Debra Fischer, NSF/MPS/AST DD

Board on Physics & Astronomy
NSF / AST Astro 2020

Astro-2020
Science-centered

Astro2020 describes a pathway to major scientific breakthroughs

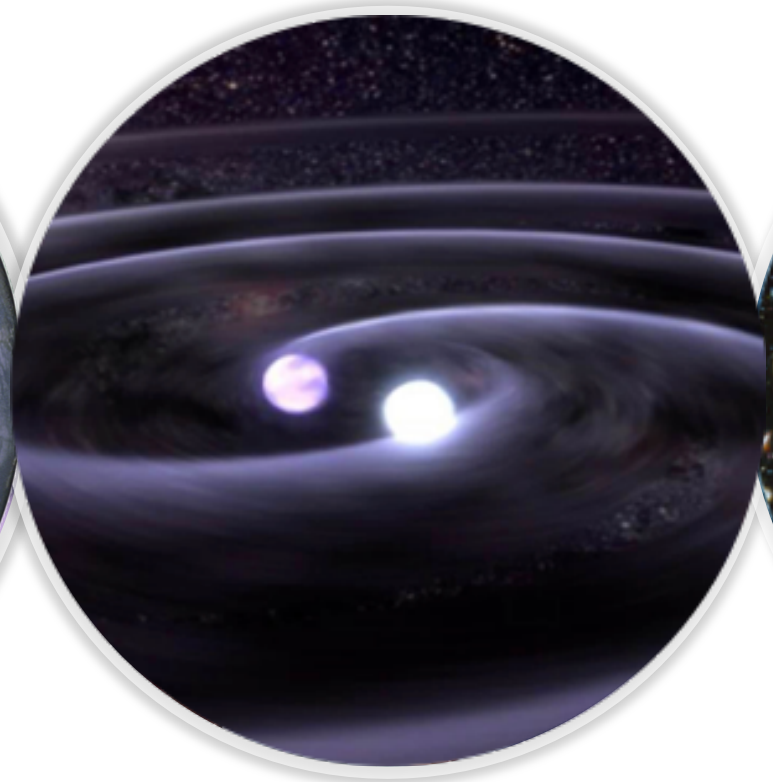
The discoveries will impact the lives of our citizens

Role of NSF: support fundamental research for discovery (grants, facilities)

Astro 2020 Science:

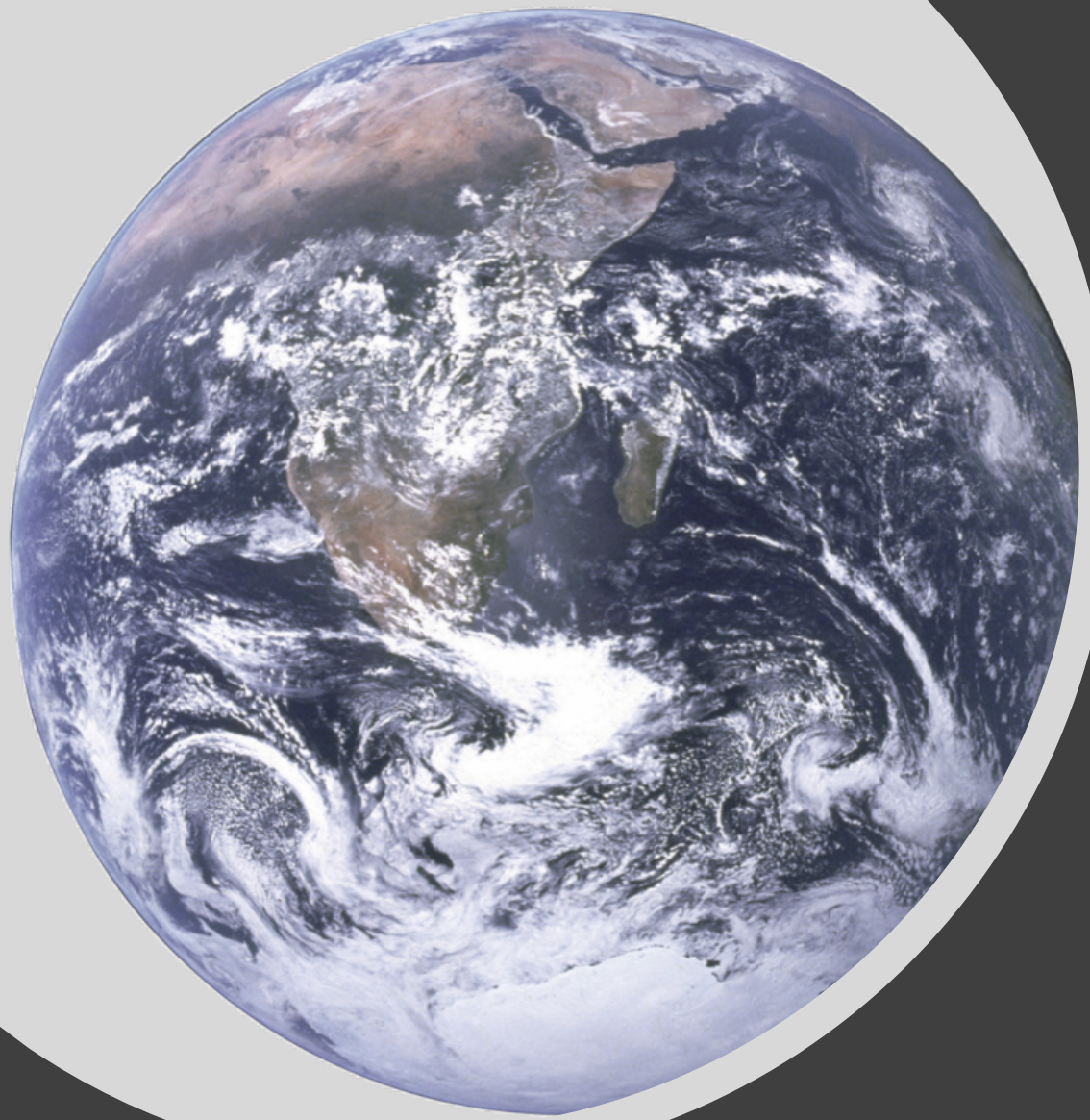
Three science themes addressing fundamental and profound questions for humanity and for understanding our place in the space and time of the Cosmos.

A step-by-step path to discovering habitable worlds and life elsewhere.



Time-domain multi-messenger astrophysics to trace the earliest stages of the observable universe

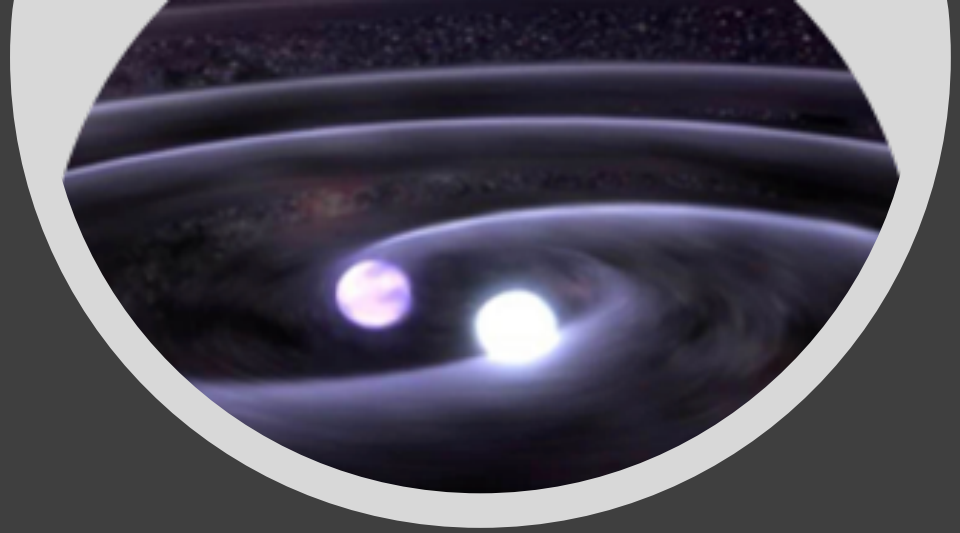
Formation and evolution of stars and galaxies from the Big Bang to today



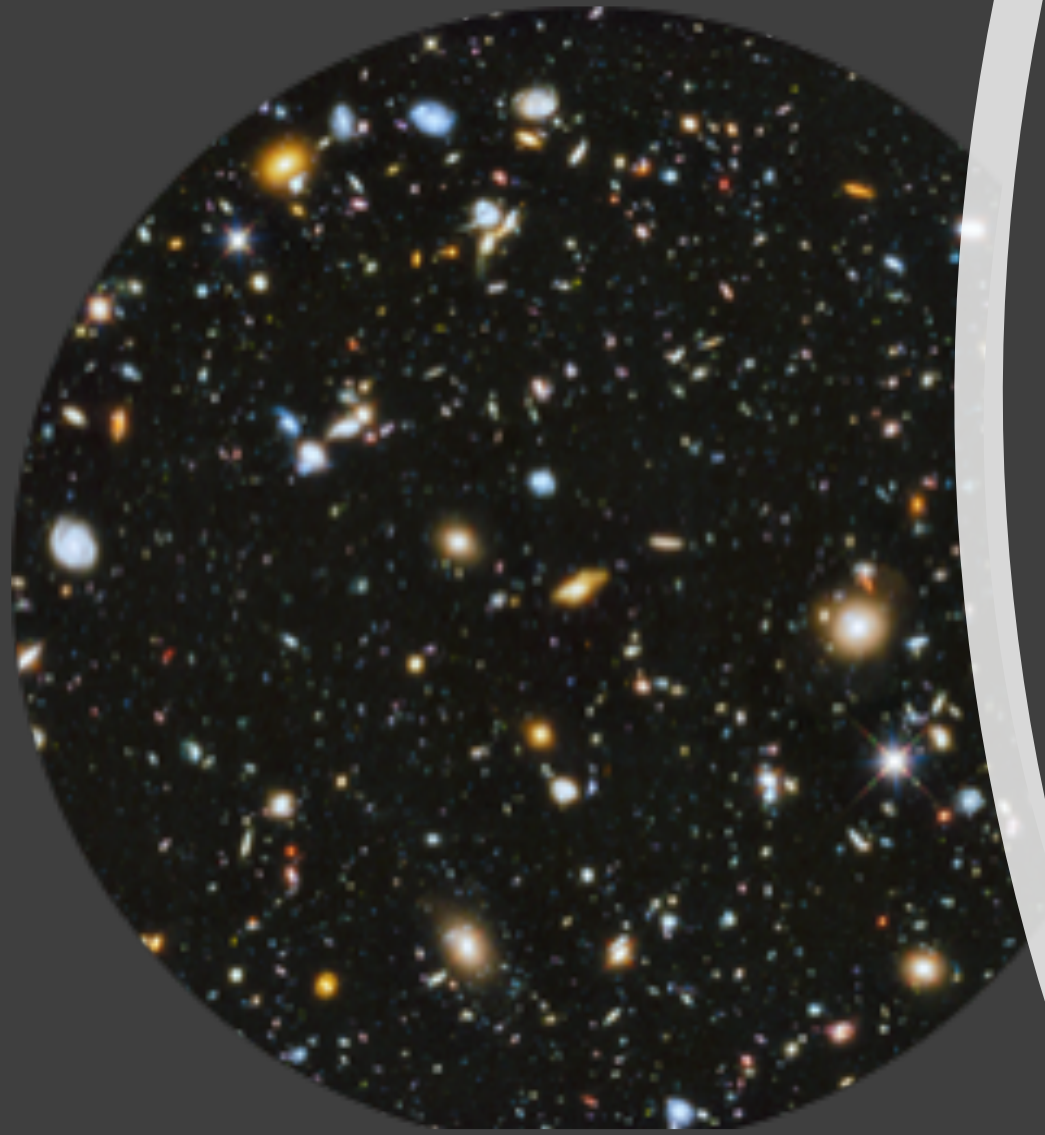
Support for exoplanet science:

- NSF funding for public access on the WIYN / NEID spectrograph (NN-EXPLORE) to measure RVs with precision of ~30 cm/s.
- NSF funding for the Keck Planet Finder with public time contribution and open-access time through NASA.
- NSF funding for the EXtreme PREcision Spectrograph with RV precision of 30 cm/s at Lowell Observatory.
- NSF's Gemini telescopes: MAROON-X visitor instrument, GPi high contrast imaging.
- ALMA – studying protoplanetary disks and chemistry

Support for Time-Domain Multi-Messenger Astronomy:

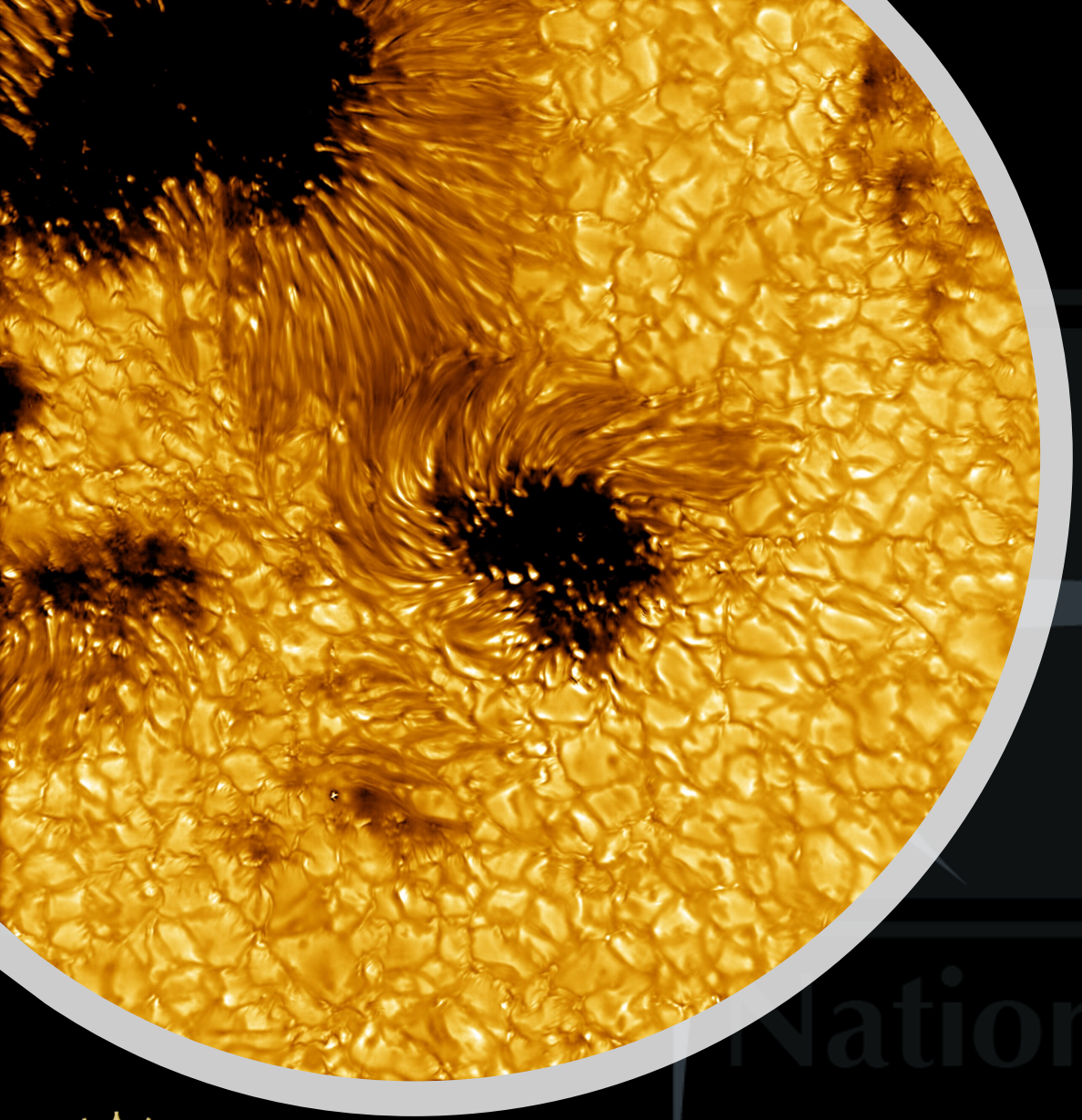


- NSF Windows on the Universe program supports TD/MMA is a partnership between PHY, AST and other NSF divisions
- Zwicky Transient Factory
- Rubin telescope (partnership with NSF / DOE) will be commissioned in 2024 and will scan the southern hemisphere sky every 4 days.
- Many PI-led consortia and supernova programs



Support for Understanding Cosmic Environments:

- Most of AAG program and facility observations support this goal
- Support for development of CMB-S4
- OIR and Radio facilities: Gemini (N and S), VLA, VLBA, ALMA, GBO, ngVLA
- PI led research (observations, theory, simulations)



NSF's National Solar Observatory

- On 23 Feb 2022, the Daniel K. Inouye Solar Telescope (DKIST) began
- First Science Observations.

- The worlds most powerful solar telescope obtains high resolution images of sunspots coupled with measurements of electric fields. These data will reveal how *magnetic reconnection* suddenly reconfigures the solar magnetic fields, producing jets of plasma that reach into the chromosphere.

All NSF OIR facilities

Panel review of 5-year NOIRLab proposal took place in February.

- Plan to merge Gemini N-S, Rubin, MSOs (TACs, renewal timelines, data archives and pipelines).
- Center for Dark Skies (IAU initiative with SKAO)

NSF's National Radio Astronomy Observatory

- VLA, VLBA, ALMA
- Planning for ngVLA
- Central Development Lab: instrumentation for radio astronomy.

Addressing the impact of satellite constellations:

- New solicitation (ENG CISE MPS GEO): Spectrum and Wireless Innovation enabled by Future Technologies (SWIFT) includes stream of funding R&D for astronomy and satellite constellations.
- Support of U.S. statement on dark and Quiet Skies at U.N. COPUOS
- Support of SpectrumX (spectrum innovation center, Notre Dame)
- IAU SKAO / NOIRLab leadership: Center for Protection of Dark and Quiet Skies

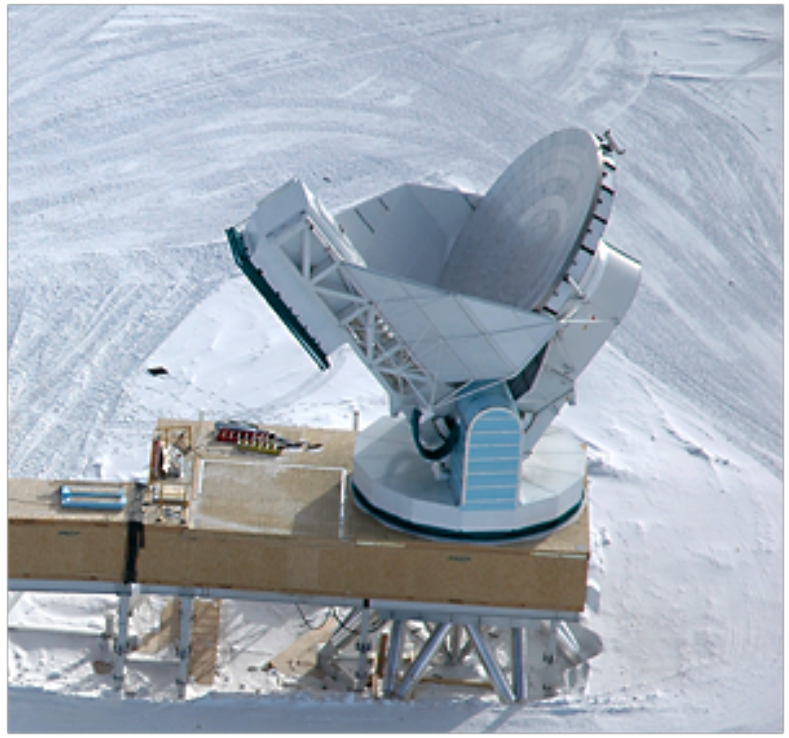
Astro2020: The Tools

Major facilities needed to make substantial progress on science questions.

Top major facility recommendation: Extremely Large Telescopes (US-ELT)

Map to the 3 science pillars to study exoplanets, carry out follow-up on faint sources (Rubin discoveries) and track the composition and structure of distant young galaxies as they form.

Two second-ranked major facility recommendations (equal weighting):



(2a) CMB-S4 probe the earliest moments of the universe, seeds of galaxy formation.

(2b) (ngVLA) formation of planets and the earliest galaxies, Earth orientation (GPS and global navigation satellites).

Astro2020: Develop the Workforce

1st decadal study to address State of the Profession.

Astro 2020 recommended: “Start here”

<u>Fund people and develop the workforce</u>

- Augment and protect individual investigator grants
- Build opportunities for diversity in workforce
- Increase transparency (in budgets and proposal statistics)
- Reduce carbon footprint associated with research

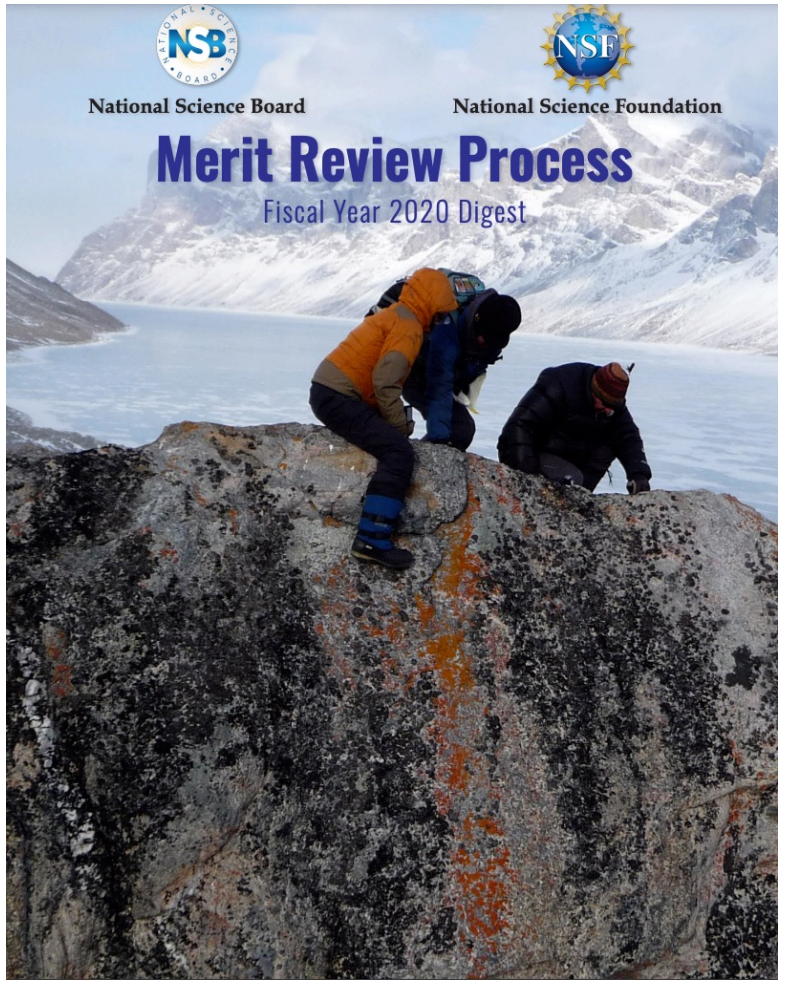
Aligned with existing MPS and AST initiatives supporting students, postdocs and early-career faculty from under-represented groups.

With a complex future (artificial intelligence, robotics), the NSF-supported workforce development provides a pathway to creative analytical skills and jobs that inherently offer flexibility and adaptability.

Astro2020 Transparency:
Demographics on Proposals

1. We are actively working to increase access to data about NSF's merit review process, including the demographics of individuals submitting proposals and receiving awards.

2. We collect and publish Directorate-level summary proposal data about gender, race, ethnicity, disability state, and career stage. (Note that there may be differences in definitions of categories between the 3 agencies.)

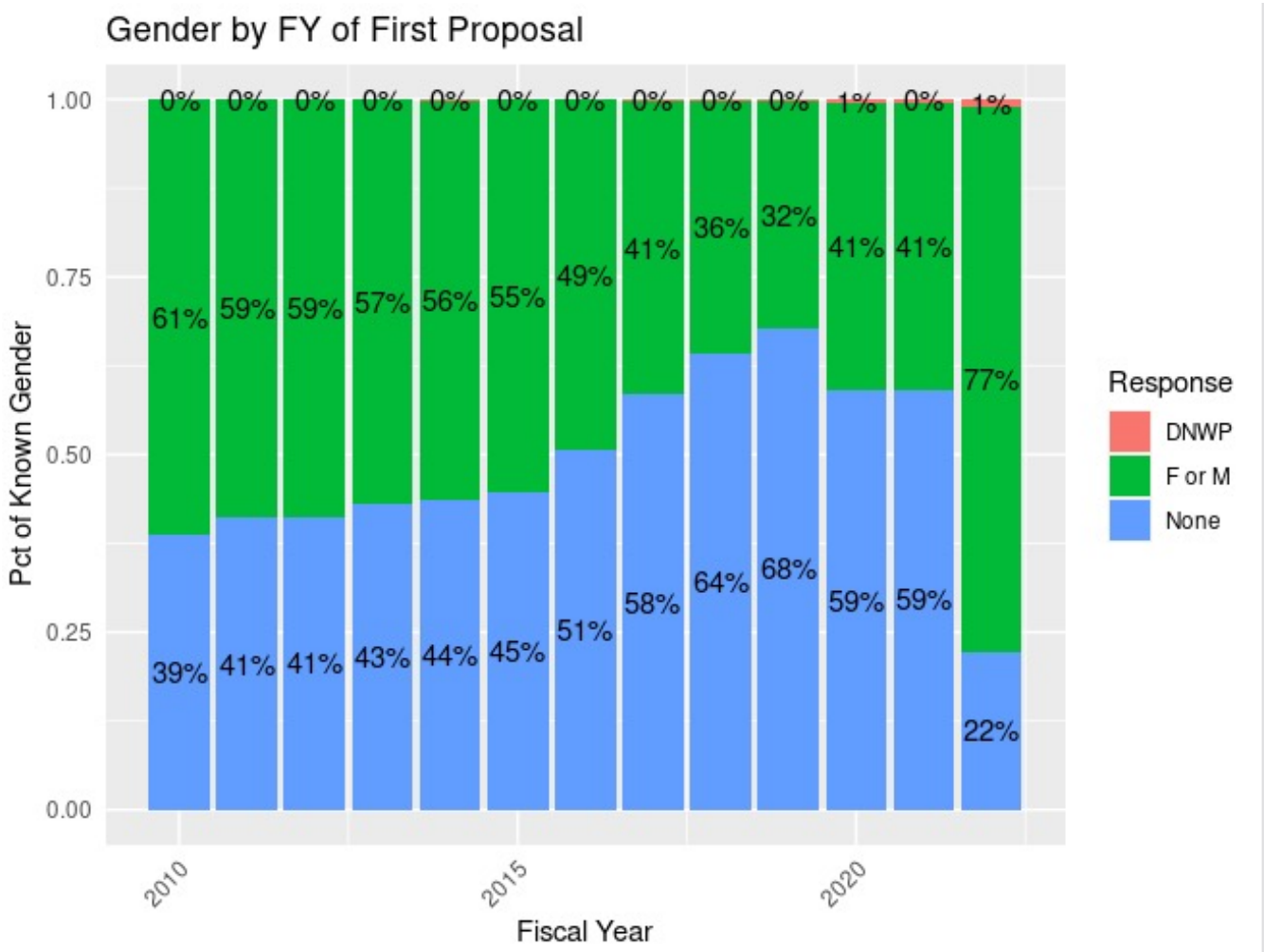


https://www.nsf.gov/nsb/publications/pubmeritreview.jsp

Demographics on Proposals

3. Not quite ready to share proposal demographic information (work in progress). This should be ready in the coming months – perhaps for the next AAAC meeting.

4. One Figure to share: a pilot program to address decreasing responses from new PIs regarding demographic information



A pilot was initiated in late FY 2021 requiring a response, while allowing a "Do Not Wish to Provide" opt out. Response improved dramatically.

Astro2020 Workforce

NSF programs to address the leaky pipeline:

1. PAARE: Partnerships in Astronomy & Astrophysics Research and Education aims to establish authentic pathways into the research enterprise and broaden the participation of individuals from groups underrepresented in astronomy. *Strong proposal response – several new partnerships*
2. REU: projects involve students in meaningful ways in ongoing research programs. *Site awards being made!*
3. ASCEND: recognize postdoctoral fellows with significant potential who will broaden the participation. *Strong response!*
4. LEAPS: an emphasis to help launch the careers of pre-tenure faculty in MPS fields at institutions that do not traditionally receive significant amounts of NSF-MPS funding; aims to broaden participation. *Reviews ongoing!*

Outreach

- NOIRLab led the *Journey Through the Universe* outreach program for the eighteenth straight year this week – where observatory staff engage with local community school kids in Hawaii.

Mentorship program:

- PROmoting VOCAtions (PROVOCA) to broaden participation of women in STEM careers in Chile. Long term commitment with female STEM professionals and students: Training (10 months), 350 hours of lectures, coaching, networking, roundtable discussions, final project presentations.

- 28 women have completed this mentorship training.
- April 2022, AUI / NRAO applications for students who will receive mentorship

Astro2020 midscale recommendations

to support research and workforce:

- Sustain instrumentation
- laboratory astrophysics
- data science and archives

"Mid-scale research infrastructure and cyberinfrastructure….must be growth areas for NSF…" NSB-2018-40

The major facilities include partnerships:

ELTs are a private-public partnership
CMB-S4 has a 50-60% DOE partnership and synergy with MPS/PHY and GEO/OPP
ngVLA has potential partnership with Advanced Wireless (ENG, CISE), NSF's Spectrum Innovation Initiative, national priority (including interagency partnership for GPS)

But, these projects are far bigger than anything we have done before.

- Design and development: critical for risk reduction pre-construction
- Agency-wide support needed for construction / MREFC
- Astro2020: need robust plan for operations & management in out years

Complex facilities are vital for new discoveries. They attract and train the next generation of scientists and engineers. They are critical for international leadership.

Significant costs will require partnerships.

If we do not build new facilities: devastating impact on astronomy research and loss of U.S. leadership.

Recommendation	Progress/effort	Comments
Call for transparency (budgets, demographics)	**Active effort, NSF priority**	NSF and AST commitment to transparent communication, portfolio review. Coordinating with NASA and DOE
State of Profession	**Active effort, NSF priority**	PAARE, ASCENDS, LEAPS, GSRF, AAPF, CAREER, Leadership by NRAO, NOIRLab, NSO
Instrumentation	**Active effort, AST and NSF priority**	NRAO CDL. Beginning study of hubs of technical excellence, TIP and other partnerships?
Data Science	**Active effort, AST and NSF priority**	NRAO, NSO, NOIRLab leadership; Rubin is pushing data science / archiving. Beginning internal study (w/ NASA) on data centers. CISE and other partnerships?
Climate change	**Active effort, NSF and AST priority**	Survey of energy use at facilities. Evaluating renewable power options.

Recommendation	Progress/effort	Comments
Increase MSIP to $50M	**Under budget pressure**	Pressure from development for new major facility recommendations. Midscale programs will probably need to compete in MSRI-1 / 2, MRI in coming year or two.
Increase ATI to $14M	**Under budget pressure**	Holding line at $8M. Will consider balance for ATI in context of technology / instrument hubs.
Invest in Lab Astro	**Active effort, AST / NSF and NASA priority**	Concern about workforce attrition. AAG for atomic and molecular physics (theory, lab – few % of grants program). Partner with PHY, CHE. Working with NASA to develop coordinated, complementary plan. ALMA produces fundamental data.

Recommendation	Progress/effort	Comments
US-ELTs: 25% of both or 50% of one	**Active effort, NSF priority**	“Absolutely essential”. Meeting with teams, working to get projects into preliminary design
ngVLA:	**Active effort, NSF priority**	Under development and working with project to begin conceptual design.
CMB-S4	**Active effort, NSF priority**	Supporting the team; some re-evaluation of South Pole infrastructure.

Committed to supporting recommendations from Astro2020 whenever possible.
(Ultimate peer review process)