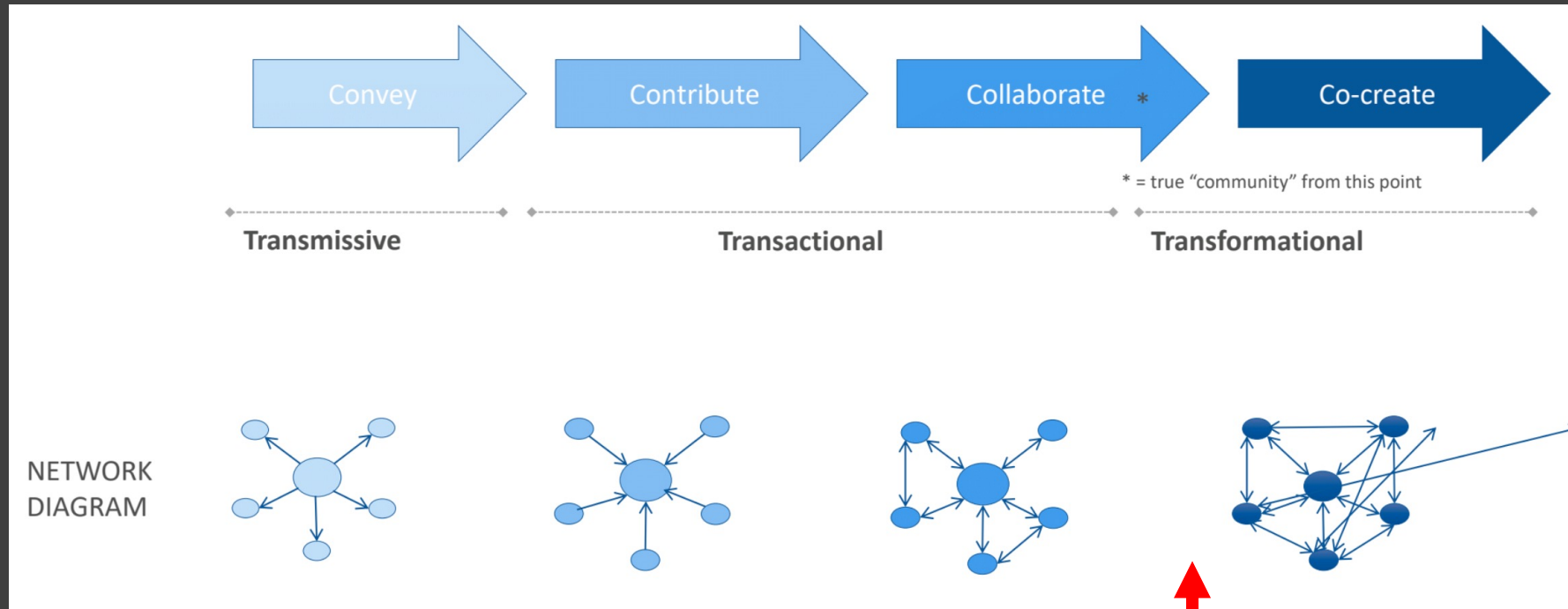


Image courtesy Lou Woodley, AAAS/Community Initiatives

We Are Here

# Towards a Transformational Community

	Collaborate	Co-create
<b>Interactions</b>	Community-sourced	Community learning
<b>Goal</b>	Share resources, knowledge to achieve a common goal	Create new knowledge together
<b>Power Balance</b>	Controlled, convened cooperation	Mutual sharing and learning
<b>Slogan</b>	We can't solve this alone	Let's figure this out together

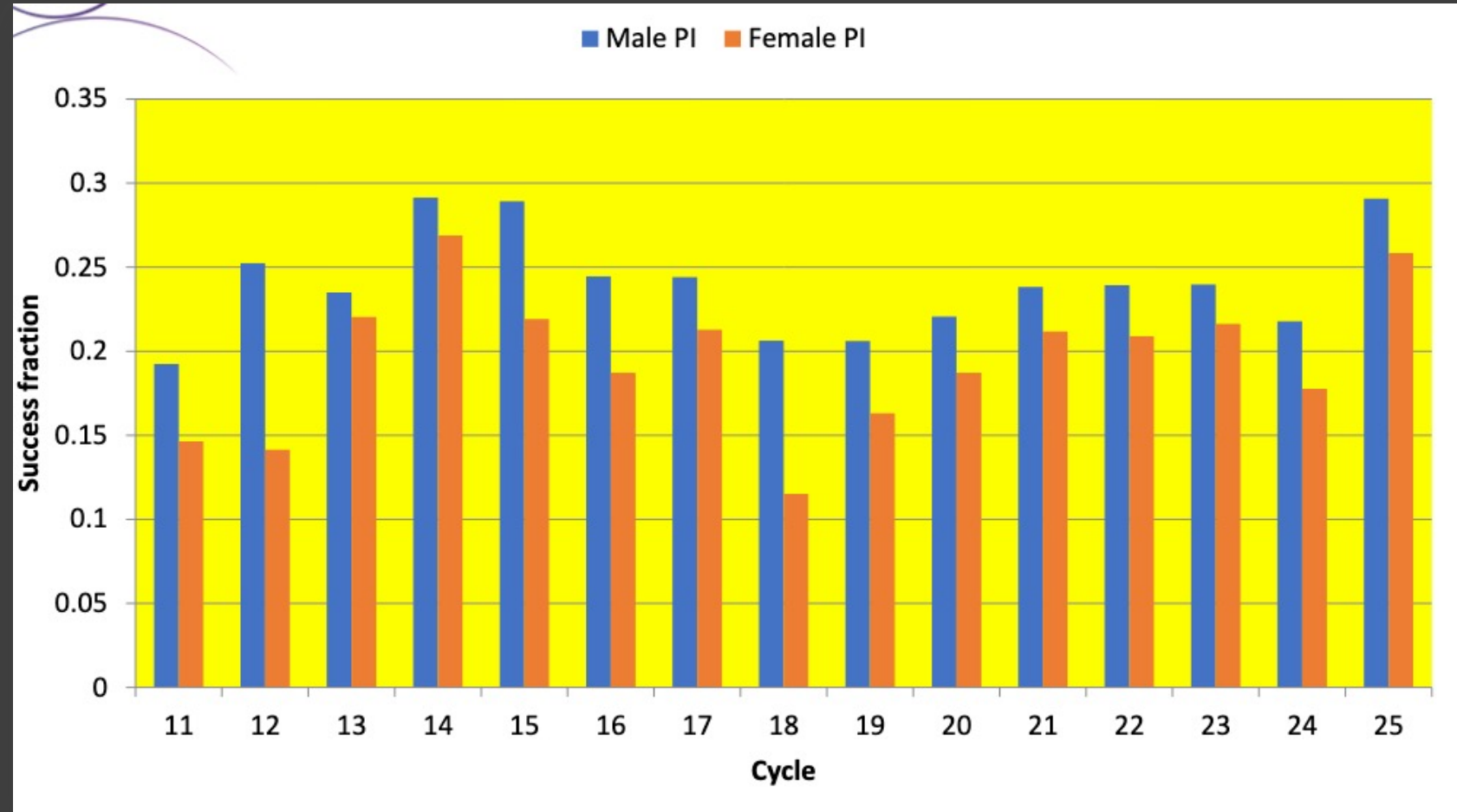
# Gender Bias

Wide-spread bias favoring men.

For example:

Time allocation for the Hubble Space Telescope disproportionately awarded to Male PIs for over a decade.

Hubble Space Telescope Time Allocation Awards



[https://www.stsci.edu/files/live/sites/www/files/home/hst/about/space-telescope-users-committee/presentations-and-documentation/\\_documents/2019\\_nov/dual-anonymous-implementation.pdf](https://www.stsci.edu/files/live/sites/www/files/home/hst/about/space-telescope-users-committee/presentations-and-documentation/_documents/2019_nov/dual-anonymous-implementation.pdf)

TABLE 2  
ETHNIC DISTRIBUTION OF SDSS-IV MEMBERS & LEADERSHIP BASED IN THE U.S. AND CANADA  
(FROM ALL RESPONDENTS WITH UNAMBIGUOUSLY REPORTED ETHNICITY)

Ethnicity	% SDSS-IV Membership (of 100)	% SDSS-IV Leadership (of 47)	% AAS (2013 <sup>a</sup> ) Membership (of 1524)	% USA (2013 <sup>b</sup> ) General Population (of 316M)
White	80	89	84	63
Asian or Asian American	15	9	8	5
Hispanic or Latino	4	2	3	17
Black or African American	0	0	1	13
American Indian or Alaska Native	0	0	< 1	1
Native Hawaiian or other Pacific Islander	0	0	< 1	< 1
Other	1	0	2	

<sup>a</sup>Anderson & Ivie 2013

<sup>b</sup><http://quickfacts.census.gov/>

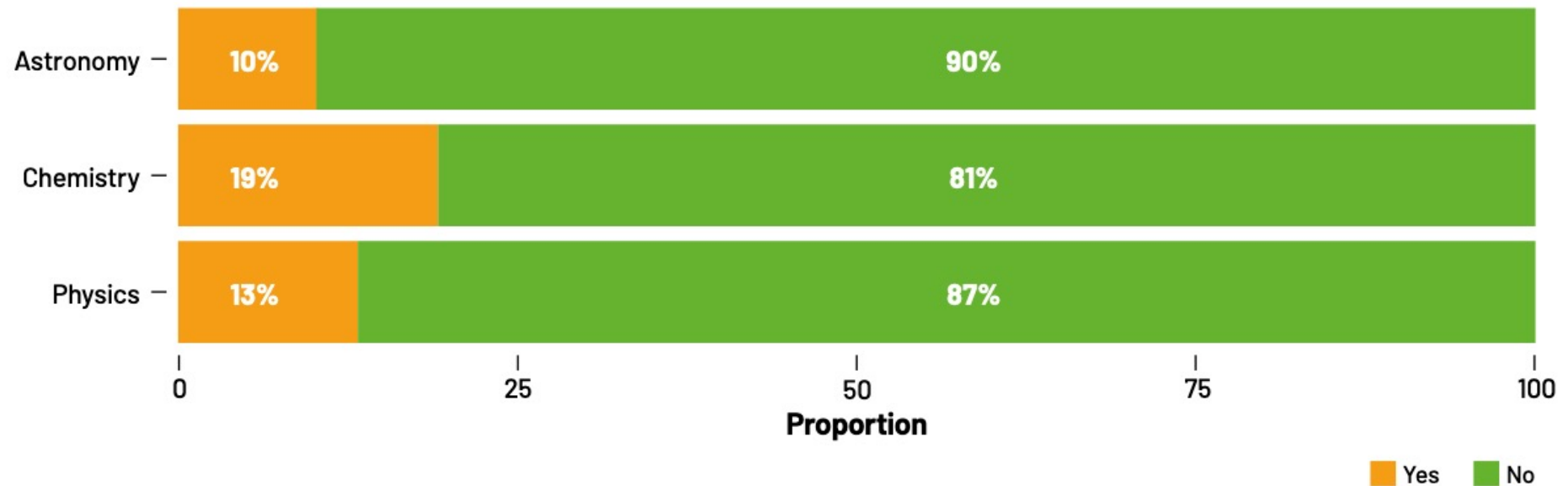
<https://arxiv.org/abs/1505.06199>

## The Number of Doctorates Earned in Physics, 2014–15 to 2018–19

Number of Doctorates Earned in Physics by People who are:	2014–15	2015–16	2016–17	2017–18	2018–19
American Indian or Alaska Native men	5	0	1	2	2
American Indian or Alaska Native women	0	1	0	0	0
Asian men	56	55	61	66	70
Asian women	17	20	19	18	27
Black or African American men	13	15	16	8	8
Black or African American women	5	9	3	4	1
Hispanic or Latino men	34	40	50	42	40
Hispanic or Latino women	10	5	7	11	10
Native Hawaiian or Other Pacific Islander men	2	1	1	1	1
Native Hawaiian or Other Pacific Islander women	0	0	0	1	0
White men	639	650	648	609	651
White women	135	142	115	165	123
Two or more races men	9	11	11	24	22
Two or more races women	1	8	6	6	6
All Other Race/Ethnicity and Gender Combinations (NonResident Alien and Unknown)	915	889	894	923	914
<b>Totals:</b>					
Non-White Only	152	165	175	183	187
White Only	774	792	763	774	774
<b>Grand Totals:</b>					
<b>Men</b>	1,474	1,489	1,511	1,478	1,497
<b>Women</b>	367	357	321	402	378
<b>All</b>	<b>1,841</b>	<b>1,846</b>	<b>1,832</b>	<b>1,880</b>	<b>1,875</b>

# UK: Gender Identity or Sexual Identity

**Figure 6: Proportion of respondents who experienced exclusionary, intimidating, offensive or harassing behaviour because of their gender identity or sexual identity in the last 12 months, by discipline**



[https://www.rsc.org/globalassets/04-campaigning-outreach/campaigning/lgbt-report/lgbt-report\\_web.pdf](https://www.rsc.org/globalassets/04-campaigning-outreach/campaigning/lgbt-report/lgbt-report_web.pdf)