National Aeronautics and Space Administration

NASA Astrophysics Update

Astrophysics Advisory Committee | June 27-28, 2023

Dr. Mark Clampin
Director, NASA's Astrophysics Division
Science Mission Directorate

Science Mission Directorate

ASTROPHYSICS

Organizational Chart

DIVISION MANAGEMENT

Dr. Mark Clampin
Director

Sandra Cauffman
Deputy Director

ADMINISTRATIVE SUPPORT
Kelly Johnson, Jennifer Baker (C), Pamela King-Williams (C)

DIVISION LIAISONS

Resource Management
Elijah Owuor (Lead)
Danielle Gervalis
Jennifer Holt

Communications
Alise Fisher (Lead)

Policy
Jason Callahan

OIIR
Peyton Blackstock

Program Support Specialist
Paola Ortiz Perez

CROSS CUTTING

Technologist
Mario Perez (Chief)
Omid Noroozian (Deputy)

APD Communications
Hashima Hasan (Lead)
Doris Daou (Deputy)
Liz Landau (C - OCOMM Liaison)
Natasha Pinol (C - Public Engagement Liaison)

Inclusion, Diversity, Equity, and Accessibility
Kartik Sheth (Lead)
Antonino Cucchiara (Deputy)

APD Information Manager
Rhiannon Roberts (C)

FLIGHT PROGRAMS

Associate Director
Joseph Smith

PROGRAM EXECUTIVES

Rachele Cocks
Julie Crooke
Lucien Cox
Shahid Habib
Janet Letchworth
Mark Sistilli

RESEARCH & ANALYSIS

Associate Director
Eric Smith

R&A Lead
Stefan Immler

PROGRAM SCIENTISTS

Manuel Bautista (IPA)
Dominic Benford
Valerie Connaughton
Antonino Cucchiara (C)
Doris Daou
Shawn Domagal-Goldman
Michael Garcia (D)
Thomas Hams (IPA)
Hashima Hasan
Doug Hudgins
Stefan Immler
Hannah Jang-Condell
Patricia Knezek
David Morris
Bill Latter (IPA)
Sangeeta Malhortra (D)
Roopesh Ojha
Joshua Pepper (IPA)
Mario Perez
Kartik Sheth
Eric Smith
Linda Sparke
Sanaz Vahidinia
John Wisniewski

PROGRAM SUPPORT SPECIALIST
Ingrid Farrell (C)

ASTROPHYSICS STRATEGIC MISSIONS

Program Director
Sandra Cauffman

Program Manager (Acting)
Garth Henning

PROGRAM EXECUTIVES

Ed Griego
Lucas Paganini
Miles Skow

PROGRAM SUPPORT
Tony Comberiate (C), Andre Davis (C)

Legend
C - Contractor
D - Detailee
IPA - Intergovernmental Personnel Act Detail Program Scientist

Sandra Cauffman
Program Director

Garth Henning
Program Manager
(Acting)

The ASTROPHYSICS STRATEGIC MISSIONS PROGRAM develops, launches, and operates large strategic observatories in accordance with NASA's goals to understand the universe and our place in it.

Ed Griego
Program Executive

Lucas Paganini
Program Executive

Miles Skow
Program Executive

FLIGHT PROGRAMS

Joseph Smith
Associate Director

PROGRAM EXECUTIVES represent the mission for "up and out" HQ-level activities by tracking and reporting objectively on the status, risk, and issues; advocate for the mission within SMD; manage and coordinate communication among project, stakeholder, and community members.

Janet Letchworth
Operating missions

Lucien Cox
GUSTO, XRISM, SOFIA, ExEP prog.

Mark Sistilli
COSI, SPHEREx, Balloon prog., Explorers prog.

Rachele Cocks
Pioneers, CubeSats, TDAMM

Shahid Habib
LISA, Athena, Ariel/CASE, Euclid, Ultrasat, PhysCOS & COR progs.

Julie Crooke
GOMAP
Project Executive

RESEARCH & ANALYSIS

Eric Smith
Associate Director

Stefan Immler
R&A Lead

PROGRAM SCIENTISTS are the senior NASA Scientists responsible for the science content of an SMD Science investigation. They ensure that the science NASA selects is the science NASA gets and advocates at HQ for the science of the mission.

Antonino Cucchiara
Fermi, FINESST, NHFP, Bridge Program

David Morris
Explorers Deputy, Cubesats Deputy, APRA Deputy

Doris Daou
Euclid, NEO Surveyor, New Horizons, Precursor, ADAP Deputy

Hannah Jang-Condell
Explorers, XRP, EXEP

Kartik Sheth
SPHEREx, Athena, IR Portfolio

Mario Perez
Swift, ISFM, RTF, SAT, UVO Deputy

Roopesh Ojha
NICER, High End Computing, ADCAR, Data, R&A Deputy

Stefan Immler
Chandra, COSI, Spektrum X Gamma

Bill Latter
GUSTO Deputy, LabAstro Deputy

Doug Hudgins
Ariel/CASE, EPRV, NexSCI, ADAP Deputy, EXEP

Hashima Hasan
IXPE, NuSTAR, Citizen Science, Keck, ADCAR Deputy

Linda Sparke
ADCAR, Explorers Deputy, COSI Deputy

Michael Garcia
Hubble, Pioneers, CubeSats, UVO, Sounding Rockets Deputy

Sanaz Vahidinia
XRISM, ATP, TCANN, IR Portfolio Deputy

Thomas Hams
GUSTO, LISA, Balloons, Sounding Rockets, PFP, IR Portfolio Deputy

Dominic Benford
Roman, APRA

Eric Smith
JWST

Joshua Pepper
TESS, ADAP

Manuel Bautista
UltraSat, XMM, LabAstro, Probes Deputy, COR

Patricia Knezek
SOFIA, Explorers, ADCAR Deputy, NHFP Deputy

Sangeeta Malhortra
Roman Deputy, ATP Deputy, FINESST Deputy

Valerie Connaughton
HEA, PhysCOS, TDAMM

John Wisniewski
SPHEREx Deputy, XRP Deputy

Shawn Domagal-Goldman
GOMAP Program Scientist

CROSS CUTTING staff are responsible for managing and developing the technology programs, coordinating IDEA activities and programs, as well as APD communications in support of the division.

Mario Perez
Chief Technologist

Omid Noroozian
Deputy Technologist

Doris Daou
Communications Deputy

Hashima Hasan
Communications Lead

Elizabeth Landau
OCOMM Liaison

Natasha Pinol
Public Engagement Liaison

Kartik Sheth
Inclusion, Diversity, Equity, and Accessibility (Lead)

Antonino Cucchiara
Inclusion, Diversity, Equity, and Accessibility (Deputy)

Rhiannon Roberts
APD Information Manager

Astrophysics by the NUMBERS

RESEARCH

~350 U.S. Science PIs Funded
~120 Individual Institutions Selected
~$135M Awarded Annually

TECHNOLOGY DEVELOPMENT

~$220M Invested Annually

SMALLSATS/ CUBESATS

2 Science Missions Launched
9 Science Missions in Development
1 ISS-attached Science Mission

REFEREED PUBLICATIONS

22,073 Total Publications
20,853 Hubble Publications (1991-Current)
934 JWST Publications (As of April 2023)

SOUNDING ROCKETS

15 Science Missions Launched (Suborbital)
6 In Development

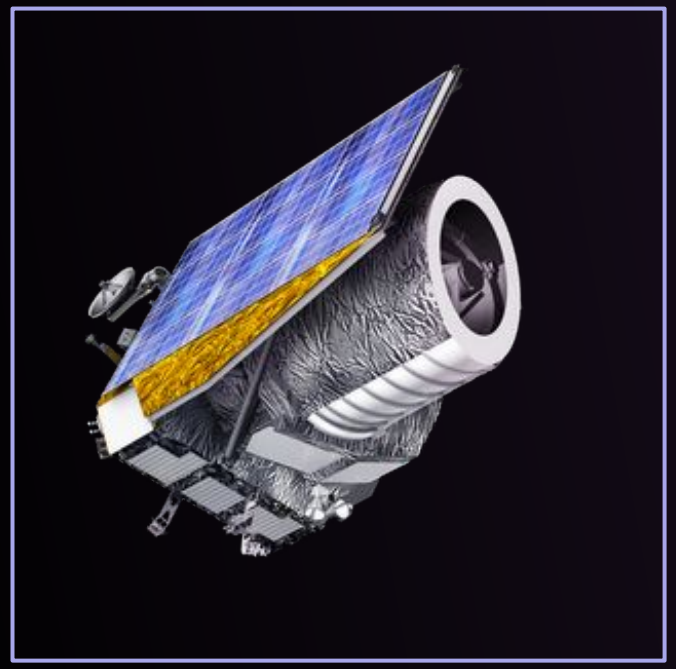
MISSIONS

11 Missions Operating
12 Missions in Development

BALLOONS

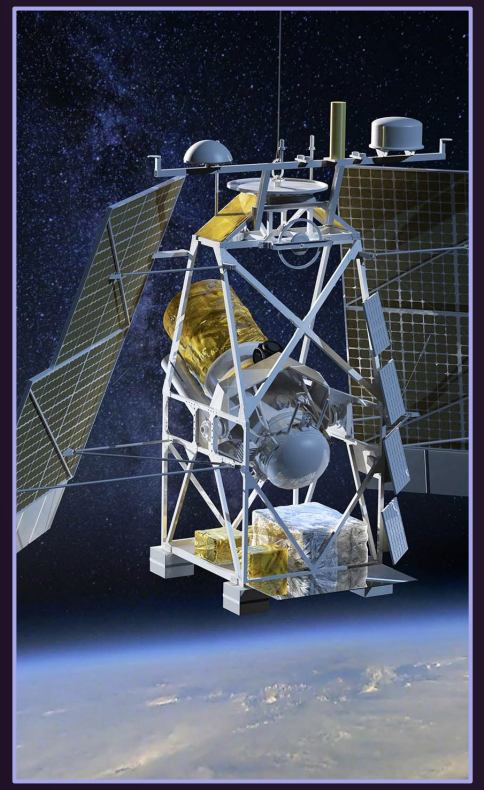
17 Suborbital Balloons Launched
20 Missions in Development

Astrophysics Division Launches: CY2024



Euclid
Kennedy Space Center,
1st July 2023

XRISM:
Tanegeshima, Japan
2023



GUSTO (SMEX Balloon)
Antarctica,
December 2023

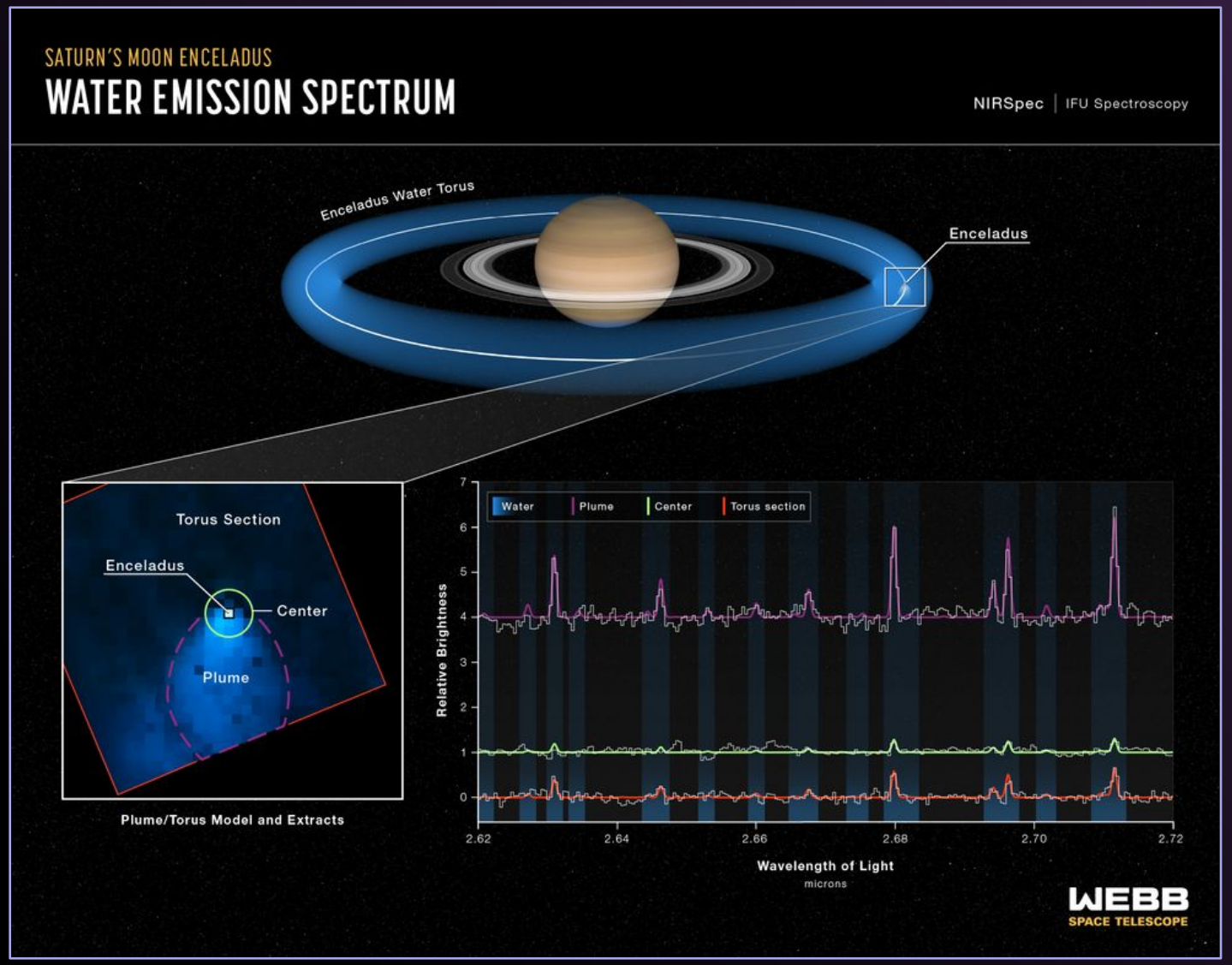
January-May 2023 Highlights

Webb Science Team Won Awards

- In total, Webb and the team members who have worked on the telescope, have won 13 awards
  - Aviation Week Grand Laureate Award
  - TIME Magazine Invention of 2022
  - Popular Science ‘Best of What’s New’ Award in the Aerospace category
  - Greg Robinson and the James Webb Space Telescope named as TIME Magazine’s 2022 Innovator of the Year
  - Dr. Jane Rigby selected by Nature magazine as one of “Nature’s 10: Ten People Who Helped Shape Science in 2022”
  - Bloomberg Businessweek’s the 2022 Bloomberg 50
  - The Space Foundation’s 2023 John L. “Jack” Swigert, Jr. Award for Space Exploration
  - Dr. Jonathan Gardner named a 2023 Fellow of the American Astronomical Society
  - The king and queen of Spain awarded Begoña Vila the Embajadores Honorarios de la Marca España (Honorary Ambassador for the Spanish Brand) for Science and Innovation.
  - 2023 Michael Collins Trophy for Lifetime and Current Achievements
  - The National Space Society (NSS) awarded the Wernher von Braun Memorial Award
  - The American Association for the Advancement of Science (AAAS) awarded its inaugural Mani L. Bhaumik Breakthrough of the Year Award to standout contributors to Webb.
  - National Aeronautic Association Robert J. Collier Trophy

JWST Water Plume

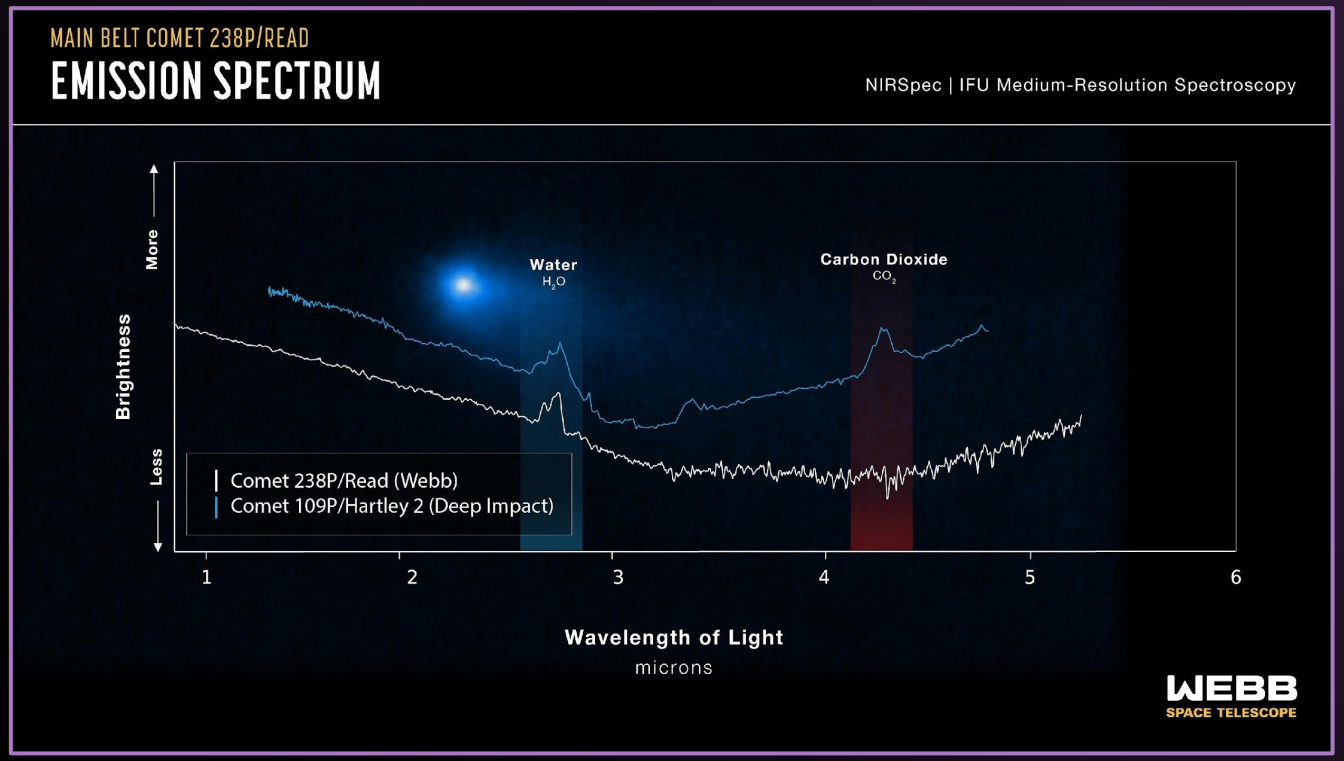
- Webb's instruments revealed details into how one of Saturn's moon's feeds a water supply to the entire system of the ringed planet.
- New images from Webb's NIRSpec (Near-Infrared Spectrograph) revealed a water vapor plume jetting from the southern pole of Enceladus, extending out more than 20 times the size of the moon itself.
- The Integral Field Unit (IFU) aboard NIRSpec also provided insights into how the water from Enceladus feeds the rest of its surrounding environment.



Credits: NASA, ESA, CSA, STScI, Leah Hustak (STScI)

NASA's Webb Finds Water, and a New Mystery, in Rare Main Belt Comet

Artist's Concept of Comet 238P/Read



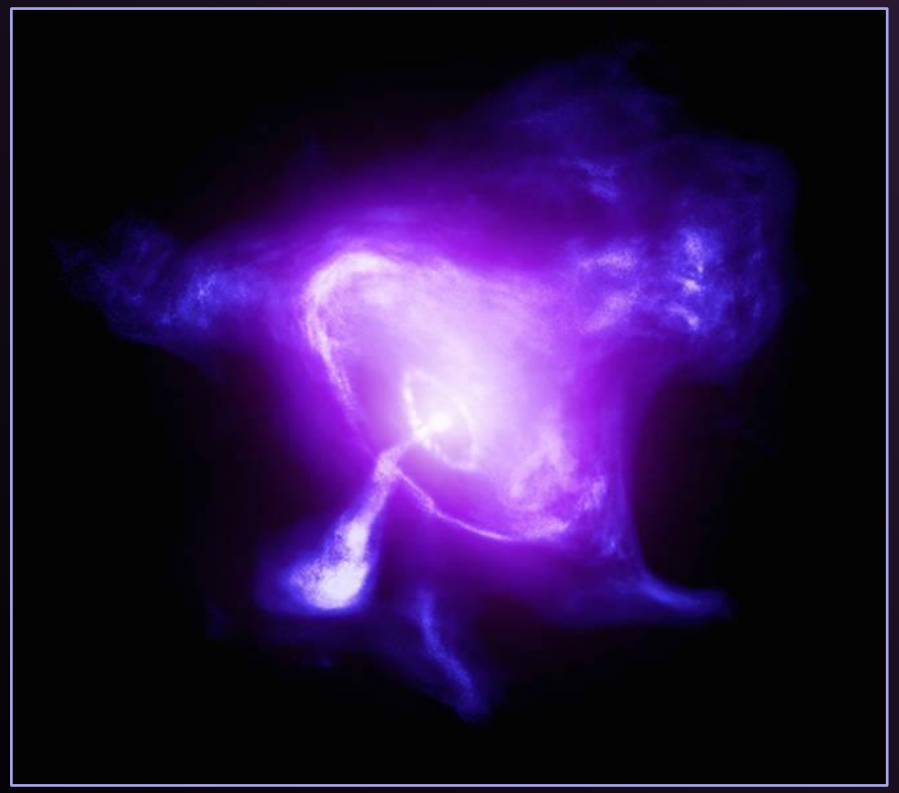
- Using Webb's NIRSpec (Near-Infrared Spectrograph) instrument, astronomers have confirmed gas – specifically water vapor – around a comet in the main asteroid belt for the first time, proving that water from the primordial solar system can be preserved as ice in that region.

- Understanding the history of water distrubution in the solar system will help us understand other planetary systems and see if they could potentially be on their way to hosting an Earth-like planets eventually.

Historic Nebula Seen Like Never Before With NASA's IXPE

- Scientists recently used the Imaging X-ray Polarimetry Explorer (IXPE) satellite to create a detailed, nuanced map of the Crab Nebula's magnetic field, revealing more of its inner workings than ever before.

- IXPE data shows that the Crab Nebula's magnetic field resembles that of the Vela Pulsar Wind Nebula but with areas of magnetic field turbulence which are patchier and more asymmetrical than expected.

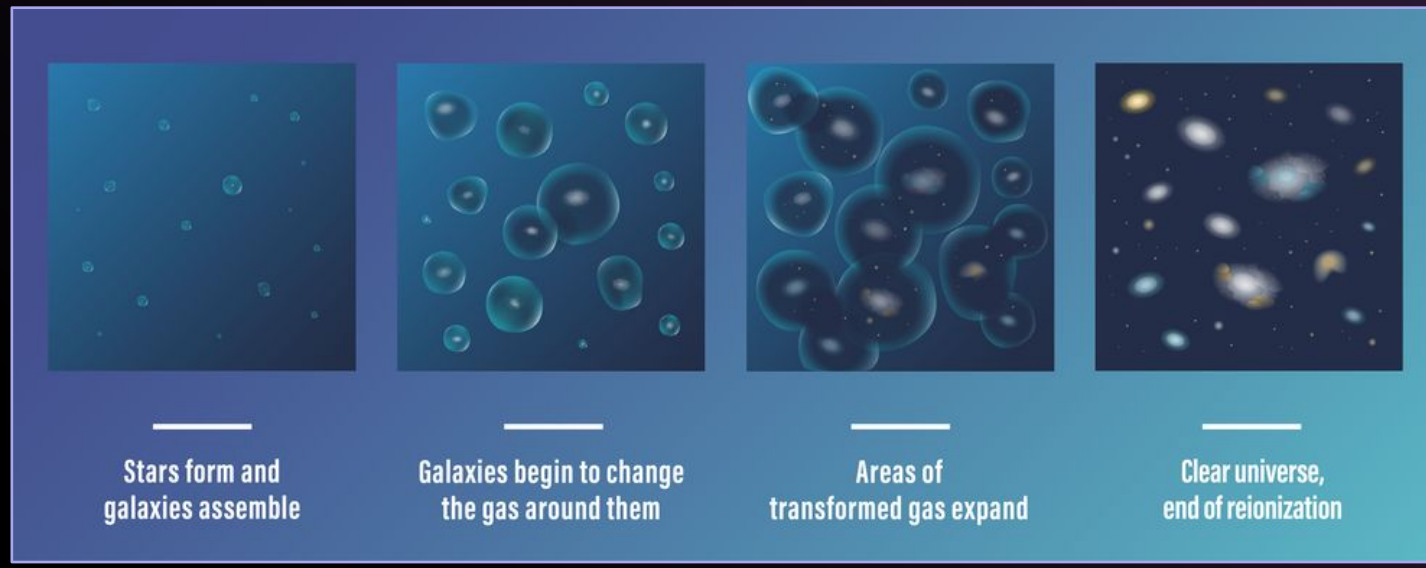


This image of the Crab Nebula combines data from NASA's Imaging X-ray Polarimetry Explorer (IXPE) in magenta and NASA's Chandra X-ray Observatory in dark purple.
Credits: X-ray (IXPE: NASA), (Chandra: NASA/CXC/SAO) Image processing: NASA/CXC/SAO/K. Arcand & L. Frattare

Webb Proves Galaxies Transformed the Early Universe

- By analyzing new observations from Webb Telescope, a team in Switzerland found evidence that galaxies – which existed 900 million years after the big bang – ionized the gas around them, causing them to become transparent.

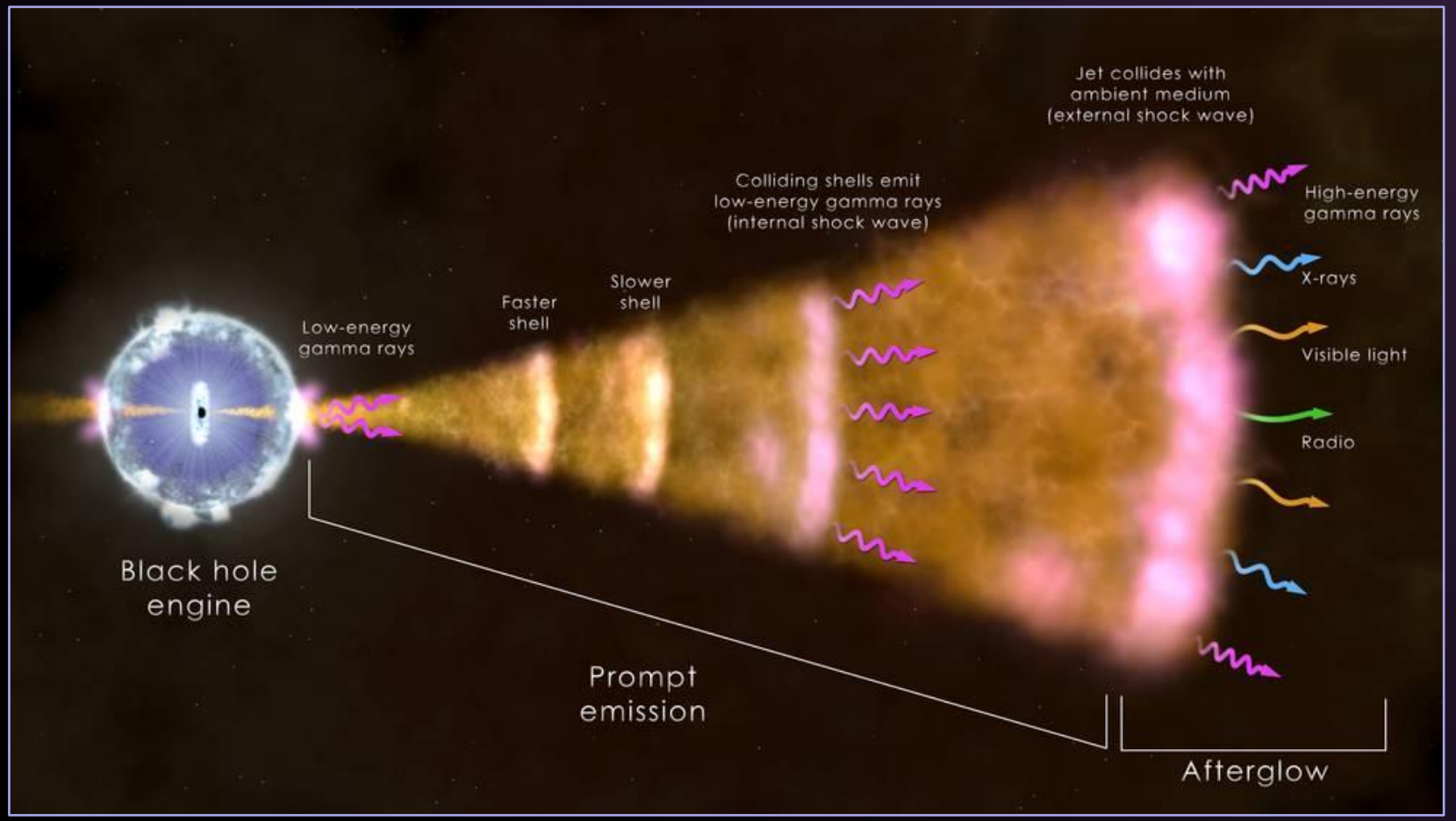
Credits: NASA, ESA, CSA, Simon Lilly (ETH Zürich), Daichi Kashino (Nagoya University), Jorryt Matthee (ETH Zürich), Christina Eilers (MIT), Rob Simcoe (MIT), Rongmon Bordoloi (NCSU), Ruari Mackenzie (ETH Zürich); Image Processing: Alyssa Pagan (STScI) Ruari Macken



Credits: NASA, ESA, CSA, Joyce Kang (STScI)

NASA Missions Study What May Be a 1-In-10,000-Year Gamma-ray Burst

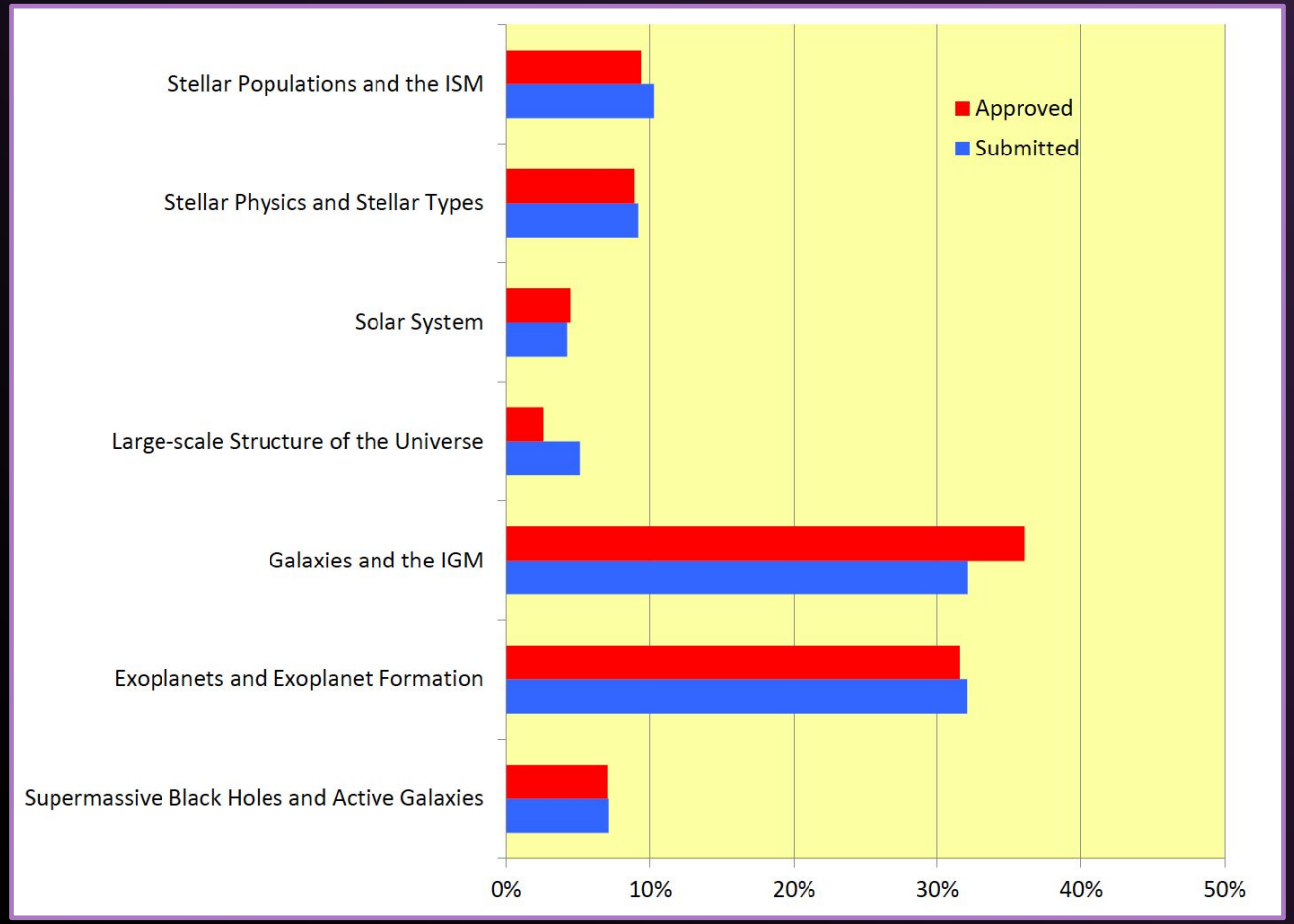
- On Sunday, Oct. 9, 2022, a gamma-ray burst (GRB) swept through the solar system triggering detectors on numerous spacecraft and observatories.
- GRB 221009A was likely the brightest burst in 10,000 years.



Credit: NASA's Goddard Space Flight Center

The Telescope Allocation Committee: Selecting What Webb Observes Next

- Acceptance Rate
  - GO 1 in 6.5 for proposals and 1 in 7.3 for Hours
- Instruments:
  - MIRI 29.6%, NIRCam19.9%, NIRISS 4.1%, NIRSPEC 46.4%
  - Imaging 23.4% vs Spectroscopy 76.6%
- Student led PIs 10.4% (26)
  - (Cycle 1 8.7% for 25 proposals)
- 49% of PIs are 1st time HST or JWST PIs
  - (115 of 235 unique)



Budget

Astrophysics Budget

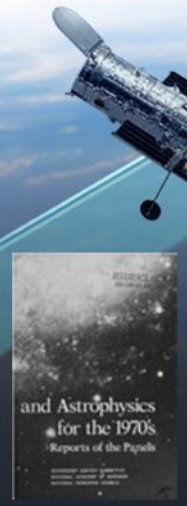
- FY23 appropriation $1,510M, versus FY22 appropriation of $1,589M.

- FY24 President's Budget:
  - FY24 request $1,557M (FY23 PBR $1,556M)
  - Modest decadal wedge begins in FY24 for technology maturation in support of Decadal Survey-recommended GOMAP for Habitable Worlds Observatory
  - Extend operating missions per Senior Review recommendations, including Hubble, Chandra and the Transiting Exoplanet Survey Satellite (TESS)
  - SOFIA close out budget FY23-25 permits responsible closeout, dispositioning of assets, data reprocessing and archiving, and career transition for early careers
  - Delays in Explorers program up to one year
  - Replanning ATHENA funding pending ESA re-formulation activities

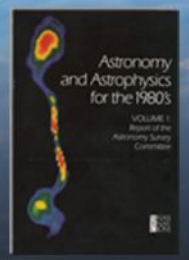
Mission Status

Astrophysics

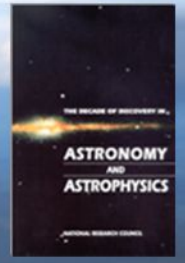
Decadal Survey Missions



1972
Decadal Survey
Hubble



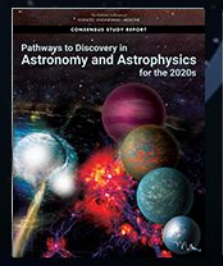
1982
Decadal Survey
Chandra



1991
Decadal Survey
Spitzer

2001
Decadal Survey
Webb

2010
Decadal Survey
Roman



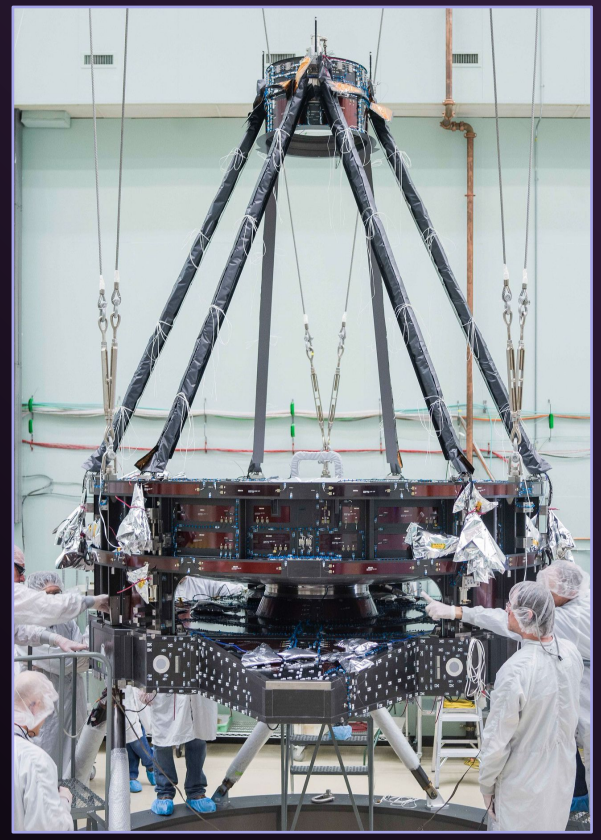
2021
Decadal Survey

Nancy Grace Roman Space Telescope

- The Roman Space Telescope is a NASA observatory designed to unravel the secrets of dark energy and dark matter, search for and image exoplanets, and explore many topics in infrared astrophysics.

- The Wide Field Instrument is one of two instruments aboard the Nancy Grace Roman Space Telescope
  - The WFI is the primary instrument which provides wide-field imaging and multi-object, slitless spectroscopy over an. 0.281 deg^2 field-of-view.
  - This 300-megapixel infrared camera will allow scientists to explore the cosmos all the way from the edge of our solar system to the farthest reaches of space.

- KDP-D Sept. 2024. Meeting cost and schedule commitments with launch by May 2027.



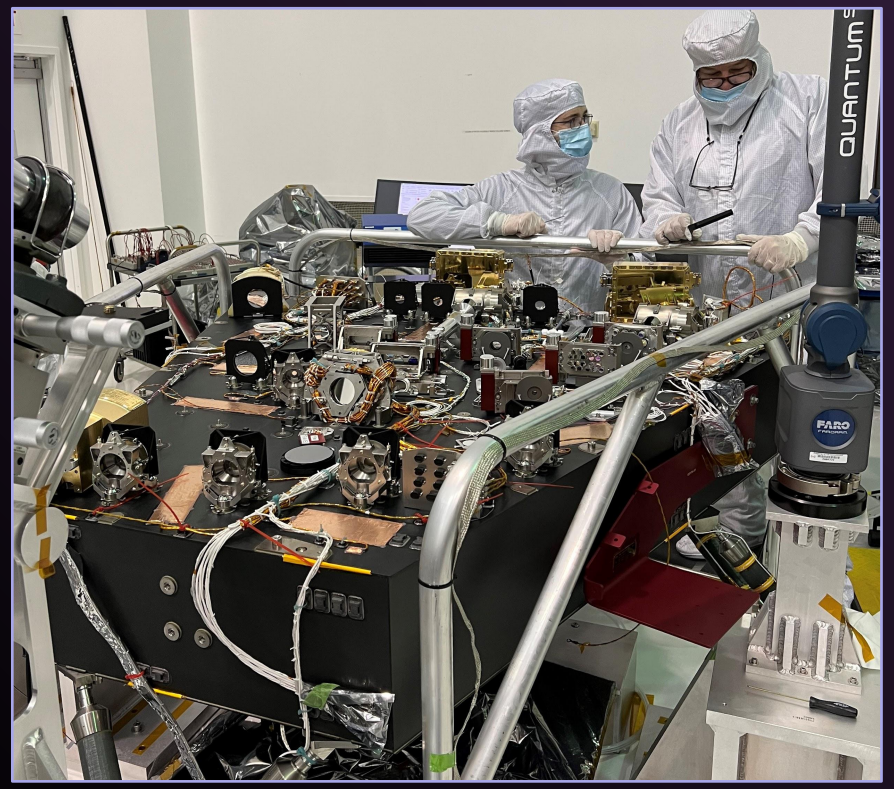
Roman Coronagraph Instrument (CGI)

Technology Demonstration on Nancy Grace Roman Space Telescope

- The Coronagraph Instrument is one of two instruments aboard the Nancy Grace Roman Space Telescope

- It will demonstrate the first high-performance coronagraph system (utilizing active wavefront control) in space capable of imaging gas giant exoplanets, like our own Jupiter, in reflected starlight

- Highlights:
  - Adaptive optics include a pair of Deformable Mirrors for precision wavefront control
  - Capable of detecting planetary companions 10 million times fainter than their host star and located >0.3 arcseconds away
  - Currently all flight optics are mounted and aligned with the supporting electronics being functionally evaluated
  - Instrument Delivery to GSFC – May 2024



All flight optical components installed on the CGI Optical bench. Supporting electronics to be installed in coming weeks.

Credits: Jet Propulsion Laboratory

Roman Community Engagement

- Solicitation for funding Roman preparatory science work released as part of ROSES-22; 90 proposals reviewed in May; with selections coming soon.

  - Provides for Project Infrastructure Teams
    - Support the community in major science investigations of enduring value

  - Provides Wide Field Science teams
    - Targeted work across the broad range of science with Roman

  - Provides for a Coronagraph Community Participation Program
    - Preparation for the technology demonstration work with the CGI

Roman Community Engagement

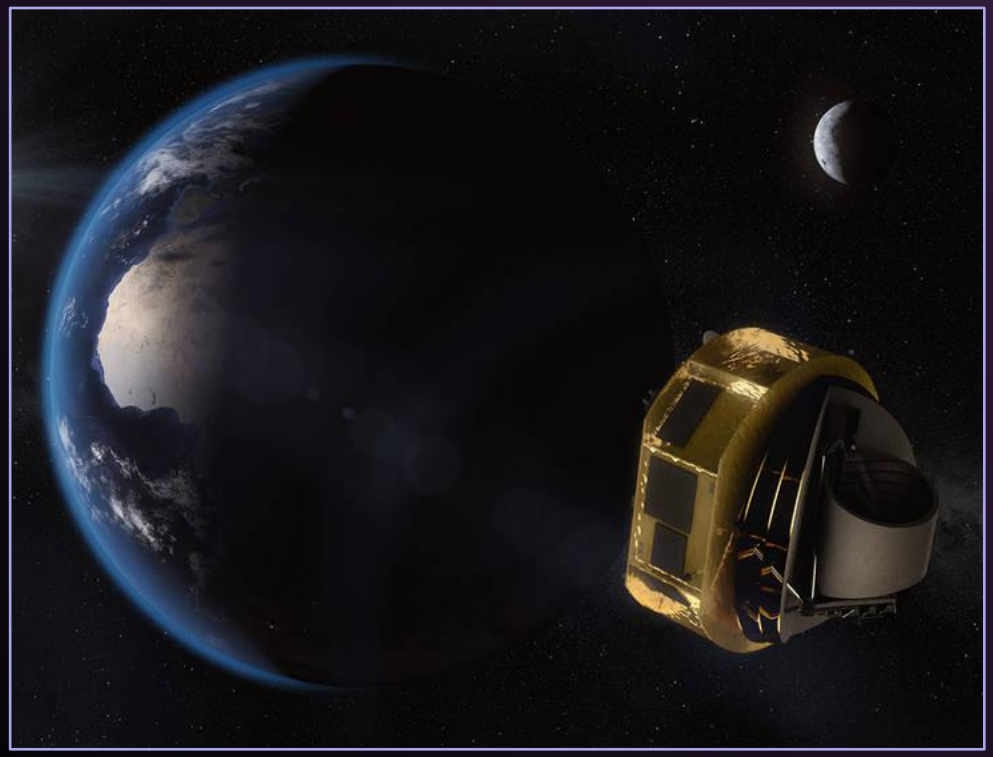
- Core Community Survey definition is underway via an open process. White paper submissions describing the observational strategies necessary to enable your desired science investigations with Roman's Core Community Surveys are due by June 16, 2023.

- These are an important component of the input to the survey definition committees.
  - First 'science pitch' call resulted in >100 submissions in Feb 2023
  - Present call is for more detailed descriptions; anyone can submit – see https://roman.gsfc.nasa.gov/science/ccs_community_input.html to participate!

CASE

Contribution to ARIEL Spectroscopy of Exoplanets

- NASA is contributing detector subsystems (known as CASE – Contribution to Aerial Spectroscopy of Exoplanets) to ESA's ARIEL mission that will explore the atmospheres of exoplanets for the first time.
- CASE will add scientific capabilities to ESA's Atmospheric Remote-sensing Infrared Exoplanet Large-survey, or ARIEL, mission.
- CASE is a PI-led mission, managed by Mark Swain/Jet Propulsion Laboratory.
- KDP-D: ~March 2025, ARIEL launch is scheduled for Dec. 2029.



This artist's concept shows the European Space Agency's ARIEL spacecraft on its way to Lagrange Point 2 (L2) — a gravitationally stable, Sun-centric orbit — where it will be shielded from the Sun and have a clear view of the sky. NASA's JPL will manage the mission's CASE instrument.

Credits: ESA/STFC RAL Space/UCL/Europlanet-Science Office

COSI

The Compton Spectrometer and Imager

- The Compton Spectrometer and Imager (COSI) is a space telescope that will study the recent history of star birth, star death, and the formation of chemical elements in the Milky Way.
- The gamma-ray telescope is expected to launch in 2027 as NASA's latest small astrophysics explorer mission.
- COSI's principal investigator is John Tomsick at the University of California, Berkeley.
- KDP-C: ~April 2024

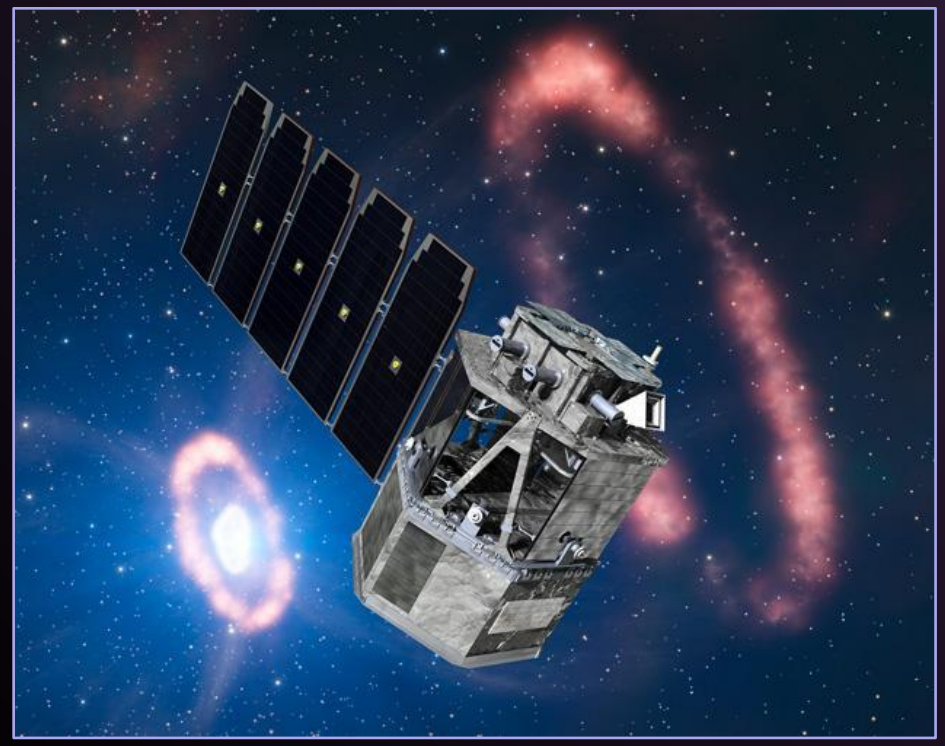
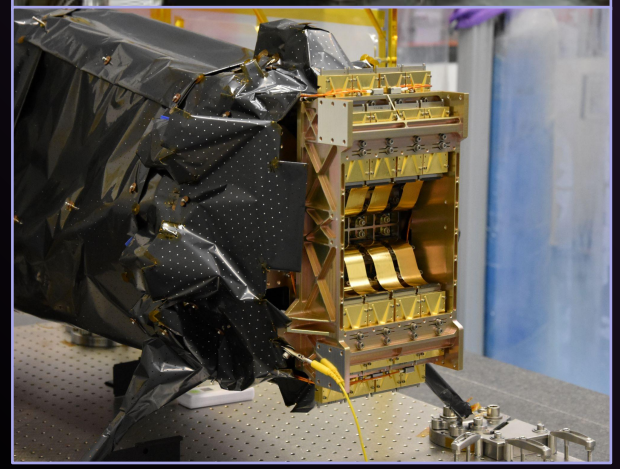


Image by Jim Willis, courtesy of Northrop Grumman Corporation ½ Space Systems; background image courtesy of European Southern Observatory

EUCLID

- Euclid is ESA's second medium-class mission (M2) in the Cosmic Vision Program (2015-2025), to map the geometry of the Universe and better understand the mysterious dark matter and dark energy, which make up most of the energy budget of the cosmos.

- NASA Contributions
  - 16 Characterized Flight and 4 Spare Sensor Chip Systems (SCS) for the NISP Instrument that includes:
    - Sensor Chip Assembly (SCA)
    - Cryo-Flex Cable (CFC)
    - Sensor Chip Electronics (SCE)
  - U.S. Science Team members (over 70)
  - Euclid NASA Science Center at IPAC (ENSCI)
- Launch scheduled for 1st July 2023 from Kennedy Space Center on a SpaceX Falcon launch vehicle.



Rear view of near-IR detector system

IXPE

Imaging X-ray Polarimetry Explorer

- IXPE (collaboration between NASA and the Italian Space Agency) launched on December 9, 2021.
- IXPE is NASA's first mission to study the polarization of X-rays from many different types of celestial objects.
  - Source classes with robust detections of polarization include magnetars, accreting neutron stars, blazars, accreting stellar mass black holes, and supernova remnants.
- The IXPE mission will be extended by 20 months with a General Observer (GO) program from February 2024-September 2025.
  - NASA has released the Announcement of Opportunity for the IXPE GO Cycle 1 program (6/8/2023):

Galaxy Centaurus A (Cen A).
Credits: X-ray: (IXPE): NASA/MSFC/IXPE/S. Ehlert et al.; (Chandra): NASA/CXC/SAO; Optical: ESO/WFI; Image processing: NASA/CXC/SAO/J.Schmidt
Released: May 2, 2023

ULTRASAT

Ultraviolet Transient Astronomy Satellite

- NASA will launch Israel's first space telescope mission, the Ultraviolet Transient Astronomy Satellite (ULTRASAT).
  - Led by the Israel Space Agency and Weizmann Institute of Science.
  - In addition to providing the launch service, NASA will also participate in the mission's science program.
- ULTRASAT, an ultraviolet observatory with a large field of view, will investigate the secrets of short-duration events in the universe, such as supernova explosions and mergers of neutron stars.
- Following a ROSES 22 competition, NASA is very close to selecting the U.S.-based scientists who will join the ULTRASAT working groups.
- Launch is scheduled for Aug. 2026.

An illustration of the ULTRASAT satellite.
Credits: Weizmann Institute

XRISM

X-ray Imaging and Spectroscopy Mission

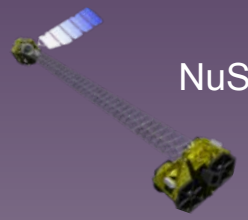
- XRISM is a JAXA/NASA collaborative mission, with ESA participation
- Objective of this mission is to investigate celestial X-ray objects in the Universe with high-throughput imaging and high-resolution spectroscopy.
- NASA/GSFC developed the Resolve detector system and many of its subsystems together with the X-ray Mirror Assemblies. Also responsible for the Science Data center, which developed the analysis software for all instruments, the data processing pipeline, as well as support of Guest Observers and the XRISM Guest Observer (GO) Program.
- KDP-E: July 25
- Launch date has been confirmed and will be officially announced by JAXA end of June.

The XRISM spacecraft as it appeared in May at Tsukuba Space Center, Japan. The open compartment near the bottom houses its Goddard-developed Resolve instrument. Credit: JAXA/NEC

Astrophysics Explorers Program

Selected before 2011

Gehrels Swift



NuSTAR

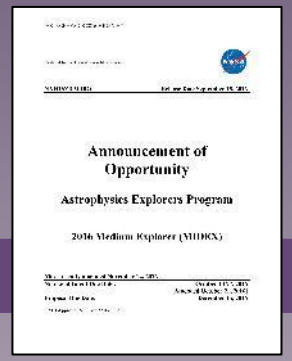
PROBE 2023

SMEX ~~2024~~ 2025

4 AOs per decade

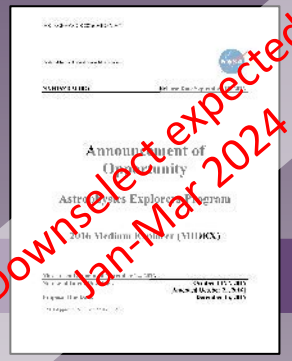
MIDEX 2011

SMEX 2014



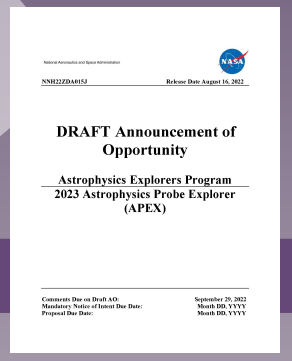
MIDEX 2016

SMEX 2019



Downselect expected Jan-Mar 2024

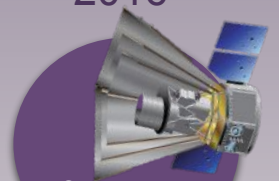
MIDEX 2021



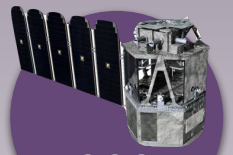
Small and Mid-Size Missions

TESS

IXPE



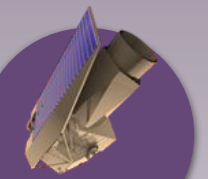
SPHEREx



COSI

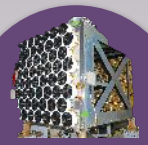
STAR-X
UVEX

Directed 2013



Euclid

Missions of Opportunity



NICER

GUSTO

ARIEL

LEAP
MoonBEAM

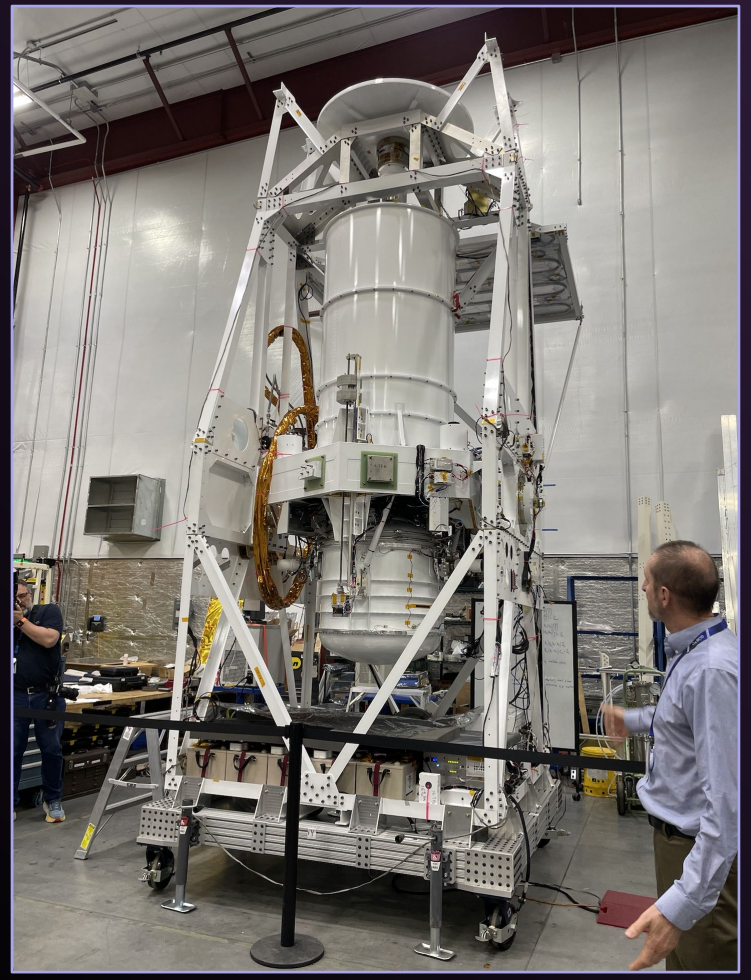
Directed 2017

XRISM

GUSTO

Galactic/Extragalactic ULDB Spectroscopic Terahertz Observatory

- GUSTO aims to provide a comprehensive understanding of the inner workings of the Milky Way and the Large Magellanic Cloud (LMC) by surveying them in 3 important far-infrared (THz) interstellar lines.
  - Provides a cost-effective approach to probe the full life-cycle of star formation and stellar evolution.
  - NASA's First Balloon Class D Explorer Mission
  - Pathfinder for future bold balloon programs
- PI is Dr. Christopher Walker (University of Arizona)
- KDP-E: Early-mid October
- Launch is scheduled for early December 2023 from Antarctica



SPHEREx

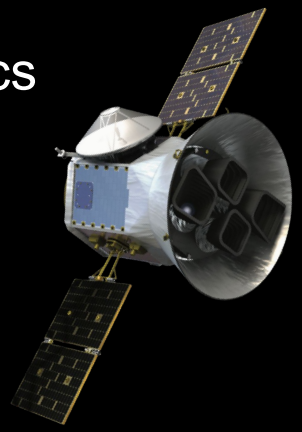
Spectro-Photometer for the History of the Universe, Epoch of Reionization and Ices Explorer

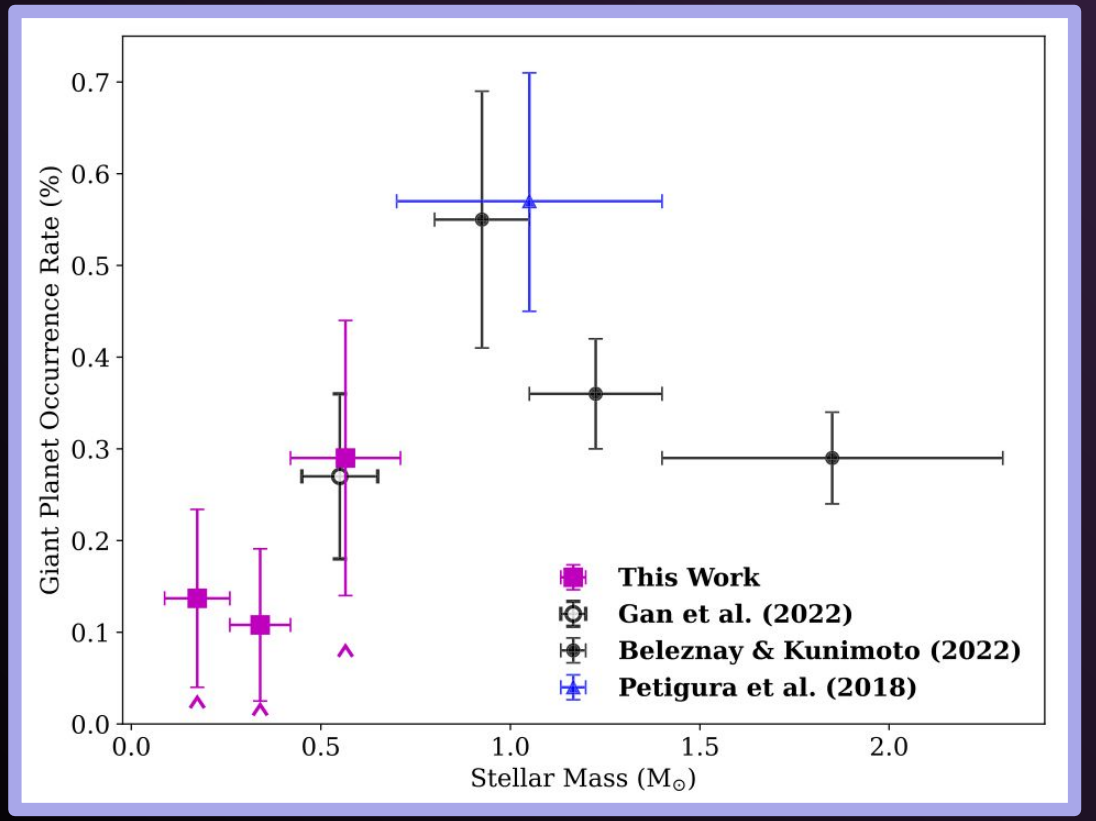
- The SPHEREx mission will provide the first all-sky spectral survey.
- Over a two-year planned mission beginning in 2025, the SPHEREx Observatory will collect data on more than 300 million galaxies along with more than 100 million stars in the Milky Way in order to explore the origins of the universe.
- SPHEREx PI Dr. Jamie Bock leads the investigation. The California Institute of Technology and Jet Propulsion Laboratory will develop the SPHEREx payload. The spacecraft bus and telescope will be supplied by Ball Aerospace. The Korea Astronomy and Space Science Institute will contribute the non-flight cryogenic test chamber.
- KDP-D: ~January 2024

TESS
Transitioning Exoplanet Survey Satellite

- Planet count: 346 confirmed planets
  - 116 with radii < 2.5 REarth
  - 225 with radii > 2.5 REarth
  - 5 with unknown radii
  - 6,586 candidate planets

- Publication Count: 1611 submitted, 1397 peer-reviewed
  - 40% exoplanets
  - 60% astrophysics





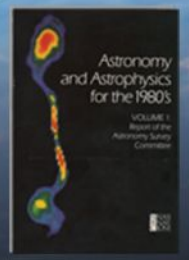
The Occurrence Rate of Giant Planets Orbiting Low-mass Stars with TESS (Bryant et al. 2023, MNRAS, 521, 3663)

ASTRO2020 Forward Plan

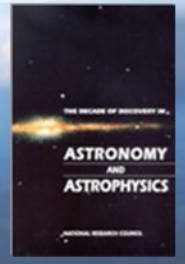
Astrophysics

Decadal Survey Missions

1972
Decadal Survey
Hubble



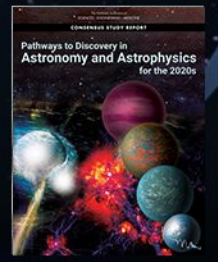
1982
Decadal Survey
Chandra



1991
Decadal Survey
Spitzer

2001
Decadal Survey
Webb

2010
Decadal Survey
Roman



2021
Decadal Survey

Status of Astro2020 Key Recommendations

Key Mission Recommendations	Latest Action
Near-Infrared/Optical/Ultraviolet 6-m telescope with high-contrast imaging capability (part of GOMAP program)	See GOMAP recommendation action below.
Great Observatory Mission and Technology Maturation Program (GOMAP)	GOMAP planning underway within NASA, START Team call issued, selections will be announced soon.
Space-based time-domain and multi-messenger counterparts program (TDAMM)	APD formulating plans for how its current and future programs will enhance the community's capability to perform time domain and multi-messenger astrophysics
Astrophysics Probe Mission	8/16/2022 Draft Call for Proposals
End SOFIA operations by 2023	SOFIA operations ended. NASA's Press Release 9/30/2022

APD Responses to Decadal

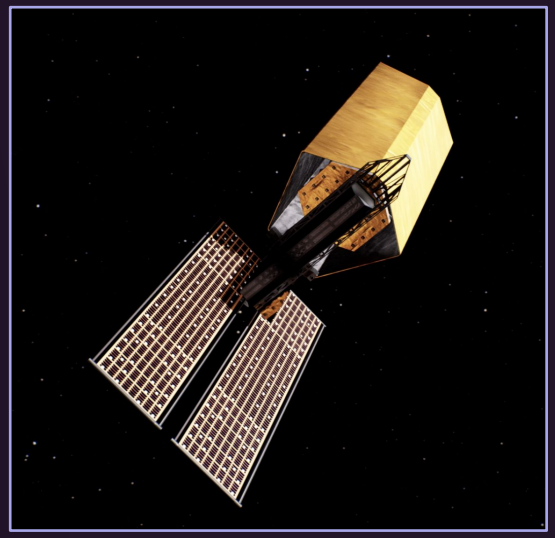
Response to Decadal Survey

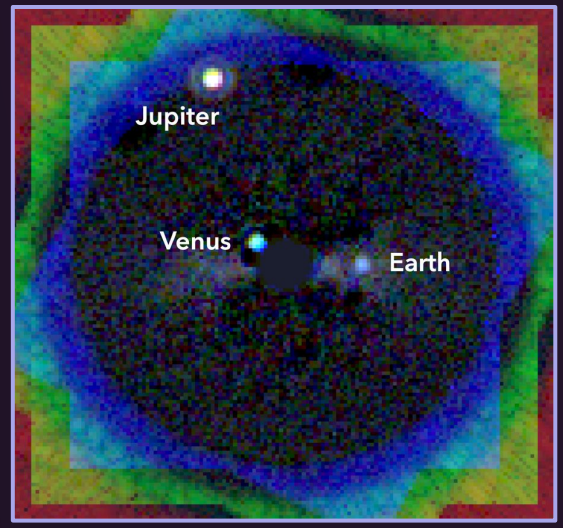
- Decadal Survey (ASTRO2020) priority science area
  - Are there habitable planets harboring life elsewhere in the universe?
  - Survey sun-like, nearby stars for habitable planets and search for evidence of life
  - Study the life cycle of galaxies with large-apparture space telescope

- Response to primary recommendation:
  - Space telescope similar in wavelength coverage to Hubble, with an aperture of ≥ 6 meter and coronagraphic imaging capability

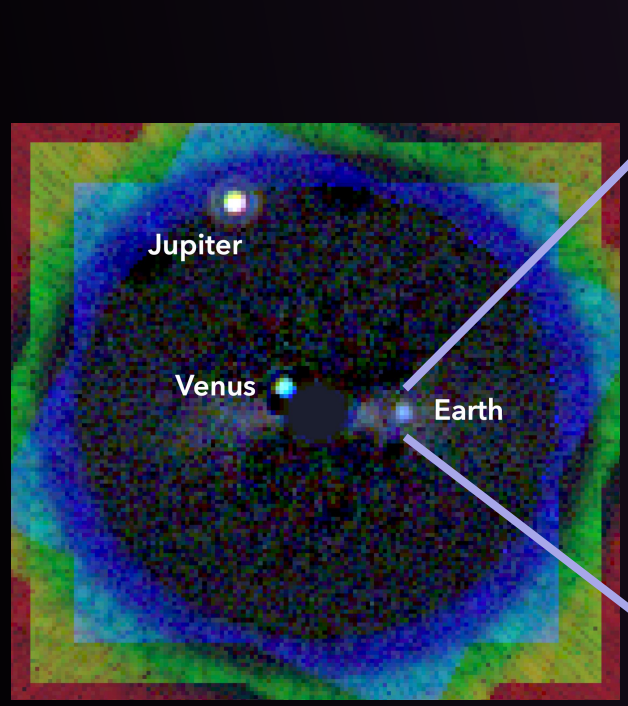
- Primary technical requirements
  - 6-meter Segmented mirror telescope
  - Active control of optics to achieve
    - Ultrastability at level of ~10 pm over control cycle
  - Coronagraph achieving contrast levels of 10^{-10}

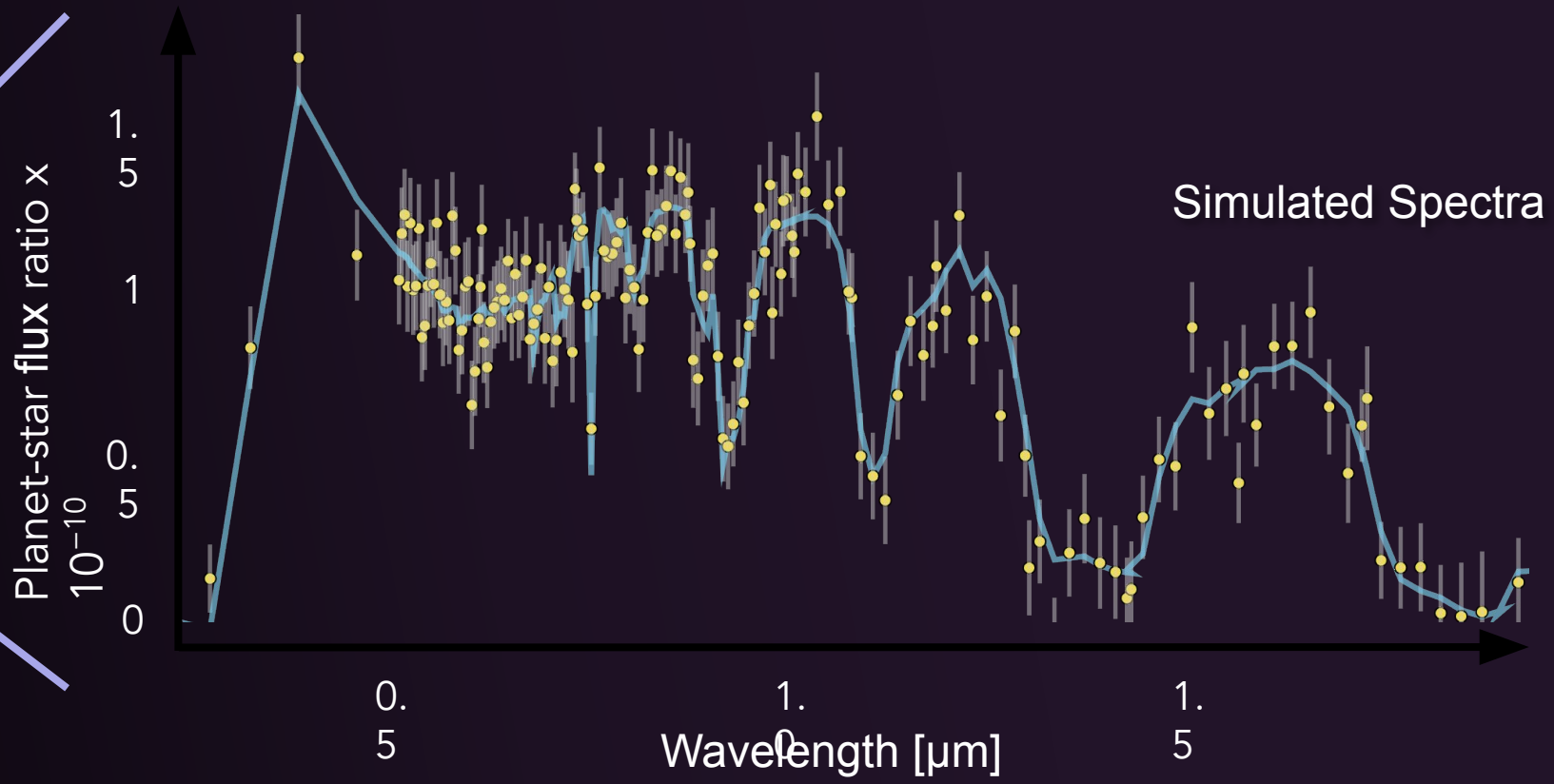
- Habitable Worlds Observatory
  - Survey and characterization of habitable worlds candidates
  - General astrophysics program





Searching for Life Outside the Solar System





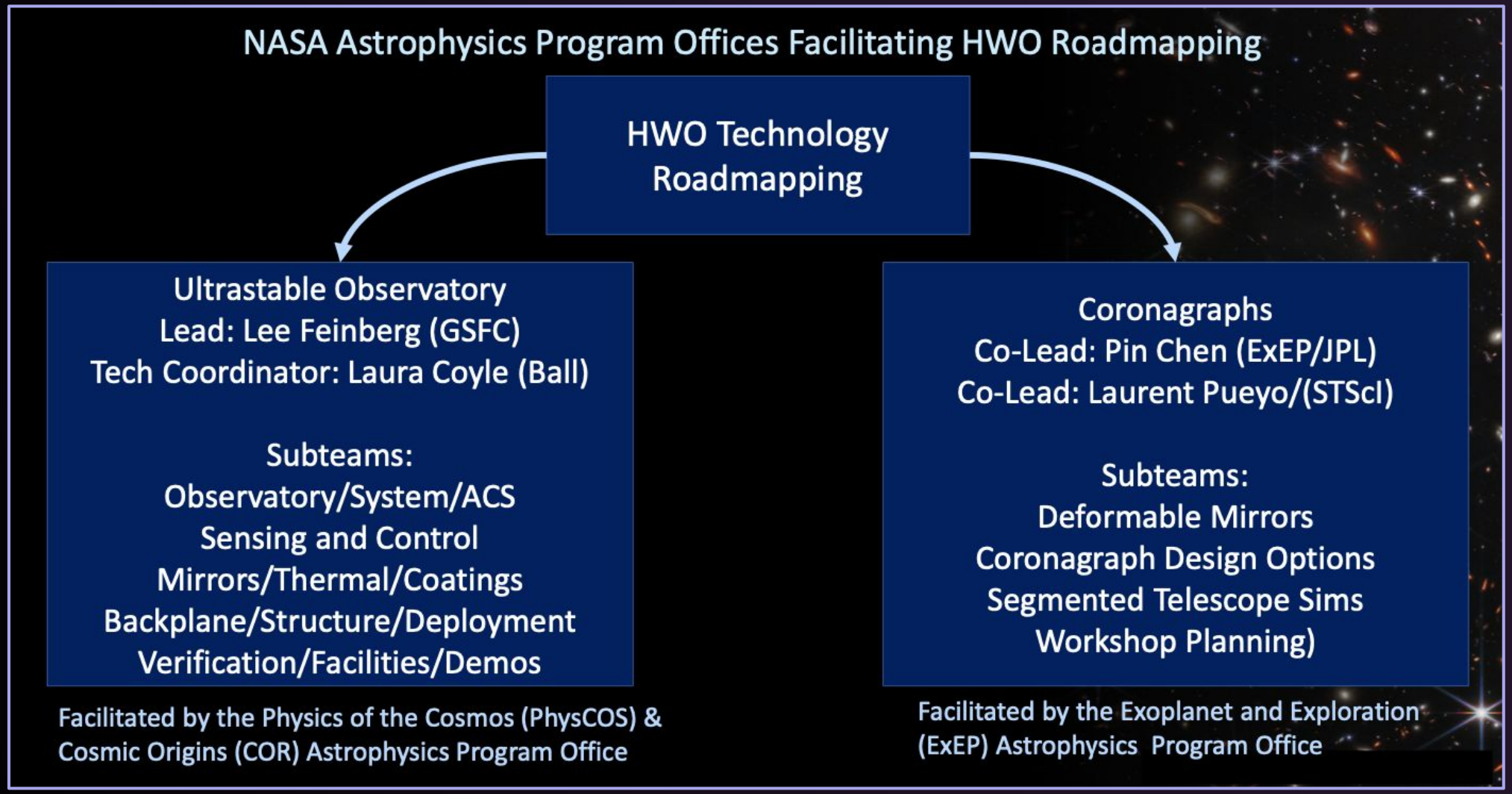
Analyze light directly reflected by the planet, with little or no starlight mixed in

The Habitable Worlds Observatory:
Big Picture Strategy

- **Build to schedule**: Mission Level 1 Requirement e.g. Planetary mission strategy
- **Evolve technology**:
  - Build upon current NASA investments and TRL-9 technology
  - Segmented optical telescope system from JWST
  - Coronagraph from Roman ‘s coronagraphic imager program
- **Next Generation Rockets**:
  - Larger telescope aperture sizes
  - Leverage opportunities offered by large fairings to facilitate mass & volume trades
- **Modular and Scalable Architecture/Design**
  - **Enabled by Robotic Servicing at L2: Robotic servicing at L2**
  - **Delivers Robust Margins with large scientific, technical, and programmatic margins**
- **Mature technologies first**: Reduce risk by fully maturing the technologies prior to development phase.

What are we Doing Now?

Current Activities:II



The Habitable Worlds Observatory:
Current Activities: III

- **Science, Technology, Architecture Review Team (START)**
  - Which decadal science questions can Habitable Worlds Observatory help address?
  - What observations do we need to answer those questions?
  - What capabilities will deliver those observations?
  - What performance can we expect?
  - Where do performance breakpoints exist?
  - What models do we need to predict performance?

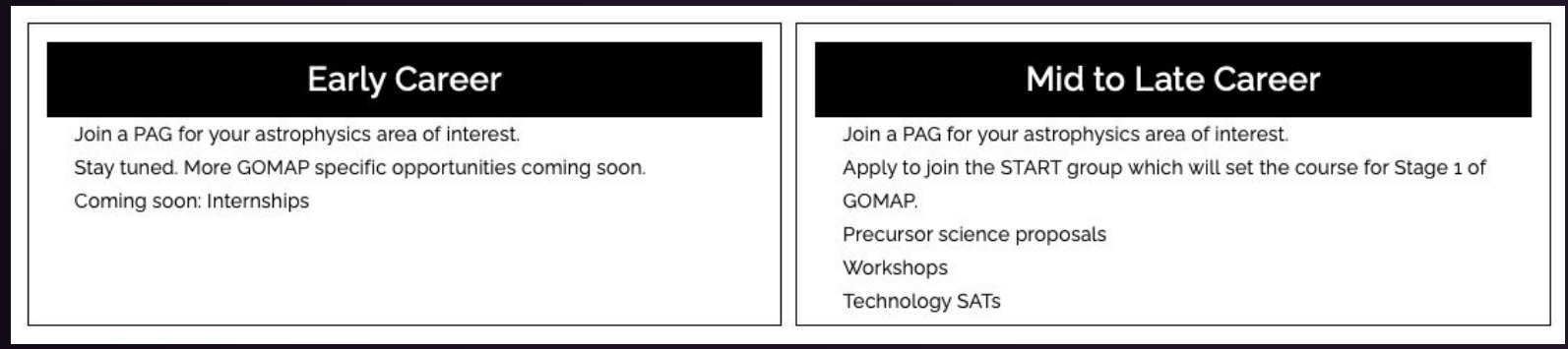
Technical Assessment Group (TAG)

- What architecture trades remain?
- How are those trades related/coupled to each other?
- Which trades are the most important to study now?
- What are the technologies associated with those trades?
- What cost/schedule risks exist for those trades?
- How might those risks be mitigated?
- How can external partners be involved?

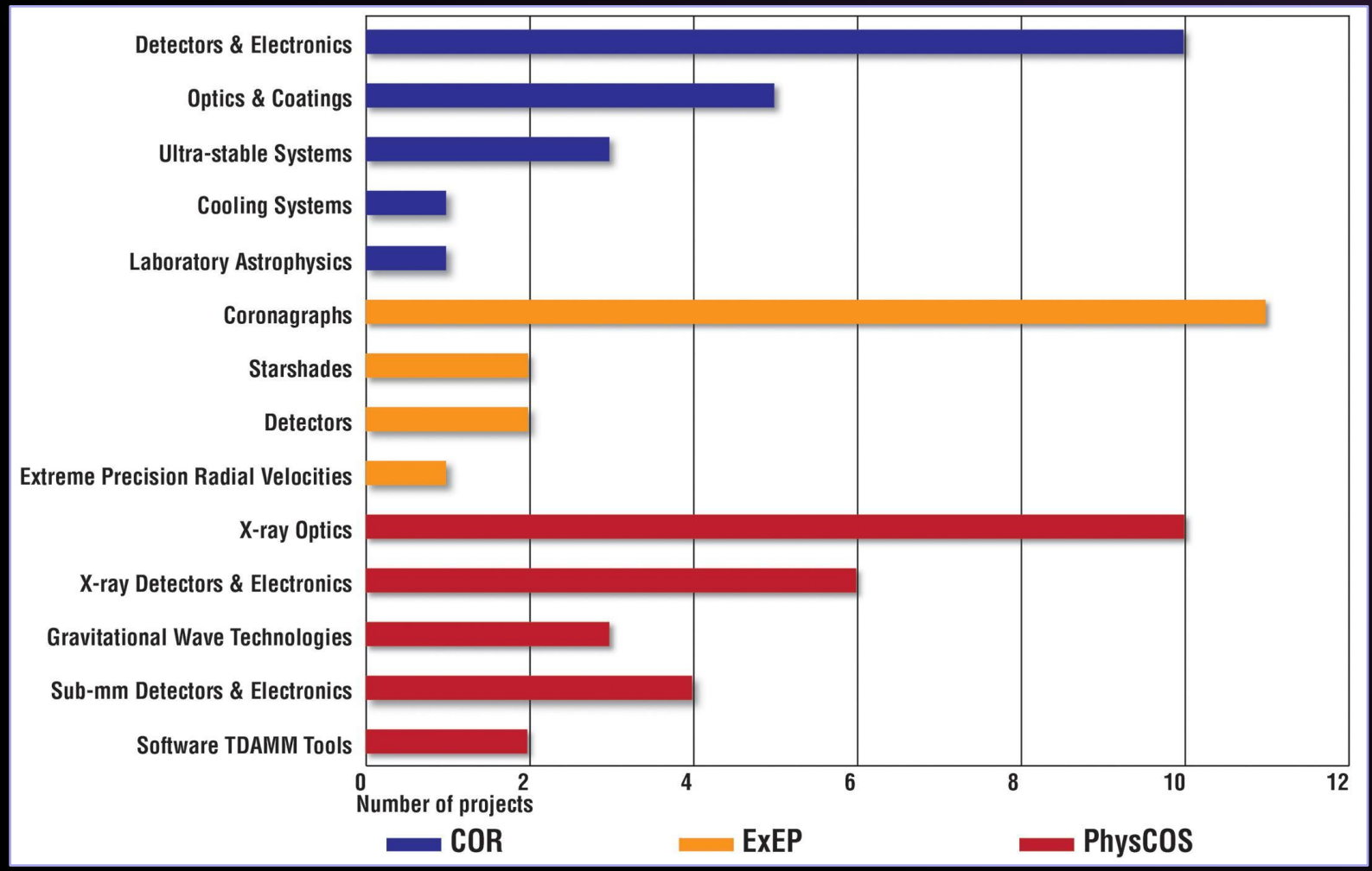
The Habitable Worlds Observatory:
How Do I Get Involved?

- **Science**
  - Pre-Cursor Science (ROSES call)
  - Science, Technology, Architecture Review Team (START) (Dear Colleague Letter)
  - Extreme Precision Radial Velocity (EPRV) (ROSES)

- **Technology**
  - Technology Development: (SAT, APRA, ROSES, Directed, etc.)
  - Technology Roadmapping (Facilitated by the Astrophysics Program Offices)
  - Interoperable Integrated Modeling



Current Strategic Technology Projects



Astrophysics Probe

- On August 16, 2022 NASA issued a draft AO for a PI-led Astrophysics Probe for comment.
- The PI cost cap is $1B; AO requires a General Observer/Guest Investigator (GO/GI) Program during the 5-year prime mission. For a pointed observatory, 70% of observing time is allocated for GO. A survey observatory will make data available as soon as practicable.
- The target date for the final Probe AO remains July 2023
- This is a two-step AO: because the Probes are more complex than previous Explorers, and this is the first one, the competitive Phase A studies will last 12 months
- In response to the recommendation of Astro2020, Astrophysics will accept proposals for:
  - A far-infrared imaging and/or spectroscopy mission
  - An X-ray probe
- Proposing teams should check the Q&As frequently at https://explorers.larc.nasa.gov/2023APPROBE/

Release of final AO:	**July 2023 (target)**
Proposals due:	NET mid-November 2023

IDEA Initiatives

On-going & Planned IDEA Initiatives in APD

- Inclusion Plans in ROSES22:
  - Piloting continues - APRA, LISA, SAT, TCAN, Roman, Precursor Science – lots of lessons being learned
  - IP assessment criteria are not part of evaluation criteria but if IP is inadequate, funding released only after IPs are judged to be adequate
  - ROSES 23 has new standardized language and various programs across SMD will continue to pilot this effort
  - SMD held a community workshop and a resources page available as of January 2023 under SMD Inclusion webpage
- APD Community Days have begun
  - APD Virtual visit (Clampin, Eric Smith, Cucchiara, Sheth) visited Puerto Rico on March 7th.
  - Stakeholders on the island engaged in planning
  - Faculty and graduate students across island invited
  - Follow up visits planned to further engage on specific areas (i.e. engineering / technology as well as undergraduate research etc.)

On-going & Planned IDEA Initiatives in APD

Continued

- Statement of Principles by APD developed and shared across NASA Astrophysics ecosystem

- Regular attendance at National Society of Black Physicists (NSBP) and Society for Advancement of Chicanos and Native Americans in Science (SACNAS) meetings

- Other previous APD pioneering efforts:
  - Code of Conduct for review panels developed by APD, now adopted SMD-wide!
  - Changes in language to Senior Review (SR) aligned with NASA's core value of Inclusion – our changes to SR adopted SMD-wide!
  - Changes to AO language

Statement of Principles

Code of Conduct

SMD Inclusion Plan Resource Page

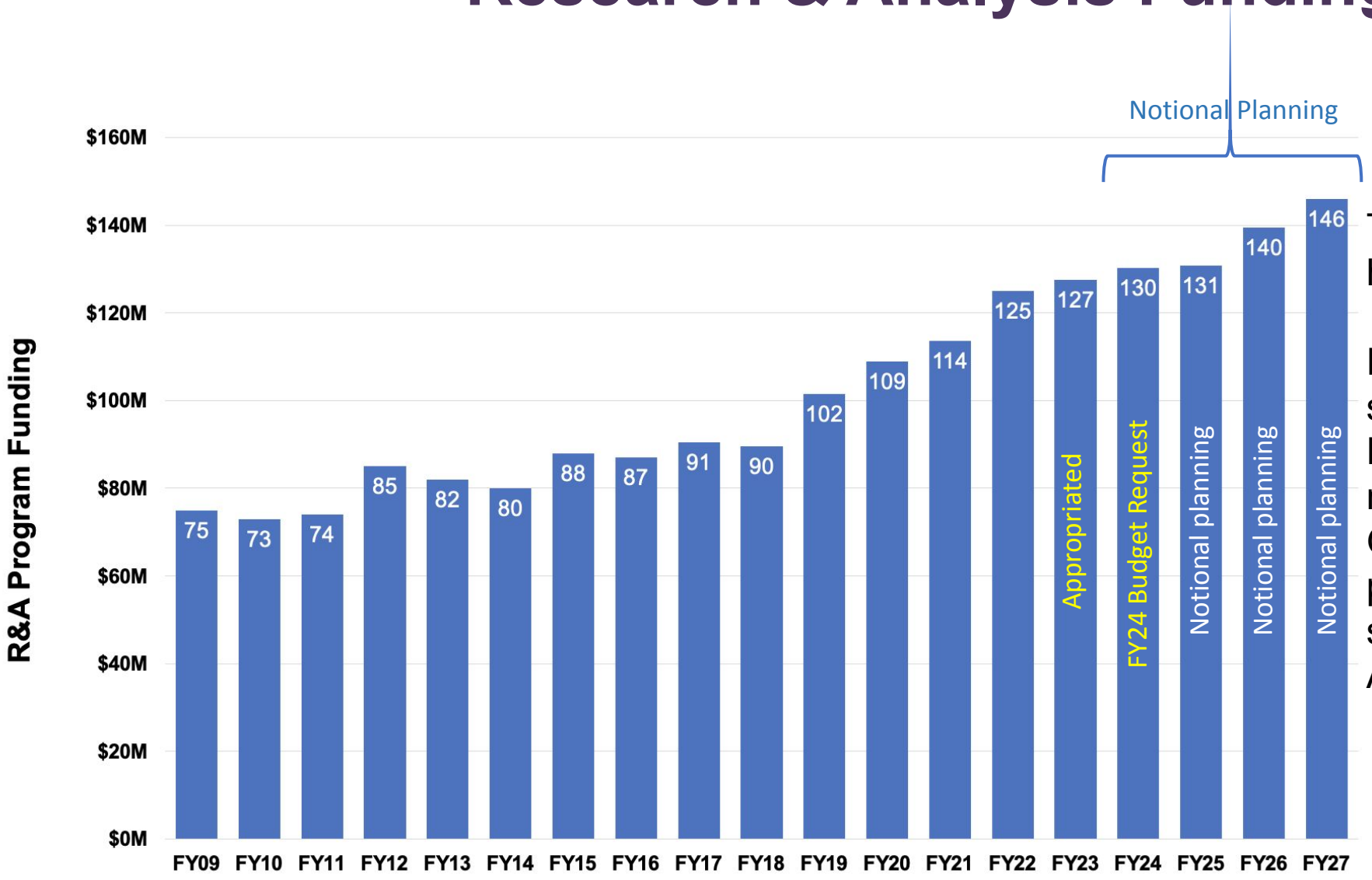
Community Engagement

- We must ensure that people from all over our nation are aware and engaged

- NASA Astrophysics (APD) has launched a virtual and in person (when possible) “road tour” to visit with different community members to provide an overview of APD, listen to the community’s questions, concerns and suggestions on our plans, and expand the footprint of our scientific and technology community engaged in work with our division.
  - The first of these events was with the University of Puerto Rico on March 7th
    - APD has been working with Dra. Mayra Lebrón Santos, Dra. Carmen Pantoja, Dra. Desireé Cotto Figueroa, Dr. Héctor J Jiménez González, Dr. Gerardo Morell Marrero, Dr. Rafael Rodríguez and Prof. Abel Méndez, as well as Dr. Héctor Arce on crafting the event and understanding the needs of the Puerto Rican community

R&A

Research & Analysis Funding



The Astrophysics R&A Program has seen a sustained growth.

For the last 12 months, the selection rates were 21% for R&A programs and 24% for mission's General Observer and General Investigator (GO/GI) programs, with a total average selection rate of 24% for all Astrophysics ROSES programs.

2023 Astrophysics Research Solicitations

Supporting Research and Technologies			
Astrophysics Research & Analysis	APRA	IP	
Strategic Astrophysics Technology	SAT	IP	
Astrophysics Theory Program	ATP	IP	DAPR
Nancy Grace Roman Technology Fellowships	RTF		
Astrophysics Decadal Survey Precursor Science	ADSPS	IP	DAPR
Data Analysis			
Astrophysics Data Analysis	ADAP		DAPR
Fermi, Swift, NuSTAR, NICER, TESS, **IXPE** New	GO/GI		DAPR
Mission Science and Instrumentation			
Astrophysics Pioneers (suborbital science)	Pioneers		DAPR
Suborbital payloads solicited through APRA	APRA	IP	DAPR
Roman Research and Opportunities	Roman	IP	DAPR
Cross Divisional			
Exoplanets Research Program	XRP		DAPR
Topical Workshops, Symposia and Conferences	TWSC		
Citizen Science Seed Funding Program	CSSFP		
Graduate Student Research Awards	FINESST		

Solicited Separately			
JWST, Hubble, Chandra GO/GI/Archive/Theory programs	GO/GI		DAPR
NASA Hubble Fellowship Program	NHFP		
NASA Postdoctoral Program	NPP		
Support for XMM-Newton U.S. PIs (selected by ESA)	XMM GO		
Not Solicited in ROSES-23			
Theoretical and Computational Astrophysics Networks, every other year	TCAN	IP	DAPR

IP: Proposals require an Inclusion Plan for creating and sustaining a positive and inclusive working environment.

Assessment of IP not part of adjectival rating / does not inform selection of proposals. However, funding only released after a satisfactory Inclusion Plan is accepted.

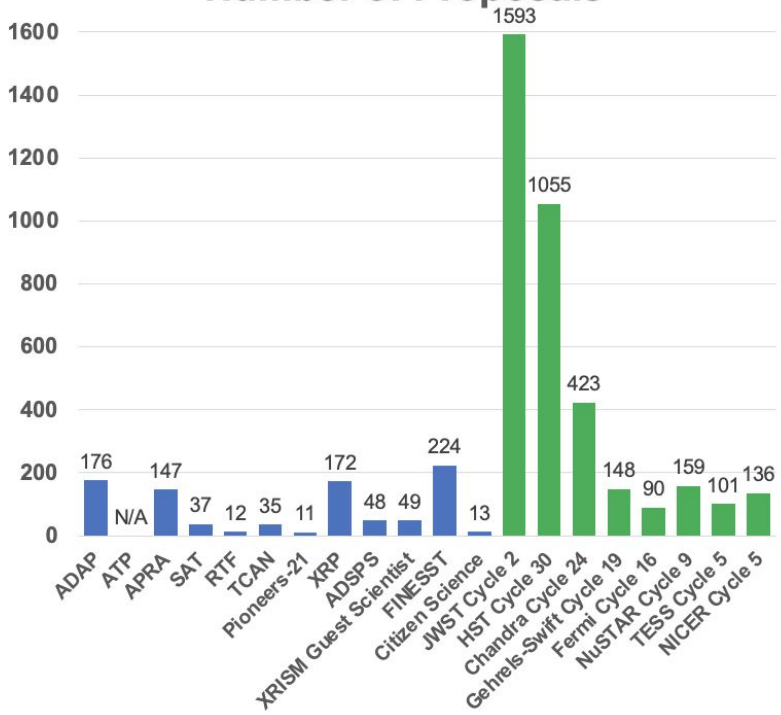
Inclusion Plan pilot program will continue in 2023 but likely not expand until later.

DAPR: Proposals evaluated using dual-anonymous peer reviews where panelists do not know the identities of the proposing teams and institutions.

Astrophysics R&A Selection Rates

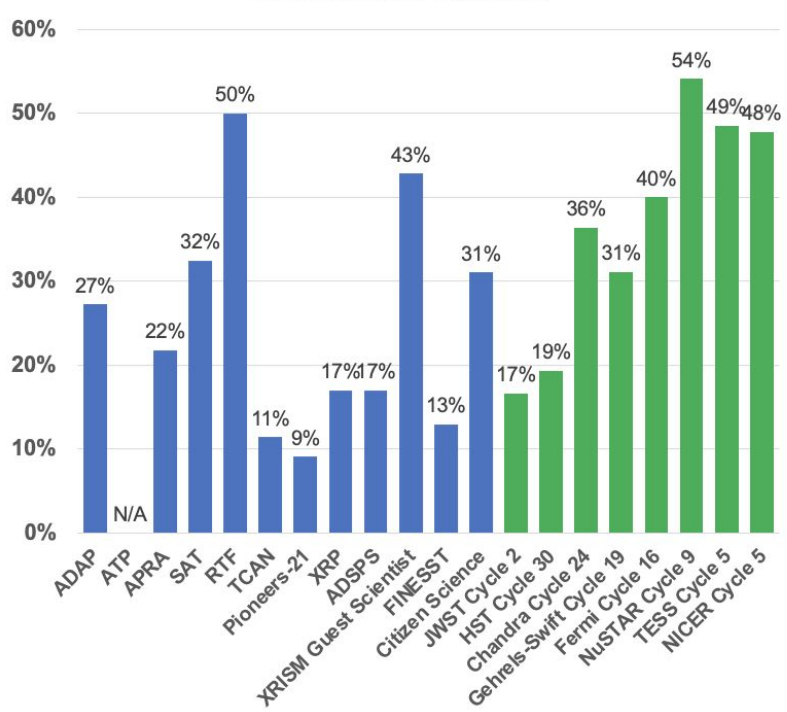
June 2022-2023

Number of Proposals



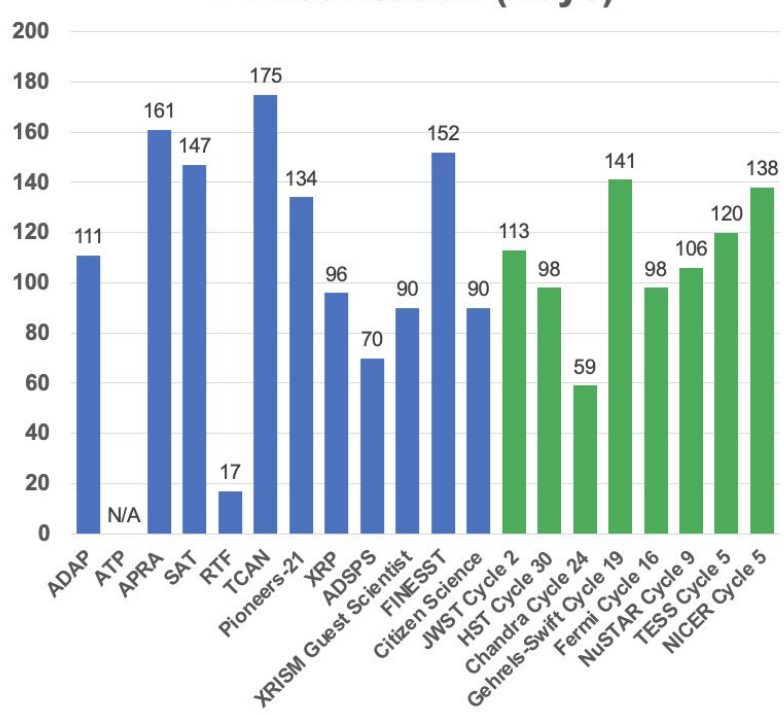
R&A: 924 proposals
GO/GI: 3,705 proposals
Total: 4,629 proposals

Selection Rates



R&A: 21%
GO/GI: 24%
Average: 24%

PI Notification (Days)



80% of PI notification:
R&A: 112 days
GO/GI: 107 days

* Only programs with selections made and PIs notified

Superpressure Balloon (SuperBIT) Launched and Landed

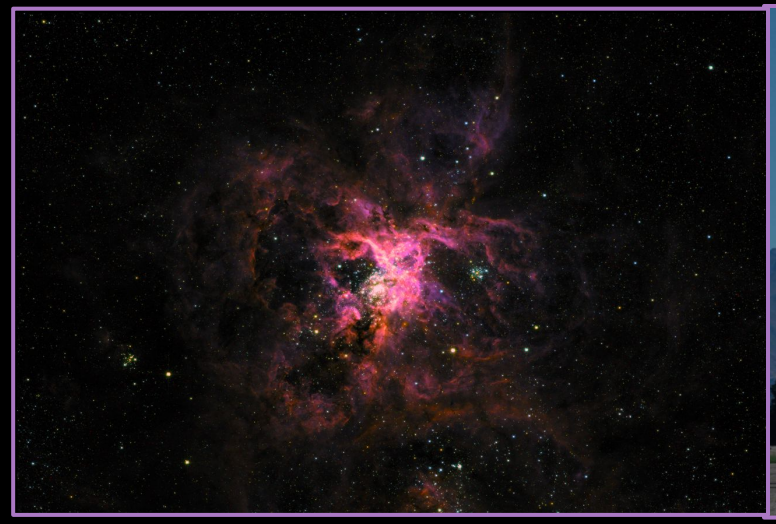
- NASA's Scientific Balloon Program successfully launched its football-stadium-sized, heavy-lift super pressure balloon (SPB) from Wānaka Airport, New Zealand in April, and after circling the Southern Hemisphere five times, the mission landed in Argentina on May 25.
- The balloon carried the Super Pressure Balloon Imaging Telescope (SuperBIT) from Princeton University which used a wide field of view to image large galaxy clusters from a balloon platform in a near-space environment.
- A few of the preliminary research images are of the Southern Pinwheel spiral galaxy (top image) and the Sombrero galaxy (bottom image).

M83 with SuperBIT

SuperBIT

SuperBIT was a balloon-borne 0.5-meter telescope which operated in the near ultraviolet to near infrared that was designed perform large viewed of view, diffraction limited survey of galaxy clusters in the southern hemisphere.

Led by PI William Jones at Princeton University, SuperBIT is studying dark matter distribution through weak gravitational lensing of background galaxies.



Tarantula Nebula with SuperBIT

SuperBIT launch May 15, 2023, Wanaka, NZ

SuperBIT completes its 39-dayjourney

Independent Balloon Program Review

Independent Balloon Program Review Team

First	Last	Organization
William C	Jones	Princeton University
John	Sample	Montana State University
Carolyn	Kierans	Goddard Space Flight Center
Linnea	Avalone	National Science Foundation
Kenneth	Jucks	NASA HQ Earth Science Division
David	Gregory	Former NASA Wallops Flight Facility
Joaquin	Vieira	University of Illinois Urbana-Champaign
Jessica	Gaskin	Marshall Space Flight Center
Neeharika	Thakur	Prince George Community College
Scott	Nutter	Northern Kentucky University
Jose V	Siles	Jet Propulsion Lab
Aamir	Ali	Templeton Foundation

- Decadal recommended IBPRT
- Terms of Reference here
- Non-government members being appointed as Special Government Employees (SGEs)
- Tentative timeline:
  - 1st meeting in April / May
  - Interim report to APAC (Oct '23)
  - Final report to APAC ('Mar '24)

Balloon Program

In CY23 NASA continues to successfully implemented a scientifically productive Balloon Campaign.

- In March-May, the Program conducted the Wanaka Balloon Campaign with two super-pressure balloons certification launches, each balloon carried a payload of opportunity (SuperBIT and EUSO-SPBs).
- In July, the Program will conduct a small planetary payload (WHATSUP) hand-launch from Palestine, TX.
- There are 7 primary payload launches on the manifest for the Fall Ft. Sumner Campaign, August-October.
- The Austral Summer LDB Campaign from Antarctica will support the GUSTO mission and AESOP-Lite (HPD).
- Looking into CY24, the Program is currently planning a Sweden LDB Campaign with up to four payloads.

Status of Science Data Policy

Year of Open Science

Science Data Policy and a Year of Open Science

- SMD has released SPD-41a: Scientific Information Policy for the Science Mission Directorate to provide guidance on the open sharing of publications, data, and software created in the pursuit of scientific knowledge.

- SMD has developed Open Science Guidelines that provide further guidance to the community on general implementation of SPD-41a.

- The Astrophysics Scientific Information Management Policy provides further clarification on the application of SPD-41a to the Astrophysics Division.

Science Data Policy and a Year of Open Science

- 2023 Year of Open Science is a multi-agency initiative to spark change and inspire open science engagement through events and activities that will advance adoption of open science. NASA is a participating agency.

- NASA’s participation in the Year of Open Science is part of SMD's Transform to Open Science (TOPS), a $40 million 5-year mission to accelerate adoption of open science.

APAC Recommendations

APAC Recommendations from March 2023

Recommendation	Response
The APAC recommends that every APAC presentation describe how IDEA is implemented in their mission and/or program. Examples may include: team demographics, an inclusion plan, description of IDEA initiatives, and/or metrics.	APD will start asking our presenters to do this and help them with their presentations. We plan to start this for during the Fall APAC meeting.
The APAC recommends a mechanism for engaging the public when naming Flagship missions and Great Observatories and reiterates that more caution be used when naming missions after people.	NASA will follow the recently established process (NPD 7620.1J) for naming its future flagship missions

APAC Recommendations from March 2023

Recommendation	Response
The APAC notes that the HWO key technical requirements, an extremely stable wave-front error (10s of pm) and an ultra-high contrast coronagraph (10^{-10}), are several orders of magnitude better than the current TRL-9 technology. Therefore, the APAC requests information on the current state of the technological challenges, as well as an update on the timeline, technology roadmap, mitigation strategies, and key decision points to determine whether reformulation is needed. In particular, members of the APAC are interested in the tradeoff between on and off axis coronagraphs for HWO. The APAC recommends a standing risk review board to report periodically to APD and the APAC addressing these issues.	1) HWO Technology-focused presentation will be shown during fall/spring APAC. The presentation will address the current state of the art in coronagraph performance, and large telescope stability. 2) Technology roadmaps are currently under development at the EXEP and COR Program Offices. We will plan to present to APAC when they are completed. 3) We will provide regular status reports from the START team once they begin meeting. Since we are following Astro2020 guidance, it is premature to discuss architecture trades.

APAC Recommendations from March 2023

Recommendation	Response
Given the funding climate and GOMAP prioritization of HWO, the APAC requests a presentation on how SAT and APRA will be used to maintain the X-ray and Far-IR communities.	Included in Dr. Clampin's presentation
The APAC recommends that APD accelerate the implementation of the NHFP report recommendations. As an example, it is puzzling why some of the seemingly straightforward recommendations, such as virtual panels to increase panel diversity, are planned to be implemented by FY30 and not sooner. The APAC would like a thorough update on the evaluation criteria of NHFP candidates based on inclusive leadership requirements.	NHFP update will be presented at the fall APAC meeting.
The APAC recommends that APD investigate consequences and mitigation for aging instruments/missions that support TDAMM, with emphasis on Fermi and Swift.	APD plans to rely on smaller programs and partnerships to fill gaps that may be required to mitigate the aging of instruments and missions that support TDAMM.

APAC Recommendations from March 2023

Recommendation (JWST)	Response
The APAC recommends higher prioritization of TDAMM. As a first step, APAC recommends a reanalysis of APD's current portfolio to determine how to maximize TDAMM capabilities, such as prioritizing TDAMM in mission selection or enabling TDAMM science through multi-messenger joint analysis tools in TDAMM-specific ADAP opportunities.	APD does not intend to prioritize TDAMM in mission selection at this time. Investments are being made in joint analysis tools.
The APAC is cognizant that the shift to open data can disproportionately affect early career and under-resourced scientists. Although there is a mechanism to request additional proprietary time, few proposers are aware of this – indeed, many proposers have expressed concern that a request for any proprietary time be viewed unfavorably by the TAC. The APAC recommends that information on the length of (or lack of) proprietary time requested in proposals be kept confidential from the TAC.	The default exclusive use time for JWST is still 12 months. User's have always been able to request additional time and peers are the best judge of whether that extra time is needed for the investigation.
The APAC recommends that APD consider mechanisms to make limited proprietary time models more equitable for early career and under-resources GOs.	APD will follow the guidance of SMD with regards to data access for new missions.

APAC Recommendations from March 2023

Recommendation (Euclid)	Response
The APAC recommends funding to jointly analyze Euclid, Roman, and Rubin data to maximize the science impact of the three missions, as well as to build infrastructure to enable time-domain and multi-messenger astronomy.	APD believes that this is important analysis work that should be undertaken. However, at this time it cannot be funded.
The APAC recommends that APD conduct an analysis on how to broaden participation in Euclid science, particularly for marginalized and early career groups.	Research funding for analysis of Euclid data will be available through the ADAP-24 call, which uses dual-anonymous peer review.
The APAC requests discussion of the tangible benefits to the Apache and Hawaiian communities for partnering with APD beyond land acknowledgements.	In Hawaii, both IRTF and Keck Observatory, facilities used by APD-supported scientists, have active on-going programs to support and engage the Hawaiian communities participating in educational, training, students' internships, teachers' workshops, and workforce building. Furthermore, both observatories are part of the new Maunakea Governance Authority as established by the Governor to further build trust and bridges with the local community.

APAC Recommendations from March 2023

Recommendation (Roman)	Response
The APAC requests an update on the Community Survey progress, as well as that of the Infrastructure teams.	Another update in the Roman presentation at this APAC meeting.
As Roman is being referred to as a TDAMM mission within APD, the APAC would like a conversation on how the project is specifically enabling the aspects of TDAMM that were prioritized by the TDAMM workshop report.	The selection of a Time Domain Project Infrastructure Team for Roman has elevated its role as a dedicated TDAMM mission.
The APAC suggests that APD explore ways to magnify the impact of the SMD Bridge through institutional buy-in. One suggestion is to have MSI institutions support teaching release, and explicitly recognize the value of the bridge program in the components used to evaluate promotion and tenure dossiers: research, teaching, mentoring, advising and service.	Discussion with SMD brifge program underway.

APAC Recommendations from March 2023

Recommendation (SMD Bridge Program)	Response
We also note the plethora of existing efforts within federal agencies and suggest that partnering with other Inclusion programs, such as the NSF REU, NSF INCLUDES, NSF Louis Stokes Regional Centers for Excellence, DOD ASSURE, DOE FAST, AAAS SEA Change, etc., may be fruitful to share mentoring resources, best practices for evaluation, as well as to avoid duplication of effort.	APD is discussing coordination with other government efforts.
The APAC suggests that APD explore ways to magnify the impact of the SMD Bridge through institutional buy-in. One suggestion is to have MSI institutions support teaching release, and explicitly recognize the value of the bridge program in the components used to evaluate promotion and tenure dossiers: research, teaching, mentoring, advising and service.	

APAC Recommendations from March 2023

Recommendation (JWST Naming Investigation Report)	Response
We also note the plethora of existing efforts within federal agencies and suggest that partnering with other Inclusion programs, such as the NSF REU, NSF INCLUDES, NSF Louis Stokes Regional Centers for Excellence, DOD ASSURE, DOE FAST, AAAS SEA Change, etc., may be fruitful to share mentoring resources, best practices for evaluation, as well as to avoid duplication of effort.	NASA will coordinate with other government efforts.
The APAC requests an update at the next meeting on APD IDEA efforts specifically for the LGBTQIA+ community.	We are working on IDEA efforts to be more inclusive along all axis of diversity. We are not specifically targeting one group, except via ERGs at NASA which are designed to help LGBTIQA+ community internal to NASA and help with recruiting external to NASA.

APAC Recommendations from March 2023

Recommendation (GUSTO)	Response
The APAC requests a short status on mission progress at the Summer APAC meeting.	GUSTO is on schedule for the December 2023 balloon launch from Antarctica. The Observatory integration is completed at APL. The GUSTO performance enables the 70-day survey aloft meeting the baseline science level 1 requirements (50-day threshold). Next step is the GUSTO Compatibility Test with the Balloon Program flight system in Palestine, TX before shipping the Observatory to Antarctica (Via Christchurch, NZ).

APAC Recommendations from March 2023

Recommendation (GOMAP)	Response
In addition to the other GOMAP-related recommendations elsewhere, the APAC would like more clarification on the connection, synergies, and overlap between the START team and the PAGs at the Fall meeting. The APAC requests a presentation on the programmatic support of NASA for interdisciplinary astrobiology studies.	To be included in GOMAP presentation.

Recommendation (TDAMM)	Response
The APAC would like a summary of the TDAMM workshop report to be presented at a future meeting. In addition, it may be fruitful to engage the NSF in a joint TDAMM discussion at the next APAC meeting.	See Dr. Connaughton's presentation

Recommendation (Science Activation Program)	Response
The APAC is interested in the metrics and evaluation report and requests an update at a future meeting.	Update will be given at Fall meeting.

APAC Recommendations from March 2023

Recommendation (Explorer Program)	Response
The APAC recommends continued support for the Explorer program, and efforts should be made to shield the 4 calls per decade cadence in addition to the plans for a large explorer/probe from budget constraints.	

Recommendation (SPHEREx)	Response
SPHEREx is scheduled to undergo an SIR review in November 2023. The APAC recommends that the review panel, either at this review or at KDP-D, evaluate funding the pipeline development beyond the launch date. In particular, the cosmology science cases of SPHEREx may not be achieved with continued pipeline development.	SPHEREx Phase E/F science operations will be reviewed at the SIR, with recommendations including funding levels to be addressed at the subsequent KDP-D planned for ~January 2024.

APAC Recommendations from March 2023

Recommendation (Ultrasat)	Response
In future international agreements, APD does not limit the funding to perform science to preselected science team members.	APD allocates budget limits to international collaborations in accordance with various programmatic factors, including the mission's duration and the levels of NASA's participation in the project. ULTRASAT has an expected duration of only three years and NASA is not contributing to the instrument, but only the launching vehicle. Moreover, APD ran an open ROSES competition for US science participation following our IDEA policies, including a dual-anonymous review process. We do anticipate another ROSES call for this mission after launch. After the exclusive-use period (1 year), all data collected with ULTRASAT will be archived at IPAC and eligible for investigators to propose through ADAP.

APAC Recommendations from March 2023

Recommendation (COPAG/PhysPAG/ExoPAG)	Response
The APAC would like to see the Terms of Reference for the cross-PAG TDAMM Science Interest Group at the next meeting.	Available to APAC.
The APAC approves the TDAMM Communications Science Analysis Group and looks forward to hearing the result.	N/A for this meeting
The APAC is concerned that PhysPAG may be missing an opportunity to capitalize on the interest in multi-messenger astronomy through more connected interactions 10 between the PhysPAG SIGs and suggests a strategic planning exercise to increase its impact and development of the community.	TDAMM SIG is viewed as cross-SIG and cross-PAG interest group. TOR was circulated to other PAGS for input.

THANK YOU