Debra Fischer, NSF/MPS/AST DD

Astro 2020 Updates
Board on Physics & Astronomy

November 29, 2022

Astro-2020 Science-centered

Astro2020 describes a pathway to major scientific breakthroughs

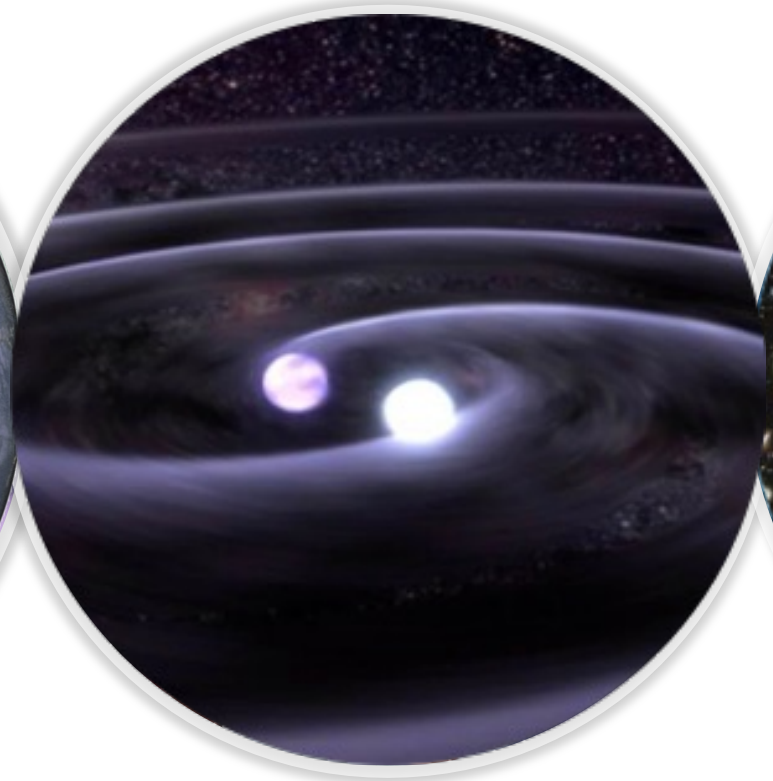
The discoveries will impact the lives of our citizens

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

Recommendations: Develop the Workforce

Increase funding incentives for improving diversity among college/university astronomy faculty (e.g. number of awards for development and retention of early-career faculty).

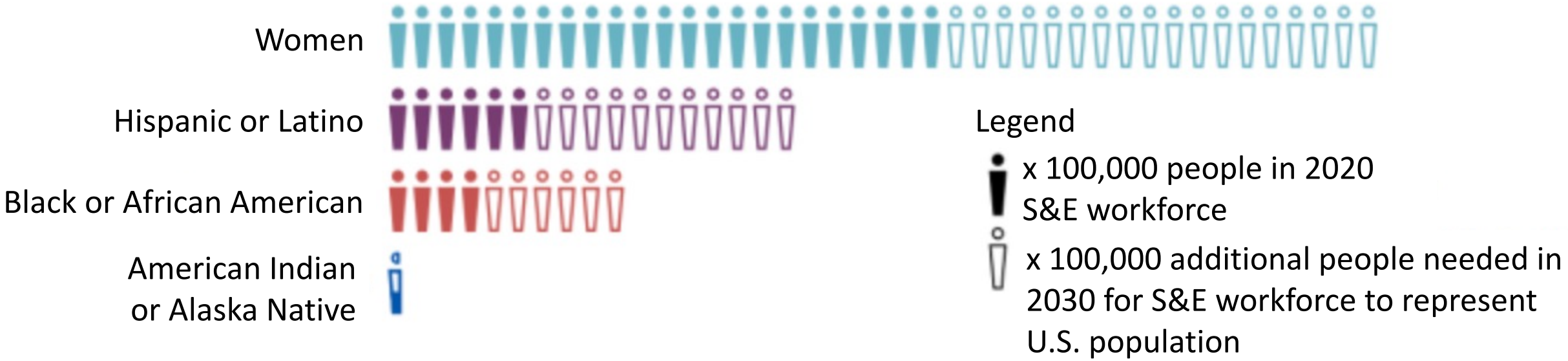
Pipeline transitions are loss points: support creation and continued operation of "bridge" type programs.

Provide undergrad and graduate "traineeship" funding for professional workforce development.

Support postdoctoral fellowships that provide independence and encourage development of scientific leaders.

Include diversity of project teams and participants in evaluation of funding awards to PIs, projects, teams, and organizations that manage facilities.

NSB: Faster progress increasing diversity is needed to reduce significant talent gap.



The qualities that make great scientists are not linked to gender, race, ethnicity, country of origin. They are linked to opportunities and inclusion.

NSF must partner with universities to support research and training.

Examples: MPS-ASCEND

Natalie Nicole Sanchez

Aaron Stemo

Raquel Martinez

Erin Cox giving her first press conference (June 2022)

	Description	FY22
PAARE	Partnerships in Astronomy & Astrophysics Research and Education	10
REU	Research Experience for Undergraduates	10
GRFP	Graduate Student Research Fellowships Program	51
ASCEND	MPS: postdocs with potential to broaden participation	5
LEAPS	MPS: early career faculty at institutions with little NSF STEM funding	7

Examples: Partnerships in Astronomy & Astrophysics Research and Education (PAARE)

University of Texas Rio Grande

City University of New York

AstroCom NYC program

We support CUNY students up to the challenge to join this exciting community of New York City astronomers.

Eligible students may apply now at https://bit.ly/2QIYblo.

Deadline: Fri, Oct 14, 2022

California State University Fullerton

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The PAARE program provided $5.4 million in grants to support 10 programs in 7 states and Puerto Rico. Supports students in undergraduate and graduate programs and on the path between. Enhance and develop research capability at minority-serving institutions, provide student traineeships and diversify the astronomy workforce.

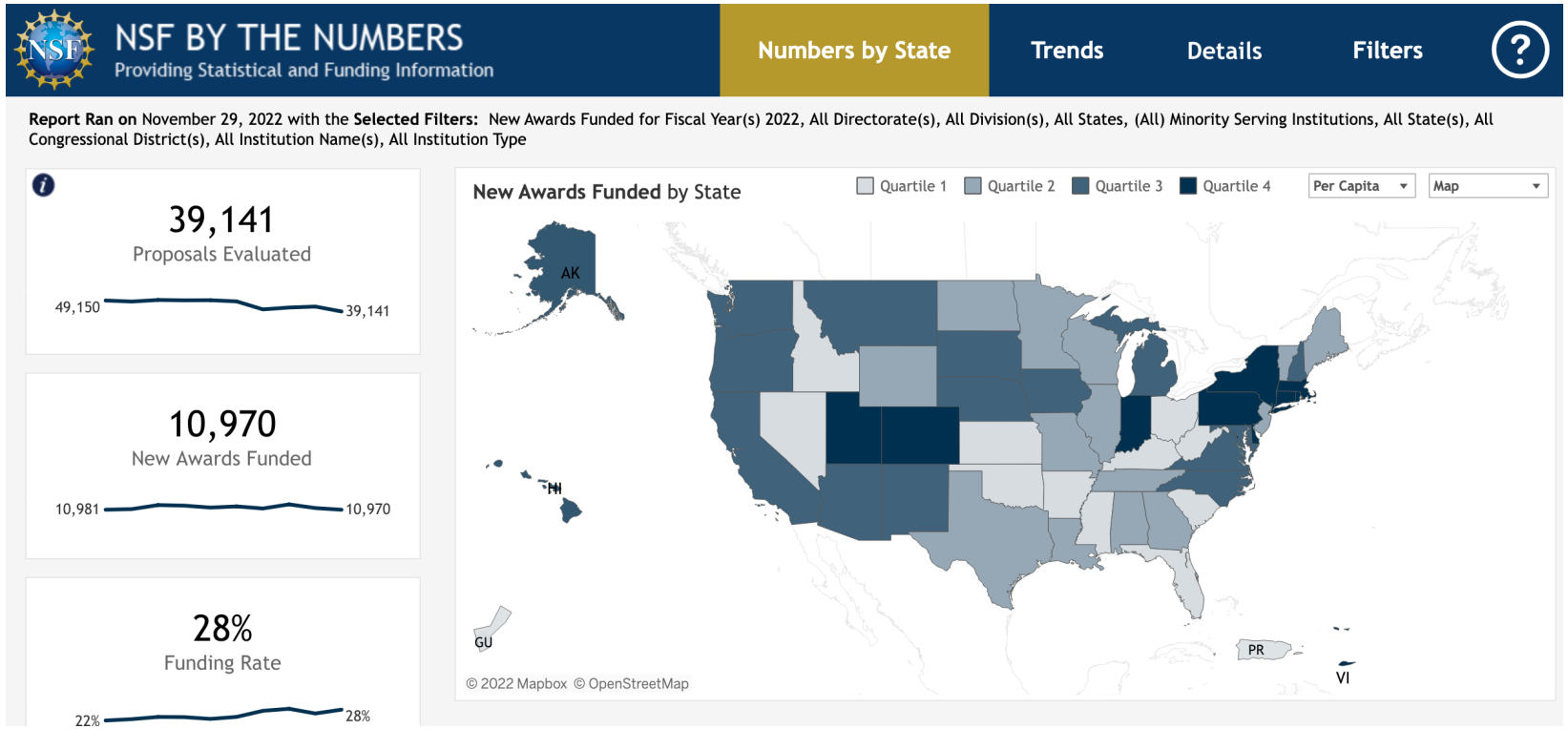
Recommendations: Collect and Report Demographic Data

- *Ensure that scientific integrity policies address harassment and discrimination as forms of research/scientific misconduct.*
- *Establish a cross-agency committee or working group for collecting, evaluating and publicly reporting demographic data pertaining to proposal competitions.*

NSF (and NASA and DOE) should release data on proposal success rates on annual basis and track metrics that allow statistical analysis of what is being supported.

NSF By the Numbers: web interface to Tableau data visualizations.

- Information is aggregated for all of NSF, and can be resolved by Directorate (e.g., MPS)
- Working on how far down this can be divided before identifiable information released.
- There is missing context and some nuance that is important for small number statistics (e.g. no “Return Without Review” or holds on declines)



Recommendations: Protect the Skies

Work with federal regulatory agencies to develop a regulatory framework to control impacts of satellite constellations on astronomy and the night sky. International issues.

Avoidance and mitigation of radio-frequency interference. Seek spectrum allocations to radio astronomy in bands above 95 GHz with international coordination.

Radio Spectrum Management and Addressing the Impact of Satellite Constellations (existential threat for astronomy):

- NSF led U.S. astronomy community input for four new ITU-R reports (three address >95 GHz)
- Updated Coordination agreement with SpaceX (details forthcoming at January AAS meeting)
- Continued support:
  - National Academies Committee on Radio Frequencies (CORF); WRC-23 views report and FCC filings
  - U.S. delegations to U.N. COPUOS and ITU-R
  - Support of SpectrumX (Spectrum Innovation Initiative, including passive services)
  - IAU SKAO / NOIRLab leadership: Center for Protection of Dark and Quiet Skies

Electromagnetic Spectrum Management

In the future, observatories like ngVLA will have to work around radio frequency (RF) interference from other users that knocks out access to certain frequencies at certain times. NSF working on dynamic scheduling plan to enhance spectrum management.

The expected lack of flexibility associated with pre-assigned radio frequencies and times will be a challenge for time domain astronomy (TDA).

NSF's NRAO and NSF's NOIRLab working on technical collaboration with SpaceX and other satellite operators.

Recommendations: More funding for individual investigator research

NSF should increase funding for AAG by 30% in real dollars b/t 2023 – 2028 to restore success rates to a healthy competitive level.

NSF should create three tracks withing the AST Mid-Scale Innovations Program (MSIP)

1. *Open calls*
2. *Strategic proposals*
3. *new instruments on existing facilities*

NSF should increase midscale funding with a target of reaching $50M / yr for MSIP

NASA Astrophysics Theory Program should resume annual cadence and be augmented. Here, NSF is partnering to expand the impact of ATP.

The New York Times

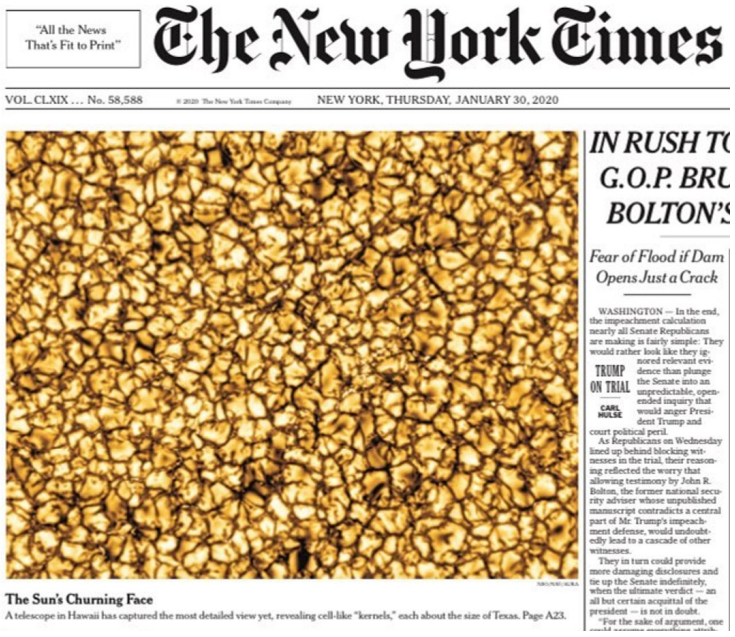
58,294 © 2019 The New York Times Company THURSDAY, APRIL 11, 2019

EVENT HORIZON TELESCOPE COLLABORATION, VIA NATIONAL SCIENCE FOUNDATION

Scientists captured a view of a black hole at the heart of a galaxy known as Messier 87, some 55 million light-years away from Earte.

Peering Into Light's Graveyard: The First Image of a Black Hole

pher Nolan's outer-space epic "In-



"All the News That's Fit to Print"

The New York Times

VOL. CLXIX ... No. 58,588 © 2020 The New York Times Company NEW YORK, THURSDAY, JANUARY 30, 2020

The Sun's Churning Face

A telescope in Hawaii has captured the most detailed view yet, revealing cell-like "kernels," each about the size of Texas. Page A23.

IN RUSH TO G.O.P. BRU BOLTON'S

Fear of Flood if Dam Opens Just a Crack

WASHINGTON — In the end, the impeachment calculation nearly all Senate Republicans are making is fairly simple: They would rather look like they ignored relevant evidence than plunge the Senate into an unpredictable, open-ended inquiry that would anger President Trump and court political peril.

TRUMP ON TRIAL

CARL HULSE

As Republicans on Wednesday lined up behind blocking witnesses in the trial, their reasoning reflected the worry that allowing testimony by John R. Bolton, the former national security adviser whose unpublished manuscript contradicts a central part of Mr. Trump's impeachment defense, would undoubtedly lead to a cascade of other witnesses.

They in turn could provide more damaging disclosures and tie up the Senate indefinitely, when the ultimate verdict — an all but certain acquittal of the president — is not in doubt.

"For the sake of argument, one

"All the News That's Fit to Print"

The New York Times

VOL. CLXXI .... No. 59,483 © 2022 The New York Times Company NEW YORK, WEDNESDAY, JULY 13, 2022

NASA, ESA, CSA, AND STSCI

WHERE STARS ARE BORN The cliffs of the Carina nebula, captured by the James Webb Space Telescope. Its images revealed the earliest periods of star formation.

Midscale and new major facilities are critical to innovation.

Astronomical discoveries are very high profile and a source of national pride. Workforce development is a key pillar for the NSF.

"The world's best talent – including American talent – will go where the opportunities are greatest and research infrastructure is increasingly an essential part of the equation" – NSB "Vision 2030".

NSF Response:

Workshop on Centers of Excellence for Instrumentation and technology

Thinktank: building an integrated system of centers in universities (astronomy, physics, engineering, business), each with specialized technical expertise to retain scientist-engineers and seed innovation

- Workforce development, translation of innovation into commercial ventures
- Potential partnerships with TIP, federal facilities, community, private organizations. Coordinate and collaborate with other agencies, potentially NASA, DOE.

Workshop planned: Spring / Summer 2023

Recommendations: Reduce greenhouse gas emissions associated with research

Increase remote observing, hybrid conferences to reduce travel impact on carbon emissions

Astronomy is **contributing** to climate change

Nature Astronomy 2022

Jürgen Knödlseder ✉, Sylvie Brau-Nogué, Mickael Coriat, Philippe Garnier, Annie Hughes, Pierrick Martin and Luigi Tibaldo

Astronomy facilities / missions contribute 2 million metric tons of carbon emissions per year, 36 tons per year for each astronomer.

Astronomy is **affected** by climate change

Wildfires are threatening Observatories. Domes need to remain closed to protect mirrors from smoke damage.

Astronomers can **help solve** climate change

Our view of Earth from space changes how **we see ourselves**. The images we see instill awe. Awe triggers empathy and a recognition of the interconnectedness of all creatures.

Astronomers can **help inspire activism on** climate change

"If somebody had said before the flight, 'Are you going to get carried away looking at the Earth from the moon?' I would have said, 'No, no way.' But yet when I first looked back at the Earth, standing on the moon, I cried."

- Alan Shepard (Apollo 14)

ASTRONOMERS FOR PLANET EARTH

Share this incredible perspective! More than 300,000 students in Astro101 classes each year.

Astronomers can help solve climate change and we are stepping up!

Big thanks to Inger Jorgenson and the NOIRLab team!

Gemini-S Observatory: NSF funding to make G-S carbon neutral with PV arrays and battery backup in the next few years.

Working to reduce the GHG emissions of all NOIRLab facilities by ~50% in the next few years (infrastructure upgrades).

Requiring new section on climate impact for major facility proposals.

Working with all facility directors to get estimates of energy use, carbon emissions, and possible renewable power.

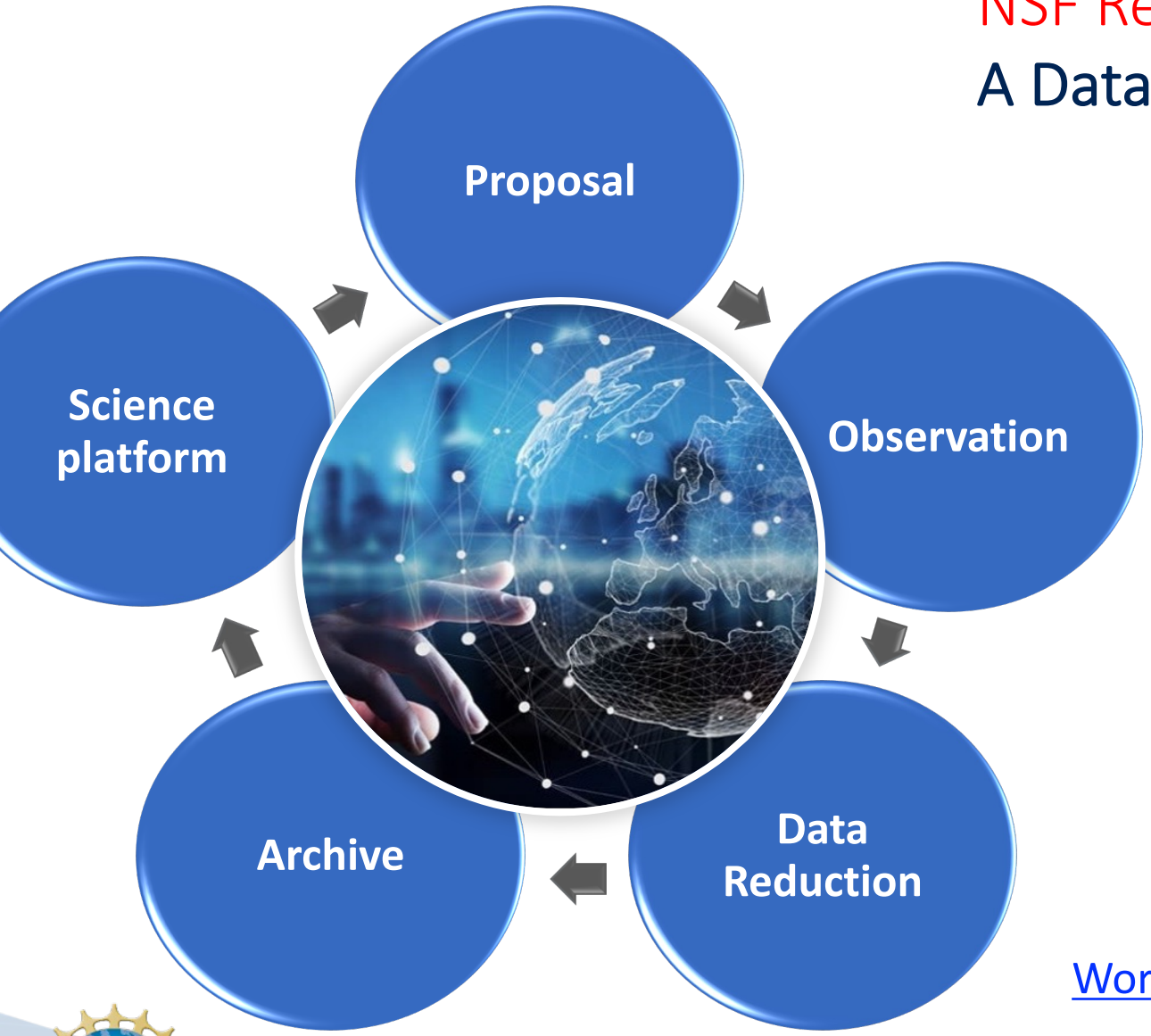
Recommendations: Improve data management across agencies

Fund data analysis and production of high-level data products for large PI-led programs on MREFC-scale astronomical facilities.

NASA and NSF should explore mechanisms to improve coordination among U.S. archive centers and create a centralized nexus for interacting with international archive communities.

Plan how to design, build, and sustain pipelines for producing science-ready data across all ground-based observatories, providing funding in exchange for ensuring that all pipelined observations are archived in a standard format for eventual public use.

NSF Response:
A Data-oriented Integrated OIR System



Thinktank: build an integrated system focused on delivering high quality, science ready data for all instruments:

- Unified archive and science platform
- Unified data reduction framework
- General data acquisition framework and standardized metadata
- coordinate private and federal facilities, collaborate with NASA and DOE, and leverage the expertise of our data centers and of the community

Workshop scheduled: February 2023 @Flatiron Inst

Recommendations: Support laboratory astrophysics

Convene a broad panel of experts to identify needs for supporting laboratory data to interpret results from new generation of astronomical observatories, Identify national resources that can be brought to bear to satisfy those needs. Consider new approaches or program for building the requisite databases.

- Program officers from NSF and NASA working together.
- They have chartered a task force through the AAAC; invitation to TF members will go out in ~ the next week.
- Planning for a first meeting of the TF during the January 2023 AAAC meeting.

Recommendations: Sustainable plan for operations and management of facilities

The addition of new MREFC facilities should be contingent on implementation of a sustainable plan for O&M.

- This is an important and recurring recommendation (NSB 2018 report recommended developing a plan for operations and management).
- This would apply to facilities NSF-wide (much bigger than just AST).
- Do not yet have a silver bullet, but this is on the radar for the CORF, who has been working on this.

Recommendations: New major facilities needed to address science frontiers

NSF should invest in at least one and ideally both of the two Extremely Large Telescopes (GMT and TMT) with a target level of at least 25% of the time on each telescope. If only one project proves to be viable, NSF should invest in a 50% time share. Conduct external review in FY23.

The NSF and DOE should pursue design and implementation of the next generation ground-based CMB experiment (CMB-S4).

The NSF should proceed with a program to support science design, development, cost studies and antenna prototyping for the ngVLA.

Are these investments that we should make?

Is there a role for the Nation in these facility recommendations?

- Ensure US leadership and scientific competitiveness
- National Service (GPS, Near Earth Asteroids, space weather)
- Develop workforce – not just for astronomy, but for the nation.

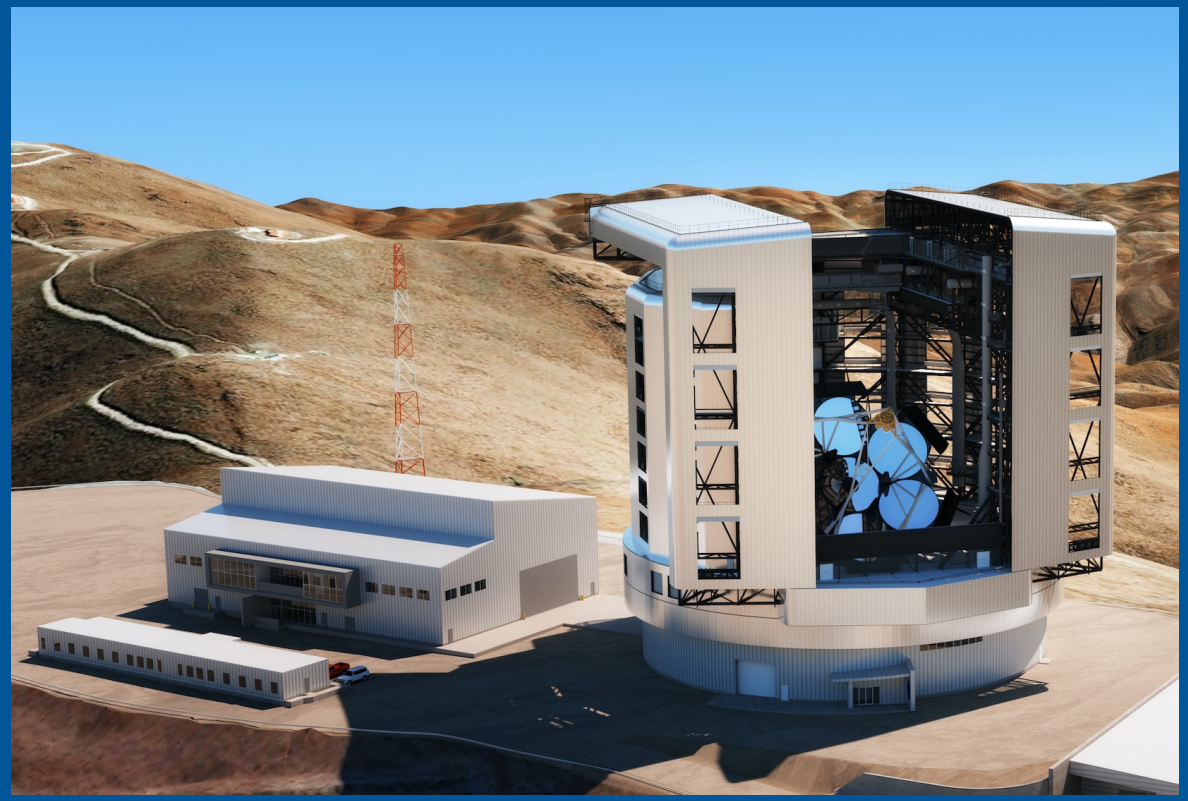
A role for the federal government?

- Too big for states or universities
- Partnerships with other countries, agencies, national defense

A role for the NSF?

"To promote the progress of science; to advance the national health, prosperity, and welfare; and to secure the national defense…."

- Leader in ground-based astronomy
- Broaden participation – STEM for the missing millions.
- Access to facilities for all astronomers



The existing suite of ground and space-based astronomical telescopes have allowed scientists to glimpse amazing phenomena in the universe, but our data are severely biased by small number statistics of the nearest and brightest objects.

Next generation of 30-m telescopes will see further and with greater resolution.

ELTs

- Regular (weekly+) engagement between NSF and the GMT and TMT teams; both projects are technically advanced
- NSF issued a notice of intent to prepare an Environmental Impact Statement and initiate Section 106 Consultation for a potential investment and construction of a northern hemisphere ELT, including public scoping meetings and comment period
- Working with NOIRLab to define their role in data management for a US-ELT program.

Status of Maunakea and TMT

We have been engaged - in discussions within NSF, with other Maunakea Observatories, with members of the Native Hawaiian community, and with the IfA at UH about astronomy on Maunakea.

State of Hawaii is moving the management of Maunakea to a new Oversight Authority: 11 members representing a broad range of interests and expertise, including, importantly, a recognized practitioner of Native Hawaiian traditional and customary practices.

NSF is committed to building a stronger relationship with the Hawaiian community.

Cosmic Microwave Background – Stage 4 (CMB-S4) probe the earliest moments of the universe, trace seeds of galaxy formation. (50% split w/DOE)

Next-Gen Very Large Array (ngVLA) formation and orbital motion of planets and complex pre-biotic molecules, chart assembly, structure and evolution of the earliest galaxies, formation and evolution of black holes, Earth orientation (GPS and global navigation satellites).

CMB-S4

- Team has been funded to develop alternative designs with different infrastructure footprints at South Pole.
- Regular engagement between NSF / DOE / OPP

ngVLA

- Prototype ngVLA antenna nearly complete.
- Internal NRAO preliminary design review for ngVLA antenna in Dec 2022
- NRAO design and development program office funded for FY23.
- MOU between NRAO and UNAM for ngVLA activities signed Nov 2022.
- Regular engagement with ngVLA team and NSF to develop

Recommendations: Community Portfolio reviews

NSF should establish a regular cadence of reviews of operational portfolio, at frequency that is sufficient to respond to changes in scientific and strategic priorities in the field (2 portfolio reviews per decade).

- We agree! Schedule for the next 6 months is quite intense.
- Planning a “committee of visitors” meeting in Fall 2023 and we would like to combine this with a portfolio review that considers facilities.

Astronomical observatories advance physics, chemistry, atmospheric science, and potentially biology.

- The standard model of particle physics fails to explain 95% of the universe; an uncertainty of 10^{-23} in vacuum energy results in dramatically different models: constant *vs* accelerating expansion of universe. Unmeasurable in labs, but ELTs provide multiple ways to explore DM / DE: lensing, dwarf galaxies, SN on astronomical scales.

- Extreme temperature and extreme density laboratories for chemistry and quantum mechanics.

- Spectroscopy of exoplanet atmospheres may help advance understanding origin of life, erased on Earth.

- Earth orientation (ngVLA) supports high fidelity GPS and technology transfer (detectors, lasers, photonics) enriches lives.

Committed to supporting recommendations from Astro2020 whenever possible. (They represent the ultimate peer review process)