



Space Studies Board

March 21, 2022

Debra Fischer

NSF MPS/AST DD

Facility Updates and Science News



The National Radio Astronomy Observatory (NRAO)



- VLA Sky Survey continues
- VLA and VLBA fully operational
- NRAO's CDL supports the evolution of technology and expertise to build the next generation of radio astronomy instruments.

Karl G. Jansky Very
Large Array (VLA)



Very Long Baseline Array
(VLBA)



NRAO Central
Development Lab



VLA image of the M87 radio jet

*Credit: Pasetto et al., Sophia Dagnello,
NRAO/AUI/NSF.*

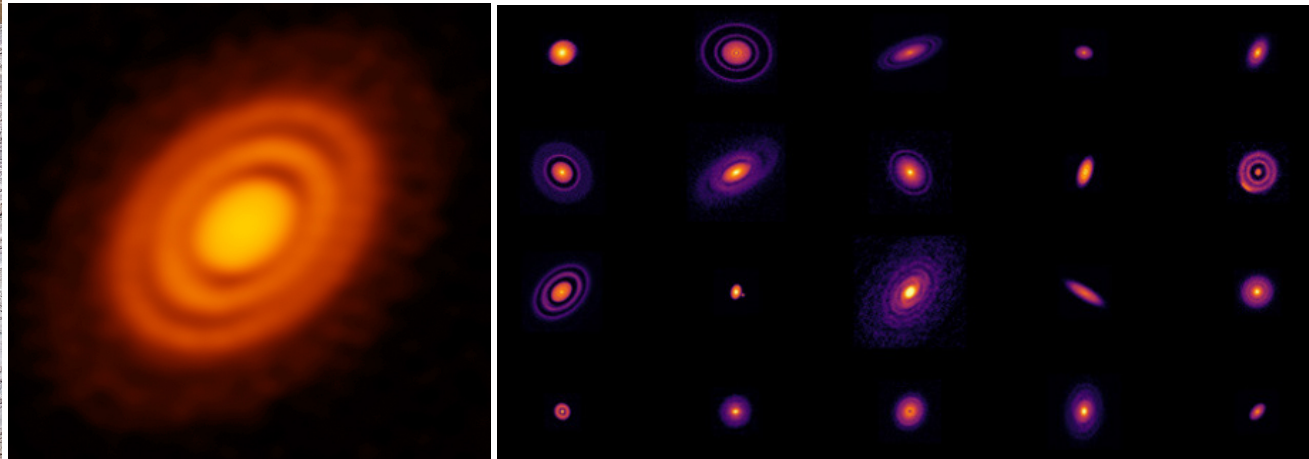
This is the first 3-D study of the M87 jet. A corkscrew-like helical structure seen in the inner part of the jet, which originates at the core of the galaxy where a supermassive black hole resides.

Polarization from the jet's magnetic field measured out to $\sim 3,300$ light years, the farthest ever. The magnetic field is expected to weaken with distance from the central black hole but does not (not only in M87 but in jets in general). This study indicates flow instabilities that may make the magnetic field more ordered and compressed, producing the helical structure.

The Atacama Large Millimeter/submillimeter Array (ALMA)



- ALMA is fully operational
- Continuing to break records: 1,765 Cycle 8 proposals for 26,000 hours of 12-m time
- Wideband sensitivity upgrade for Band 6 receiver approved

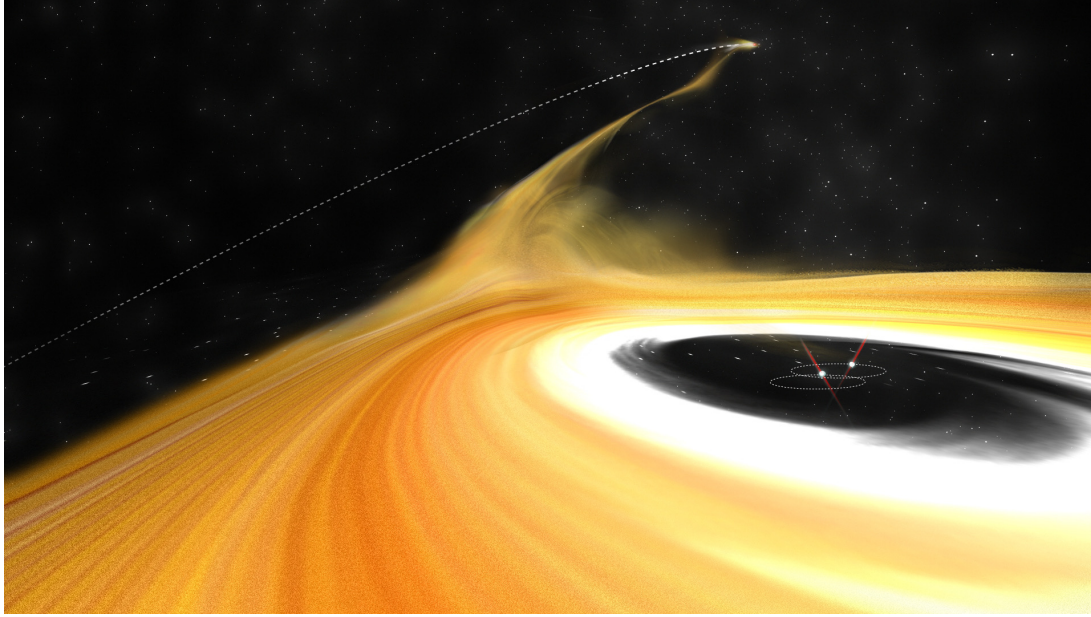


ALMA / APEX
contributed to EHT
image of BH in M87.

High spatial resolution of protoplanetary disks for HL Tau (2015) and studies of disk demographics and stellar age.



The Atacama Large Millimeter/submillimeter Array (ALMA)



An intruder object

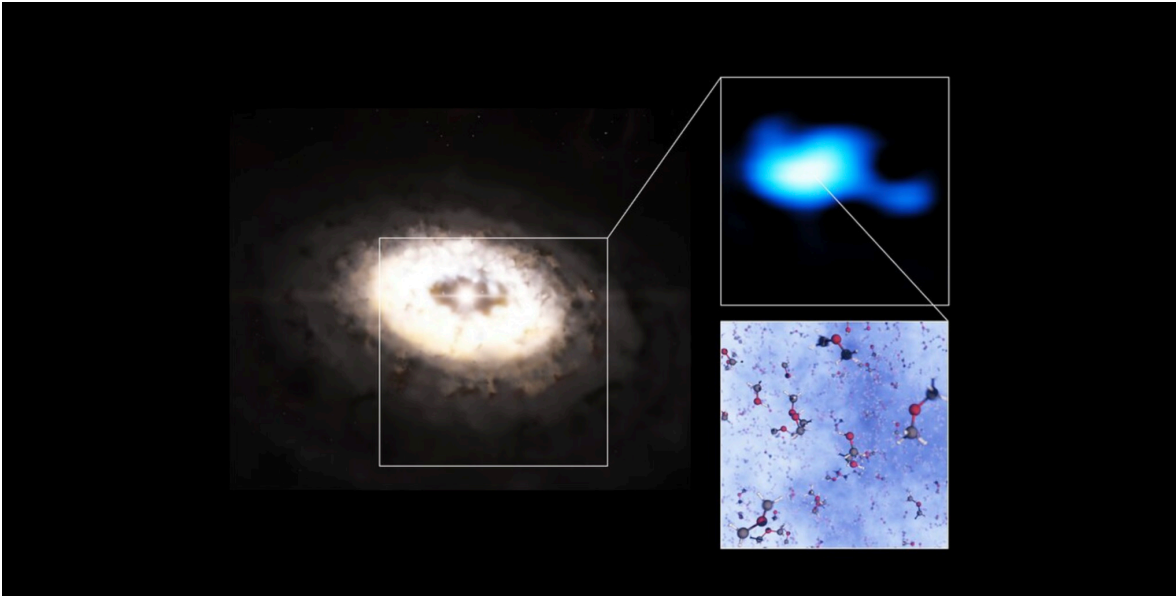
caught disrupting protoplanetary disk of a binary protostar in Canis Majoris.

Observational data from the Subaru Telescope, VLA, and ALMA suggest the intruder object was responsible for the creation of these gaseous streams, and its “visit” may have other impacts on the growth and development of planets in the star system.

Dong et. al, (2022) “A likely flyby of binary protostar Z CMa Caught in Action,” Nature Astronomy



The Atacama Large Millimeter/submillimeter Array (ALMA)



Dimethyl Ether in protoplanetary disk

With nine atoms, this is the largest molecule identified in such a disc to date. It is also a precursor of larger organic molecules that can lead to the emergence of life.

Brunken et al. 2022, “A major asymmetric ice trap in a planet-forming disk:

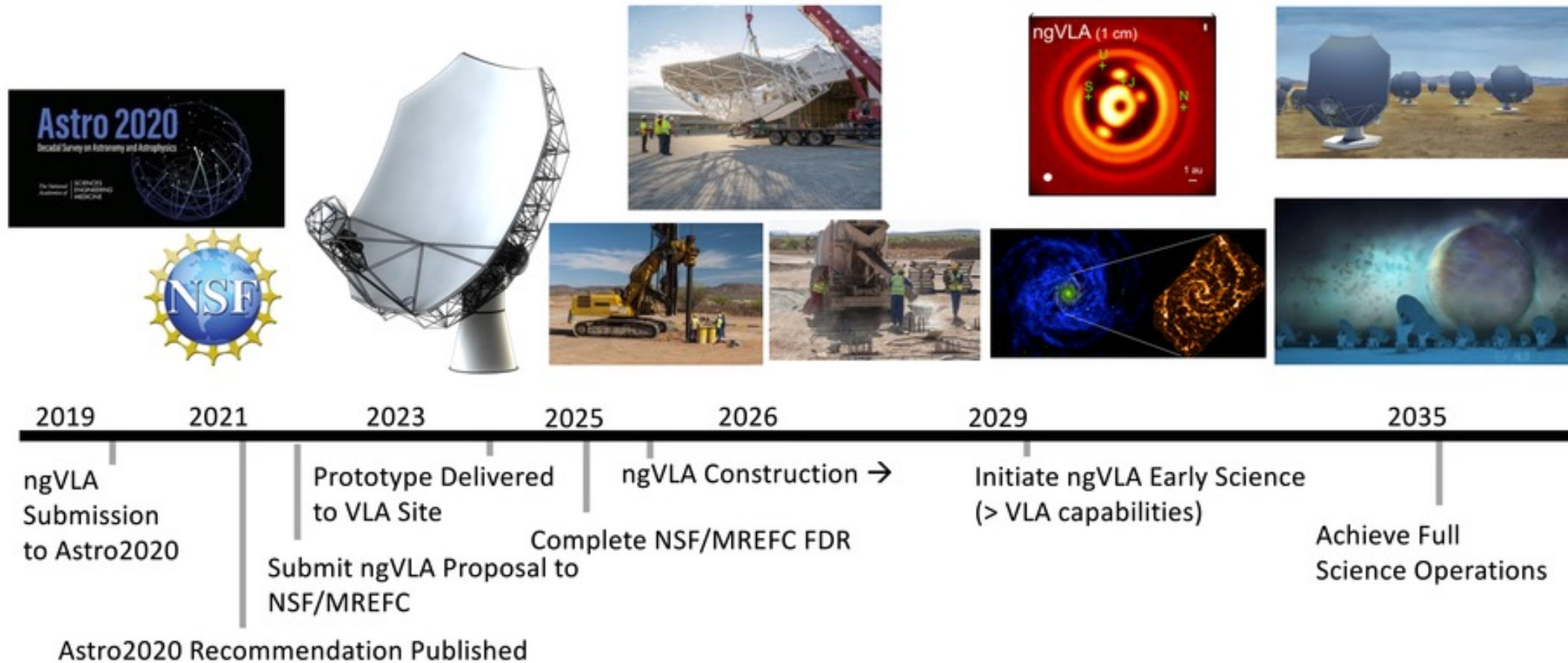
III. First detection of dimethyl ether”



The National Radio Astronomy Observatory (NRAO)

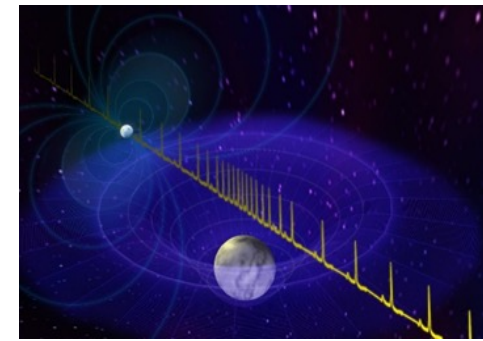


- ngVLA prototype antenna production in process



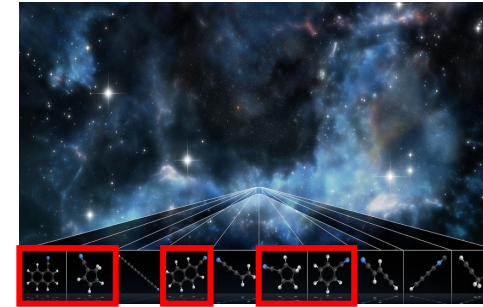
The Greenbank Observatory (GBO)

- Worlds largest, fully steerable single dish telescope
- GBT contributing to Astro2020 high priority areas
- new development (e.g., radar transmitter)



Pulsar timing/compact objects [Most massive neutron star detected](#)

NANOGrav collaboration
Cromartie et al. (2020) *Nature Astron.*,
4, pp 72-76.
Credit: J. Mallusky, GBO/AUI



Astrochemistry [Direct detection of small PAHs in Taurus](#)

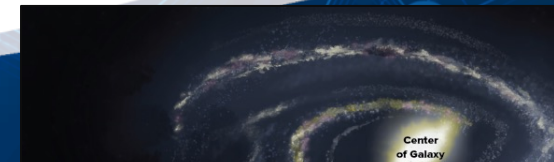
GOTHAM Large Project; PI: B. A. McGuire,
MIT McGuire et al. (2021) *Science*, 371, Issue
6535, pp 1265-1269. +6 papers in *Nature
Astronomy* and *ApJ L* Credit: J. Mallusky,
GBO/AUI



Planetary radar [Radar imaging of Tychonius](#)

Credit:
NRAO/GBO/Raytheon/AUI/NSF

See also: Wilkinson et al. 2022 *A*
"Planetary Radar System for
Detection and High-Resolution
Imaging of Nearby Celestial Bodies"
Microwave Journal

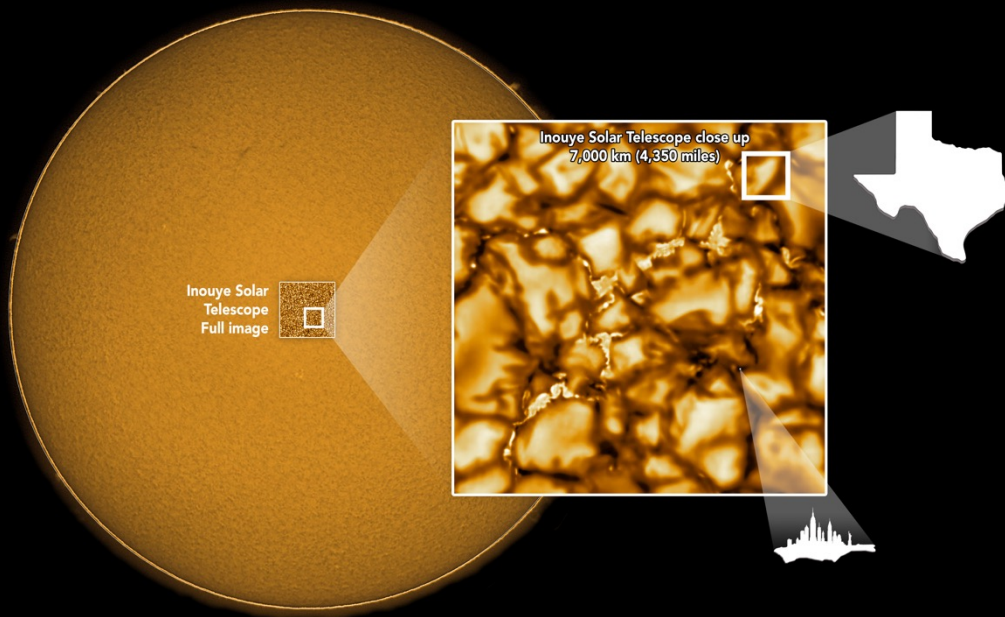
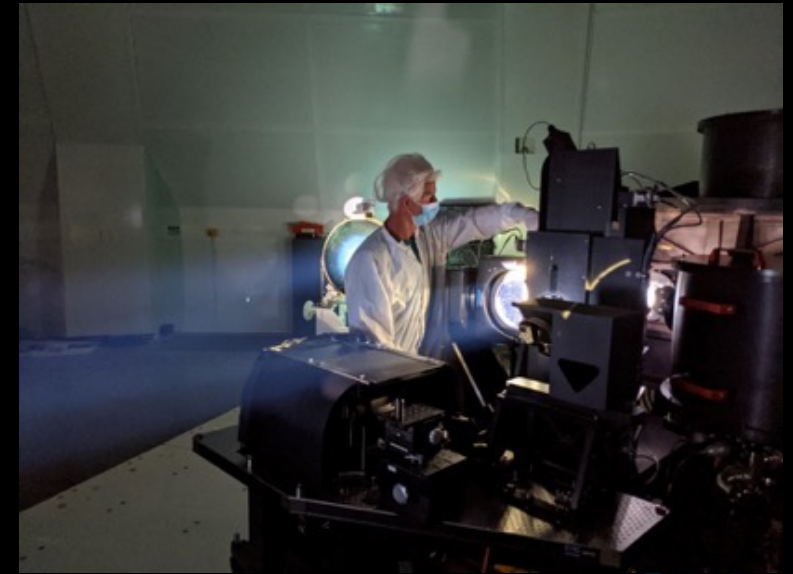


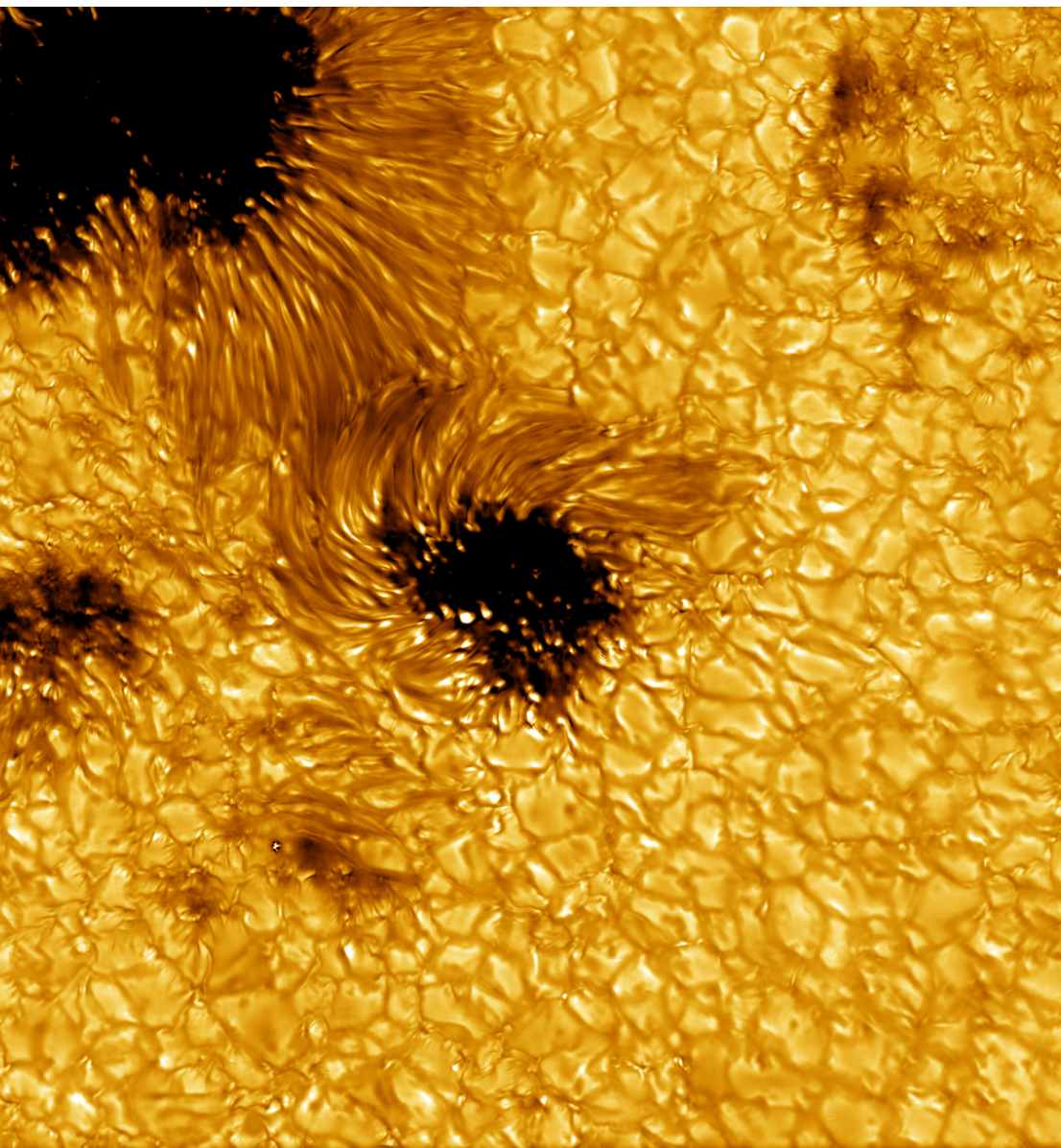


Daniel K. Inouye Solar Telescope

The largest, most powerful solar observatory on planet Earth

Now in operations!





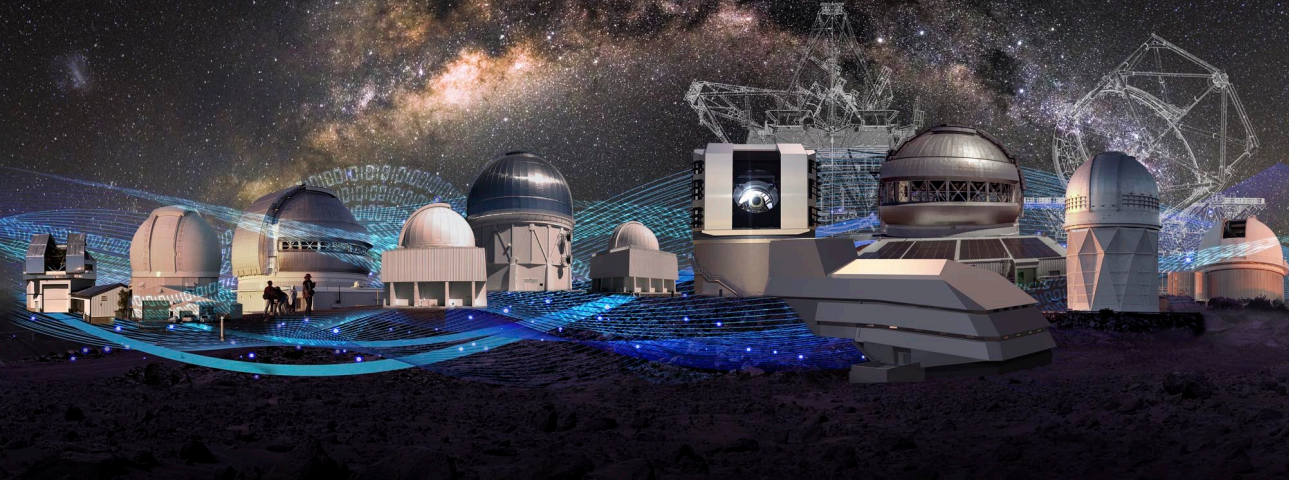
On 23 Feb 2022, the Daniel K. Inouye Solar Telescope (DKIST) began

First Science Observations.

The world's 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.



NSF's NOIRLab



Another major activity for NSF/AST:

Panel review of 5-year NOIRLab proposal took place in February and their report back to NSF was recently received.





The DOE-funded and fabricated DECam (CTIO / Blanco in Chile) was used to image NGC1566 “Spanish Dancer” galaxy.



Fastest Orbiting Asteroid Discovered at NOIRLab’s CTIO



Largest Collection of Free-Floating Planets Found in Milky Way using NOIRLab observations and archival data



Blanco captures a doomed galaxy falling into the heart of the Fornax Cluster

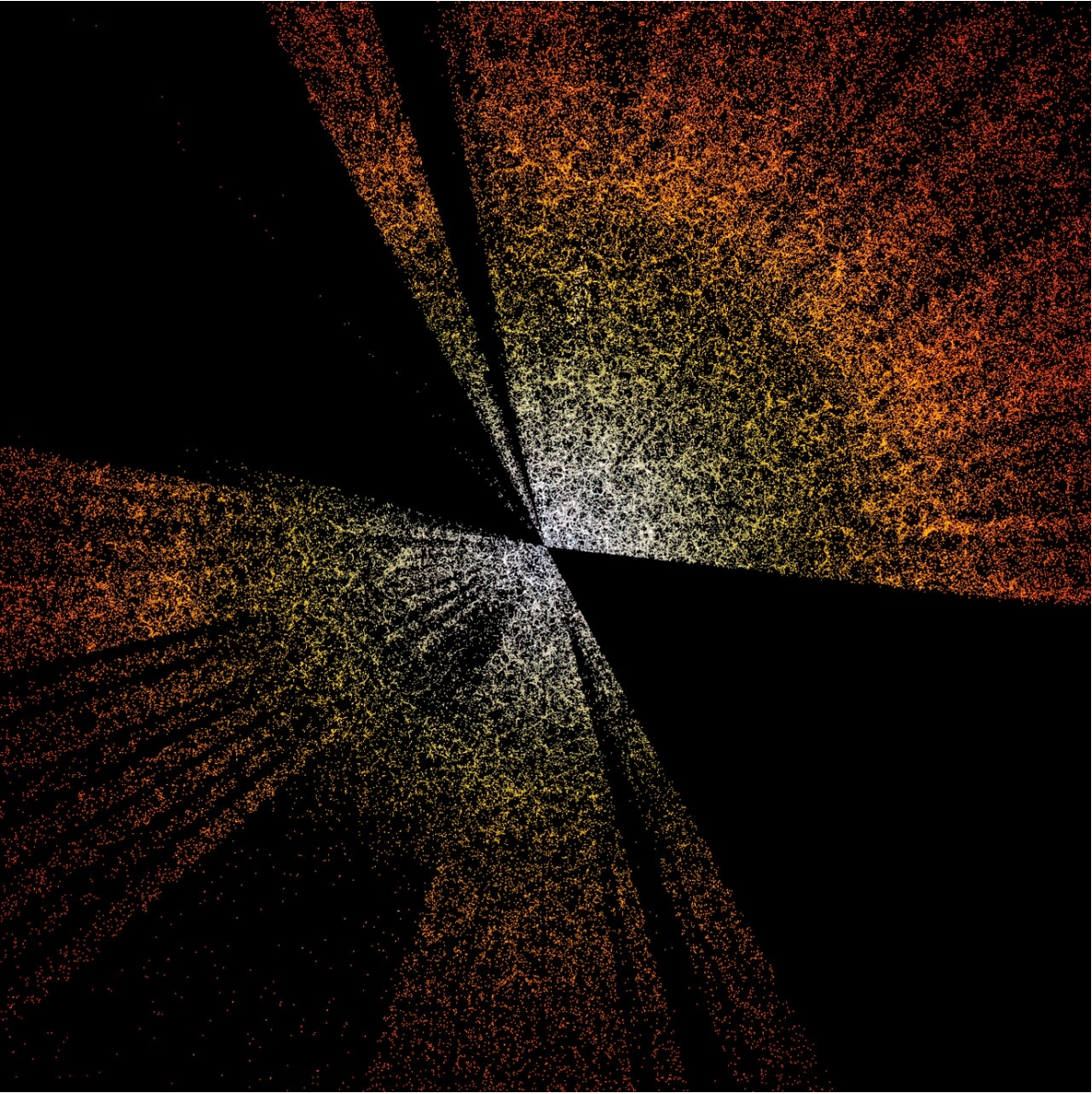




Renovation of the McMath-Pierce Solar Observatory on Kitt Peak.

The first phase of conversion of this iconic facility to the *Windows on the Universe* outreach center, will be completed this May. Work now underway on design and installation of exhibits – including a Science of a Sphere Theater.





Redshifts!

The DOE DESI project at the NSF Mayall telescope has already obtained more than 10 million redshift measurements since the start of science operations last summer. This is more galaxy redshifts than all previous 3D surveys combined.



Vera C. Rubin Observatory

- NSB authorized additional funding to cover known COVID delays to construction (December 2021)
- Good progress on construction - completion expected July 2024.
- NSF and DOE closely coordinate COVID schedule impacts.



National Science Foundation



U.S. DEPARTMENT OF
ENERGY
OFFICE OF SCIENCE



Addressing the impact of satellite constellations:

1. 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.
2. Support of U.S. statement on dark and Quiet Skies at U.N. COPUOS
3. Support of SpectrumX (spectrum innovation center, Notre Dame)
4. IAU SKAO / NOIRLab leadership: Center for Protection of Dark and Quiet Skies



Arecibo Observatory



Cleanup is complete; forensic investigation by UCF's contractor in final stages.

National Academies panel on Analysis of Causes of Failure and Collapse of Arecibo has begun.

<https://www.nationalacademies.org/event/01-24-2022/analysis-of-causes-of-failure-and-collapse-of-the-305-meter-telescope-at-the-arecibo-observatory-meeting-1>



Center for Advanced Radio Sciences and Engineering

AST partnership with EPSCoR that also includes collaboration with industry to work on active RFI cancellation.

Launch of the Center at end of March 2022 at the University of Mayagüez in Puerto Rico.





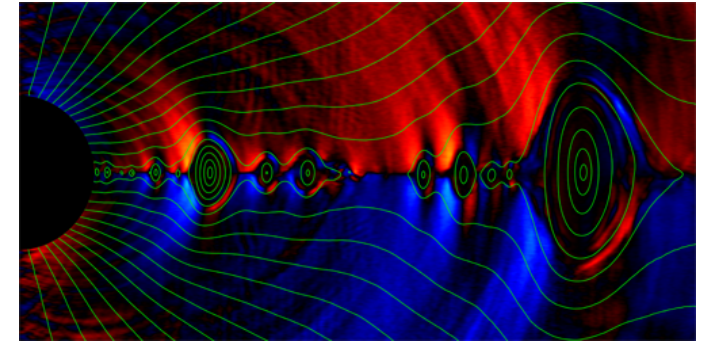
Space as a Physics Laboratory

-- Theoretical, computational, and experimental work in plasma, nuclear, high energy, and gravitational physics is advancing our understanding of space from compact astrophysical objects and their environments to space weather prediction on our own planet. E.g.:

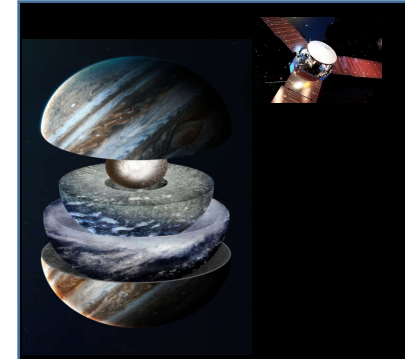
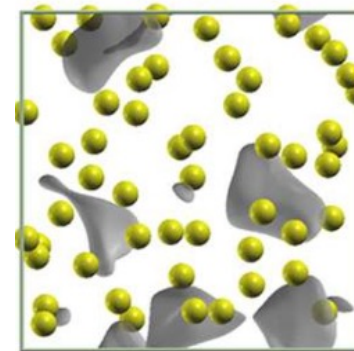
- From APS Physics, [Balding Black Holes Lose Their Magnetic Hair](#): *First-principles plasma simulations show that black holes can't keep their magnetic fields.*
- From U. Rochester, [Tracing the evolution of galaxy clusters](#): *Scientists have replicated for the first time in a laboratory setting conditions that exist within galaxy clusters, some of the largest known structures in the universe.*
- From West Virginia U., [Magnetic reconnection breakthrough, may help predict space weather](#): *research is the first-of-its-kind in the laboratory setting, could prevent space storms from wreaking havoc on the Earth's satellite and power grid systems.*

-- NSF Physics Frontiers Centers such as [NANOGrav](#) and [CMAP](#) bring together a critical mass of observers, experimenters, and theorists to help understand the origins and nature of the universe, and the habitability and inner workings of planets.

-- NSF has recently established a new cross-agency program – [ECosystem for Leading Innovation in Plasma Science and Engineering \(ECLIPSE\)](#) – whose primary goal is to “identify and capitalize on opportunities for bringing fundamental plasma science investigations to bear on problems of societal and technological need”. Research efforts within the scope of the program may span the range from studies of complex plasmas under microgravity on ISS for novel materials design, to development of new computational methods and tools for space weather prediction, to novel sensor development for cubesat-based geospace measurements.

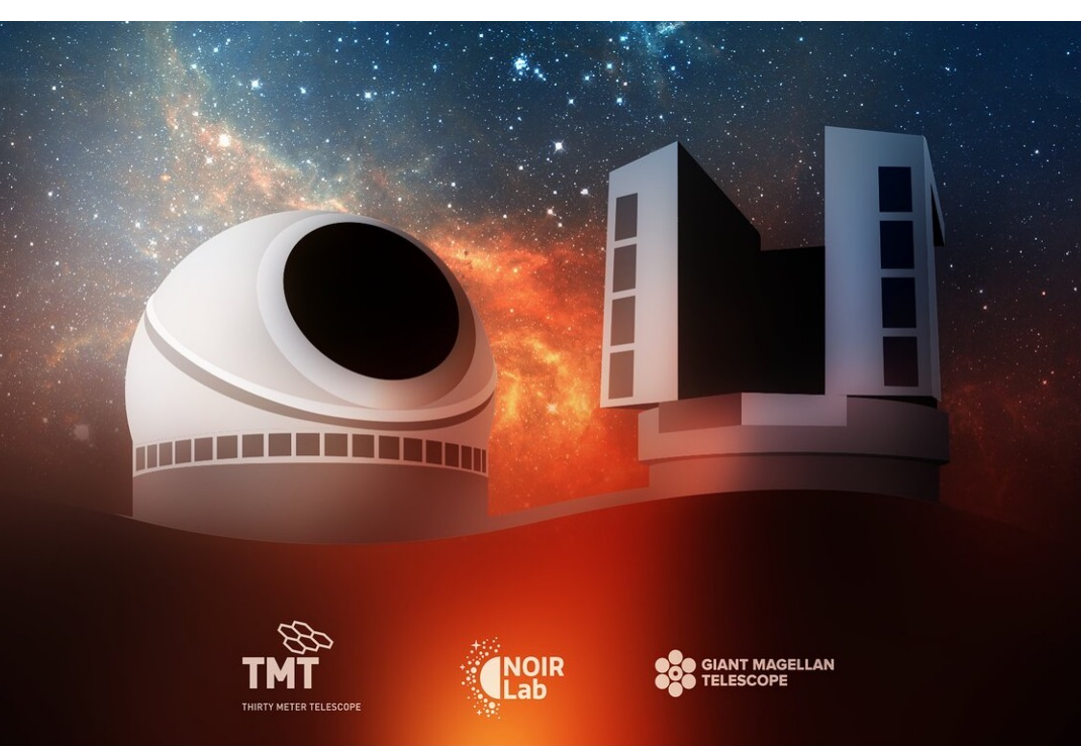


Bransgrove et al., [Phys. Rev. Lett. 127, 055101 \(2021\).](#)



Astro2020





Extremely Large Telescopes (US-ELT)

CMB-S4

ngVLA

Recommendations for these major facilities made in FY22.
Considering / inviting design and development proposals.
Earliest opportunity for significant construction funding: FY24



NSF programs to support students and early career scientists:

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!*
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 by P.E.E.R. individuals. *Reviews ongoing!*
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 to include members from P.E.E.R. *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 **VOCA**tions (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.

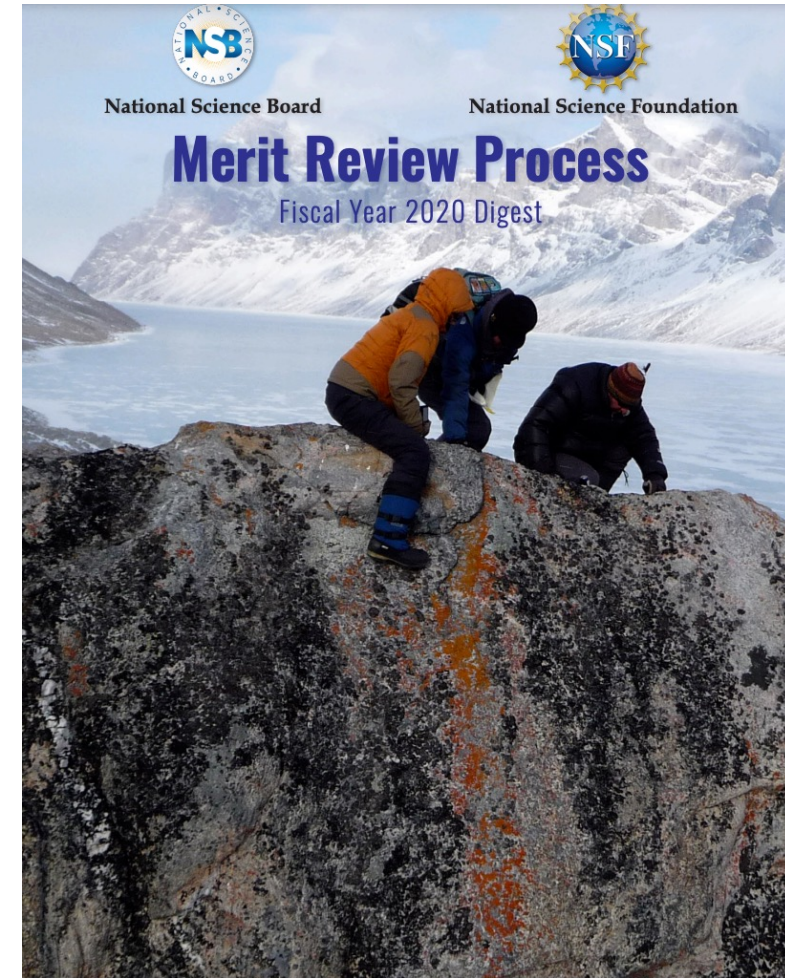
April 2022, AUI / NRAO applications for students who will receive mentorship



Demographics on Proposals

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.

We collect and publish Directorate-level summary proposal data about gender, race, ethnicity, disability state, and career stage.

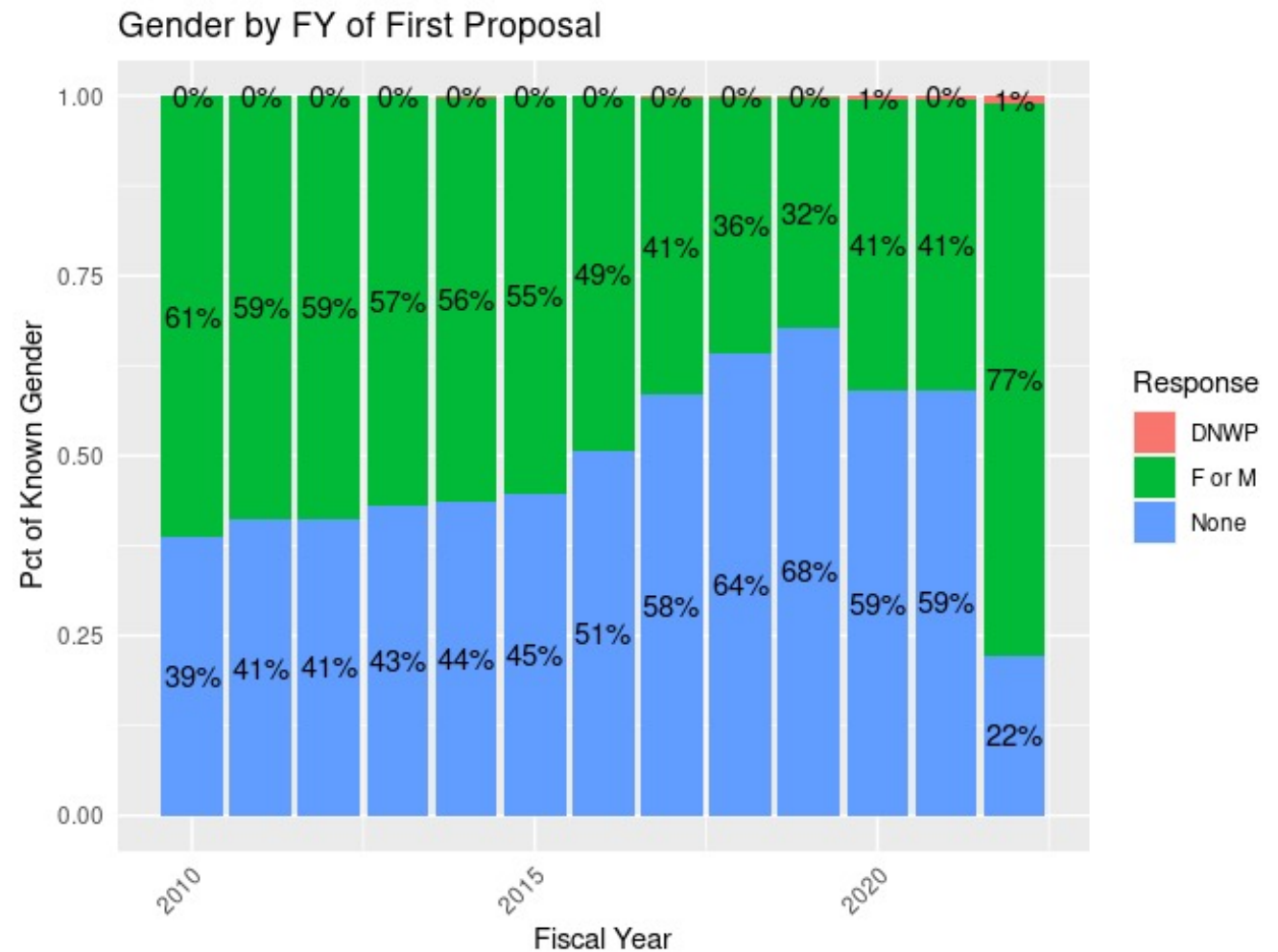


<https://www.nsf.gov/nsb/publications/pubmeritreview.jsp>



Demographics on Proposals

NSF has carried out 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.



A new Directorate at NSF



Meet TIP – Technology, Innovation and Partnerships

A new directorate at the U.S. National Science Foundation

Support use-inspired research and the translation of research results to the market and society. Strengthen the intense interplay between foundational and use-inspired work, enhancing the full cycle of discovery and innovation.



