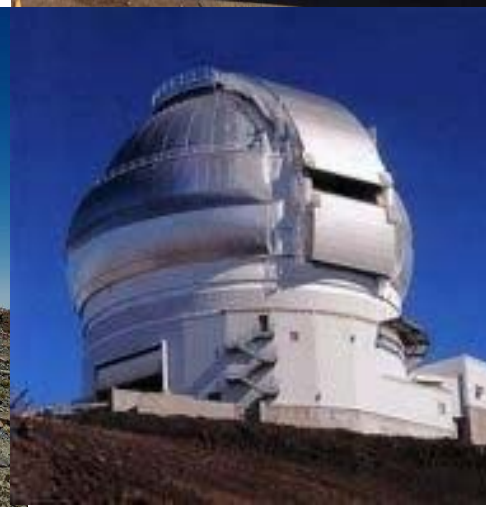
NSF/AST Update AAAC

Ralph Gaume

NSF Division of Astronomical Sciences

January 26, 2021



Question: So, what's been happening in NSF, MPS, and AST since September 21, 2020?

Answer: A whole lot of things!

Highlights

2020 Nobel Prize in Physics

PRESS RELEASE

6 October 2020

The Nobel Prize in Physics 2020

The Royal Swedish Academy of Sciences has decided to award the Nobel Prize in Physics 2020 with one half to

Roger Penrose

University of Oxford, UK

"for the discovery that black hole formation is a robust prediction of the general theory of relativity"

and the other half jointly to

Reinhard Genzel

Max Planck Institute for Extraterrestrial Physics, Garching, Germany and University of California, Berkeley, USA

Andrea Ghez

University of California, Los Angeles, USA

"for the discovery of a supermassive compact object at the centre of our galaxy"

Black holes and the Milky Way's darkest secret

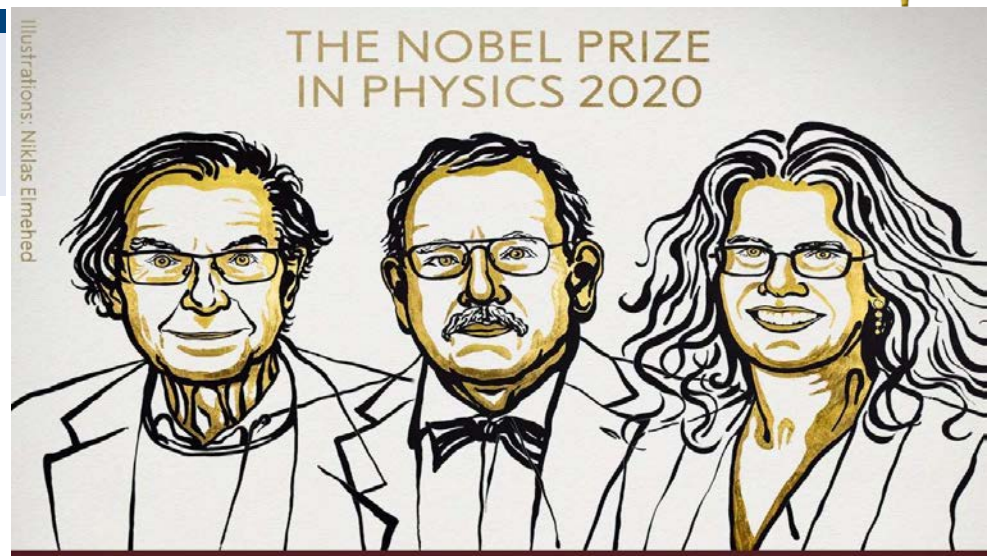
Three Laureates share this year's Nobel Prize in Physics for their discoveries about one of the most exotic phenomena in the universe, the black hole. Roger Penrose showed that the general theory of relativity leads to the formation of black holes. Reinhard Genzel and Andrea Ghez discovered that an invisible and extremely heavy object governs the orbits of stars at the centre of our galaxy. A supermassive black hole is the only currently known explanation.

Roger Penrose used ingenious mathematical methods in his proof that black holes are a direct consequence of Albert Einstein's general theory of relativity. Einstein did not himself believe that black holes really exist, these super-heavyweight monsters that capture everything that

dizzying speeds. Around four million solar masses are packed together in a region no larger than our solar system.

Using the world's largest telescopes, Genzel and Ghez developed methods to see through the huge clouds of interstellar gas and dust to the centre of the Milky Way. Stretching the limits of technology, they refined new techniques to compensate for distortions caused by the Earth's atmosphere, building unique instruments and committing themselves to long-term research. Their pioneering work has given us the most convincing evidence yet of a supermassive black hole at the centre of the Milky Way.

"The discoveries of this year's Laureates have broken new ground in the study of compact and supermassive objects. But these exotic objects still pose many questions that



Roger Penrose: 6 DMS & 11 PHY awards 1984 – 2008

Reinhard Genzel: 8 AST awards 1982 – 1987

Andrea Ghez: 10 AST awards 1994 – 2019

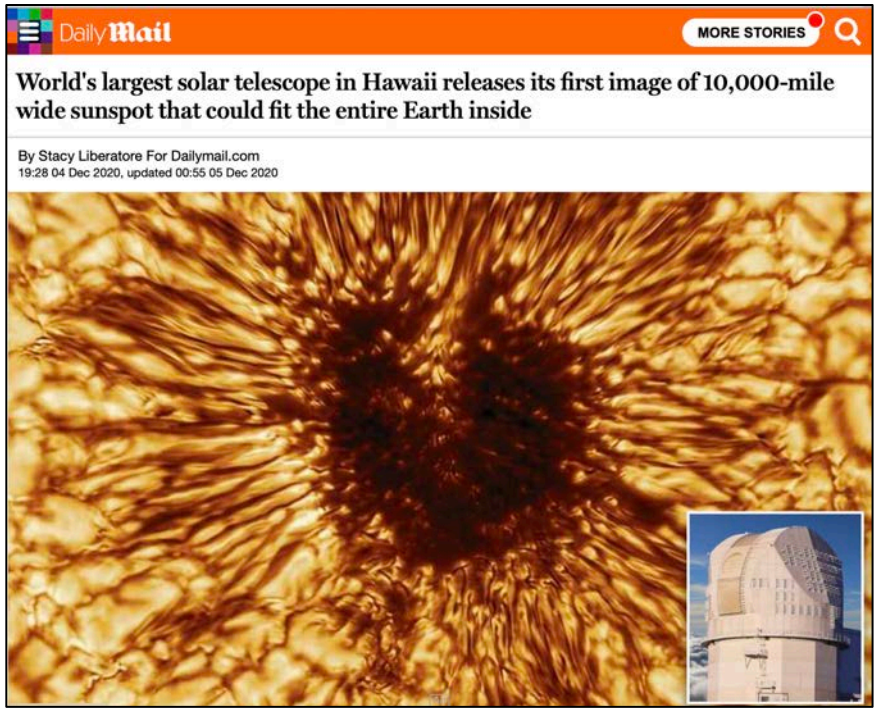
Fed News Radio discussion with A. Ghez & G. Langston

https://federalnewsnetwork.com/fedtalk/2021/01/federally-funding-world-class-scientific-research/

Daniel K. Inouye Solar Telescope

- March 17, 2020: DKIST site construction halted
- July 6, 2020: Project transitioned to a phase 1b return-to-work that allows for two overlapping shifts of approximately 35 personnel per shift; ~60-70% efficient
- June 22, 2020: NSF Acting Director authorized $9.4M in Management Reserve
- Primary activities: IT&C on Wavefront Correction System and 4 facility instruments (VBI, ViSP, DL-NIRSP, Cryo-NIRSP)
- Current Start of Operations milestone is May 2021, but expected to slip due to COVID-19 impacts

- Press Release – Dec. 8, 2020
  - Highest resolution image of a sunspot ever recorded
  - Diffraction-limited image taken earlier in the year (Jan. 28) with the context imager
  - Released in conjunction with DKIST overview journal paper: Rimmele, T.R. et al., 2020, Sol Phys, 295, 172



Vera C. Rubin Observatory

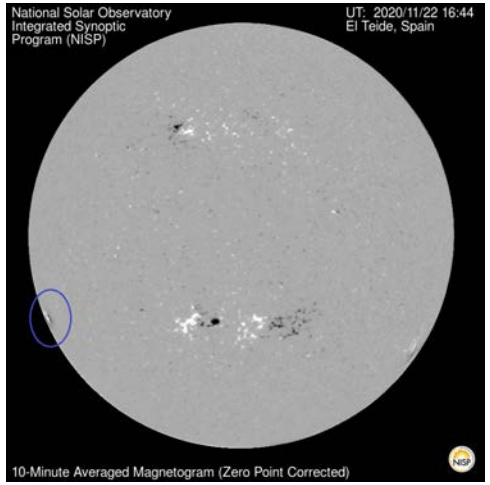
- Ramp up of construction activity on summit began as planned on September 28 under COVID protocols with excellent progress.
- Currently, work crew size about half pre-pandemic level.
- Critical path subsystem, Telescope Mount Assembly (TMA), currently restarting work, expected to be in full swing in February.
- Expected: COVID delay about one year with detailed replan this year.
- Pre-operations standing up Interim Data Facility in Google cloud, and US Data Facility management to be led by SLAC in coordination with AURA.
- Dome now substantially closed, protecting TMA.

National Solar Observatory

- NSO is preparing for DKIST Operations and Commissioning Phase
  - First round of observing proposals received and have been evaluated
- GONG and Dunn Solar Telescope are continuing to operate
  - GONG is renewing an IAA with NOAA/SWPC
- NSO to transfer Sac Peak relocatable Housing Units to White Sands Habitat for Humanity – first units should transfer in Jan/Feb 2021
- GONG measures complex “Thanksgiving Sunspot” on the farside of the sun before it can be seen on the Earth facing disk

Solar astronomers can now predict future sunspots. There should be a big one in a couple of days

The surface of the Sun is a turbulent dance of gravity, plasma, and magnetic fields. Much like the weather on Earth, its behavior can seem unpredictable, but there are patterns to be found when you look closely.



Monster sunspot AR2786 swings into better view

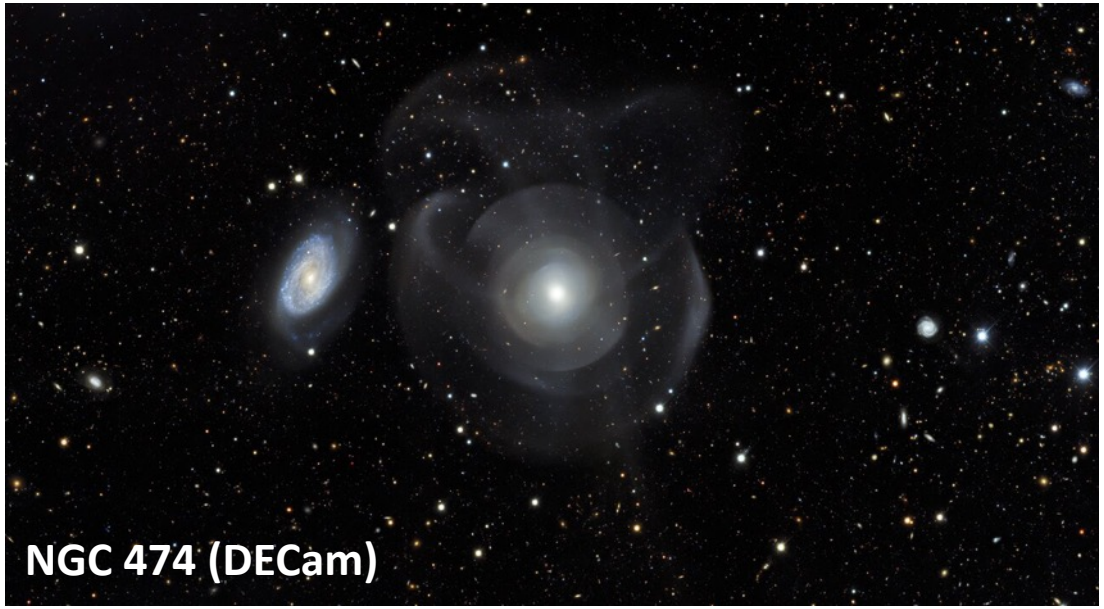
Posted by **Eleanor Imster** *and* **Deborah Byrd** *in* **SPACE | SUN | TODAY'S IMAGE** | November 29, 2020

The sun is becoming active again as it enters Solar Cycle 25. This week, scientists' predictions of sunspots were proven via photos from astronomers around the world. Giant sunspot AR2786 can be viewed with proper filters and may create strong flares that reach Earth.

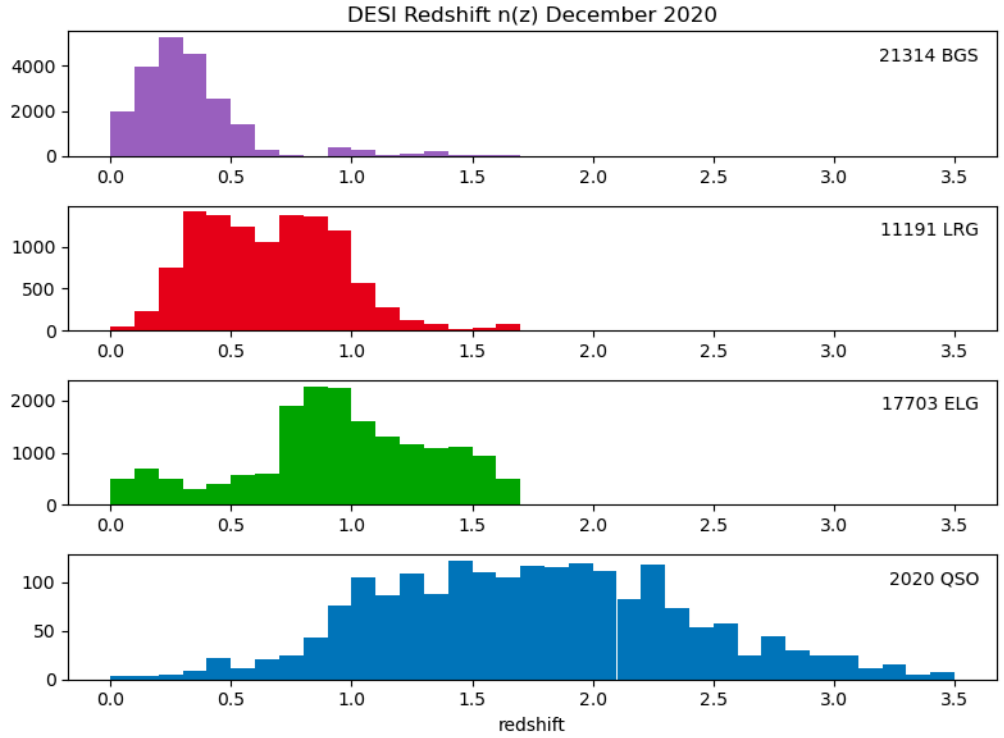
Sharing is caring!

NOIRLab: MSO and CSDC

- Kitt Peak and Cerro Tololo Observatories operating since Sept. 2020
  1. Mayall: DESI preparing for start of 5-year Dark Energy Spectroscopic Survey in early 2021
  2. WIYN: NEID commissioning continues with shared risk observing available in 2021B
  3. SOAR: AEON-mode now provides queue-based observing with support for time domain alerts
  4. Blanco/CSDC: Dark Energy Survey (DES) DR2 release



DES: DR2 public release (Jan 2021) of images and object catalogs with data on almost *700 million* objects
(DR2 processed by NCSA and hosted by CSDC/Astro Data Lab)

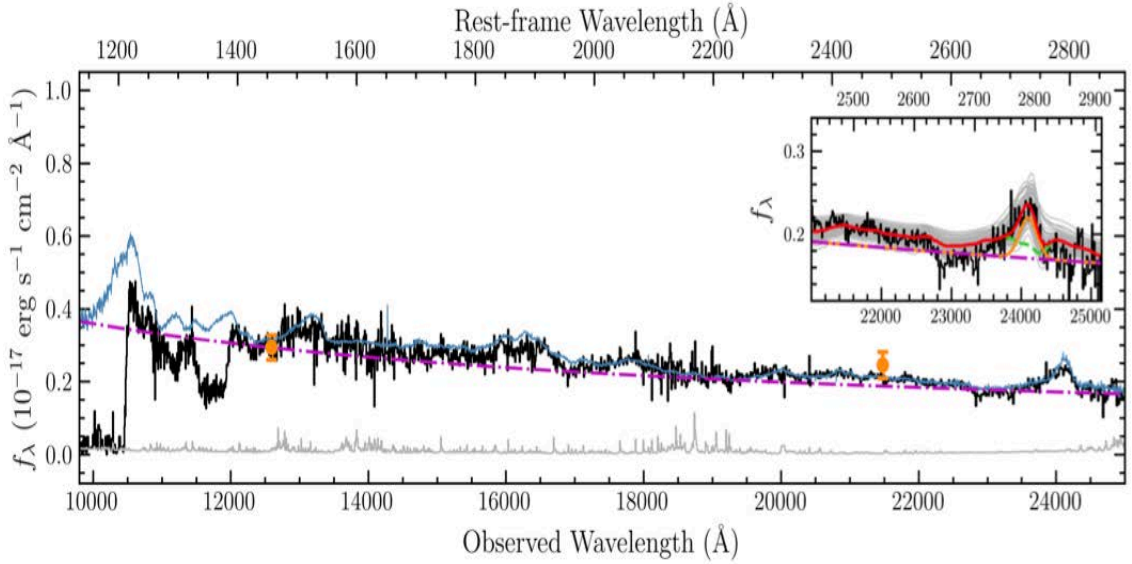


DESI: More than 50,000 redshifts measured
(DESI Collaboration, December 2020)

International Gemini Observatory

- Current status:
  - Gemini-N has been conducting nighttime observations since May 19, 2020.
  - Gemini-S returned to science on Oct 22, 2020.
  - The Gemini offices in Hilo and La Serena are operating under mostly telework.
  - Ongoing instrument development programs include:
    - GHOST (high-resolution spectroscopy),
    - SCORPIO (multi-channel time–domain imaging and spectroscopy, g, r, i, z, Y, J, H, and K_S)
    - GNAO (Gemini-N Adaptive Optics upgrade)

- Science Highlight:
  - Wang+ (2021), *A Luminous Quasar at z = 7.642*.
  - The Earliest Supermassive Black Hole detected in the Universe; 670 million years after Big Bang, 1.6 x 10^9 $M_\odot$.
  - "The presence of such a massive black hole so early in the Universe's history challenges theories of black hole formation".



Facilities: Gemini (FLAMINGOS-2), Gemini (GNIRS), Keck (NIRES), ALMA, Magellan (FIRE)

Green Bank Observatory

- Current Status
  - Operational: Science operations continue with COVID-19 protocols in place and ~50% of the staff currently on-site; travel paused, on-site workshops/meetings canceled or made virtual
  - Numerous “Community Zoom Updates” offered since spring 2020 have been well attended
  - Announcement in response to collapse of Arecibo (sympathy, expression of support)
- Science Highlight

Composite image by Kat Barger, with GBT data shown in orange; background Milky Way Panorama (credit ESO/S. Brunier.)

Sensitive, large-scale map of High Velocity Cloud Complex A (HVC-A) sheds light on how galaxies capture material:

- Understanding hydrodynamic instabilities during interaction with Milky Way halo
- Implications for prolonging star formation in galaxies (HVC-A > 2×10^6 M_{sol})

K. Barger *et al.* (October 2020) *ApJ*, 902, 154
Highlighted at AAS 237 press conference;
Link to GBO release

The Very Large Array (VLA)

Currently operating as usual

- Science operations have continued, uninterrupted; including observer support and array-configuration changes
- NRAO management devised Covid-19-safe practices for maintenance and operations
- The Visitor Center is closed

Data indicate how radio galaxies exist in the crowded environment of a cluster of galaxies

- The images (right) show jets interacting with gas in the cluster (being stopped, blown back, etc.)
- Images help understand the complex environment of clusters, the largest gravitationally-bound structures in the universe, and which harbor a variety of still poorly-understood phenomena

M. Gendron-Marsolais *et al*. 2020. *MNRAS* 499, 5791

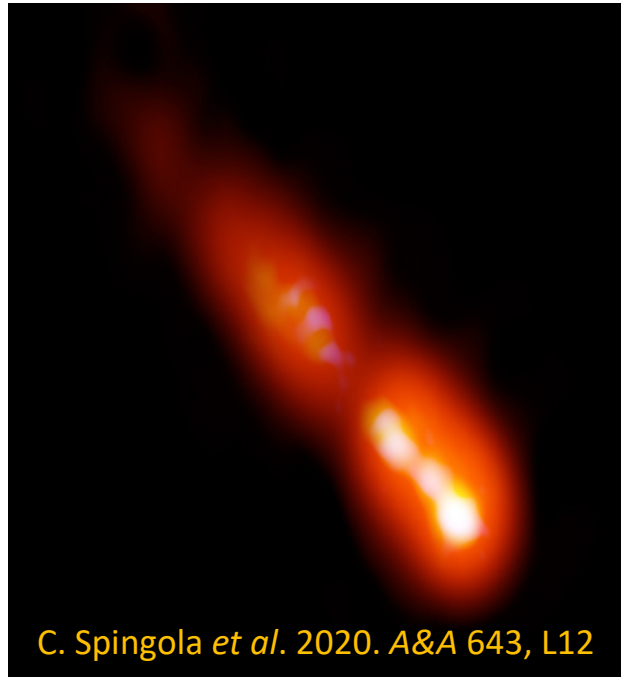
The Very Long Baseline Array (VLBA)

Currently operating as usual

- In 2020, science operations continued, uninterrupted, at all 10 VLBA Stations across the continental USA, HI, and the US VI
- Hurricane Maria repairs have been completed at St. Croix, and all 10 stations are now connected via fiber

VLBA detected a relativistic jet from a radio-loud quasar at 12.8 Bly

- The 1,600 ly-long jet, powered by a supermassive black hole located at the lower right corner, moves outward to the upper left at 3/4 the speed of light
- This is the brightest radio-emitting blazar seen at that distance
- The observation provides observational support for theoretical understanding of why these objects are so rare, especially in the early universe



C. Spingola *et al*. 2020. *A&A* 643, L12

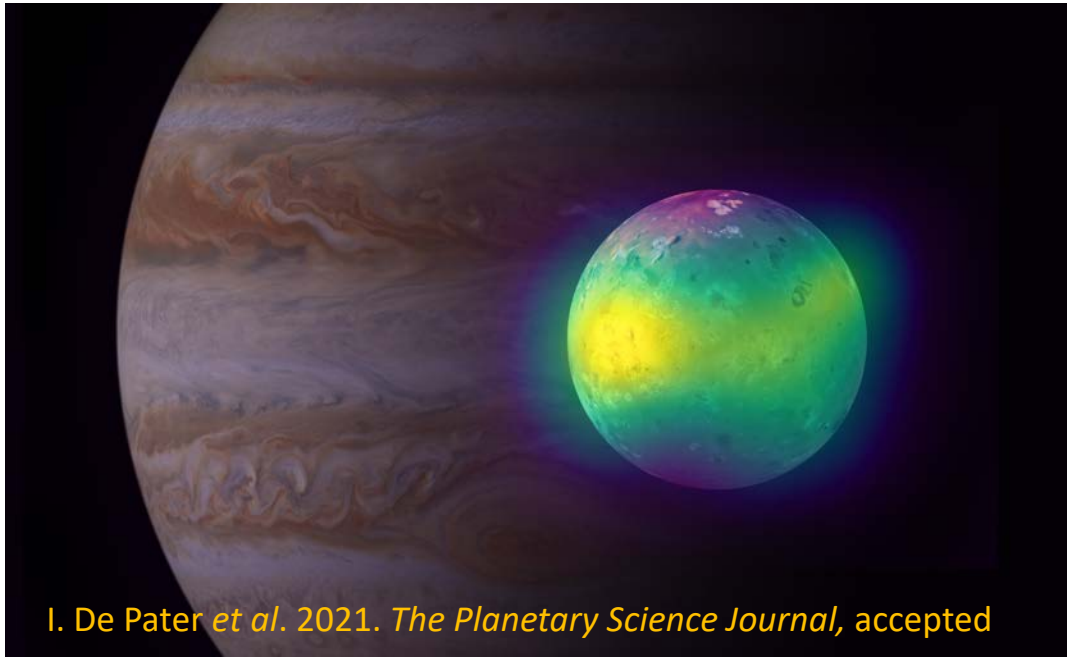
The Atacama Large Millimeter/submillimeter Array (ALMA)

ALMA has been shut down since Mid-March

- In final step of startup: Individual antennas are being powered
- Proceeding nominally, with only minor issues to date
- All 66 antennas should be on-line with science operations expected by mid-March
- Safety of staff is of paramount importance

ALMA shows for 1st time how Io's volcanoes impact its atmosphere

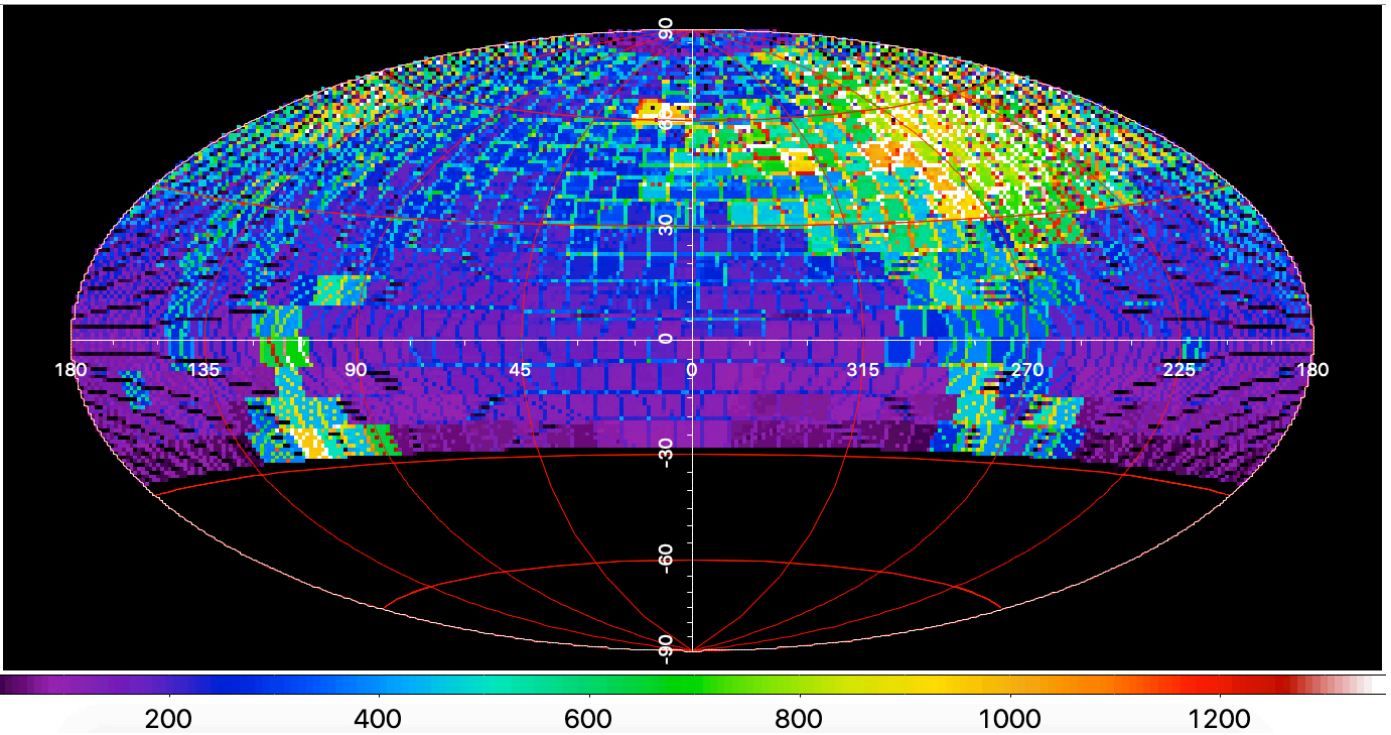
- Previously unknown which processes drive Io's atmosphere
- ALMA detected plumes of sulfur dioxide and sulfur monoxide from volcanoes, producing 30-50% of atmosphere



I. De Pater *et al*. 2021. *The Planetary Science Journal,* accepted

Mid-Scale Activity

- Current Status
  - Approximately two dozen mid-scale projects supported in AST by the MSIP and MSRI programs are adjusting for the pandemic impact and the loss of Arecibo. Meanwhile, science continues.
- Science Highlight



ZTF_r filter DR4 sky depth-of-coverage in Equatorial coordinates

The Zwicky Transient Facility (ZTF) and IPAC at CalTech announced the fourth ZTF Public Data Release on December 9th, 2020. Now available to everyone are ~18.5 million single-exposure images, ~144,000 co-added images, source catalog files containing ~296 billion sources, and ~2.7 billion light-curves.

See https://www.ztf.caltech.edu/page/dr4 and https://irsa.ipac.caltech.edu/Missions/ztf.html

Personnel

Directorate for Mathematical and Physical Sciences (MPS)

- Anne Kinney, Assistant Director (AD) for MPS, left NSF May 1, to become the GSFC Deputy Director in May 2020.

- Sean Jones, was appointed AD for MPS on Sept. 29.

- Tie Luo, was appointed Deputy AD for MPS on Jan. 17, 2021.

Division of Astronomical Sciences (AST)

Management Team

Ralph Gaume
Division Director

James Neff
Deputy Division Director

Craig McClure
Program Support Manager

Donna O'Malley
Financial & Operations Specialist

Administration

Elizabeth Pentecost
Project Administrator

Matthew Viau
Program Analyst

Allison Farrow
Program Analyst

Renee Adonteng
Program Analyst

Individual Investigator Programs (IIP)

Hans Krimm
Program Director

IIP Coordinator; Lead: Stellar Astro.

Nigel Sharp
Program Director

Lead: Estragalactic & Cosmology; cross-NSF programs

Glen Langston
Program Director

Lead: Galactic Astronomy

Harshal Gupta
Program Director

Lead: Postdoctoral Fellowships; Lab Astro

Luke Sollitt
Program Director

Lead: Planetary Astronomy

Sarah Higdon
Program Director

Lead: CAREER; AAG

Zoran Ninkov
Program Director

Lead: Advanced Technology & Instrumentation; AAG

Marc Seigar
Program Director

Lead: REU; AAG

James Higdon
Program Director

AAG; SAA, EXC

Facilities, Mid-Scale, & MREFC Projects

Nigel Sharp
Program Director

MSIP; MSRI

David Boboltz
Program Director

DKIST

Christopher Davis
Program Director

NOIRLab

Edward Ajhar
Program Director

Vera C. Rubin Observatory

Joe Pesce
Program Director

NRAO; ALMA

Harshal Gupta
Program Director

GBO

Ashley VanderLey
Program Director

Arecibo

Martin Still
Program Director

Gemini

Carrie Black
Program Director

NSO

Alison Peck
Program Director

Arecibo

ESM

Ashley VanderLey
Program Director

Jonathan Williams
Program Director

David Morris
AAAS Fellow

New positions in AST

- AST Senior Advisor for Facilities (closed, interviews underway)
- AST Division Director
  - Opened January 15th 2021
  - Closes April 16th 2021
  - Suggested Candidates? Email Sean Jones (sjones@nsf.gov),Tie Luo (tluo@nsf.gov), & Ralph Gaume (rgaume@nsf.gov)
- AST Jobs Announcements on USAJOBS very soon:
  - AST Grants support: hired as VSEE, Fed. Temp., or IPA
  - AST Facilities: hired as permanent, Rubin Observatory support
  - AST Grants support: hired as permanent Fed. Employee

Programs

AST Division Programs

Individual Investigators
(Lead: Hans Krimm)

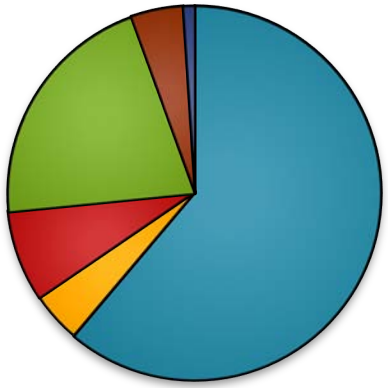
Research
- AAG
- CAREER
- AAPF

Technology/ Instrumentation
- ATI
- MRI

Education and Special Programs
- REU
- ESP

Mid-scale
(Lead: Nigel Sharp)

- MSIP
- MSRI



Facilities

- NRAO
- ALMA
- GBO
- Arecibo
- NSO
- NOIR Lab
- Gemini N & S
- MidScale Obs

MREFC

- DKIST
- Rubin

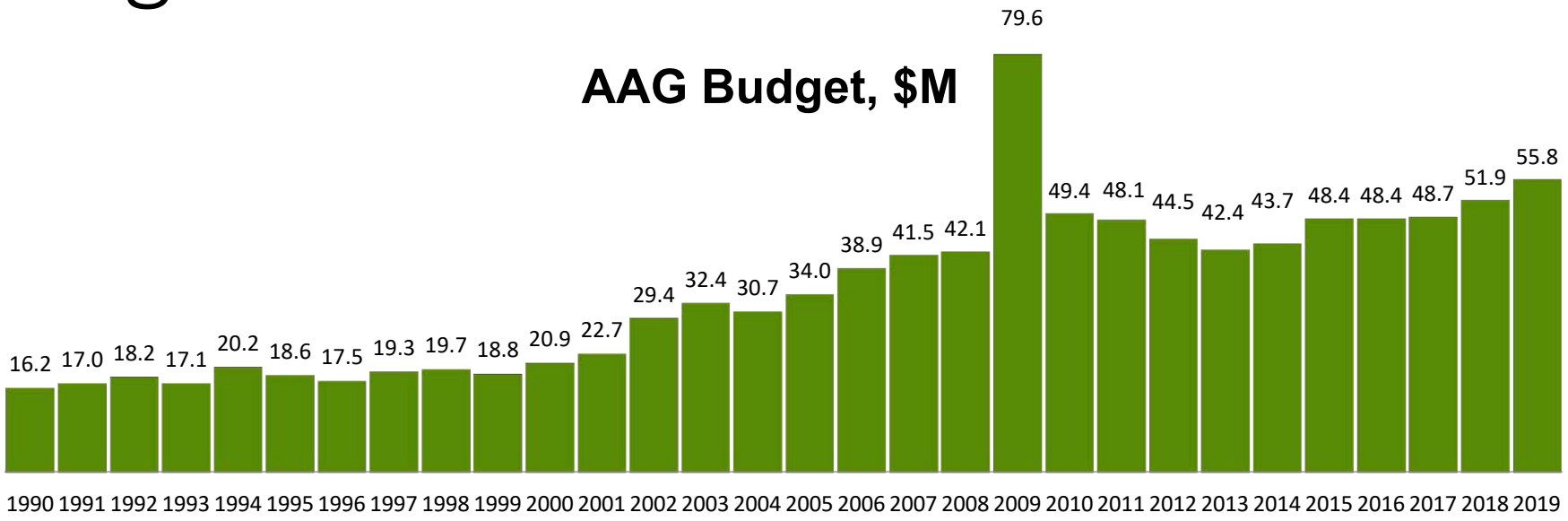
FY 2021 Programs and Deadlines

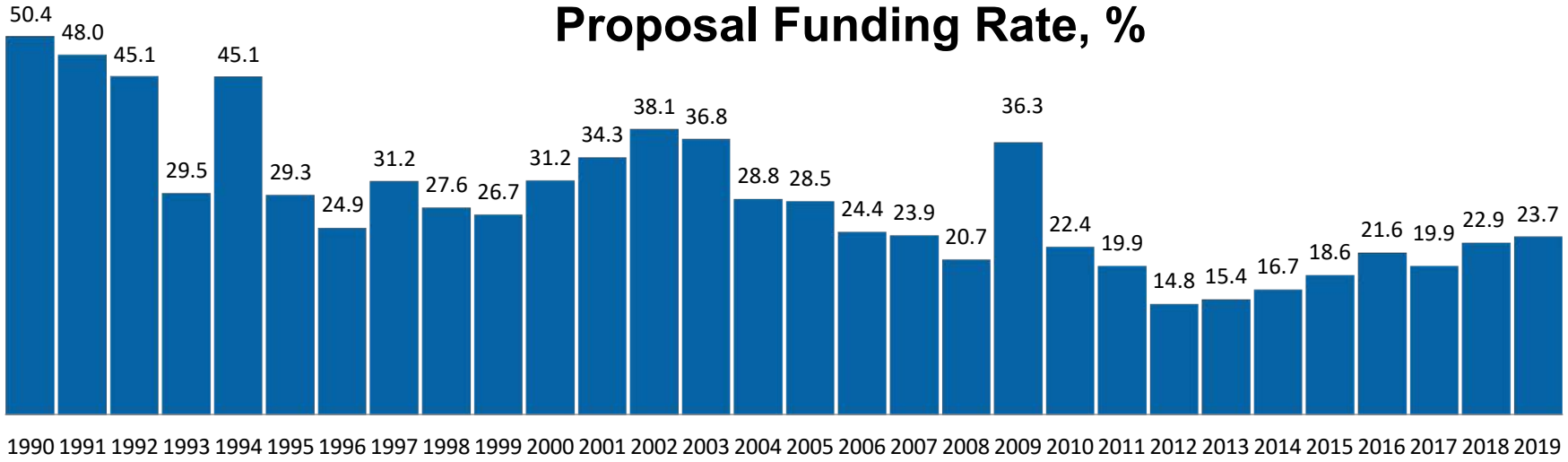
Acronym	Program Name	Deadline	Program Lead
CAREER*	Faculty Early Career Development Program	27 Jul 20	S. Higdon
REU Sites*	Research Experiences for Undergraduates	28 Aug 20	Seigar
AAPF	Astronomy & Astrophysics Postdoctoral Fellowships	15 Oct 20	Gupta
AAG	Astronomy & Astrophysics Research Grants	16 Nov 20	Sharp (EXC), Langston (GAL), Krimm (SAA), Sollitt (PLA)
ATI	Advanced Technology and Instrumentation	16 Nov 20	Ninkov
MRI*	Major Research Infrastructure	19 Jan 21	Ninkov
MSRI-2*	Mid-scale Research Infrastructure-2	LOI: 03 Feb 21 Pre: 05 Mar 21 Full: 20 Sept 21(if invited)	Sharp
MSRI-1*	Mid-scale Research Infrastructure-1	Pre: 07 Jan 21, 23 Apr 21 (if invited)	Sharp

* NSF-wide solicitations

Budget: FY 2020

AAG program stats



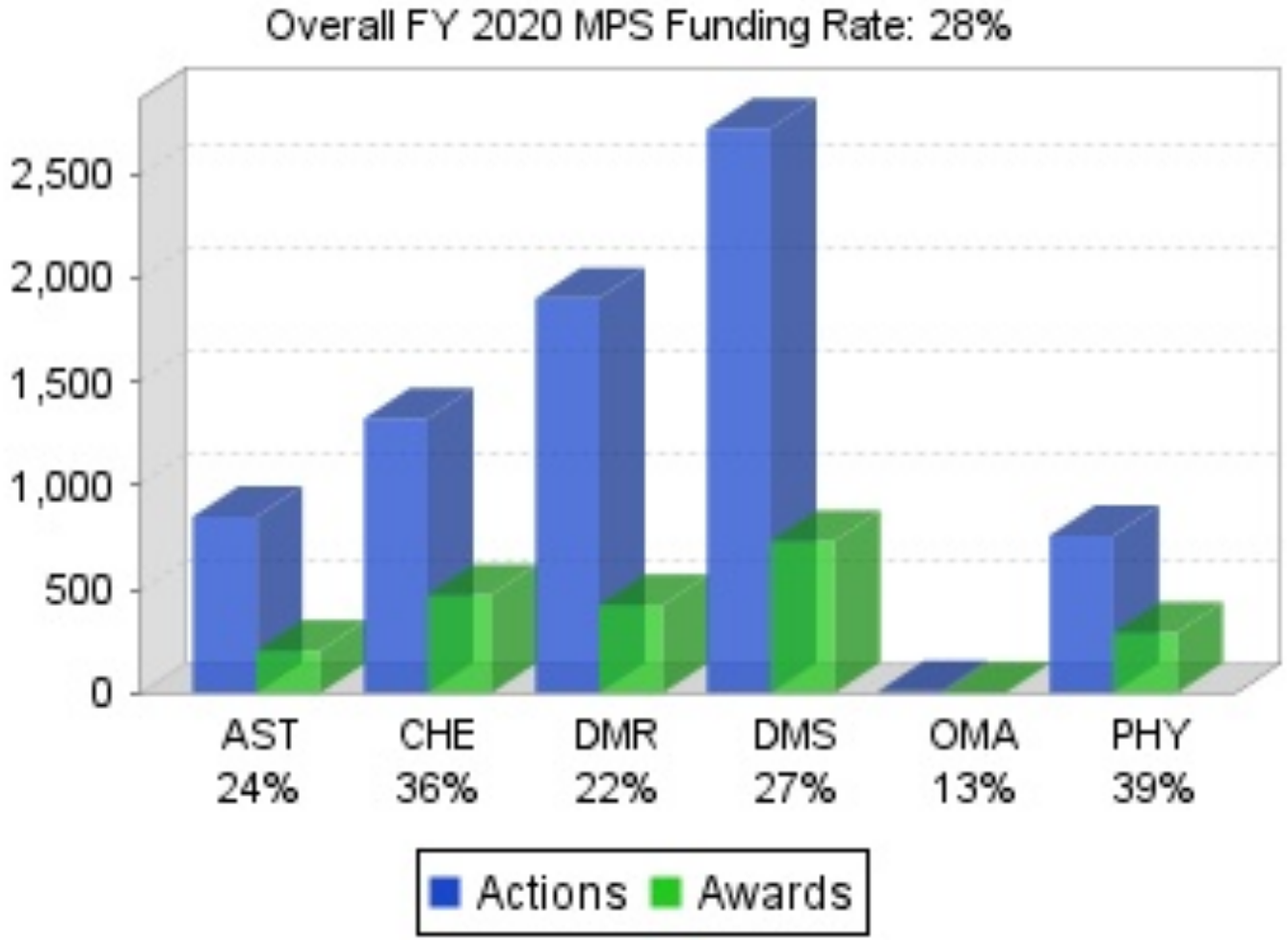


2020: Between 2018 and 2019 levels

MPS funding stats for FY 2020

Overall FY 2020 MPS funding rate: 28%

Division	Funding Rate	Actions	Awards
AST	24%	850	203
CHE	36%	1322	473
DMR	22%	1902	427
DMS	27%	2718	733
OMA	13%	8	1
PHY	39%	760	294



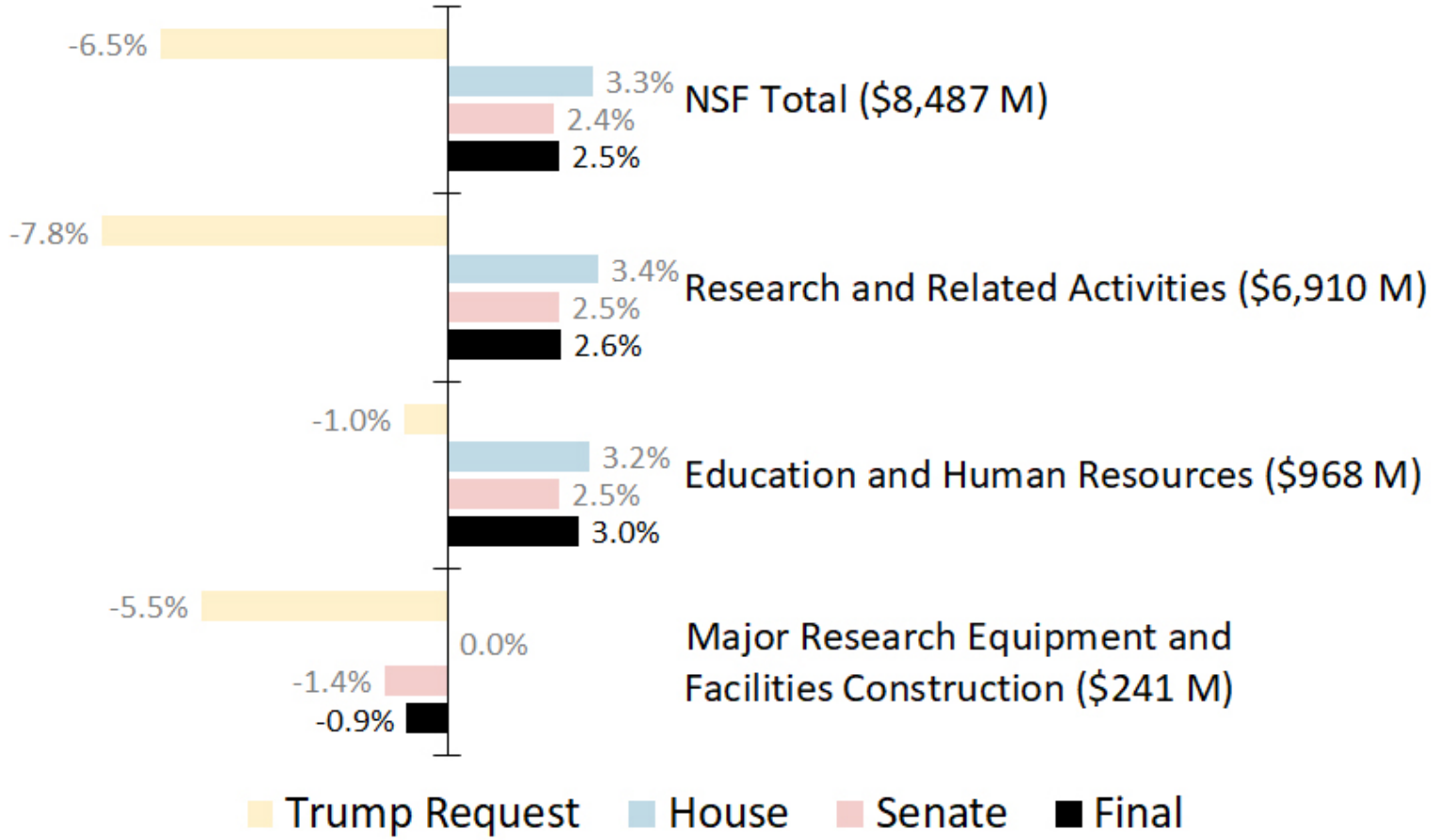
Budget: FY 2021

FY 2021 Budget

- Continuing Resolutions through Dec 27th .
- Enacted Foundation appropriation increases R&RA 2.6% (to $6,910M).
- MREFC line fully funds Rubin Observatory at request level.
- AST/AAG (grants program): should be reasonable year.

FY21 Appropriations: National Science Foundation

$ in ( ) are the FY21 amounts



American Institute of Physics | aip.org/fyi

Budget: FY 2021
AST-related
report language

House report language (RG synopsis)

- Allocate no less than FY 2020 levels to existing research infrastructure. *The Committee instructs NSF to sustain support for programs and scientific facilities funded by the Astronomical Sciences Division at no less than fiscal year 2020 levels to maintain full scientific and educational operations.*
- Keep Committee informed of O&M partner cost-sharing. Divestment of facilities proposed as part of future NSF budget request.
- Support existing astronomical facilities through WoU-MMA Big Idea.
- Astro 2020: Supports preliminary investments in emerging priority facilities, *such as the next generation Very Large Array and the Extremely Large Telescopes.* Committee encourages NSF to continue providing preparatory funding over the coming year.
- Continue to partner with academic institutions to operate Dunn Solar Telescope.
- Within 90 days report to Committee on implementation of Facility Operation Transition pilot program.
- Rubin Obs: recommend funding at requested level.
- Mid-Scale Research Infrastructure: Funded at requested level.
- Infrastructure Planning: *The Committee encourages NSF to develop a comprehensive and prioritized list of large-scale facilities requested by NSF-supported science disciplines.*

Senate report language (RG synopsis)

- Committee expects NSF to continue support for astronomy facilities and instrumentation while preparing for facility upgrades and Astro 2020. Explore partnership when feasible, including for next generation optical and infrared telescopes.
- DKIST: supports at request, encourages NSF support for ancillary partnerships that have made construction successful.
- Continue working with NSO and academic community to operate Dunn Solar Telescope.
- Fully fund Facility Operation Transition activity.
- Supports investment in the Spectrum Innovation Initiative to realize goals without negatively impacting radio astronomy.
- Green Bank Observatory: Committee encourages development of multi-agency management plans for GBO.
- Rubin Observatory: support at request level.
- Mid-Scale Research Infrastructure: support at $10M above request level.
- Infrastructure planning: Understand the impact of extended construction shutdowns and continue planning and budgeting for next generation of major facilities

Omnibus language (RG synopsis)

- Maintain Core Research (including astronomy facilities) at no less than FY 2020 level.
- Support DKIST budget at request level and ancillary academic partnerships.
- Support Facility Operation Transition at budget request level.
- Support Spectrum Innovation Initiative.
- Green Bank Observatory: Supports NSF effort to develop multi-agency plans. Funding at no less than request level.
- Rubin Observatory: funded at the requested level
- Mid-scale Research Infrastructure funded at $76.25M. Encouraged to award at least one mid-scale research infrastructure led by an institution in an EPSCoR State.
- Infrastructure Planning: Include in annual budget request to Congress plans for construction, repair, & upgrades to national research facilities. *In lieu of House language regarding infrastructure planning, NSF and the Board are encouraged to engage in robust planning for and investments in the next generation of world class facilities, including any projects recommended by the upcoming Astrophysics decadal survey.*

Omnibus language

<u>Arecibo Observatory (AO) -</u> The significant loss caused by the collapse of the 305-meter radio telescope at the Arecibo Observatory in Arecibo, Puerto Rico, is devastating. During its 57 years in operation, the telescope was an integral part of U.S. capabilities to advance scientific research and served as an iconic, beloved site for the residents of Puerto Rico and the scientific community. With this in mind and keeping safety as the number one priority, NSF is directed to report to the Committees within 60 days of enactment of this Act on the causes and extent of the damage, the plan to remove debris in a safe and environmentally sound way, the preservation of the associated AO facilities and surrounding areas, and the process for determining whether to establish comparable technology at the site, along with any associated cost estimates. NSF shall keep the Committees informed of any other activities related to this facility.

Questions?