



National Aeronautics and
Space Administration

NASA Astrophysics Update

Dr. Mark Clampin

Director, Astrophysics Division

NASA Science Mission Directorate

July 23, 2024



Science Mission Directorate
ASTROPHYSICS
 Organizational Chart

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

DIVISION MANAGEMENT



Dr. Mark Clampin
 Director



Sandra Cauffman
 Deputy Director

ADMINISTRATIVE SUPPORT

Jennifer Baker (C), Balam "Orby" Yaxkin (C), Joshua Diaz Calo (C)

DIVISION LIAISONS

Resource Management

Elijah Owuor (Lead)
 Jenna Robinson (Detail)
 Jennifer Holt

Communications

Alise Fisher

Policy

Mariah Baker

OIIR

Peyton Blackstock

Program Support Specialist

Paola Ortiz Perez

CROSS CUTTING

Technologist
 Mario Perez (Chief)
 Dominic Benford (Deputy)

Executive Officer
 Rhiannon Roberts (C)

Science Activation Lead
 Hashima Hasan

APD Communications
 Liz Landau (C - OCOMM Liaison)
 Julie Stoltz (C - Strategic Integration &
 Engagement Lead)

Inclusion, Diversity, Equity, and Accessibility
 David Morris (Lead)
 Antonino Cucchiara (Deputy)

FLIGHT PROGRAMS

Associate Director
 Joe Smith

PROGRAM EXECUTIVES

Rosa Avalos-Warren
 Rachele Cocks
 Lucien Cox
 Julie Crooke
 Ed Griego
 Shahid Habib
 Janet Letchworth
 Lucas Paganini
 Miles Skow
 Mark Sistilli

RESEARCH & ANALYSIS

Associate Director
 Eric Smith

R&A Lead
 Roopesh Ojha

PROGRAM SCIENTISTS

Alessandra Aloisi (D)
 Megan Ansdell
 Dominic Benford
 Valerie Connaughton
 Antonino Cucchiara (C)
 Doris Daou
 Michael Garcia (D)
 Thomas Hams (C)
 Hashima Hasan
 Stefan Immler

Hannah Jang-Condell
 Patricia Knezek
 David Morris
 Roopesh Ojha
 Joshua Pepper (IPA)
 Mario Perez
 Linda Sparke
 Sanaz Vahidinia
 John Wisniewski

RESEARCH PROGRAM SPECIALIST

Ingrid Farrell (C)

**ASTROPHYSICS
 STRATEGIC MISSIONS**

Program Director
 Sandra Cauffman

Program Manager
 Garth Henning

PROGRAM EXECUTIVES

Ed Griego
 Lucas Paganini
 Miles Skow

PROGRAM SUPPORT

Tony Comberiate (C), Andre Davis (C)



Sandra Cauffman
Program Director



Garth Henning
Program Manager

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



Joe 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.



Rosa Avalos-Warren
Pioneers, UVEX



Rachele Cocks
UVEX, TDAMM



Lucien Cox
GUSTO, SOFIA, PUEO,
COSI, Balloons



Julie Crooke
HWO



Ed Griego
Roman, CGI



Shahid Habib
Ultrastat, LISA, Athena,
Ariel/CASE, PhysCOS &
COR



Janet Letchworth
Operating missions,
Sr. Review



Lucas Paganini
Roman, CGI, ExEP



Miles Skow
Roman, CGI



Mark Sistilli
SPHEREx, COSI,
Probes, Explorers

RESEARCH & ANALYSIS



Eric Smith
Associate Director



Roopesh Ojha
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.



Alessandra Aloisi
ADCAR Deputy,
Data



Megan Ansdell
HWO



Dominic Benford
Roman, LabAstro, APRA Deputy,
Deputy Technologist



Valerie Connaughton
UVEX, XMM, Spectrum X-
Gamma, HEA, PhysCOS, TDAMM



Antonino Cucchiara
Fermi, FINESST, NHFP,
Bridge Program, TDAMM



Doris Daou
Euclid, NEO Surveyor,
New Horizons, Explorers,
Precursor, EPRV, ATP Deputy



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



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



Hashima Hasan
IXPE, NuSTAR,
Citizen Science, Keck,
Science Activation Lead



Stefan Immier
Chandra, R&A



Hannah Jang-Condell
NexSCI, ExEP



Patricia Knezek
Explorers, NHFP, Probes,
ADCAR, COR



David Morris
Fermi, Athena,
Cubesats Deputy,
APRA



Joshua Pepper
TESS, HWO Deputy,
Pioneers Deputy, ADAP, HEA



Mario Perez
Swift, ISFM,
RTF, SAT, UVO



Linda Sparke
Explorers Deputy,
COSI, ADCAR



Sanaz Vahidinia
XRISM, ATP, TCANN,
ADAP, PhysCOS



John Wisniewski
SPHEREx, XRP, ExEP, UVO

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



Dominic Benford
Deputy Technologist



Rhiannon Roberts
Executive Officer



Hashima Hasan
Science Activation Lead



Elizabeth Landau
Multimedia Lead and
OCOMM Liaison



Julie Stoltz
Strategic Integration
& Engagement Lead



David Morris
Inclusion, Diversity,
Equity, and Accessibility
(Lead)



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

Astrophysics by the NUMBERS

RESEARCH

~**365** U.S. Science PIs Funded
 ~**130** Individual Institutions Selected
 ~**\$145M** Awarded Annually

SMALLSATS/CUBESATS

4 Science Missions Launched
 1 Mission complete
 3 Operating/commissioning
 1 ISS-attached Science Mission
10 Science Missions in Development
 8 Free-flying CubeSats
 1 ISS-attached Science Mission
 1 Supporting Technology Development Project

SOUNDING ROCKETS

17 Science Missions Launched (Suborbital)
7 In Development

BALLOONS

27** Suborbital Balloons Launched
 **Includes APD, HPD, PSD, ESD, educational, & engineering missions
23 Missions in Development

TECHNOLOGY DEVELOPMENT

~**\$160M** Invested Annually

REFEREED PUBLICATIONS

>**23,432** Total Publications (2019-Current)
 >**21,249** Hubble Publications (1991-Current)
 >**542** Webb Publications (July 2022-Current)

MISSION SUMMARY

15* Missions Operating
17* Missions in Development
2 Tech. Demos
 *Including international

Astrophysics Mission Classes

DECADAL SURVEY

>\$2.5B

LARGE CLASS

Great Observatory
or Flagship

~\$1.5B

MEDIUM CLASS

Probe
PICC \$1B*

EXPLORER AO

~\$450M

SMALL CLASS

Medium Explorer
(MIDEX)
PICC \$300M*

~\$225M

SMALL CLASS

Small Explorer
(SMEX)
PICC \$145M*

\$80M

SMALL CLASS

Mission of
Opportunity

RESEARCH MISSIONS

\$20M

SMALL CLASS

Pioneers
SmallSat**



ASPERA
STARBURST
PANDORA
TIGERISS
LANDOLT

\$20M

SUBORBITAL

Pioneers
Balloon

\$10M

SUBORBITAL

APRA
Balloon

\$5M

SMALL CLASS

APRA
CubeSat

CUTE
BURSTCUBE
SPRITE
BLACKCAT
SPARCS

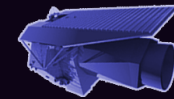
\$5M

SUBORBITAL

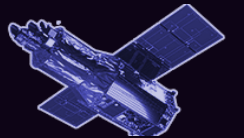
APRA
Sounding
Rocket

INTERNATIONAL

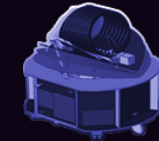
\$100M - \$1.0B



EUCLID



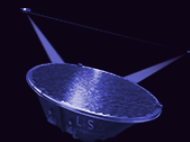
XRISM



ARIEL



ULTRASAT



LISA

Astrophysics Community Recognition

- Dr. Jane Rigby, Senior Project Scientist for JWST, received Medal of Freedom for work on Webb
- Marcia Rieke, Professor at the University of Arizona and PI for the near-infrared camera (NIRCam), awarded Gruber Cosmology Prize for work on Hubble and Webb
- Exoplanet researchers David Charbonneau (Harvard) and Sara Seager (MIT) have won the 2024 Kavli Prize in Astrophysics



Chandra's 25th Anniversary

Timeline of Key Contributors to Chandra's Success

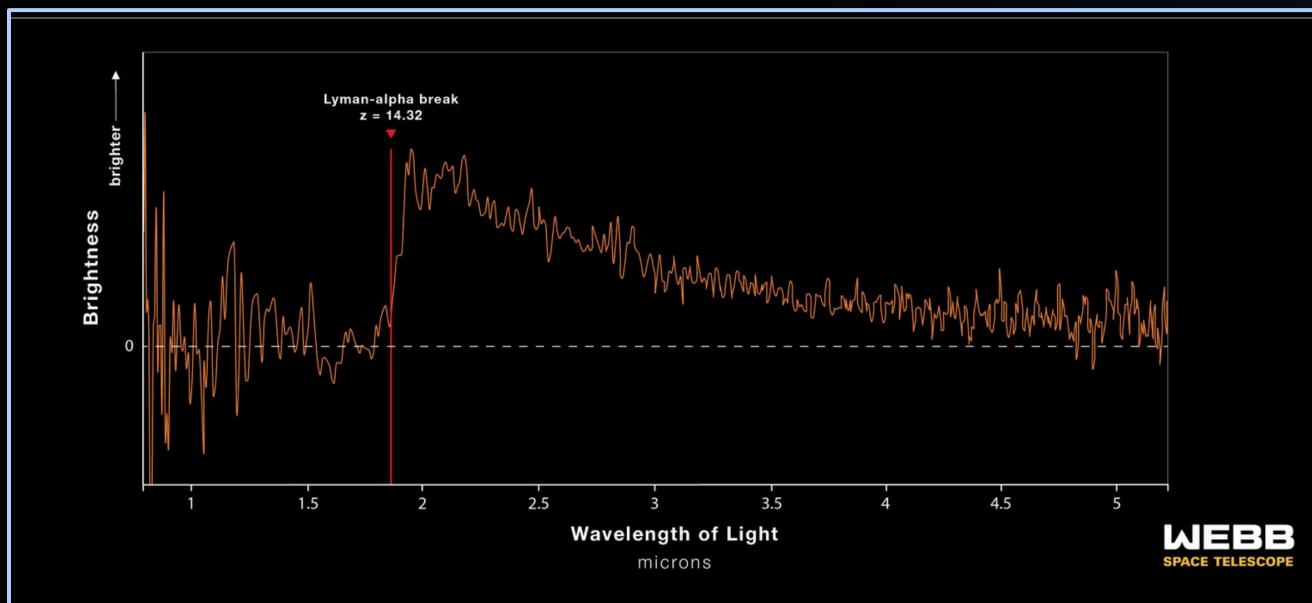
- 1976
 - Riccardo Giacconi and Harvey Tananbaum first proposed to NASA the mission that would one day become Chandra.
- July 23, 1999
 - The space shuttle Columbia launched into orbit carrying Chandra, the heaviest payload ever carried by the shuttle at the time. With Commander Eileen Collins at the helm, the astronauts aboard Columbia successfully deployed Chandra into its highly-elliptical orbit.
- 2002
 - Giacconi was awarded the Nobel Prize in Physics “for pioneering contributions to astrophysics, which have led to the discovery of cosmic X-ray sources,” laying the foundation for the development and launch of Chandra.
- Chandra science has led to over 700 PhDs and has supported a diverse talent pool of more than 3,500 undergraduate and graduate students, about 1,700 postdocs and over 5,000 unique principal investigators throughout the U.S. and worldwide.



James Webb Space Telescope

JWST Highlights

- JWST recently discovered the most distant known galaxy, which existed only 290 million years after the big bang.
- Celebrated 2-year anniversary with a new image release
- Mike Davis will start as new Project Manager on August 11.



Credit: NASA, ESA, CSA, STScI, Brant Robertson (UC Santa Cruz), Ben Johnson (CfA), Sandro Tacchella (Cambridge), Phill Cargile (CfA)

Webb

Star Clusters in a lensed arc emitting light when Universe was roughly 460 million years old

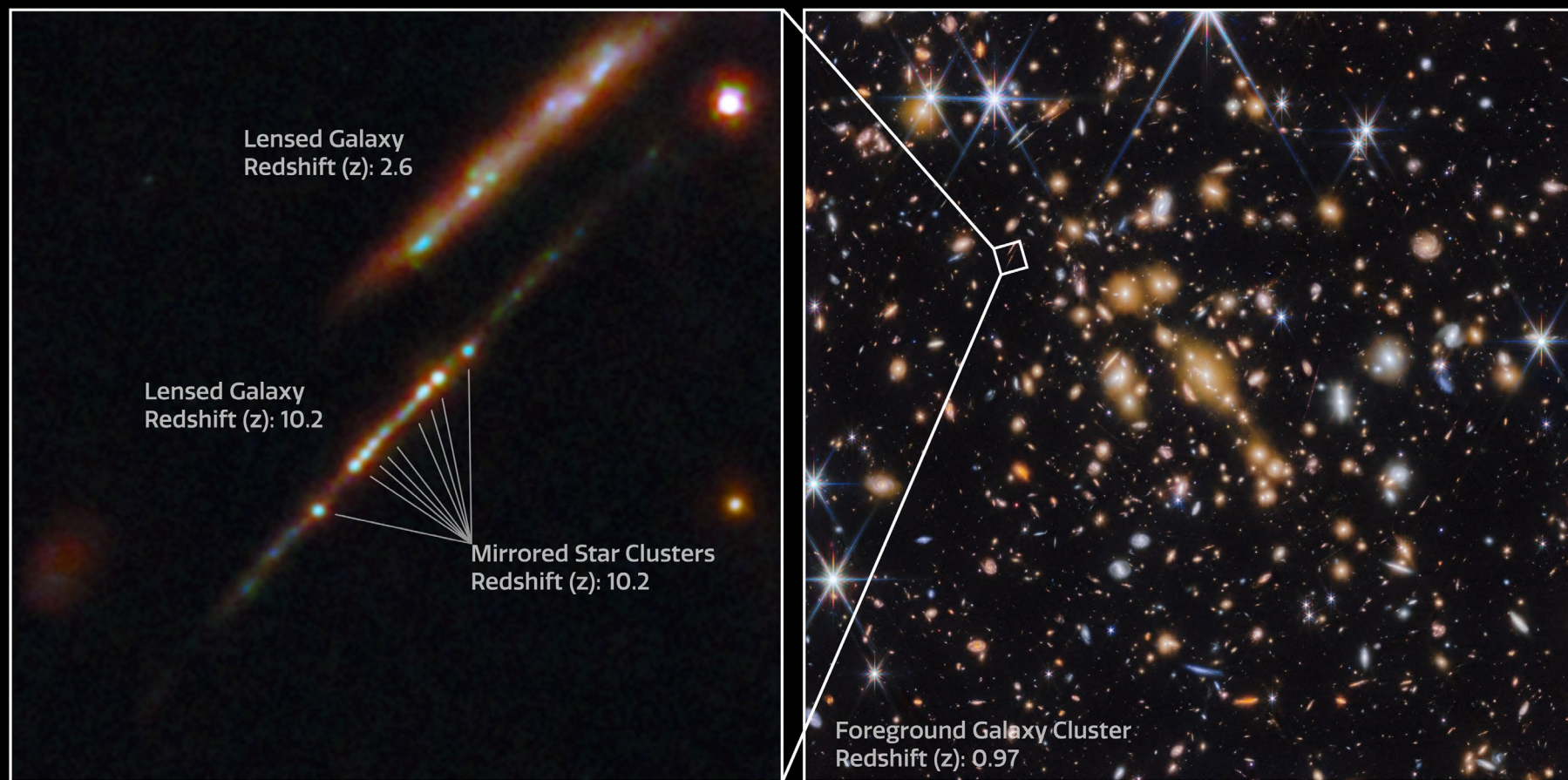


Image credit: ESA/Webb, NASA & CSA, L. Bradley (STScI), A. Adamo (Stockholm University) and the Cosmic Spring collaboration

Super-Earth 55 Cancri e

NIRCam + MIRI Emission Spectrum

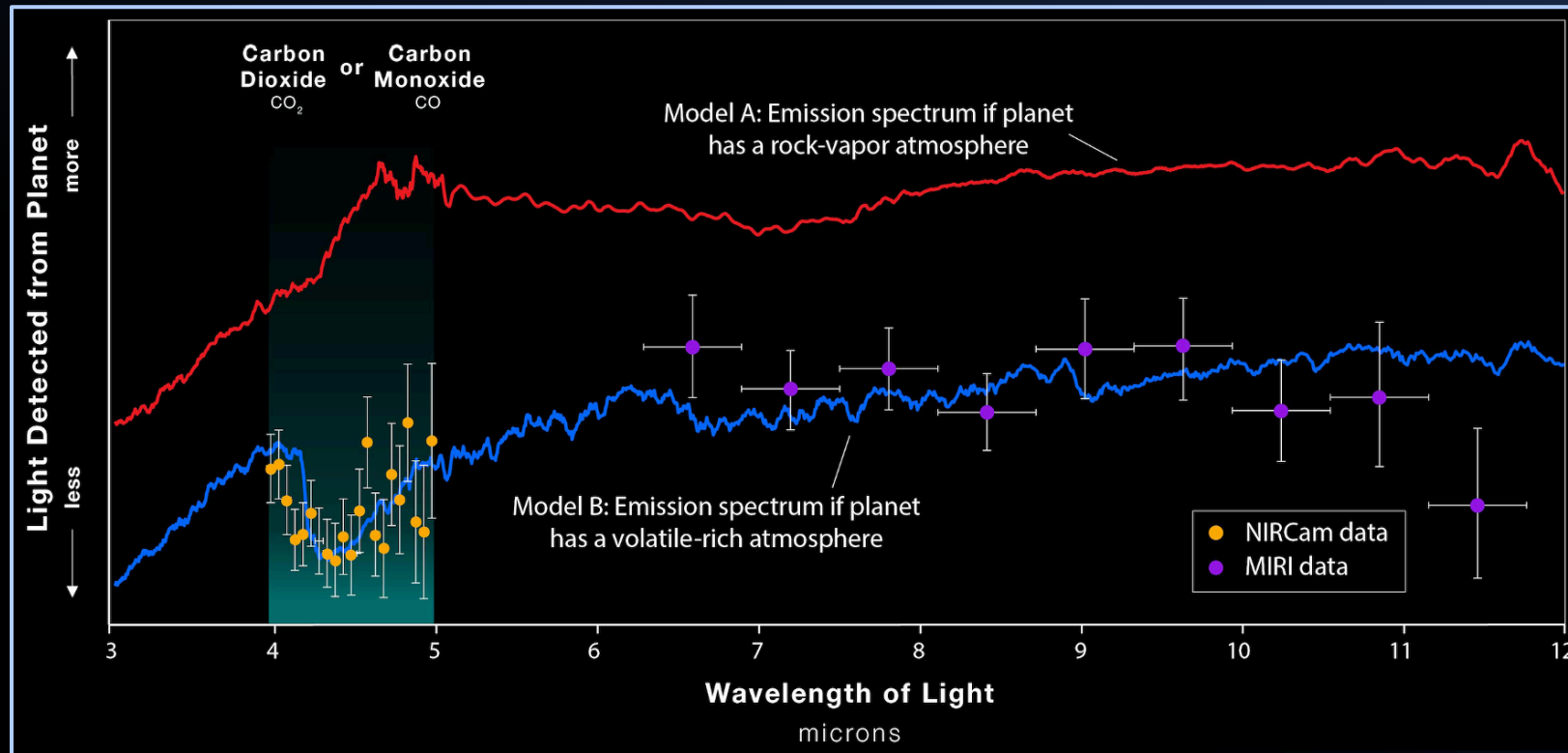


Illustration: NASA, ESA, CSA, Joseph Olmsted (STScI) Science: Renyu Hu (JPL), Aaron Bello-Arufe (JPL), Michael Zhang (University of Chicago), Mantas Zilinskas (SRON Netherlands Institute for Space Research)

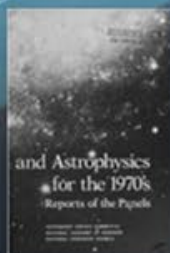
A thermal emission spectrum of the super-Earth exoplanet 55 Cancri e, captured by Webb's NIRCam, GRISM Spectrometer and MIRI Low-Resolution Spectrometer, shows that the planet may be surrounded by an atmosphere rich in carbon dioxide or carbon monoxide and other volatiles, not just vaporized rock.

Mission Progress

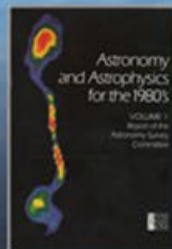


Astrophysics

Decadal Survey Missions



1972
Decadal Survey
Hubble



1982
Decadal Survey
Chandra



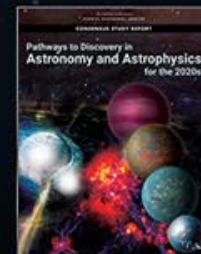
1991
Decadal Survey
Spitzer



2001
Decadal Survey
Webb



2010
Decadal Survey
Roman



2021
Decadal Survey

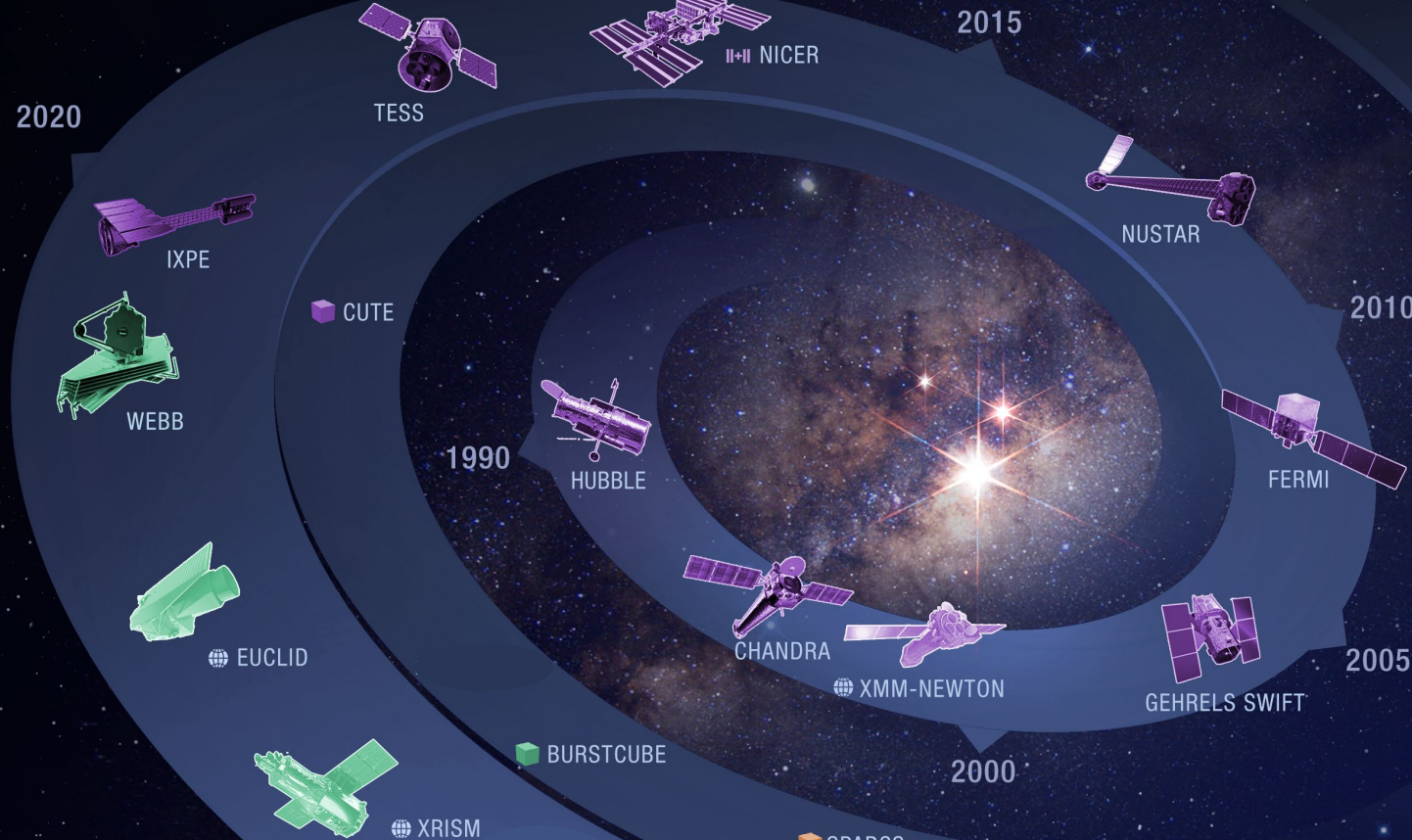
National Aeronautics and
Space Administration



ASTROPHYSICS FLEET

PRE-FORMULATION

PROBE ~2030
ATHENA EARLY 2030s



KEY

- INTERNATIONAL PARTNER LED
- ISS INSTRUMENT
- SMALLSAT
- CUBESAT
- BALLOON

- FORMULATION
- IMPLEMENTATION
- OPERATING
- EXTENDED

VERY SMALL MISSIONS

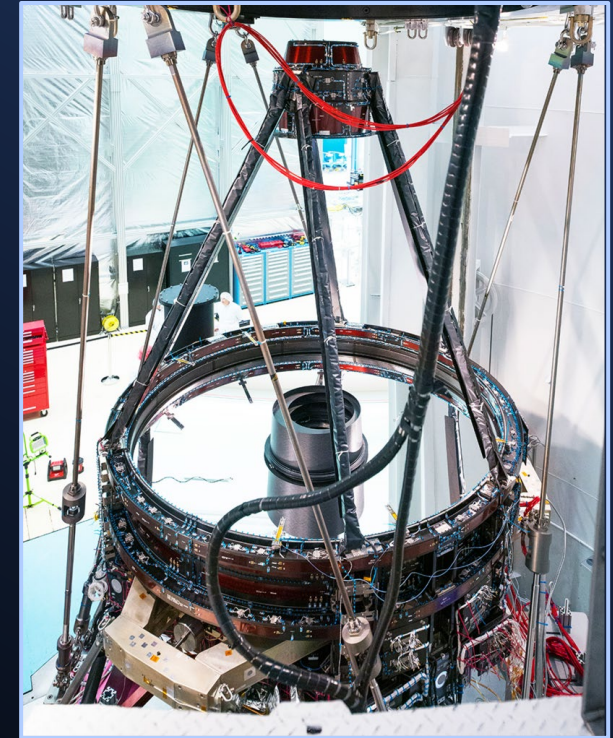
TRADITIONAL MISSIONS

Recent Accomplishments: Nancy Grace Roman Space Telescope

- The Roman Coronagraph Instrument (CGI) was delivered to GSFC on May 19. Successful CGI-Spacecraft testing completed in June.
- Widefield Instrument (WFI) environmental test program is complete. WFI is on schedule for late August delivery.

Upcoming Milestones

- July 30-August 1, 2024:
 - WFI Pre-Ship Review (PSR)
- September 17-19, 2024:
 - Roman Systems Integration Review (SIR)
- January 2025:
 - Key Decision Point D (KDP-D)



*Integrated IOA at L3Harris Technologies in Rochester, NY.
Credit: NASA/Chris Gunn*

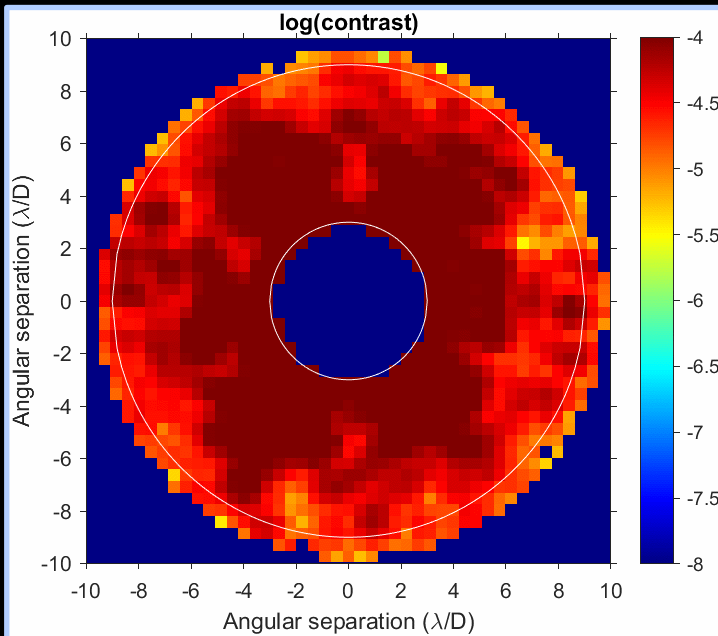


*WFI in environmental testing at BAE Systems in Boulder.
(Courtesy BAE Systems)*

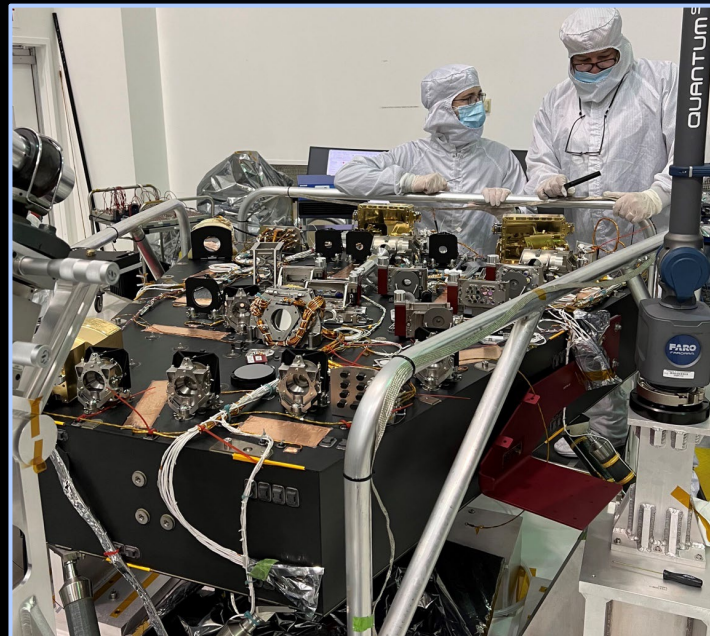
Roman Space Telescope

Coronagraph (CGI)

- CGI successfully delivered to GSFC on May 19 after completing ambient testing.
- Performance meets requirements in both modes, the Hybrid-Lyot and Shaped Pupil Coronagraph.



Sequence of high-order wavefront sensing and control iterations



Coronagraphic Imager instrument

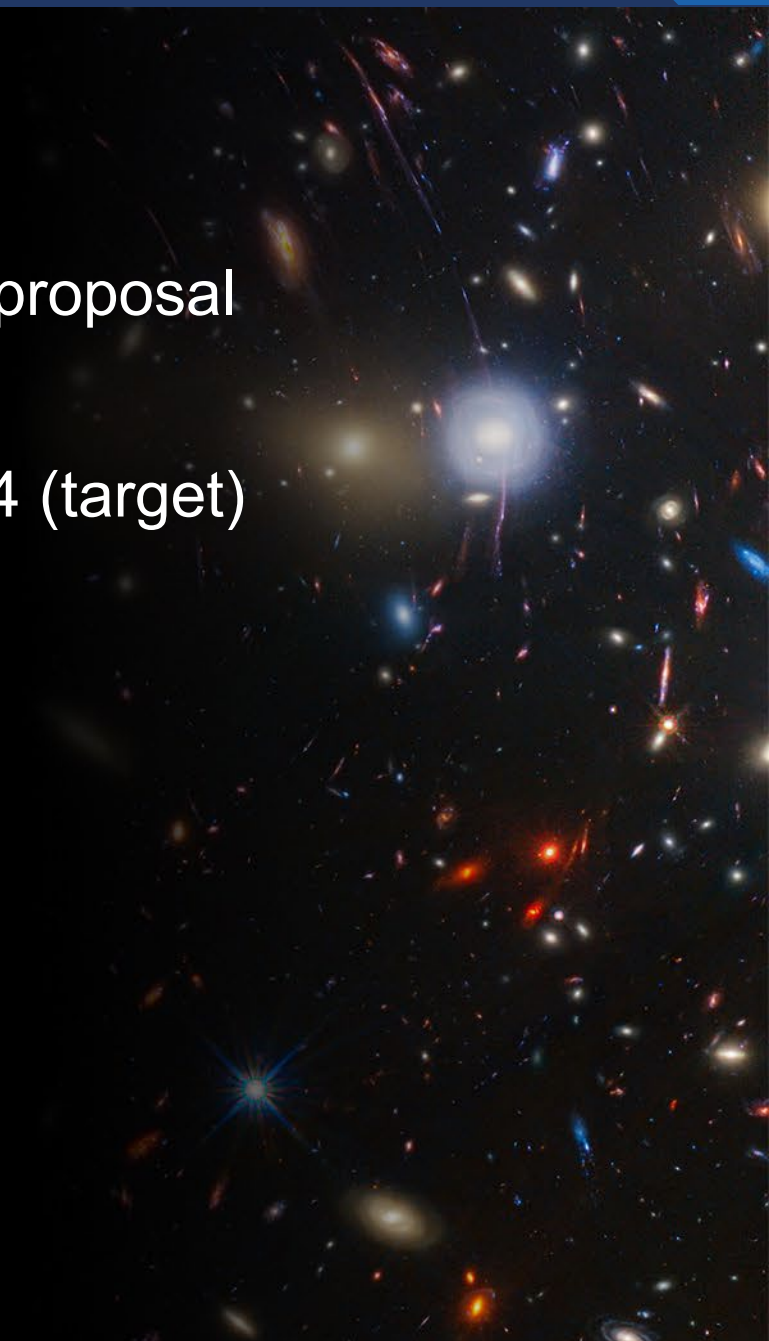


CGI cover removal upon arrival in the SSDIF at GSFC

Probes

Astrophysics Probe Announcement of Opportunity (AO) proposal submission upcoming dates:

- Selection for competitive Phase A studies: Q4 CY 2024 (target)
- Concept study reports due: Q4 CY 2025 (target)
- Down-selection: Q2 CY 2026 (target)
- AO-Required Launch Readiness Date: NLT July 2032



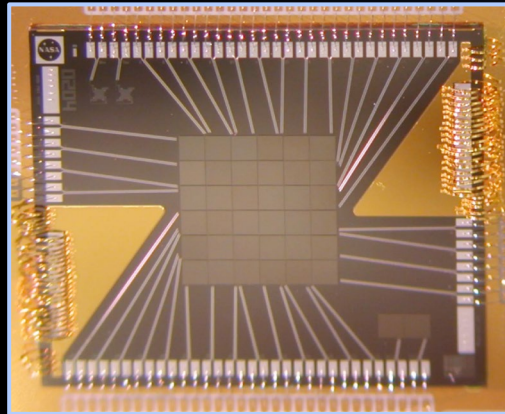
XRISM

X-Ray Imaging and Spectroscopy Mission

- Launched September 6, 2023
- XRISM is a NASA/JAXA partnership
- Microcalorimeter sensor developed at GSFC. One of the first sensors of this type used in space (technology breakthrough).

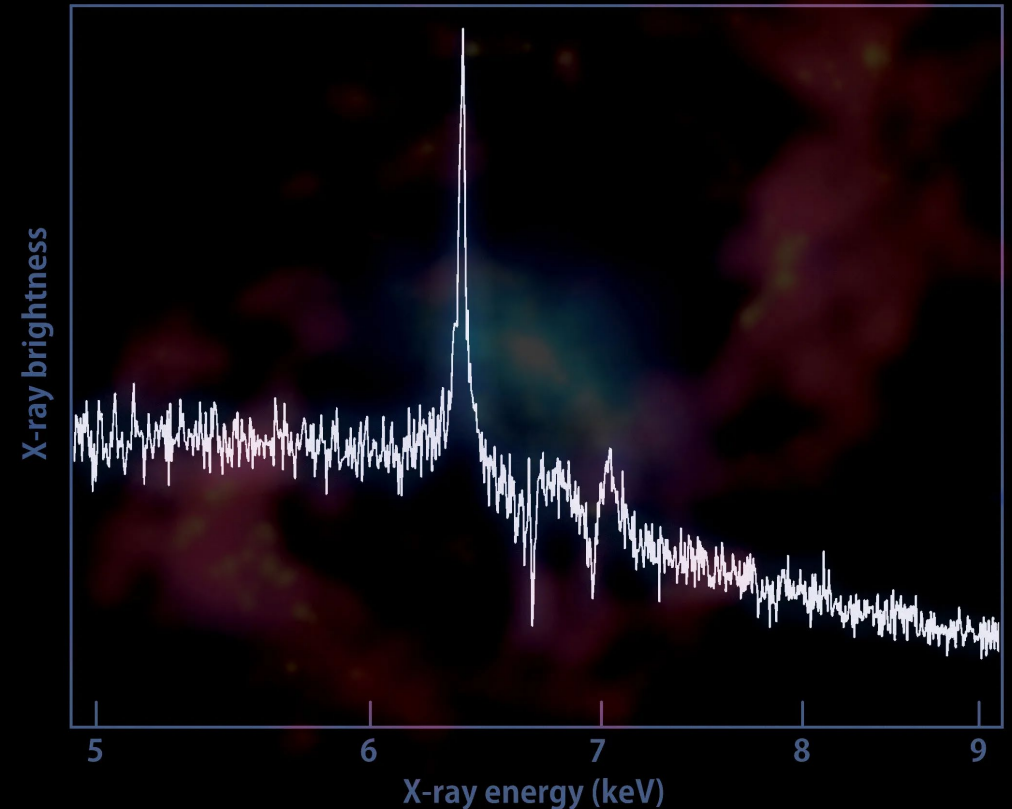
Recent and Upcoming Milestones

- After starting science operations in February, XRISM's Resolve instrument captured a detailed spectrum around a black hole at the center of NGC 4151.
- August 2024: Cycle 1 observations begin



NASA/XRISM/Caroline Kilbourne

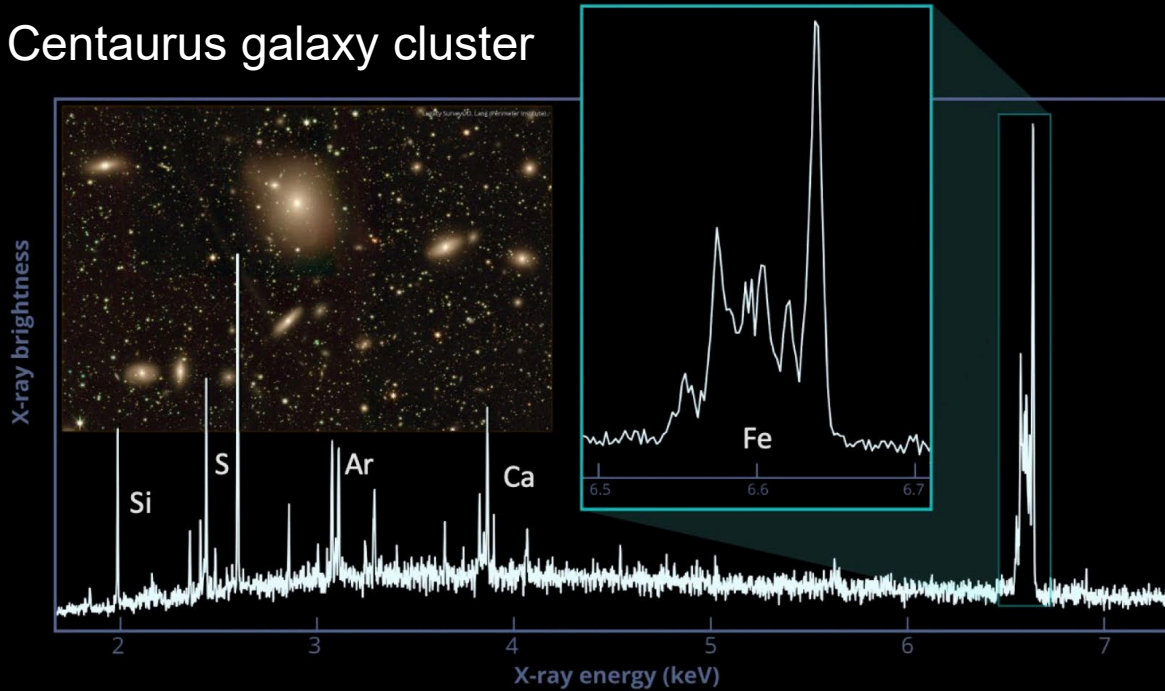
XRISM Resolve Spectrum of NGC 4151



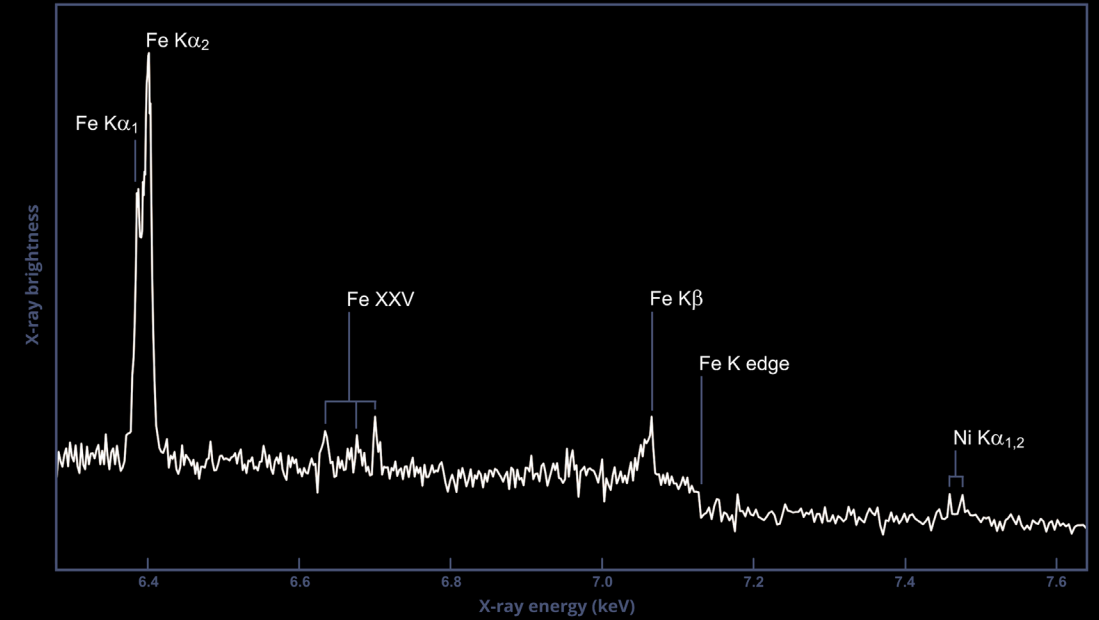
Spectrum: JAXA/NASA/XRISM Resolve. Background: X-rays, NASA/CXC/CfA/J.Wang et al.; optical, Isaac Newton Group of Telescopes, La Palma/Jacobus Kapteyn Telescope; radio, NSF/NRAO/VLA

XRISM Resolve Data

Centaurus galaxy cluster



Vela X-1 high-mass X-ray binary



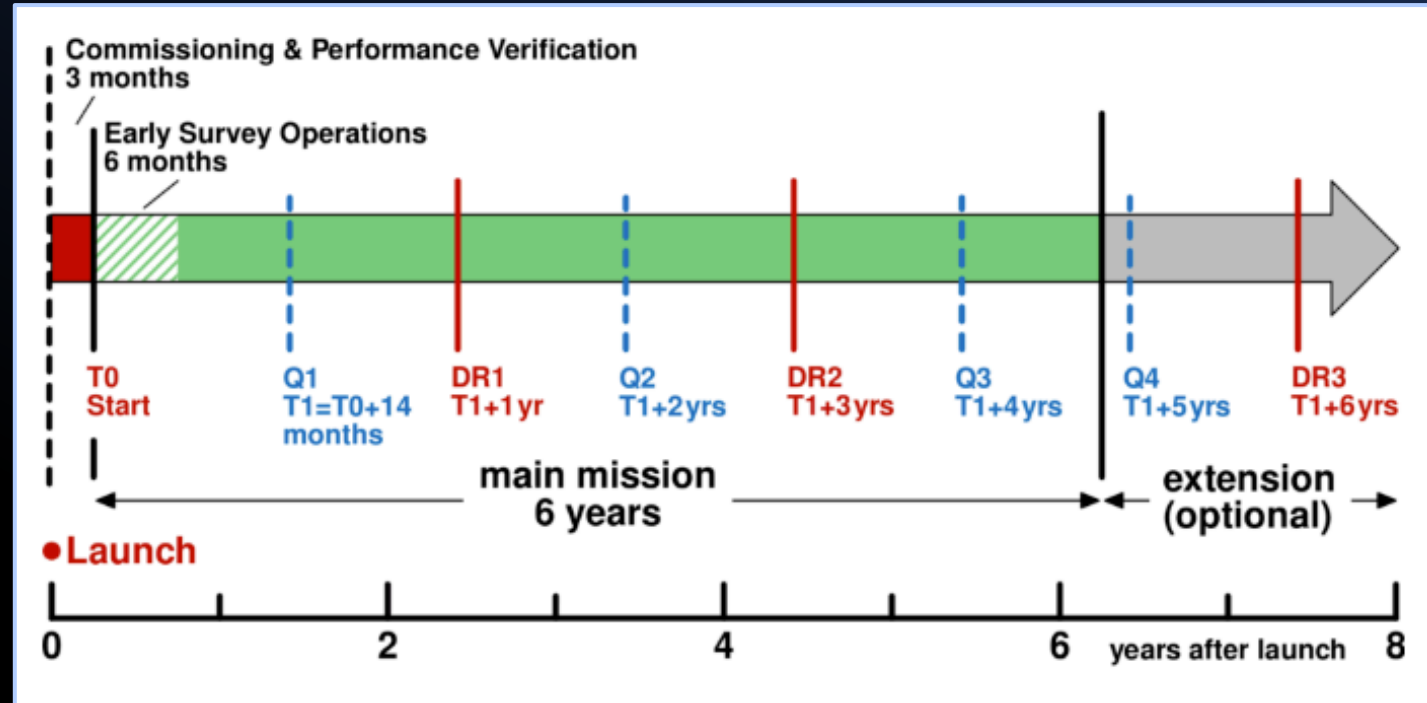
Courtesy: XRISM science Team

Euclid

- Launched July 1, 2023

Recent Milestones

- Euclid's Science Survey started Feb. 2024.
- On May 23, 2024 Euclid had a public data release of 7 deg^2 . This was from the Early Release Observations (ERO) phase.
- The ROSES call for the first Euclid GI program is out.
 - NOIs due August 22 and proposals due October 3, 2024.
- Data Release 1 (DR1) - Jun 2026



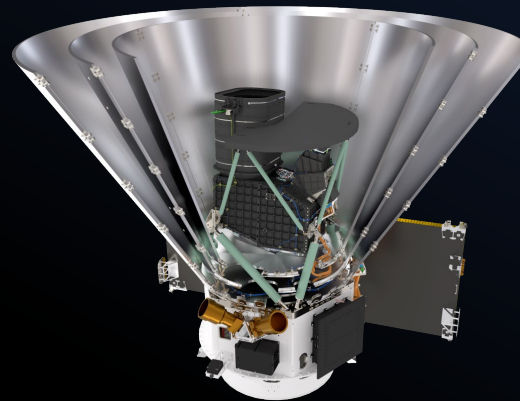
Recent Accomplishments: SPHEREx

- SPHEREx observatory was fully assembled with the payload mated to spacecraft at BAE.
- Observatory Thermal Vacuum (TVAC) testing completed at BAE in early July.

Upcoming Milestones

- Oct. 2024: SPHEREx ORR at JPL
- Mission status
 - Presentation at APAC by PI Jamie Bock

Photon shields (shown cutaway)



- Passive cooling
- LVF spectrometers
- 20 cm Wide-field telescope
- LEO spacecraft (BAeS)



SPHEREx observatory in a horizontal position, showing all three layers of photon shields as well as the telescope. Credit: BAE Systems, Courtesy NASA/JPL-Caltech.

COSI

The Compton Spectrometer and Imager

Recent and Upcoming Milestones

- KDP-C successfully held on April 16
- COSI Project proceeding towards Critical Design Review (CDR) in December 2024
- COSI LV was awarded on July 2 to SpaceX Falcon 9
- Completion of all 20 flight Germanium detectors including 4 spares planned for May 2025.

Science

- Source of 511 keV γ -ray lines, the signature of positron annihilation
- Evolution of massive stars & their SN explosions
- Polarization of GRBs and compact objects
- Multi-messenger astrophysics



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



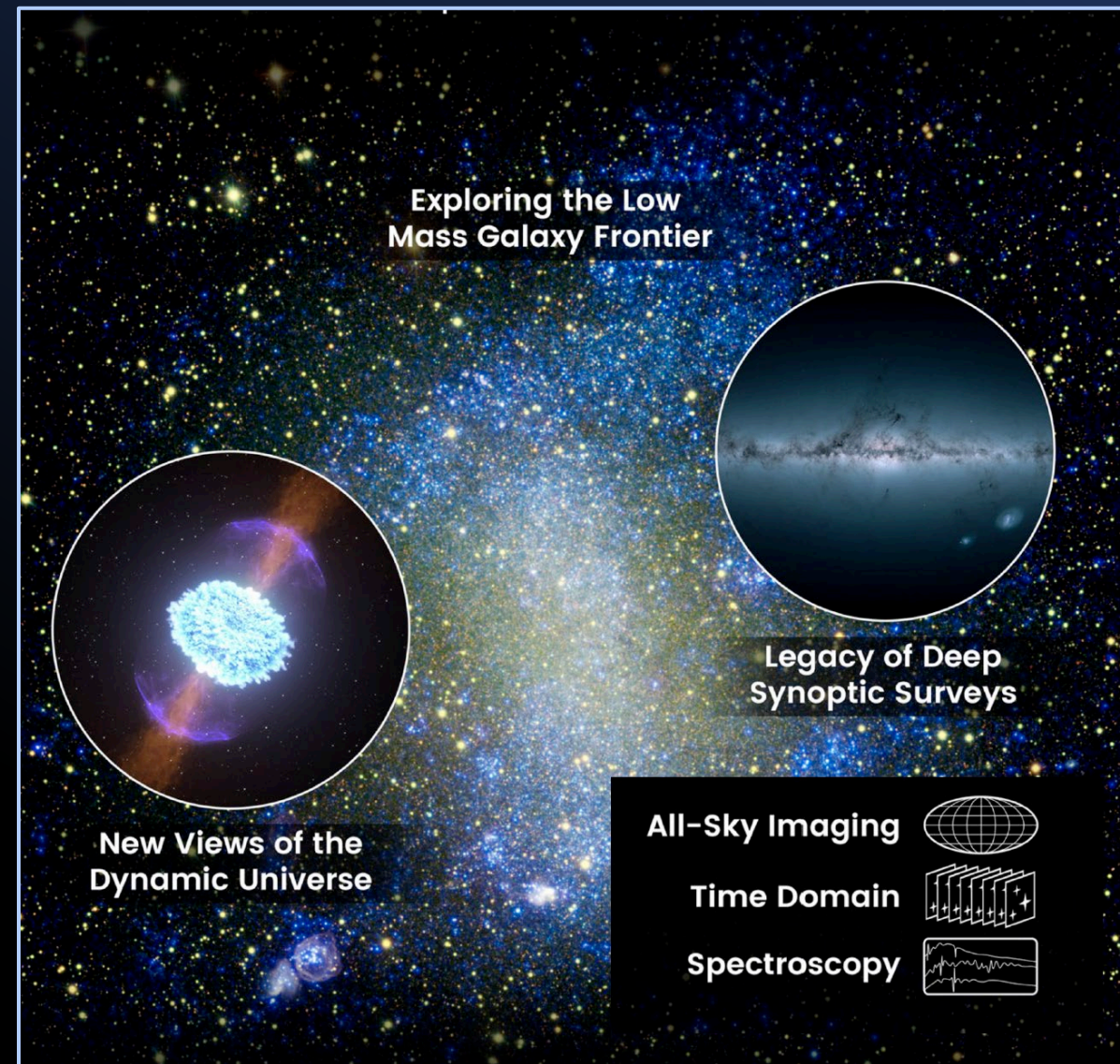
UVEX

The Ultraviolet Explorer

- Targeted to launch in 2030 as NASA's next Astrophysics Medium-Class Explorer mission.
- UVEX will undertake a synoptic survey of the entire sky in the near-UV and far-UV, probing the dynamic universe with a sensitivity more than 50 times better than GALEX.

Recent Milestones:

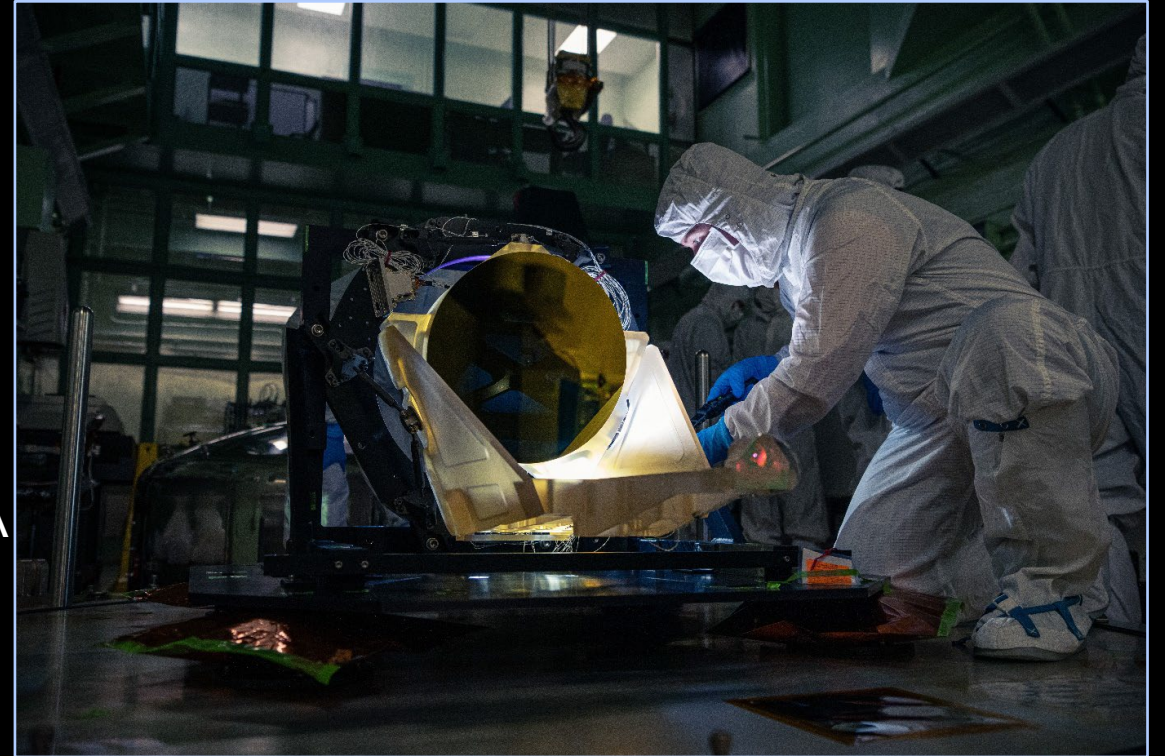
- Kick off and first MMR held in person at CalTech in June.
- Mission PI and PS have begun discussions on level 1 requirements and mission has started developing level 2 requirements.



LISA

Laser Interferometer Space Antenna

- Targeted to launch ~2035
- LISA will be the first space-based gravitational wave observatory
- NASA is partnering with ESA to provide key technology subsystems and a science center for LISA
- NASA plans to formally establish LISA as a project in early 2025



EDU1 being inspected at GSFC after delivery from L3Harris

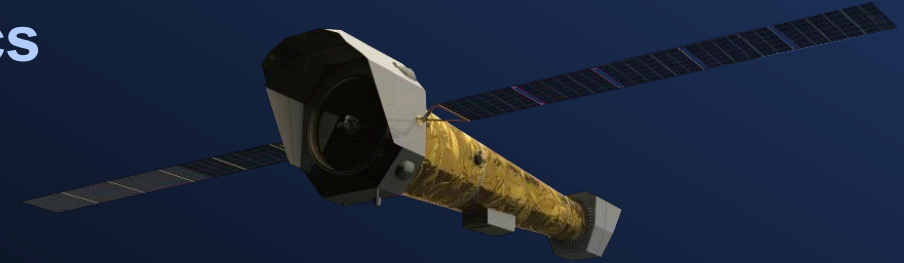
Recent Milestones:

- LISA international science team members selected. This includes six US members selected by NASA
- APD and GSFC management are preparing plans for holding the KDP-B milestone review
- Mark Voyton and Ira Thorpe were selected as LISA project manager and project scientist at GSFC

ATHENA

Advanced Telescope for High-ENERgy Astrophysics

- Planned launch: ~2037
- Flagship mission led by ESA.
- Will be the largest X-ray observatory ever built, investigating some of the hottest and most energetic phenomena in the Universe with unprecedented accuracy and depth.
- NASA is contributing transition edge detectors and the readout SQUIDS for the X-IFU spectrometer. Additional contributions include a cryocooler, Vibration Isolation system and ASIC readout circuit design for the Wide Field Imager instrument camera
- NASA also plans to have a US science ground segment for the science data



Recent Milestones

- The European Space Agency (ESA) NewAthena Science Study Team (NASST) kickoff meeting was held on July 3-4, 2024.
- US representative to the NASST, Laura Brenneman, participated remotely to discuss US involvement
- NASA is evaluating vendor proposals for the cryocooler demonstration model

Balloons

- Super pressure balloon production/construction for the FY25 Wanaka Campaign began end of May. First balloon is expected to be completed September 2024.
- Sweden campaign:
 - Successfully terminated HELIX on 6/3 after six days aloft, meeting science requirements. Payload recovery from Ellesmere Island, in Canada, Nunavut completed
 - XL-Caliber, SUNRISE III, and BOOMS/60MCF balloon payloads were launched on July 9, July 10, and 13, respectively.
 - Successfully terminated XL-Calibur (7/14), SUNRISE III, and BOOMS/60MC (both 7/16), meeting their respective science requirements.
- North American launch site analysis:
 - Tasked by Balloon Working Group (BWG) to find alternate north American location to augment current sites (Ft. Sumner, NM, Palestine, TX) in continental US (CONUS) for science community need.

Upcoming Milestones

- August 2024: Ft. Sumner campaign

Pioneers SmallSats, Balloons and ISS Payloads

- Pandora (SmallSat): Multiwavelength Characterization of Exoplanets and their Host Stars
 - Launch date: 09/2025
- PUEO (Balloon): A Long-duration Balloon-borne Instrument for Particle Astrophysics at the Highest Energies
 - Launch date: 12/2025 in Antarctica
- Aspera (SmallSat): IGM Inflow/outflow from galaxies via OVI 10^5K emission line imaging. PI Carlos Vargas
 - Launch date: 02/2026
 - CDR dPMP scheduled for 07/22/24.
- StarBurst (SmallSat): Gamma-ray ASM, Simultaneous detection of NS/NS mergers with LIGO
 - Launch date: 04/2026
- TIGERISS (ISS): Measuring ultra-heavy (r-process) cosmic rays on ISS
 - Launch date: 09/2026
 - Pre-dPMP with the PM and PI to be scheduled on 08/12/24.
- Landolt (SmallSat): Absolute stellar photometry to $<0.5\%$, PI Peter Plavchan, George Mason University
 - Launch date: 2028
 - Kick-off held on 06/24/24.

CubeSats

IN DEVELOPMENT

- SPARCS
 - Launch date: 02/2025
 - PER scheduled for 08/21/24
 - Began thermal vacuuming testing of the flight instrument.
- Sprite
 - Launch date: 04/2025
 - Completed checkout of all bus components on the flatsat.
- BlackCat
 - Launch date: 07/2025
 - Engineering model payload interface board (PIB) was built and test is in progress.
- MANTIS
 - Launch date: 2028
- CANDLE
 - Launch date: N/A

OPERATIONAL

- CUTE
 - Launched: 09/2021
- BurstCube
 - Launched: 03/2024
 - Deployed: 04/18/2024

Time Domain and Multimessenger Astronomy

- **TDAMM Science Interest Group:** newly formed community-led effort focused on making the best use of NASA assets for TDAMM activities (PhysPAG, COR, & ExEP)
- **Science Analysis Groups**
 - *Gamma-ray Transient Network:* report received summer 2023
 - *TDAMM Space Communications:* working on requirements for ground-to-space and space-to-ground communications in post-TDRS, commercial era
 - *Future Innovations in Gamma Rays* kickoff was held on 1/19
- **ACROSS pilot initiative** focused on situational awareness, observational awareness, and cross-mission follow-up decision support tools + development of TDAMM-focused AO for tools and science
 - Phase II of TDAMM study focusing on understanding how to coordinate information sharing, tool development, and coordination with ground-based community
- **NSF NOIRLab workshop *Windows on the Universe*** focused on infrastructure and ground-space coordination; 2nd white paper released December 2023
- **General Coordinates Network** investment in infrastructure upgrade to modern, open-source, reliable, and secure alert distribution technologies, and deployed in the cloud



ASTROPHYSICS FLEET

PRE-FORMULATION

PROBE ~2030
ATHENA EARLY 2030s

TDAMM Monitor or follow-up

VERY SMALL MISSIONS

TRADITIONAL MISSIONS

KEY

- INTERNATIONAL PARTNER LED
- ISS INSTRUMENT
- SMALLSAT
- CUBESAT
- BALLOON

- FORMULATION
- IMPLEMENTATION
- OPERATING
- EXTENDED

2025

2000

2005

2010

2015

2020

TESS

NICER

NUSTAR

IXPE

CUTE

1990

HUBBLE

FERMI

WEBB

EUCLID

CHANDRA

XMM-NEWTON

GEHRELS SWIFT

BURSTCUBE

SPARCS

SPRITE

BLACKCAT

PUEO

ASPERA

TIGERISS

LANDOLT

PANDORA

STARBURST

MANTIS

SPHEREX

ROMAN

COSI

UVEX

ULTRASAT

ARIEL

LISA

Budget



Budget - FY24 Committee Report

Astrophysics

The Committee recommendation for Astrophysics includes no less than \$98,300,000 for the Hubble Space Telescope, \$407,300,000 for the Nancy Grace Roman Wide-Field InfraRed Survey Telescope [Roman], and up to \$259,300,000 for Astrophysics Explorers. The Committee is encouraged by NASA's commitment to accelerate the cadence of Astrophysics Explorer missions and to continue a new line of small Pioneer-class missions that leverage advancements in low-cost platforms such as CubeSats and balloons to support groundbreaking science. Such activities can improve scientific understanding while simultaneously developing the scientific workforce through increased research opportunities for students and faculty.

Roman Telescope Mission Cost Cap

The Committee notes this telescope was the highest priority of the 2010 Astrophysics decadal survey to further investigate fundamental questions about the nature of dark energy. The Committee reiterates the expectation that NASA will use a \$3,500,000,000 development cost cap in its future execution of the mission. Roman and the Vera C. Rubin Observatory will provide data rich, large-scale observations of the universe. Combining data from these complementary facilities could speed breakthrough discoveries. As such, the Committee directs NASA to work with NSF to develop essential computational tools and interfaces, strengthen and formalize science and engineering collaborations, and enable joint data analysis.

Budget - FY24 Committee Report

James Webb Space Telescope (JWST)

The Committee congratulates NASA on the success of the JWST mission thus far, and provides \$187,000,000. JWST observations are fundamentally changing our understanding of the universe and our place within it and demonstrate continued U.S. leadership in science and technology.

Stratospheric Observatory for Infrared Astronomy (SOFIA)

Up to \$20,000,000 is provided for SOFIA to continue the orderly close-out of the mission.

Astrophysics Research

The Committee recognizes the role of the Astrophysics Research program in supporting the development of novel astrophysics observation technologies that lay the foundation for future mission architectures.

Additionally, a strong research program maximizes the scientific value of space-based missions by ensuring that the data collected through such observations can continue to provide new insights into the mechanisms behind cosmological phenomena. The Committee also understands that supporting these activities through extramural grant funding contributes to the long-term viability of the U.S. astrophysics community. As such, the Committee recommends up to \$289,900,000 for Astrophysics Research

Budget - FY24 Conference Language Report

Habitable Worlds Observatory

The Senate Report language regarding “Habitable Worlds Observatory” is adopted and the agreement provides **no less than \$10,000,000 for the mission**. In addition, the agreement **directs NASA to establish a Habitable Worlds Observatory project office at Goddard Space Space Flight Center** to leverage expertise in astrophysics and segmented mirror technology.

Senate Report Language - Habitable Worlds Observatory

The Committee supports the Great Observatory Maturation Program (GOMAP) as recommended by the Decadal Survey on Astronomy and Astrophysics, “Pathways to Discovery in Astronomy and Astrophysics for the 2020s” [Astro2020]. GOMAP will mature science and technologies needed for future flagship missions starting with the Habitable Worlds Observatory to observe habitable exoplanets. In order to cement continued American leadership in astronomy, the Committee provides the requested level for GOMAP to implement the Astro2020 recommendations. NASA is encouraged to articulate funding for GOMAP separately in future budget requests.

National Aeronautics and
Space Administration



ASTROPHYSICS FLEET

2020



WEBB

CUTE

2015

2010

1990

2005

2000



EUCLID



XRISM

Missions in Prime Science Operations

VERY SMALL MISSIONS

TRADITIONAL MISSIONS

KEY

INTERNATIONAL PARTNER LED

ISS INSTRUMENT

SMALLSAT

CUBESAT

BALLOON

FORMULATION

IMPLEMENTATION

OPERATING

EXTENDED

2025



ASTROPHYSICS FLEET

PRE-FORMULATION

PROBE ~2030
ATHENA EARLY 2030s

VERY SMALL MISSIONS

TRADITIONAL MISSIONS

KEY

- INTERNATIONAL PARTNER LED
- ISS INSTRUMENT
- SMALLSAT
- CUBESAT
- BALLOON

- FORMULATION
- IMPLEMENTATION
- OPERATING
- EXTENDED

2025



SPHEREX



ROMAN



ULTRASAT



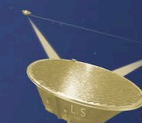
COSI



ARIEL



UVEX



LISA

SPARCS

SPRITE

BLACKCAT

PANDORA

PUEO

ASPERA

STARBURST

TIGERISS

LANDOLT

MANTIS

1990



HUBBLE



CHANDRA



XMM-NEWTON

BURSTCUBE



XRISM

EUCLID



WEBB



IXPE



CUTE

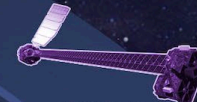


TESS



NICER

2015



NUSTAR

2010



FERMI

2005



GEHRELS SWIFT

2000

Astrophysics Priorities

Explore/Innovate/Partner/Inspire

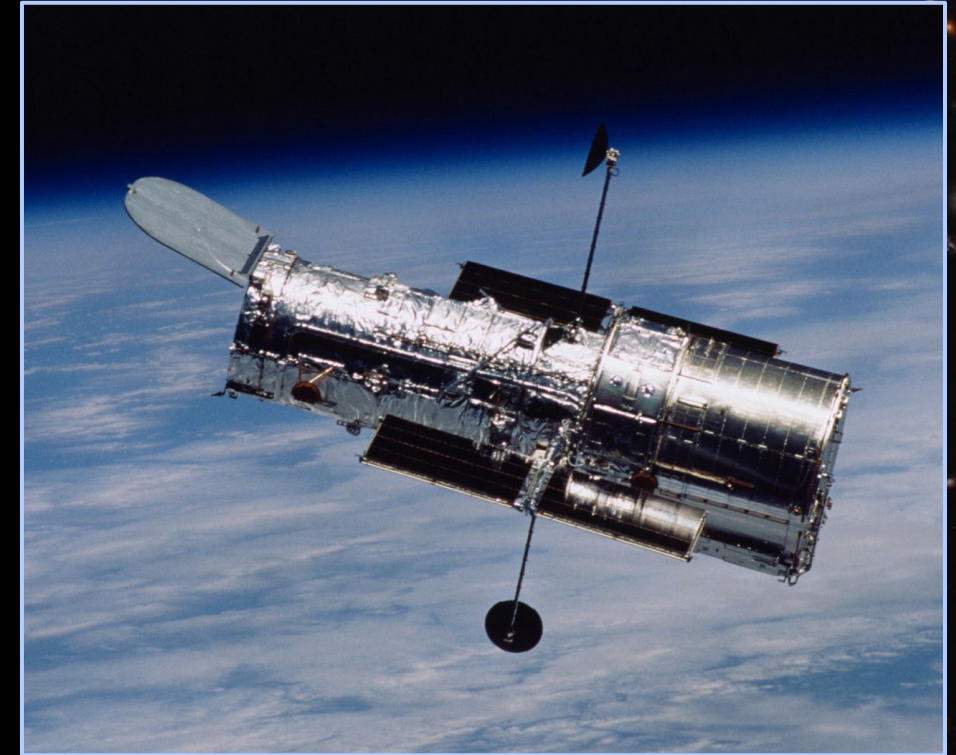
- Maintain a **balanced portfolio** during this decade and the next, by balancing investments in missions under development and future missions, against funding for large missions in extended science operations.
- Investment to advance the **Astro2020 Decadal Priorities**, including technology maturation for the **Habitable Worlds Observatory**, and the selection of an **Astrophysics Probe** mission.
- Ensure successful completion of the **Roman Space Telescope**, within the Agency commitment.
- Protect **international partnerships** such as the Laser Interferometer Space Antenna (LISA).

Operational Paradigm Change Review

- As described at previous APAC meetings, the APD convened the Operational Paradigm Change Review Committee earlier this year and has now received that committee's findings in response to submissions from the Hubble and Chandra missions
- Rob Kennicutt will be providing the APAC a courtesy briefing later today of the OPCR Committee's findings
- Note that the committee was charged only to produce findings, not recommendations, so no particular operational posture will be advocated
- If you have a conflict of interest with either the Chandra or Hubble projects, you may wish to recuse yourself, **however** –
- APD will not be commenting on the OPCR findings and is not seeking APAC comments on the findings at this time – this is an informational briefing only

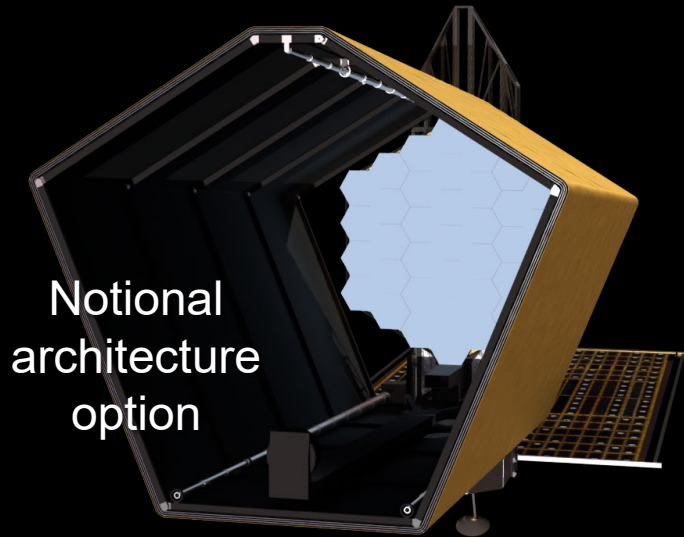
Update on Hubble Gyro Resolution

- Gyro 3 grew increasingly problematic since late 2023 significantly increasing interruptions to science.
- Transition to one gyro science (OGS) operational mode was announced June 4.
 - Uses a larger solar exclusion angle and will take more time to acquire science targets
 - Expect to schedule ~500 fewer science orbits per year
 - Field of Regard at any one time will be reduced from ~82% to ~50% (comparable to Webb), the total sky will remain available over the course of the year
- The team has returned Hubble to science operations.



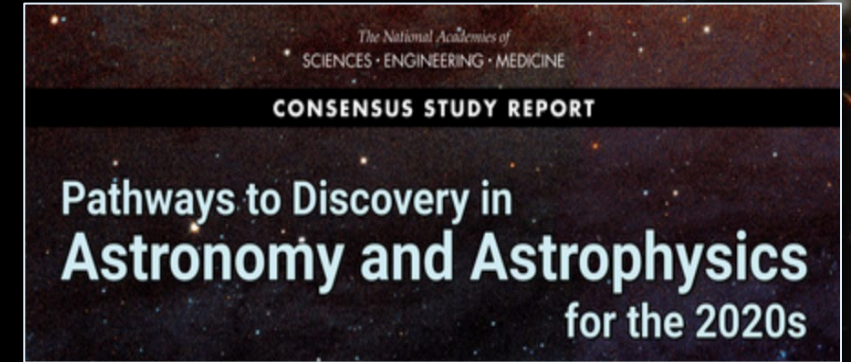
What Is Habitable Worlds Observatory (HWO)?

NASA's next flagship mission concept
recommended by Astro2020 Decadal Survey

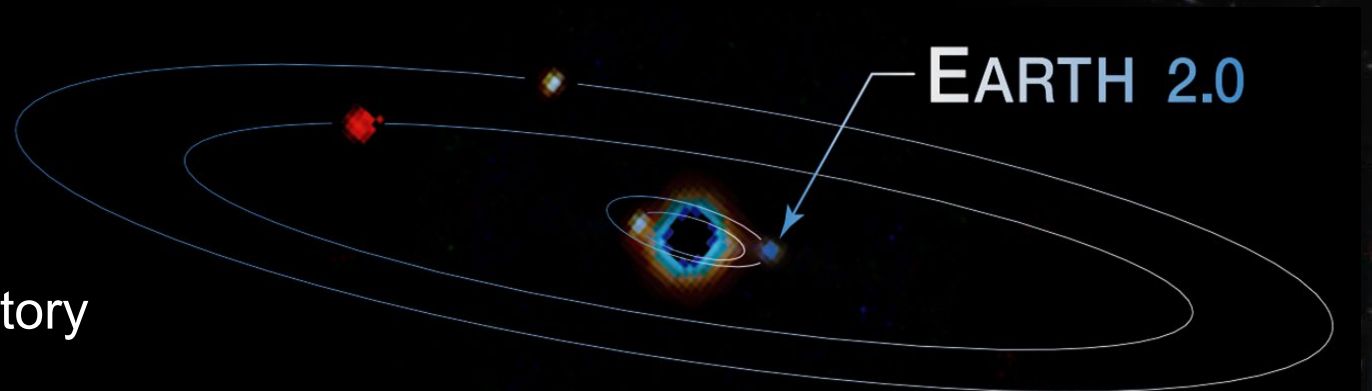


Notional
architecture
option

Large-aperture UV / Optical / NIR observatory
performing transformative astrophysics



First telescope designed to search for signs of life on planets
outside our solar system



Habitable Worlds Observatory

Decadal Recommendations → 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
- **Planned Servicing:** Robotic servicing at L2
- **Robust Margins:** Design with large scientific, technical, and programmatic margins
- **Mature technologies first:** Reduce risk by maturing the technologies prior to formulation

UV Science and Instrumentation Workshop

On the Way to the NASA Habitable Worlds Observatory and Beyond



Held on May 7-9 at JPL with 183 participants.

Habitable Worlds Observatory

- The HWO Project Office at GSFC will open on August 1, 2024.
 - All plans associated with the HWO and Working Group activities circulated after the June F2F still hold, including future F2F meetings, honoraria, travel support, and science case development work.
- Science, Joint, and Community Working Groups will continue with the as-planned milestones through December 31, 2024.
 - The community will continue to have multiple opportunities to provide input regarding HWO and that NASA intends to create a Science & Technology Definition Team or an equivalent organization.
- The Project Office will be staffed by the Project Architect, Lee Feinberg, along with an Interim Project Scientist, a Project Manager, and one or more Formulation Scientists.

D.19 Habitable Worlds Observatory (HWO)

- **“Ultra-stable Telescope Research and Analysis - Critical Technologies (ULTRA-CT)”**
 - This project will focus on high-fidelity modeling and subsystem demonstrations to support future development of “ultra-stable” optical systems beyond current state-of-the-art technologies.
 - Principal investigator: Laura Coyle, BAE Systems
- **“Technology Maturation for Astrophysics Space Telescopes (TechMAST)”**
 - This project seeks to advance the integrated modeling infrastructure required to navigate design interdependencies and compare potential mission design options.
 - Principal investigator: Alain Carrier, Lockheed Martin
- **“STABLE: Systems Technologies for Architecture Baseline”**
 - This project will focus on maturing technologies that support telescope features such as a deployable baffle and a structure to support the optical train, while mitigating the impact of system or environmental disturbances.
 - Principal investigator: Tiffany Glassman, Northrop Grumman

ROSES Appendix D.20 Exoplanet Mass Measurement Program

New for ROSES 2024:

D.20 Exoplanet Mass Measurement Program: This is an expansion of the previous Extreme Precision Radial Velocity (EPRV) Foundation Science solicitation.

Scope: Investigations that will advance tools, techniques, and understanding to enable the dynamical mass measurement of exoplanets

Includes:

- Extreme Precision Radial Velocity (EPRV) measurement of planet masses
- Astrometric measurement of planet masses

Award Duration: Up to 2 years

Expected Program Funding: \$2.5 M

Due Dates:

- Mandatory NOI: January 23, 2025
- Proposal: February 26, 2025

POC: Hannah Jang-Condell (hannah.jang-condell@nasa.gov)

Emerging Technology for Astrophysics Missions

- Astrophysics is planning a dedicated workshop on emerging technologies to identify and promote more emerging technology development in APRA
- Opportunity space
 - Astrophotonics: Coronagraphs, quantum optical systems
 - Advances manufacturing & Nanotechnology: μ -shutter arrays
 - Composite materials and Meta-Materials
 - Quantum technologies
 - Super-resolution: $< \lambda/D$ imaging, interferometry
 - Metrology: Absolute calibration
 - Atom Interferometry: Gravitational wave detection
 - Sensors: TES, MKID, Nanowire

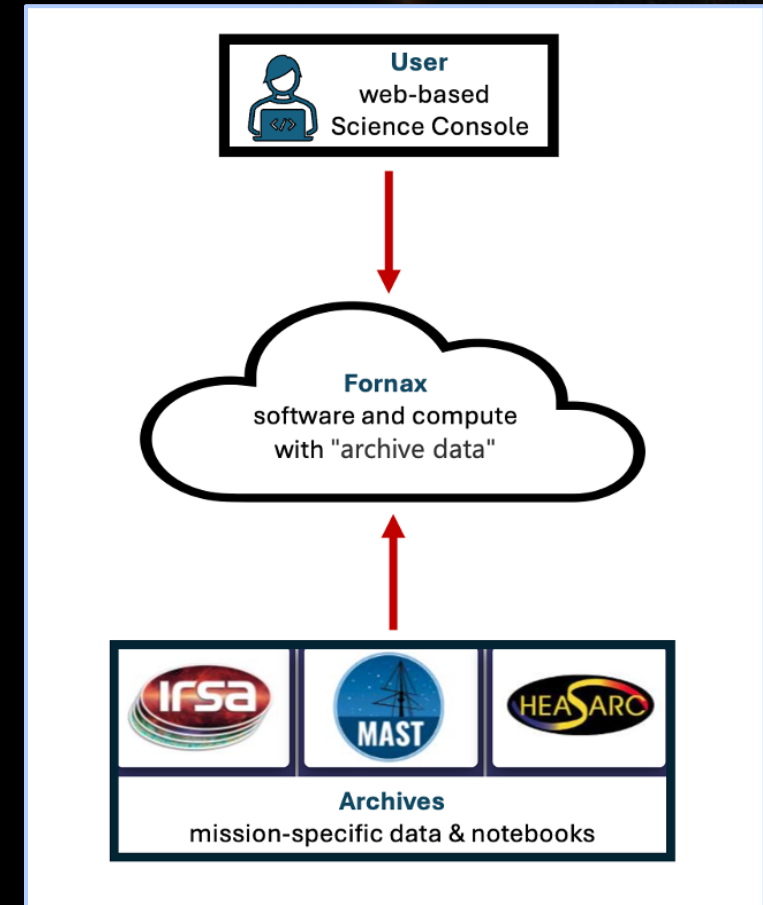
Towards a Cloud-Based Solution for APD

APD is developing the **Fornax** initiative, a cloud-based system that brings together data, open-source software, and computing so that researchers can focus on science <https://pcos.gsfc.nasa.gov/Fornax/>

- Collaboration of IRSA, MAST, and HEASARC with GSFC
- Accessible by users with a wide range of expertise
- Scalable and open-source to meet changing needs of the community

New solution will enable multi-wavelength, time-domain, big-data, and compute-intensive astronomy.

Aligned with SMD principles of FAIR (Findable, Accessible, Interoperable, and Reusable) data and SMD consolidation of science core infrastructure.



Paradigm Shift for Open-Science Proposal Reviews

SMD Office of Chief Science Data Officer (OCSDO) is working with APD on Open Science (OS)

- Open Science Data Management Plan (OSDMP) requested as part of ROSES-2023
- Developing an OSDMP template for mission proposals
- OSDMP template and instructions will create better expectations for OS “minimal” compliance
- Constructing clearer expectations for budget requests related to OS



Open-Science Incentives and Metrics

APD is collaborating with SMD and community stakeholders to create new OS-adoption incentives.

- AAS and ADS are identifying mechanisms to associate and link together DOIs to each OS component (proposal, data, software and publications).
- APD identifying ways to facilitate this effort.
- Need to involve other academic publishers

Developing SPD-41a metrics to quantify impact of OS adoption.



Open-Science Community Support and Engagement

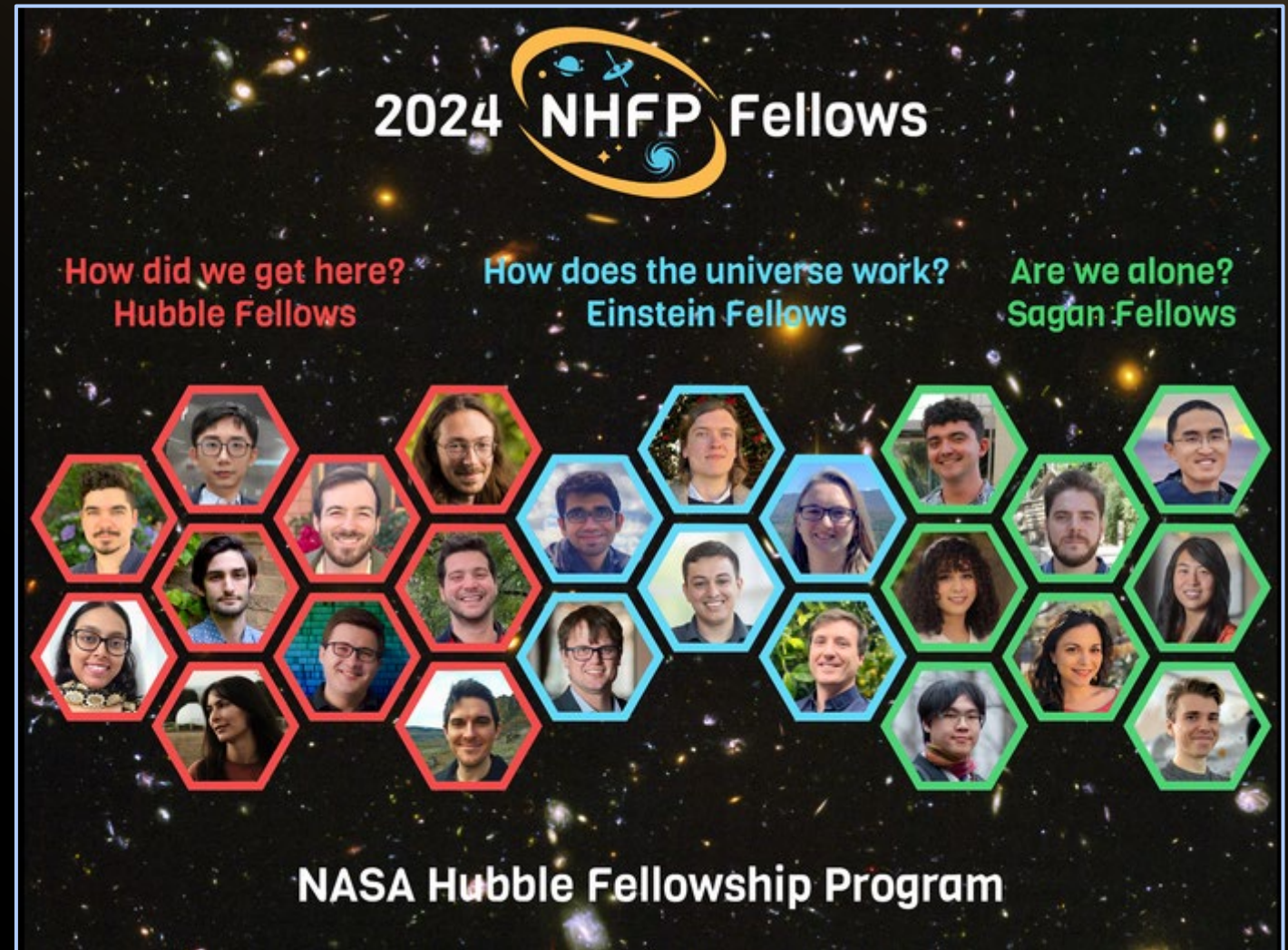
- SMD encourages software development in OS-compliant public repositories (e.g., GitHub) to access community expertise and best OS practices.
- SMD is establishing a NASA research repository center at Marshall Space Flight Center for OS research and expertise.
- Exploring avenues to educate the community, including software development sessions with OS experts.
- Planning opportunities for additional feedback on open science and potential creation of an ad-hoc working group (e.g. AAS meeting 2025)

SCaN - Communications Services Project (CSP)

- Under the direction of SCaN, the Communications Services Project (CSP) is collaborating with industry to offer commercial space relay communication services for NASA missions in the near Earth-orbit.
- To achieve this phase, six U.S. partners will develop and demonstrate space relay capabilities. In the future, NASA intends to confirm long-term contracts to acquire services for near-Earth operations.
- To learn more about these six industry partner's capabilities reference:
<https://www.nasa.gov/general/communications-services-project/#hds-sidebar-nav-2>

Astrophysics Postdoctoral Fellowships for 2024

- The NASA Hubble Fellowship Program fosters excellence and inclusive leadership in astrophysics by supporting a diverse group of exceptionally promising and innovative early-career astrophysicists.
- Out of 520 applicants, NASA Hubble Fellowship Program (NHFP) recently announced 24 new fellows to its 2024 roster.
- The NHFP remains one of the most prestigious post-doctoral opportunity available to recent graduates.



APAC Recommendations



APAC Recommendations from March 2024

Recommendation	Response
<p>The APAC strongly recommends that APD continue the Chandra mission at the current FY24 level, and not proceed with a major budget cut before all possible budgetary trades are considered. We have identified several potential areas for cost savings with less impact, and the APAC strongly recommends that an independent team consider the budgetary, programmatic, and community implications of the following, in order of priority:</p> <p>1) HWO: There are synergies between HWO technology maturation and the existing fleet, such as the Roman coronagraph and Hubble UV capabilities. It may be possible to identify ways in which APD can use HWO Project Office and tech maturation funds more efficiently to optimize savings elsewhere. For example, developing the HWO coronagraph may be aided by ground testing and calibration of the Roman coronagraph; pipeline development, simulations, and ground segment operation planning may be novel testbeds for technology maturation as well.</p> <p>2) Roman: The APAC has been kept apprised of Roman's status and is pleased to see it progresses within its cost and schedule margins. Roman may be able to maintain its cost and schedule commitment with a few percent budget cut.</p> <p>3) Guest Observer programs: The APAC discussed many options to reduce overhead within the GO programs, from pooling multiple GO proposals in various iterations (HST/JSWT, HST/Chandra, all flagships) to moving archival GO programs to ADAP and/or theory proposals to ATP. The APAC reached no consensus on which option, if any, to formally recommend; however, there was a consensus that the independent team should analyze options for reorganizing GO programs to mitigate redundancy.</p>	<p>See OPCR report presentation by Rob Kennicutt.</p>

APAC Recommendations from March 2024

Recommendation	Response
The APAC recommends that APD support a review of the Explorers Program, if so deemed by the SMD Deputy Associate Administrator for Research.	APD has initiated discussion with the DAR. These discussions also form a component of follow-up actions from SMD retreat.
After reviewing the Terms of Reference, the APAC approves two Science Analysis Groups: Technosignatures and Exoplanet Reflectance Spectroscopy for the Habitable Worlds Observatory.	
The APAC recommends the APD convene a working group to evaluate how to implement the solutions outlined in the Open Software presentation, such as awards for time with professional developers to aid in software development, mechanisms to ensure credit for open software developers, and training to encourage developing open software.	APD plans to pursue this recommendation from the APAC and has begun internal discussions.

APAC Recommendations from March 2024

Recommendation	Response
<p>Relatedly, the APAC agrees that an open science discussion would be better informed by data on the effects of open data and software on the community, and recommends that APD conduct an investigation on metrics such as time to publication of observations, the author of first paper resulting from an observation and the relation to the PI, the level of participation for under-resourced groups and other metrics as needed.</p>	<p>We are considering how to provide appropriate data to the working group.</p>
<p>The APAC endorses the ACROSS pilot and encourages stronger coordination and cooperation with NSF pilot initiatives to avoid duplication and maximize impact. It may be useful to explicitly combine NASA and NSF initiatives into one cross-agency effort.</p>	<p>APD Program Officers communicate regularly with their NSF counterparts both to avoid duplication of work, and to find areas where common investments are scientifically beneficial. Funding lines for each agency are separate making interagency communication imperative.</p>
<p>The APAC recommends that APD enlist SMD to prioritize SCan maintenance and upgrades before Roman is launched.</p>	<p>See SCan discussion at end of day.</p>



QUESTIONS?



THANK YOU!