NASA Astrophysics Update

Astronomy & Astrophysics Advisory Committee
September 28-29, 2021

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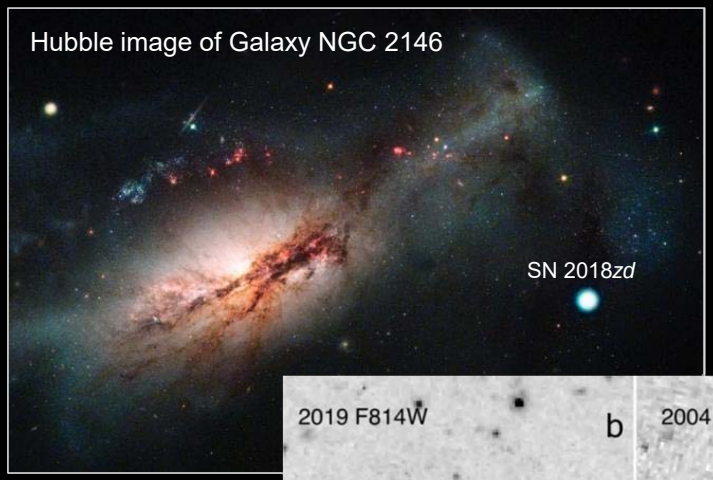
Director, Astrophysics Division
Science Mission Directorate

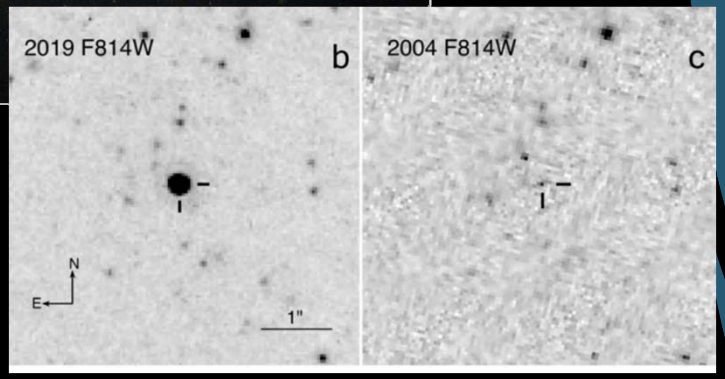
@NASAUniverse @NASAExoplanets

Hubble Detects a New Type of Supernova

Released: June 28, 2021



Credits: NASA/STScI/ J. DePasquale, S. Wilkinson, and Las Cumbres Observatory; and Nature Astronomy



Hubble images of star after (left) and before (right) the supernova explosion.

Hiramatsu, D., Howell, D.A., Van Dyk, S.D. *et al. Nat Astron* **5,** 903 (2021) https://doi.org/10.1038/s41550-021-01384-2

SCIENCE HIGHLIGHT

- Using data from the Hubble Space Telescope and the Neil Gehrels Swift Explorer, among many telescopes, scientists have identified for the first time a new, third type of supernova.
- The “electron capture” supernova explosion likely spawned from an intermediate mass red giant star 8-10 times the mass of the Sun.
- Instead of dying in superbright explosions like larger stars with an iron core, or like smaller white dwarf stars that accrete material from a companion, these intermediate mass stars spawn a lower energy explosion when electrons in the stellar core are “captured” by atoms like Mg and Ne, reducing electron pressure and creating instability.

Astronomers Find a ‘Break’ in One of the Milky Way’s Spiral Arms

Released: August 17, 2021

This illustration shows astronomers’ current understanding of the large-scale structure of the Milky Way. Stars and star-forming regions are largely grouped into spiral arms. Measuring the shape, size, and number of spiral arms is a challenge because Earth is located inside the galaxy. Credit: NASA/JPL-Caltech

M.A. Kuhn *et al. A&A* **651,** L10 (2021)
https://doi.org/10.1051/0004-6361/202141198

SCIENCE HIGHLIGHT

- Scientists have spotted a previously unrecognized feature of our Milky Way galaxy: A contingent of young stars and star-forming gas clouds is sticking out of one of the Milky Way’s spiral arms. Similar structures – sometimes called spurs or feathers – are commonly found jutting off the arms of other spiral galaxies. Stretching some 3,000 light-years, this is the first major structure identified with an orientation so dramatically different than the arms.
- Astronomers have a rough idea of the size and shape of the Milky Way’s arms, but much remains unknown: They can’t see the full structure of our home galaxy because Earth is inside it.
- To learn more, the authors of the new study focused on a nearby portion of one of the galaxy’s arms, called the Sagittarius Arm. Using NASA’s Spitzer Space Telescope prior to its retirement in January 2020, they sought out newborn stars, nestled in the gas and dust clouds (called nebulae) where they form. Spitzer detects infrared light that can penetrate those clouds.
- To get a 3D view of the arm segment, the scientists used the latest data release from the ESA Gaia mission to measure the precise distances to the stars. The combined data revealed that the long, thin structure associated with the Sagittarius Arm is made of young stars moving at nearly the same velocity and in the same direction through space.
- The newly discovered feature contains four nebulae known for their beauty: the Eagle Nebula, the Omega Nebula, the Trifid Nebula, and the Lagoon Nebula. In the 1950s, a team of astronomers made rough distance measurements to some of the stars in these nebulae and were able to infer the existence of the Sagittarius Arm. Their work provided some of the first evidence of our galaxy’s spiral structure.

SCIENCE 2020-2024: A Vision for Scientific Excellence

VISION

Lead a globally interconnected program of scientific discovery that encourages innovation, positively impacts people's lives, and is a source of inspiration

MISSION

Discover the secrets of the universe

Search for life elsewhere

Protect and improve life on Earth and in Space

VALUES

Excellence

Inclusion

Leadership

Integrity

Teamwork

Safety

PRIORITIES

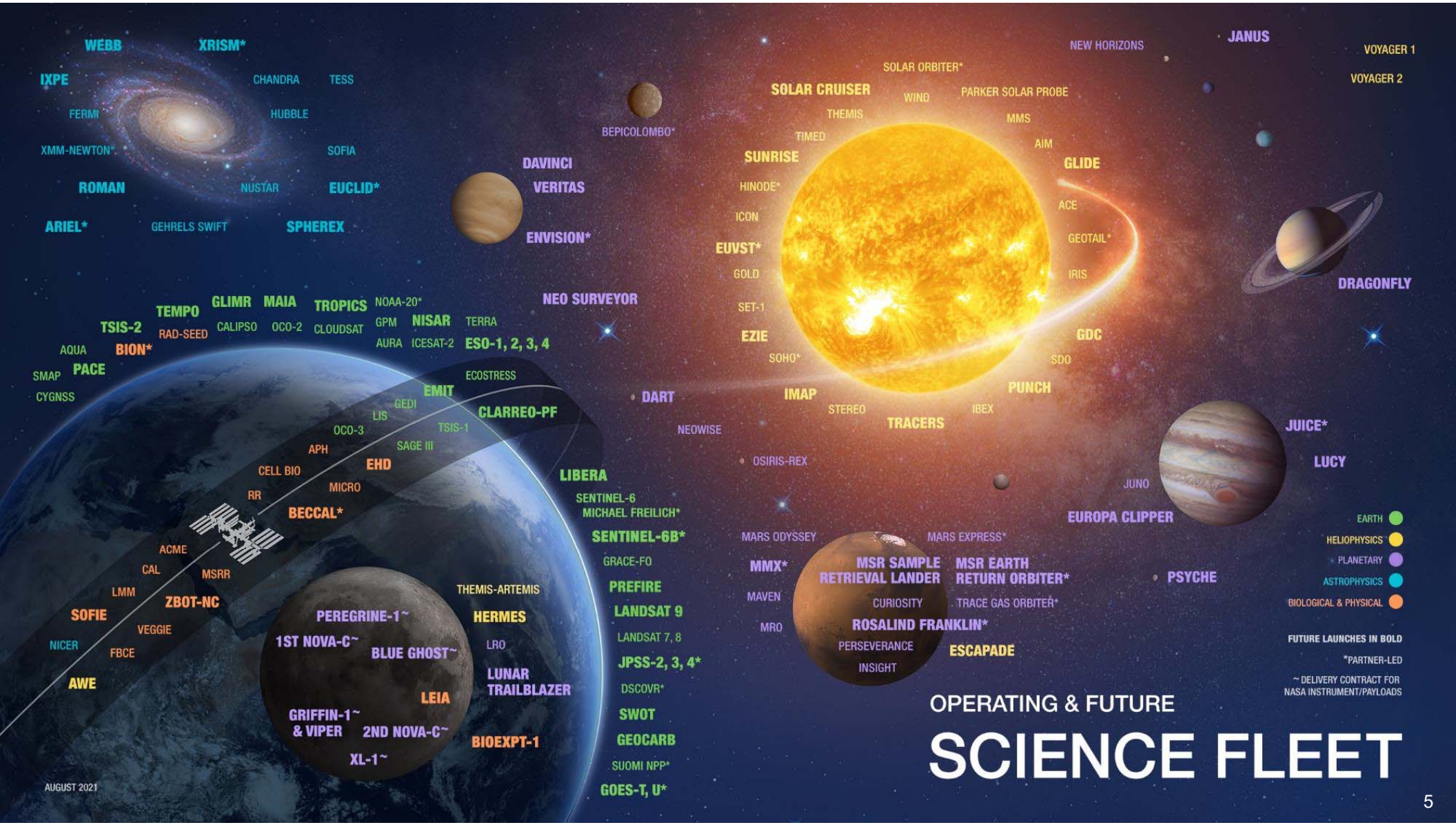
Exploration and Scientific Discovery

Innovation

Interconnectivity and Partnerships

Inspiration

Science 2020-2024: A Vision for Science Excellence
https://science.nasa.gov/about-us/science-strategy


WEBB
XRISM*
IXPE
CHANDRA
TESS
FERMI
HUBBLE
XMM-NEWTON*
SOFIA
ROMAN
NUSTAR
EUCLID*
ARIEL*
GEHRELS SWIFT
SPHEREX
DAVINCI
VERITAS
ENVISION*
BEPICOLOMBO*
NEW HORIZONS
JANUS
VOYAGER 1
VOYAGER 2
SOLAR ORBITER*
SOLAR CRUISER
WIND
PARKER SOLAR PROBE
THEMIS
MMS
TIMED
AIM
SUNRISE
GLIDE
HINODE*
ACE
ICON
GEOTAIL*
EUVST*
IRIS
GOLD
DRAGONFLY
SET-1
NEO SURVEYOR
TEMPO
GLIMR
MAIA
TROPICS
NOAA-20*
TSIS-2
RAD-SEED
CALIPSO
OCO-2
CLOUDSAT
GPM
NISAR
TERRA
AURA
ICESAT-2
ESO-1, 2, 3, 4
AQUA
BION*
EZIE
GDC
SMAP
PACE
SOHO*
SDO
CYGNSS
ECOSTRESS
EMIT
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OCO-3
TSIS-1
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CELL BIO
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LIBERA
JUNO
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RR
SENTINEL-6
MICHAEL FREILICH*
BECCAL*
EUROPA CLIPPER
SENTINEL-6B*
ACME
MARS ODYSSEY
MARS EXPRESS*
GRACE-FO
CAL
MSRR
MMX*
MSR SAMPLE
RETRIEVAL LANDER
MSR EARTH
RETURN ORBITER*
PREFIRE
LMM
PSYCHE
MAVEN
CURIOSITY
TRACE GAS ORBITER*
ZBOT-NC
LANDSAT 9
SOFIE
THEMIS-ARTEMIS
MRO
ROSALIND FRANKLIN*
PEREGRINE-1~
HERMES
VEGGIE
LANDSAT 7, 8
1ST NOVA-C~
BLUE GHOST~
PERSEVERANCE
ESCAPADE
NICER
FBCE
LRO
JPSS-2, 3, 4*
INSIGHT
LUNAR
TRAILBLAZER
AWE
DSCOVR*
LEIA
SWOT
GRIFFIN-1~
& VIPER
2ND NOVA-C~
GEOCARB
BIOEXPT-1
XL-1~
SUOMI NPP*
GOES-T, U*
AUGUST 2021
EARTH
HELIOPHYSICS
PLANETARY
ASTROPHYSICS
BIOLOGICAL & PHYSICAL
FUTURE LAUNCHES IN BOLD
*PARTNER-LED
~ DELIVERY CONTRACT FOR
NASA INSTRUMENT/PAYLOADS
OPERATING & FUTURE
SCIENCE FLEET

BIO EXP-1
ARTEMIS 1

FBCE
NG-16


LANDSAT 9


DART


WEBB


PEREGRINE-1


1ST NOVA-C

A YEAR OF SCIENCE


LUCY


IXPE


GOES-T

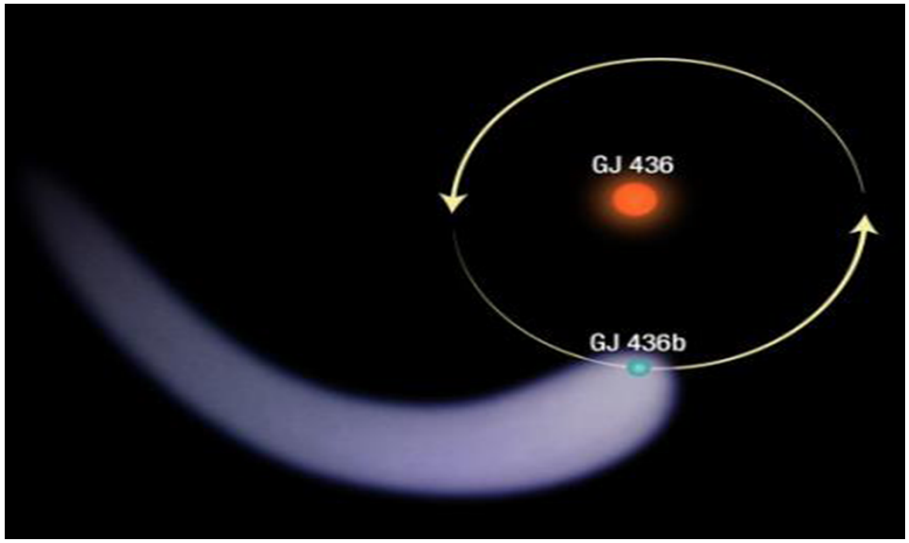
SOFIE
SPX-23


TROPICS

- LAUNCH
- DELIVERY
- LANDING
- DEPARTURE

Colorado Ultraviolet Transit Experiment (CUTE)

Grad Student Arika Egan (center) and PM Nick DeCicco (left) insert CUTE in launch deployment canister at VAFB. Photo courtesy K. France



Science Objectives: The Colorado Ultraviolet Transit Experiment (CUTE) will take multiple medium resolution UV spectra of hot Jupiters during transit, in order to measure the composition of the atmosphere being ablated away. Magnetic fields may be detected via the presence of tori or bow shocks.

Launch scheduled for September 27, 2021 as ride share with Landsat-9 primary payload

Balloon Program

Campaigns cancelled due to COVID-19: Spring 2020 (New Zealand), Summer 2020 (Palestine TX), Fall 2020 (Ft Sumner NM), Winter 2020 (Antarctica), Spring 2021 (New Zealand), and Winter 2021 (Antarctica)

Successfully demonstrated Return to Flight using COVID-safe procedures with Spring 2021 (Ft Sumner NM) campaign

Ongoing Fall 2021 (Ft Sumner NM) campaign:

- ✓ WHATS UP (Water Hunting Advanced Terahertz Spectrometer on an Ultra Small Platform)/ Tang/JPL/Planetary Science (H/L) ✓ Aug 20
- ✓ SLS (Submm Wave Limb Sounder)/Stachnik/JPL/Earth Sci ✓ Aug 28
- ✓ CSBF Engineering Test Flight (6 technologies)/Salter/CSBF ✓ Aug 30
- ✓ CSBF Engineering test Flight (1 technology)/Mullenax/CSBF ✓ Sep 6
- ✓ HASP (High Altitude Student Platform)/Guzik/LSU/ Education ✓ Sep 14
- ✓ REMOTE/Toon/JPL/Earth Science ✓ Sep 25
- ✓ Orion Eagle/Nowicki/LANL/LANL Technology (H/L) ✓ Sep 26
- PICTURE C (Planetary Imaging Concept Testbed Using Recoverable Experiment)/Chakrabarti/UMASS/Astrophysics

Planning for CY2022 includes:

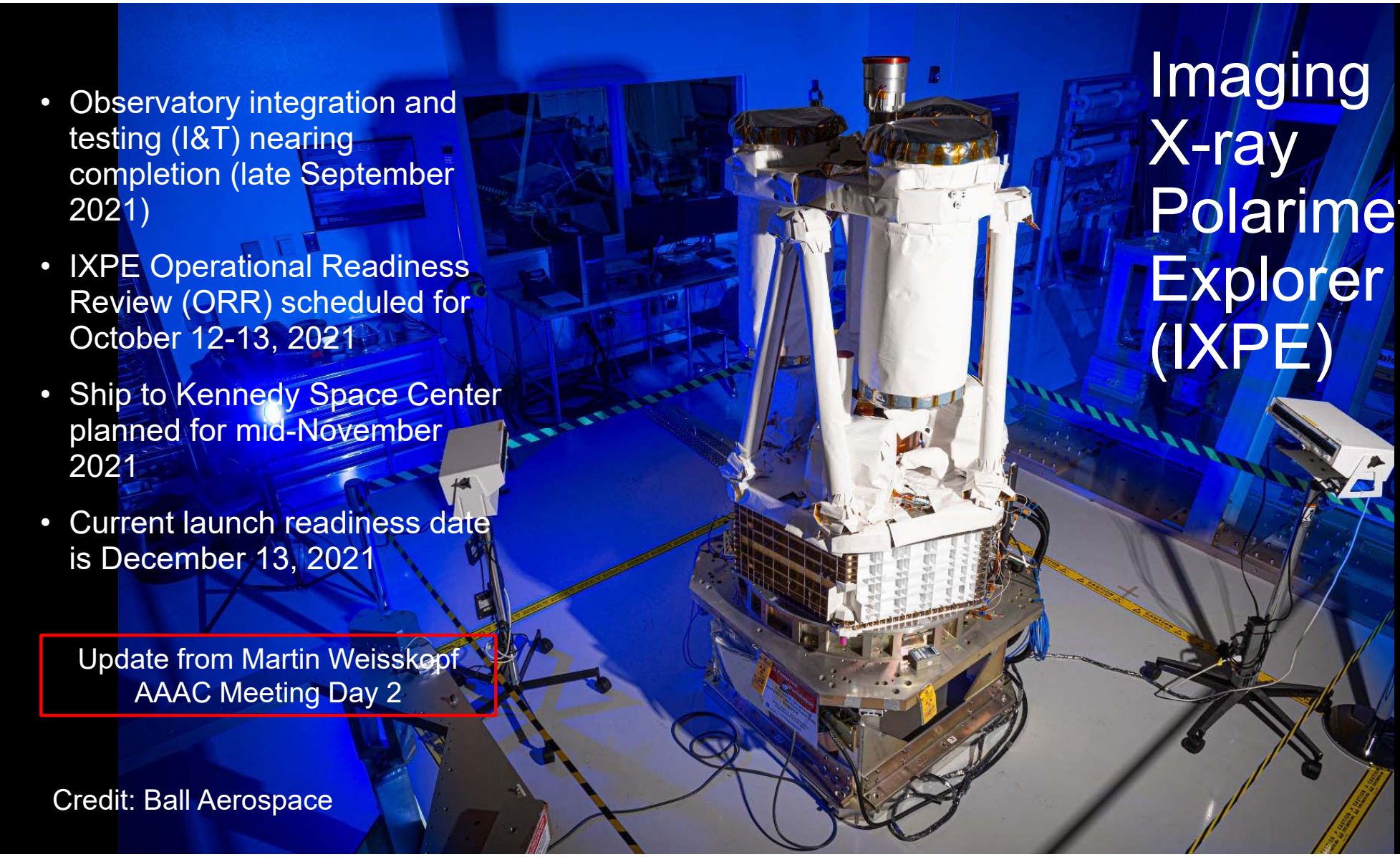
- Spring 2022 (New Zealand)
- Spring 2022 (Sweden)
- Fall 2022 (Ft Sumner NM)
- Winter 2022 (Antarctica)

Fall 2021 Balloon Campaign is ongoing in Ft. Sumner, New Mexico

Imaging X-ray Polarimetry Explorer (IXPE)

- Observatory integration and testing (I&T) nearing completion (late September 2021)
- IXPE Operational Readiness Review (ORR) scheduled for October 12-13, 2021
- Ship to Kennedy Space Center planned for mid-November 2021
- Current launch readiness date is December 13, 2021

Update from Martin Weisskopf
AAAC Meeting Day 2



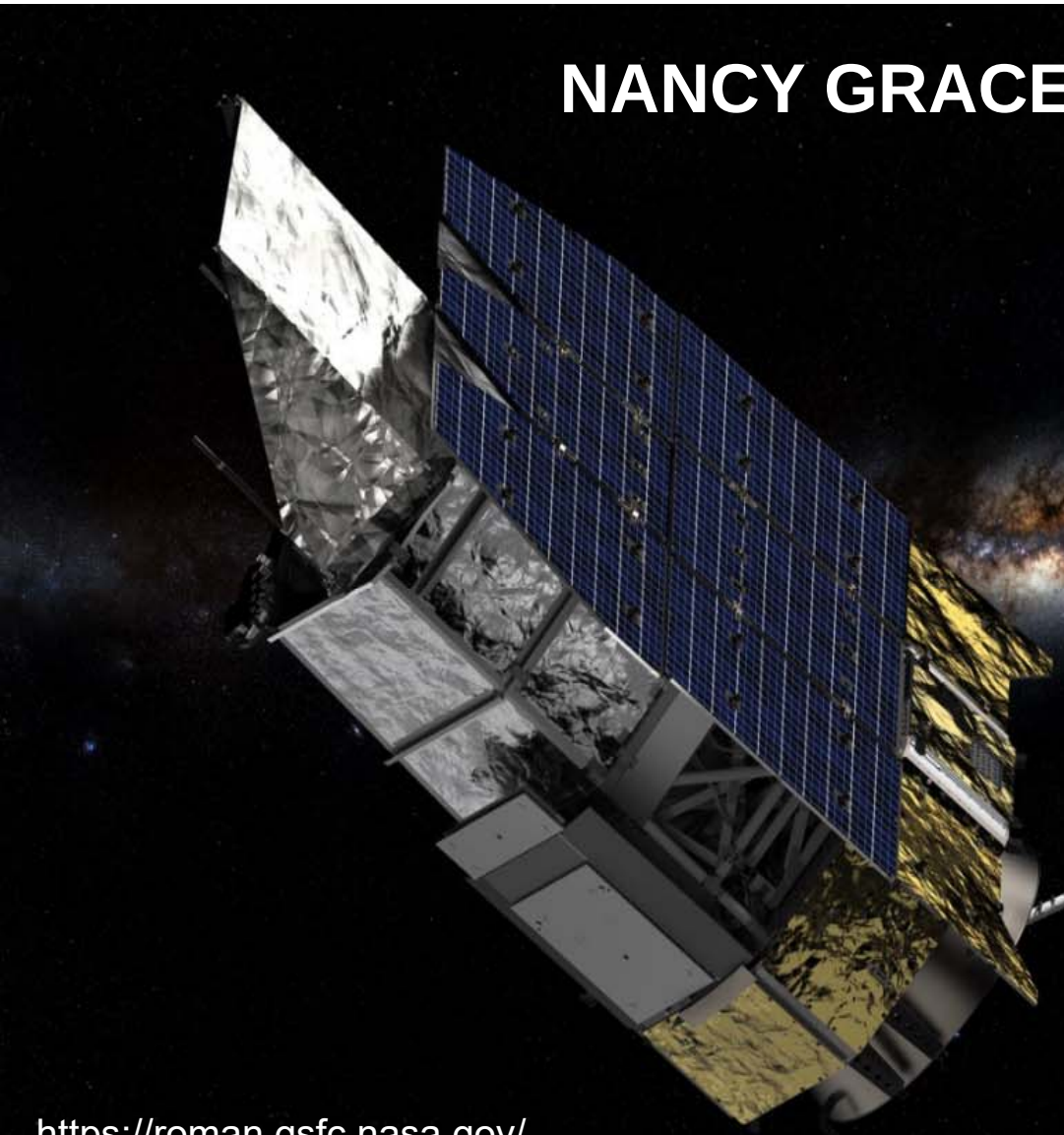
Credit: Ball Aerospace

James Webb Space Telescope

Shipping container, roll-over fixture and Webb at Northrop Grumman

Update from
Eric Smith
AAAC Meeting Day 2

NANCY GRACE ROMAN SPACE TELESCOPE



Mission passed Critical Design Reviews for Telescope, Wide Field Instrument, Coronagraph Instrument, Instrument Carrier, Ground System during past year.

Completed the Critical Design Reviews for the spacecraft and the entire mission on 20-27 September 2021.

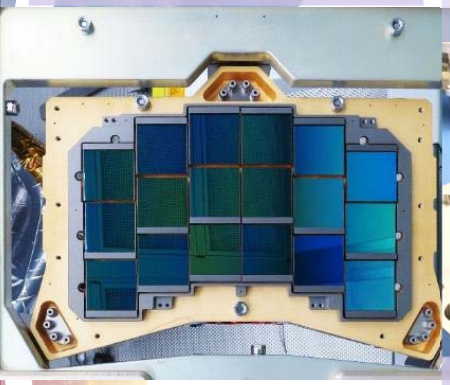
Project continues to make progress in spite of COVID inefficiencies and supply chain impacts; cost and schedule commitments have been adjusted to accommodate.

Opportunities for participation in Roman Space Telescope research and support are offered in ROSES-2021.

https://roman.gsfc.nasa.gov/

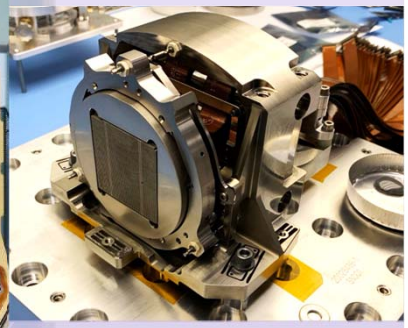
Roman Hardware Progress

Roman Wide Field Instrument critical technology: state-of-the-art infrared detectors



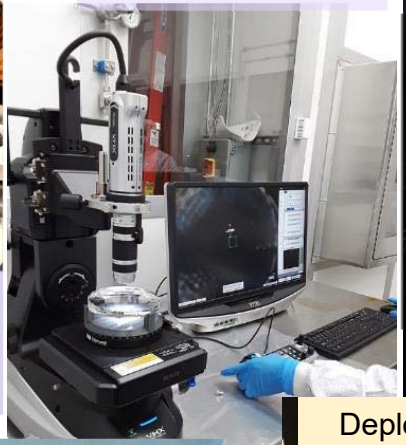
300 Mpixel Focal Plane Array Test Unit; All 24 flight candidate detectors in hand

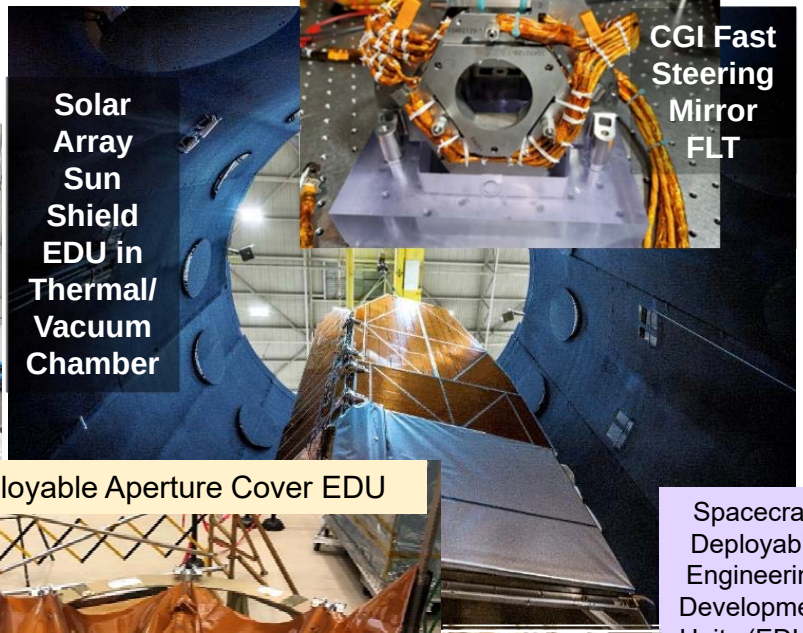
Roman Coronagraph Instrument (CGI) critical technology: deformable mirrors

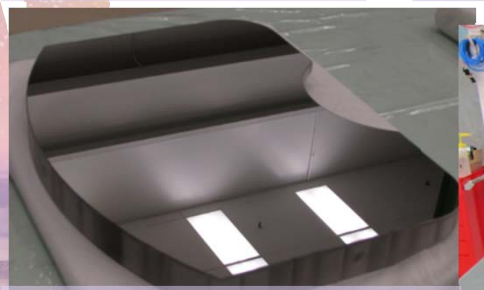


Deformable Mirror TRL-6 Model; technology has been demonstrated; two flight candidate actuators in hand

Inspection of the Grating Prism takes place in the lab at Goddard Space Flight Center.







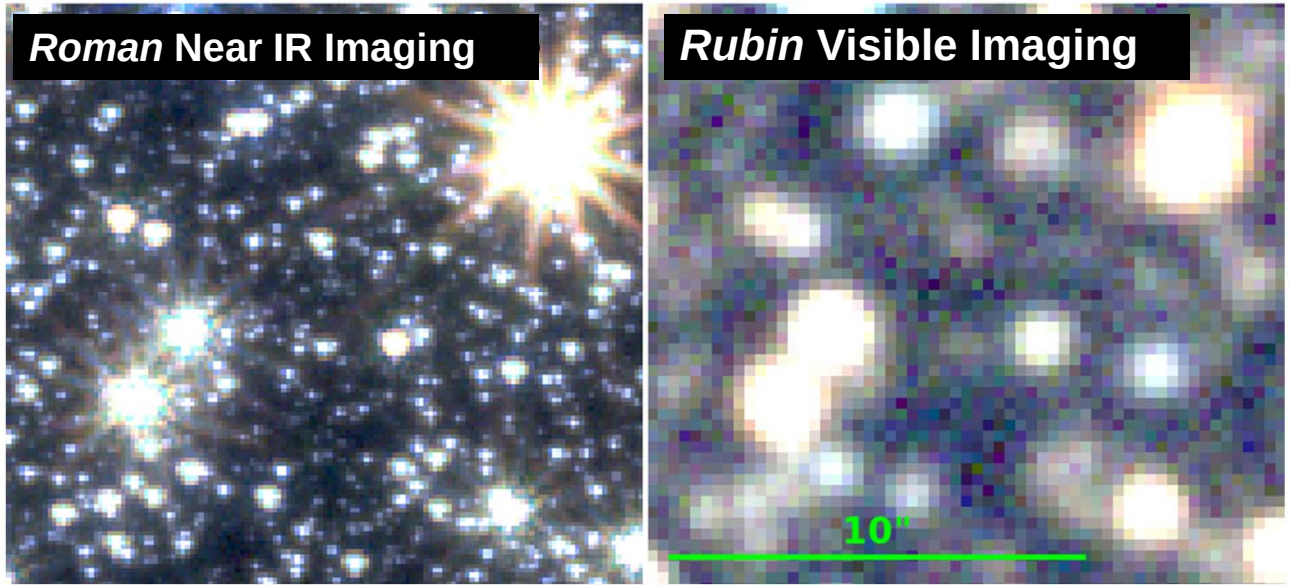
Roman Optical Telescope Assembly(OTA) Fold Mirror 2 Coated Optic

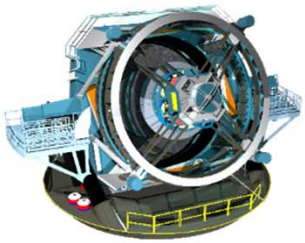
OTA Secondary Mirror baffle & shade sine vibe burst test

Deployable Aperture Cover EDU

Spacecraft Deployable Engineering Development Units (EDUs) and Mock-ups aid in maturing designs and assembly processes.

Coordination between *Roman* and *Rubin* Observatories





- NASA, NSF, DOE – through the Tri Agency Group - have charged Roman and Rubin project leads, plus US Euclid Lead, to investigate priorities for joint activities including data processing and simulations
- Much community input already via NASA/DOE RFI and anticipated via Astro2020 on leveraging synergies between *Roman* and *Rubin* (+*Euclid*)

Roman's Core Community Surveys

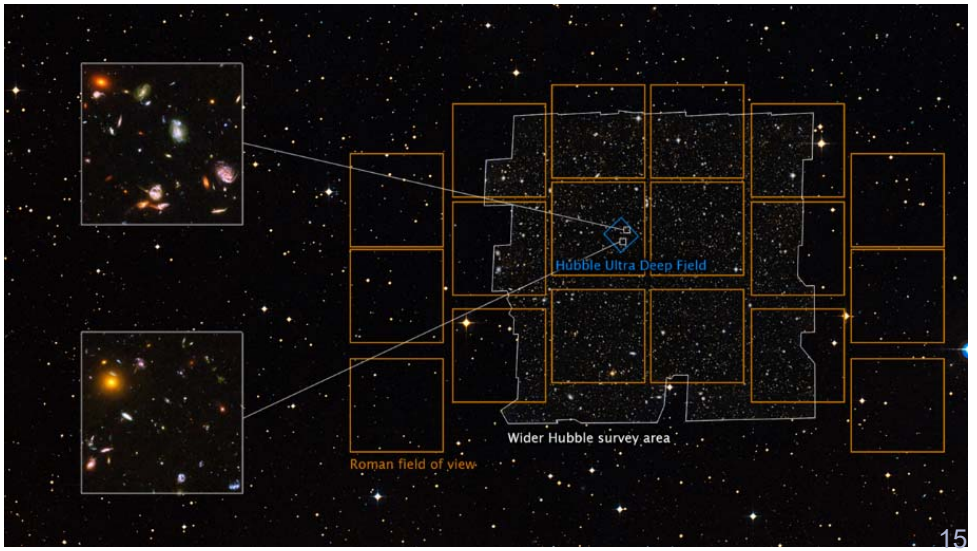
Core Community Surveys provide data needed to meet cosmology and exoplanet demographics science requirements

High-latitude Wide Area surveys	High-latitude time-domain survey	Galactic Bulge time-domain survey
Enables weak lensing and redshift cosmology investigations of dark energy	Enables Type Ia supernova cosmology investigations of dark energy	Enables exoplanet microlensing investigations

- However, the science scope and return will be *much broader*
- Core Community Surveys will be defined via an open process, with a goal of *maximizing the overall science return* while simultaneously meeting the cosmology and exoplanet science requirements
- All Core Community Surveys are owned by the community, not PIs

Other *Roman* Surveys?

- *Roman* interest groups have recommended considering early definition of additional survey(s) via broad community engagement.
- Have begun by announcing an open Request for Information to solicit science motivation for defining a *Roman* Astrophysics Survey now:
  - Consider surveys of up to 1 month scale, defined now and executed in ~first 2 years
  - Most time (≥14 months) still remains for allocation closer to launch, e.g. via proposals
  - Input accepted through Oct 22 at: https://roman.gsfc.nasa.gov/science/Early-definition_Astrophysics_Survey_Option.html
- If decision made for early definition of an additional survey, it will be followed by an open community process to define the survey itself



Future *Roman* Science Opportunities

- *Roman* opportunities announced in the ROSES call in February, proposal deadline targeted for early 2022
  - Includes opportunities for Coronagraph community participation, Wide Field Instrument preparatory science, and key project infrastructure teams.
    - Coronagraph Community Participation Program: Investigators to work with the coronagraph instrument team to plan and execute tech demo observations
    - Wide Field Instrument Preparatory Science: Investigators to work on science preparation activities related to mission performance verification and science operations preparation
    - Key Project Infrastructure Teams: Science teams to conduct scientific investigations using the data from the core community surveys
  - Accommodates stable long-term funding to support development of needed deliverables, creates flexible shorter-term opportunities to allow us to be more responsive to a changing science landscape, and allows a variety of different science community models – large open consortia, small PI-led teams, etc.

Coronagraph Instrument Information Sessions: Oct 26 & 28

https://roman.ipac.caltech.edu/mtgs/Roman_CGI_workshop.html

Wide Field Instrument Information Sessions: Nov 16-20

Website will be announced; check https://roman.gsfc.nasa.gov/

Astrophysics FY22 Budget Request

Requests $1,575.5 M for NASA Astrophysics (including Webb) in FY 2022

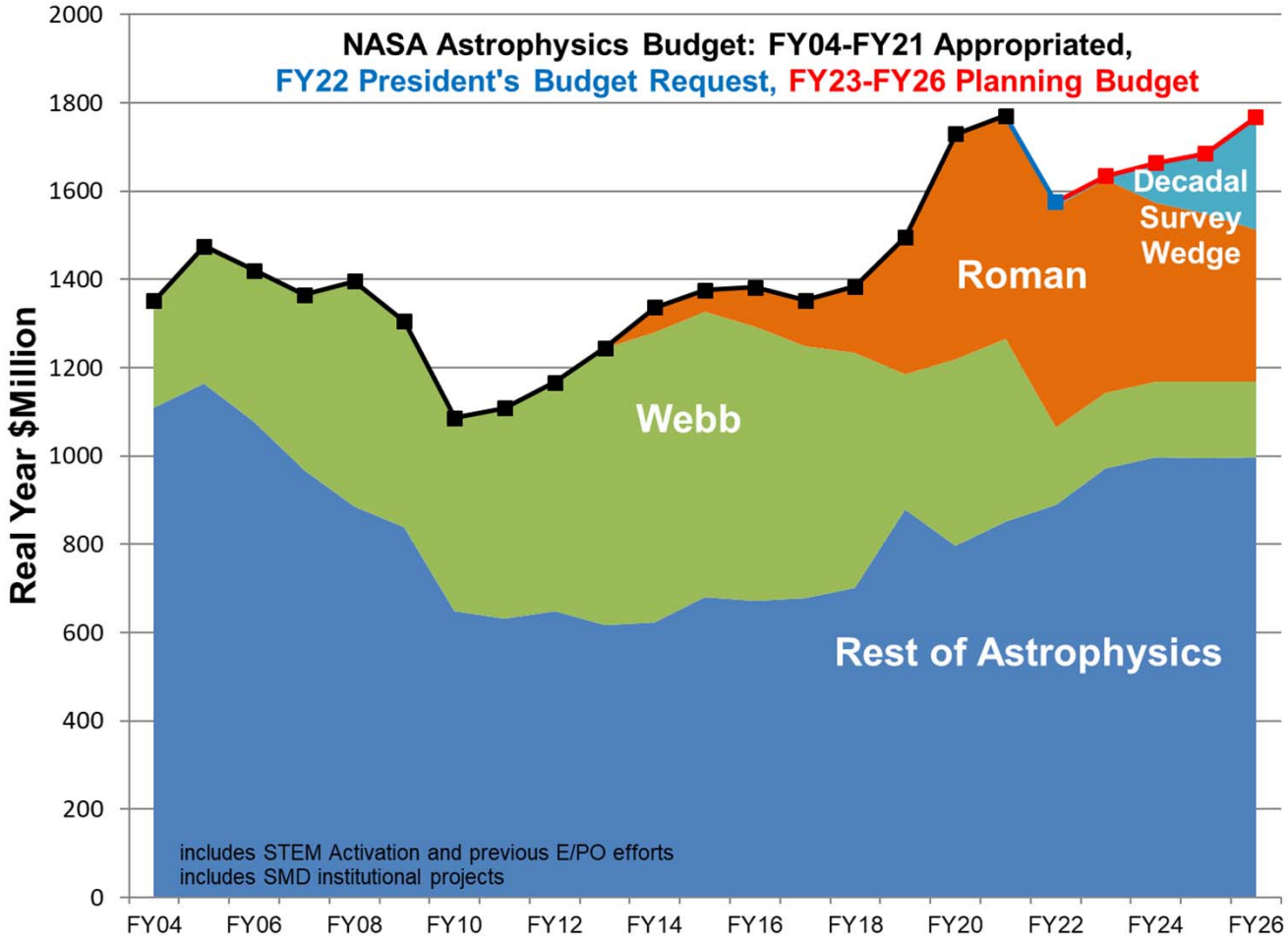
What's Changed compared to one year ago (previous budget request)

- Funds continued development of the Nancy Grace Roman Space Telescope and estimated COVID impacts
- Plans for an Astrophysics Probe-class mission and other initiatives pending receipt of the Decadal Survey
- Four Astrophysics Pioneers conducting mission concept studies
- Enhanced facilities and open science initiatives within research program (e.g., laboratory equipment upgrades, extreme precision radial velocity program, formulation for integrating data archives with cloud computing)
- Science activation increases to support diversity and inclusion initiatives
- Astrophysics Strategic Mission Program management funding to support the management of Roman and upcoming probe-class missions in recognition of the enhanced management requirements of these missions

What's the Same compared to one year ago (previous budget request)

- Webb on track to launch in 2021
- Proposes termination of SOFIA due to its high cost and lower scientific productivity than other missions
- Hubble, Chandra, and other operating missions continue
- Supports development of IXPE, GUSTO, SPHEREx, and contributions to XRISM, Euclid, ARIEL
- Maintains Astrophysics Explorers cadence including both SMEX downselect and MIDEX AO in 2021
- CubeSat initiative and balloon campaigns within healthy research program

Astrophysics Budget – FY22 Request



NASA Response to 2020-2021 AAAC Report

AAAC Recommendations

	AAAC Recommendation – March 2021	NASA Response
3	NSF, NASA, and DOE Office of Science should continue their efforts to mitigate the impacts of COVID-19, with a focus on early career scientists to the extent possible.	Concur. NASA response includes (i) Extended flexibilities in grant terms & conditions, (ii) Grant augmentations for early career researchers, (iii) Providing resources on work-life balance, (iv) Sponsoring mentoring program through AGU/AAS/ASGSR.
7	NASA, NSF, and DOE/Cosmic Frontier should support community efforts that increase public access to data, software, and data products across surveys.	Concur. NASA response includes Open Science Initiative which extends public data to publications, software, research products.
8	The three agencies should coordinate on guidelines and expectations for the public releases of data, access tools, and software associate with observations and simulations.	Partially concur. Agencies will coordinate on joint projects. Generally agencies policies are governed at higher levels (e.g., NASA astrophysics policies are governed by SMD).
9	The agencies and the AAAC should review priorities for access to data and simulations after the release of the 2020 Decadal Survey recommendations.	No action yet
12	NASA, NSF, and the DOE Office of Science should continue to collaborate on inter-agency initiatives that have significant community impact.	Concur. Ongoing efforts involving NASA include Fermi, NN-EXPLORE, Tri Agency Group initiative, NASA/DOE RFI, and other more informal collaborations.

AAAC Recommendations

	AAAC Recommendation – March 2021	NASA Response
16	The AAAC recommends continued and augmented cross agency efforts to provide data-driven recommendations for telecommunication satellite constellations that would have the lowest impact on astronomical studies.	Concur. NASA is studying the impact of future constellations on NASA science missions. NASA provides formal input to licensing agencies. NASA defers to NSF for ground-based astronomy.
20	The AAAC encourages ongoing NASA/NSF coordination, through the Planetary ~~Protection~~ Defense Coordination Office, to clearly define the role that existing and future ground and space-based astrophysics surveys and facilities can play in the discovery and characterization of NEOs.	Concur. • NASA, through its Planetary Defense Coordination Office, continues to coordinate closely with NSF on issues related to planetary defense, such as the loss of Arecibo, studies on future interagency planetary radar capabilities, and activities within the interagency National Near-Earth Object Preparedness Strategy and Action Plan. • NASA agrees that continued collaboration, particularly with the actions cited in the Action Plan, is valuable to clearly define the role that existing and future ground and space-based astrophysics surveys and facilities can play in the discovery and characterization of NEOs.
22	The AAAC recommends that NSF and NASA should continue to work with international astronomy agencies and coordinate with the relevant IEEE technical committees involved in to create and preserve geographical radio quiet zones for radio astronomy.	NASA defers to NSF

AAAC Recommendations

	AAAC Recommendation – March 2021	NASA Response
24	The AAAC recommends that the agencies continue the development of AI and ML initiatives across astrophysics including the potential creation of institutes focused on AI in the context of astrophysics.	Partially concur. NASA is developing an SMD-wide AI/ML policy and initiative. NASA does not generally support focused research institutes.
26	The AAAC recommends continuation of the expansion of dual anonymous reviews within NASA, and requests that NSF and DOE develop and adopt similar reviews or other practices that provide the committee with sufficient evidence of bias mitigation in their review processes.	Concur. NASA has expanded the use of dual anonymous peer reviews to all GO/GI (telescope allocation) reviews plus ADAP, ATP, and XRP (in astrophysics). Additional SMD reviews are dual anonymous. NASA is studying the use of dual anonymous reviews for technology, laboratory, and mission reviews.

AAAC Recommendations

	AAAC Recommendation – March 2021	NASA Response
28	The AAAC recommends that the NASA Office of the Chief Scientist share its demographic data or at a minimum provide the results of analysis of the data to the directors within NASA's Science Mission Directorate so that the divisions can evaluate the effectiveness of their processes and policies for DEI.	Concur. Demographic data on PIs and Co-Is of proposals submitted to ROSES has been shared with the SMD Office of the Deputy Associate Administrator for Research (DAAR). The DAAR's Data Analytics Team is currently completing the first analysis of these data at the SMD-, Division- and individual program-level. Results of these analyses will be presented to SMD Senior Leadership in early November and a policy on data sharing with Divisions and Program Officers is being developed. The Office of the Chief Scientist is also developing a "demographics dashboard" to be made available to Program Officers. A public-facing version of the dashboard is also under development.
30	AAAC recommends that NASA, NSF, and DOE work with OMB to collect the needed fine-grained demographic data to understand the proposal pool and the awardee pool for its entire portfolio of grants.	Partially concur. NASA has been engaging in such discussions with OMB. NASA SMD has also tasked the National Academies of Science, Engineering, and Medicine to conduct a study to develop executable measures of the health and vitality of a research community and to recommend the types of data that need to be collected in order to apply these measures. The ad hoc committee is co-chaired by Charles F. Bolden and Wanda Sigur and is a joint project of the Space Studies Board and the Committee on National Statistics.

AAAC Recommendations

	AAAC Recommendation – March 2021	NASA Response
31	The AAAC requests that NASA, NSF, and DOE provide regular updates to the committee on demographic data and DEI initiatives.	Partially concur. An update is provided at this meeting on DEI initiatives. No update is provided on demographic data.
43	The AAAC encourages inter-agency initiatives to maximize the scientific yields of the Vera C. Rubin Observatory and Nancy Grace Roman Space Telescope by considering survey designs that maximize the synergy between these two facilities.	Concur. NASA, NSF, DOE – through the Tri Agency Group - have asked the Roman and Rubin project leads, plus US Euclid Lead, to investigate priorities for joint activities including data processing and simulations.
45	The AAAC recommends that NASA Astrophysics continue to maintain the Pioneers program at least at its current level, and continue its efforts to recruit new mission PIs that move into leadership positions for the larger missions of the 2020s and 2030s.	Concur. A second Pioneers call will be issued later in 2021.
47	The AAAC recommends that SOFIA undergo senior review including a decision on mission extension, in line with normal NASA review procedures.	Concur. SOFIA is included in the 2022 Senior Review.

Selected NASA Astrophysics Updates

Personnel Update

Jeff Volosin, Deputy Director of Astrophysics, is moving to Goddard Space Flight Center at the end of October to be the Director of Earth Science Projects (Code 420)

Paul Hertz, Director of Astrophysics, will delay his transition from Astrophysics Director beyond the end of the year in order to ensure continuity for astrophysics leadership and the astrophysics program

Dan Evans is now the SMD Assistant Deputy Associate Administrator for Research

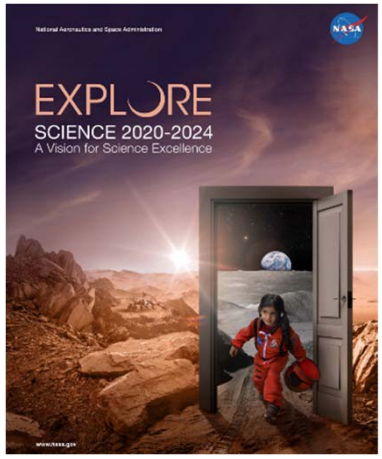
Kartik Sheth is now the Assistant Director for Research Infrastructures & Science Equity at the White House Office of Science and Technology Policy (OSTP)

New staff have joined during 2021: Program Scientists Roopesh Ojha, Sanaz Vahidinia, Heather Watson; Program Executive Rachele Cocks

Additional astrophysics program scientists (both civil servants and IPAs) will be selected / hired in the near future

Improving Inclusion at NASA

Inclusion – NASA is committed to a culture of diversity, inclusion, and equity, where all employees feel welcome, respected, and engaged. To achieve the greatest mission success, NASA embraces hiring, developing, and growing a diverse and inclusive workforce in a positive and safe work environment where individuals can be authentic. This value will enable NASA to attract the best talent, grow the capabilities of the entire workforce, and empower everyone to fully contribute.



Strategy 4.1: Increase the diversity of thought and backgrounds represented across the entire SMD portfolio through a more inclusive and accessible environment.

ROSES: SMD's goals are to develop a workforce and scientific community that reflects the diversity of the country and to instill a culture of inclusion across its entire portfolio.

Building Excellent NASA Teams Requires Inclusion and Diversity

- At NASA, we recognize that excellence is only achieved with inclusive and diverse teams. We are creating a multi-pronged approach.
  - Standing up a long-term internal activity focused on sustained engagement, systemic, and lasting changes.
    - ❖ Modifying requirements for AOs to align with NASA's new core value of Inclusion; draft modifications to be released for community comment.
    - ❖ Requesting funding (starting in FY22) to establish Bridge Programs supporting MSIs and HBCUs.
    - ❖ Increasing Science Activation program to support diversity and inclusion initiatives.
  - Hosting incubator workshops and implementing actions from those workshops focused on short-term changes to how we are operating and how we grow our leaders.
  - National Academies study of barriers to inclusion in mission leadership.
  - Adopted a Code of Conduct to improve the inclusion and process of our panels and teams.
  - Astrophysics Division task force working to align division-level practices with the NASA core value and SMD science strategy. Examining the R&A process for better inclusion and diversity.
  - Piloting inclusion plans as an evaluation criterion for R&A programs.
  - Session at SACNAS on funding opportunities; NASA Town Hall and booth at NSBP
  - Proposal Processes: Recognizing we have influence through our calls for proposals and what we reward in our selections. Piloting dual-anonymous peer review and seeking to expand that. Actively looking into how we can be a model for inclusivity.

ATP Inclusion Criterion Pilot Program

All Astrophysics Theory Program (ATP) proposals should have included an inclusion plan. This section addresses:

- Plans for creating and sustaining a positive and inclusive working environment for those carrying out the proposed investigation, and
- Contributions the proposed investigation will make to the training and development of a diverse and inclusive scientific workforce

The inclusion plans are being evaluated for adequacy and completeness. In addition to the 20 science panels (which will evaluate all 182 proposals), there are 4 inclusion panels.

- Inclusion panels made up of astronomers active in DEI and DEI experts over a range of related fields

Feedback will be provided to the proposers as part of the panel review summaries.

- The feedback will not be folded into the adjectival ratings or selection recommendations in the current ROSES cycle, but may in future cycles
- Inclusion panels will not just be providing feedback on the plans, but will be helping us produce a lessons learned document that will record their findings on how to refine the solicitation and evaluation to best incorporate our inclusion goals as a selection criterion in future reviews
- NASA plans to invite comments from proposers regarding this pilot process after they receive their review comments

COVID Impacts: Status of SMD Programs

[UNCHANGED] NASA has been in a mandatory telework posture due to COVID-19 for over 18 months; NASA work has continued though there have been impacts

COVID Impacts on Missions:

- Projects continue to respond and replan due to changes due to COVID-caused issues; replans (including changes in cost and schedule estimates) continue to be reviewed and approved through the SMD Program Management Council process
- NASA Centers are ramping up onsite activities, including laboratory research and technology development, as 25% occupancy limit is lifted
- SMD COVID assumptions have been updated (but do not account for delta variant), which allows our missions to more effectively plan for operating over the next 12 months

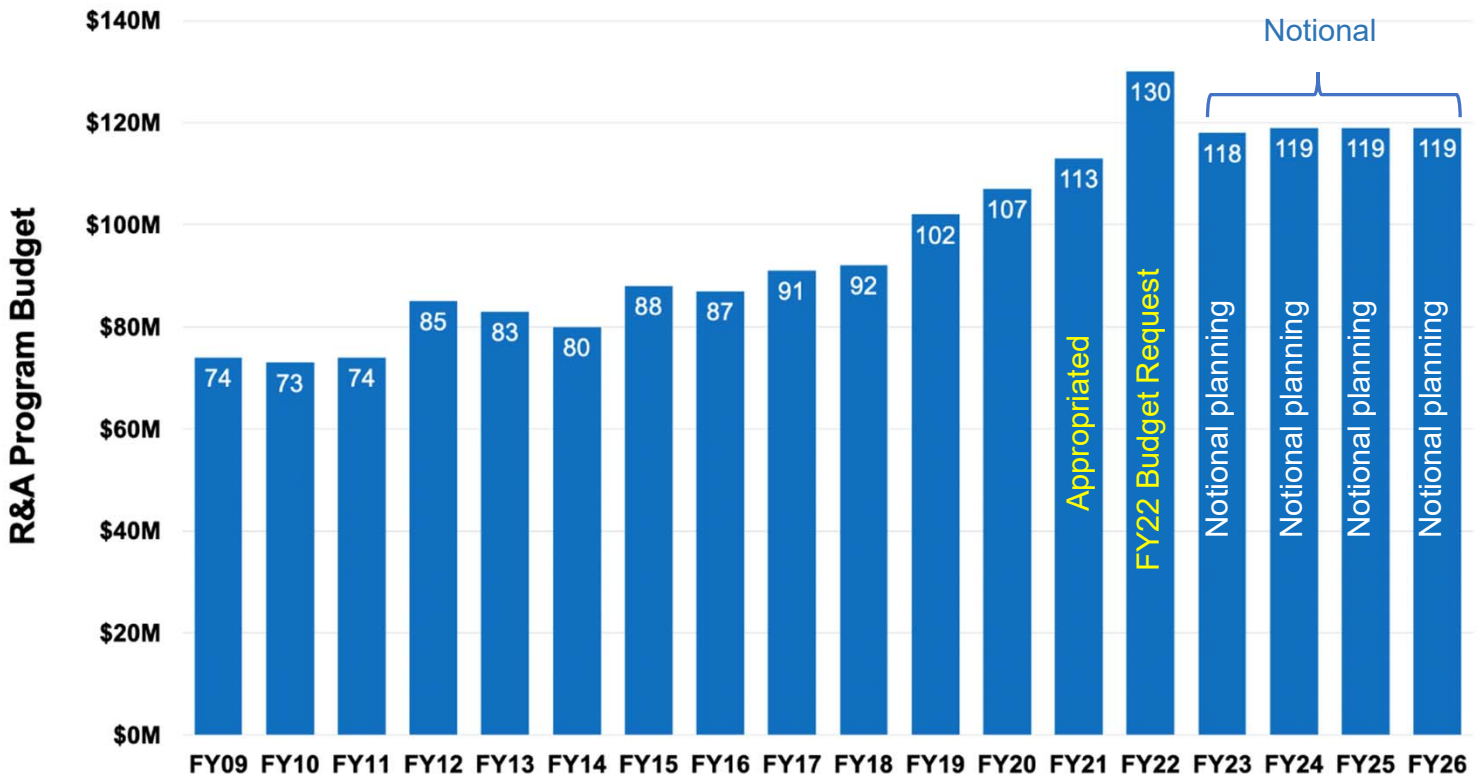
COVID Impacts on R&A:

- No R&A solicitations or selections have been cancelled due to COVID; notifications and funding have continued at the pre-pandemic pace
- Virtual peer review panels will continue through December 2021, and likely beyond

How this affects the community:

- As vaccinations increase within the community, we will be able to interact more with our project teams, partners, and vendors by increasing on-site work and travel
- SMD is working toward multiple launches scheduled for the fall and winter of this year, including Webb, Lucy, Landsat-9, DART, IXPE, and GOES-T

R&A Research Funding



Sustained growth in R&A research funding since the 2010 Decadal Survey

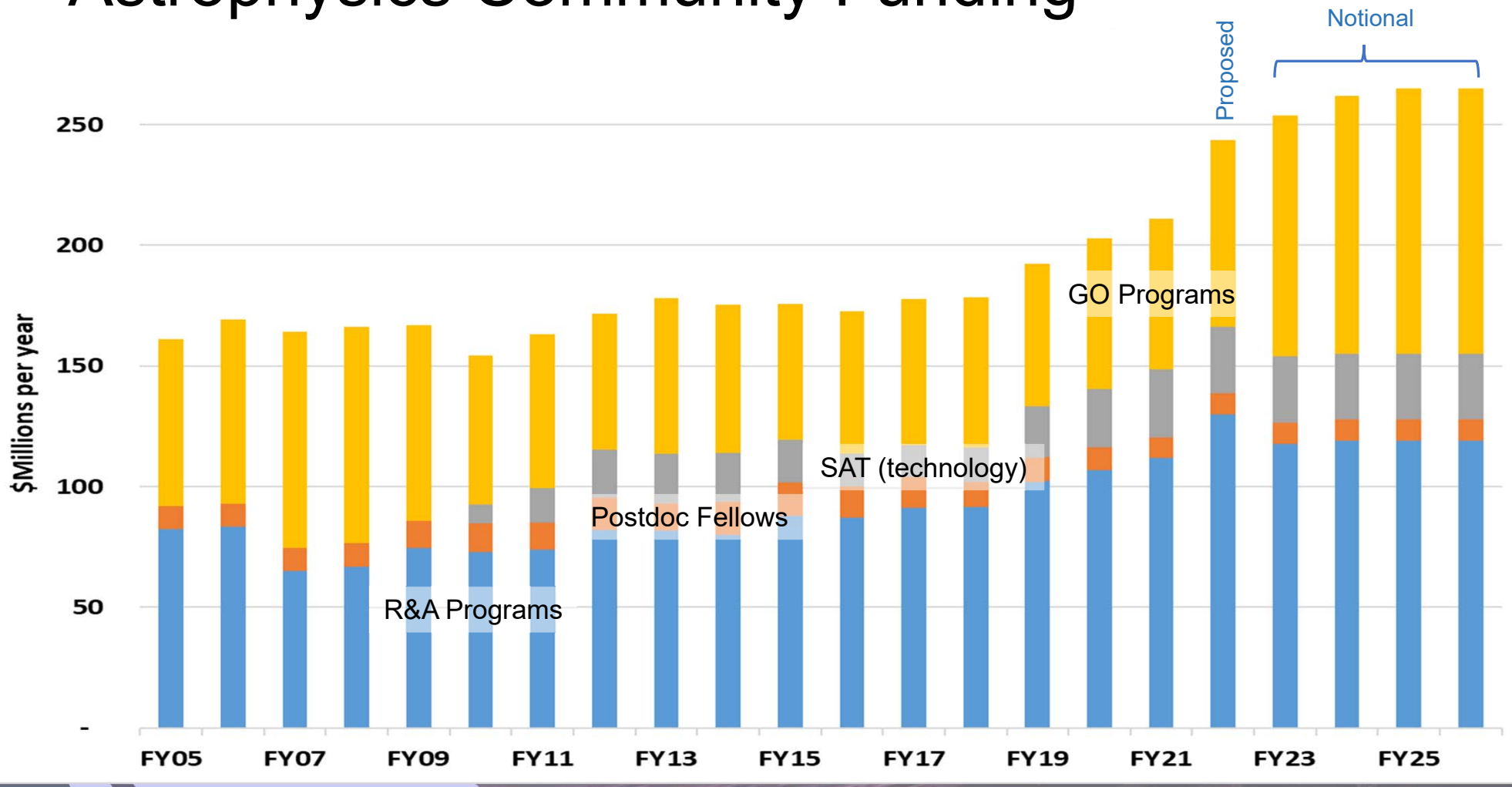
Since the last Decadal Survey:
+38% R&A funding growth

Notional Planning:
+60% over 17 years.

For the last 12 months (August 2020 – August 2021), the selection rates were 23% for R&A programs and 46% for smaller mission's general observer (GO)/guest investigator (GI) programs*, with a total average selection rate of 35% for all our ROSES programs

* Does not include Hubble, Chandra, SOFIA

Astrophysics Community Funding



From Open Data to Open Science

Throughout NASA, we are looking to adopting open science principles to help advance *transparency, accessibility, reproducibility, and inclusion* in our scientific endeavors.

SMD has released **SPD-41: Scientific Information Policy** that consolidates existing guidance on how the results of its Federally funded scientific research and technology development are shared openly. An RFI will be released soon for public comment on implementation and enhancements. This policy covers:

- Information produced by NASA Science Missions
- Information produced by NASA research awards
- Open access to NASA-funded publications, data, and software

The **Open Source Science Initiative** looks to implement this strategy through cross-divisional activities that support open science. These include:

- Targeted investments in cloud computing, HPC, and Artificial Intelligence/Machine Learning
- ROSES calls supporting open-source tool development and the opening of legacy software
- Increasing access by making NASA data and publications more discoverable

Transform to Open Science is focused on capacity building to help accelerate scientific discovery through open science. This includes workshops and summer schools in 2023; the Year of Open Science.

Open Source Science for Data Processing and Archives Workshop
Thursday, Oct 14 @ 12:00-3:00 pm ET
https://science.nasa.gov/researchers/science-data/open-source-science-workshop

NASA Hubble Fellowship Program (NHFP) Review

The (NHFP) supports outstanding postdoctoral scientists pursuing independent research that contributes to NASA Astrophysics, using theory, observation, experimentation, or instrument development.

Merged the previously separate Einstein, Hubble, and Sagan Fellows programs in 2017

In the summer of 2021, we conducted the first programmatic review of its Fellowship Program since the original Hubble Fellowship Program was created over 30 years ago.

Review is intended to assist NASA increase the effectiveness of the program and bolster its excellence. It focused on two main areas:

1. Success of the NHFP under its current structure
2. Diversity, equity, and inclusion of the program

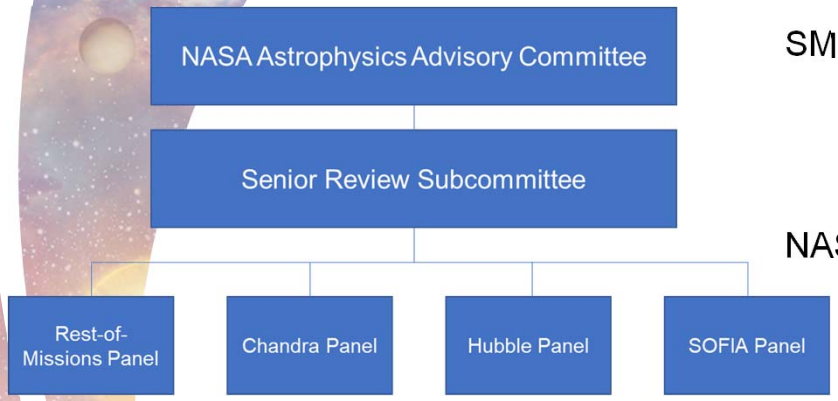
Panel convened comprised of a diverse group of astrophysicists and experts in diversity, equity, inclusion, and accessibility

- Co-chaired by Rita Sambruna, Deputy Director of the Astrophysics Division at GSFC, and Nicolle Zellner, Program Scientist in NASA HQ's Planetary Science Division
- The panel prepared a report of its findings, and the co-chairs developed a set of recommendations based on those findings.

<u>Next Steps</u>

- Co-chairs are debriefing Paul Hertz on Sep 29, 2021
- Co-chairs will report out at October APAC meeting
- Report and NASA's response will be publicly released
- A splinter session for January AAS has been proposed
  - panel co-chairs of the review process and key findings and recommendations
  - presentation by Astrophysics Division on plans to implement the recommendations and address the findings

Astrophysics 2022 Senior Review



Triennial peer-review mandated by Congress of operating missions (last one was 2019) to assist NASA in planning its strategy for extended missions

SMD Missions to be reviewed by Astrophysics Division

- Hubble, Chandra, SOFIA (separate panels)
- Fermi, New Horizons, NICER, NuSTAR, Swift, TESS, XMM-Newton (one panel)

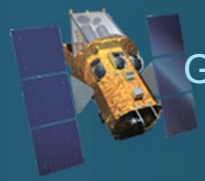
NASA will use the review information to:

- Prioritize the operating missions and projects;
- Define an implementation approach to achieve astrophysics strategic objectives;
- Provide programmatic direction to the missions and projects concerned for FY23, FY24 and FY25; and issue initial funding guidelines for FY26 and FY27 (to be revisited in the 2025 Senior Review)

Notional Schedule

- Call for proposals: 1-Oct-2021
- Proposal due date: 1-Feb-2022
- Site visits for large missions: March 2022
- Panel reviews merged and delivered to APAC: April 2022
- Special meeting of the APAC for recommendations to NASA: May 2022

Astrophysics Explorers Program



Gehrels
Swift

NuSTAR

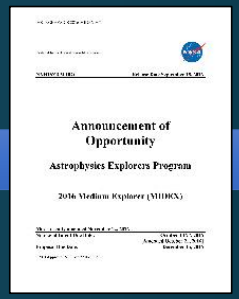
SMEX 2019 Downselect
Phase A Studies due Mar 4, 2021
Downselect decision Fall 2021

MIDEX 2021
Comm Ann release Sep 29, 2020
Draft AO release Jan 6, 2021
Comments due Feb 25, 2021
Final AO released Aug 24, 2021
NOIs due Oct 14, 2021
Proposals due Dec 9, 2021

4 AOs per decade

MIDEX
2011

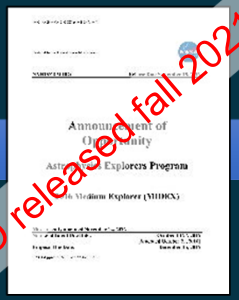
SMEX
2014



MIDEX
2016

Downselect fall 2021

SMEX
2019

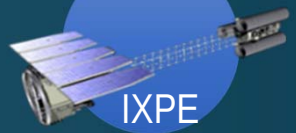


AO released fall 2021

MIDEX
2021

Small and
Mid-Size
Missions

TESS

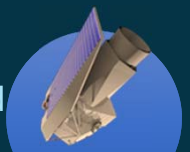


IXPE

SPHEREx

ESCAPE
COSI

Directed
2013

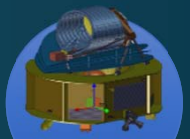


Euclid

Missions of
Opportunity

NICER

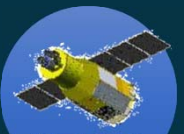
GUSTO



ARIEL

Dorado
LEAP

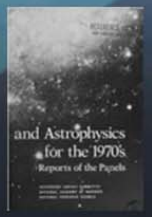
Directed
2017



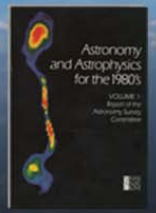
XRISM

Astrophysics

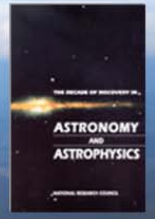
Decadal Survey Missions



1972
Decadal Survey
Hubble



1982
Decadal Survey
Chandra



1991
Decadal Survey
Spitzer

2001
Decadal Survey
Webb

2010
Decadal Survey
Roman

?
2021
Decadal Survey

NASA Planning for Astro2020

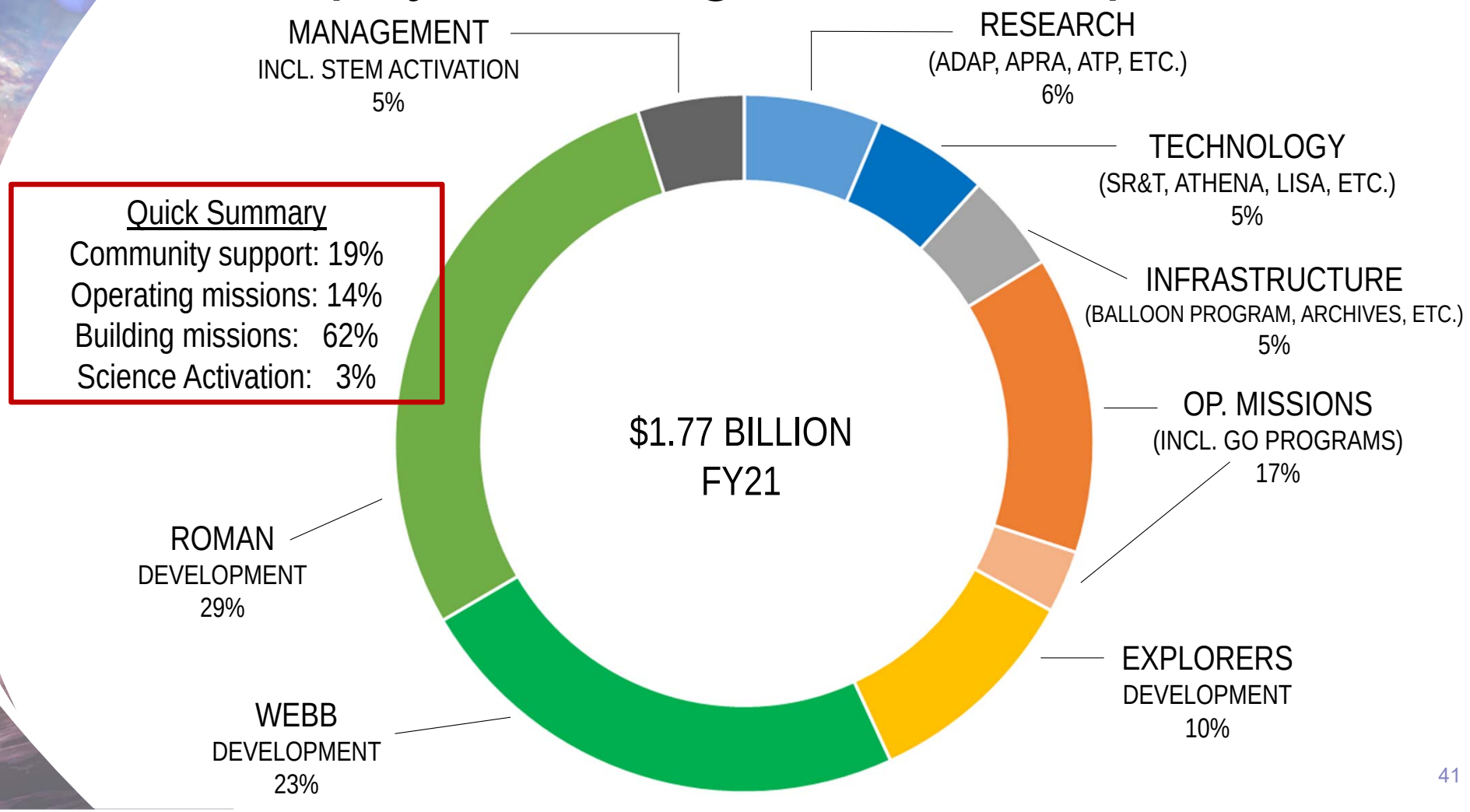
- NASA is planning for implementing the Decadal Survey
  - Reducing risks of large missions via technology development and through studying lessons learned from prior large missions
  - Developing options for recommendations in R&A, archives, suborbital, Explorers, Probes
  - Developing options for flagship risk reduction activities; stay focused on Webb and Roman
  - Holding a wedge in out year planning budget for new initiatives
- NASA plans to provide an initial response to the community within a few months of receiving the Astro2020 Decadal Survey Report
  - Announce implementation of recommendations that can be implemented immediately (within budget, within authority)
  - Announce plans for developing responses to long-term recommendations
  - Communicate and engage with the community throughout

Astrophysics is Looking Up

- Webb is launching, Roman completed CDR
- Explorers are being competed and selected regularly
- Smaller missions (e.g., CubeSats, Pioneers) are being competed and selected annually
- International partnerships are strong
- R&A budgets are up, suborbital capabilities are expanding
- Technology investments are being made for future missions
- NASA is prioritizing an inclusive and diverse astrophysics community, and is initiating changes to address systemic failures that limit accessibility
- The FY22 budget request supports all this PLUS contains a funding wedge for a Probe mission and other Decadal Survey priorities

BACKUP

Astrophysics Budget – FY21 Op Plan



Quick Summary
Community support: 19%
Operating missions: 14%
Building missions: 62%
Science Activation: 3%

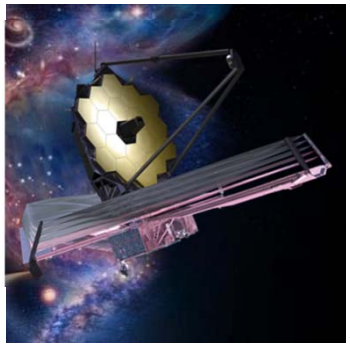
Supporting Work-Life Balance

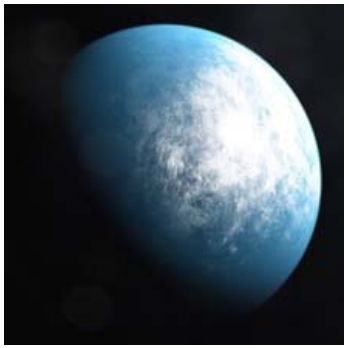
- SMD recognizes the importance of balancing one's work with the requirements of one's family, friends and personal physical and mental health
- We have created a web page to inform SMD-funded researchers about NASA-provided wellness resources and leave options that may be available

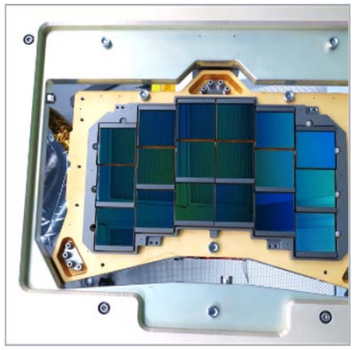
  https://science.nasa.gov/researchers/work-life-balance
- The web page discusses resources and flexibilities for
  - Recipients of NASA grants and cooperative agreements
  - NASA Civil Servant Scientists
  - NASA on-site contractors
  - NASA Postdoctoral Program Fellows
- The resources that one may access depend on one's relationship with NASA (above) and one's institution's policies
- One's first step, regardless of your relationship to NASA, should be to contact your institution's Office of Sponsored Programs, Human Resources or Human Capital Office to determine your employer's policies
  - NPP Fellows should contact their NPP Center Representative
- Please help us improve this webpage by sending suggestions, questions and feedback to sara@nasa.gov

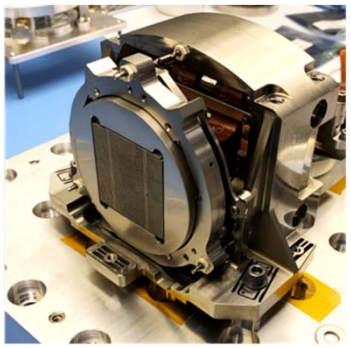
Recent R&A Initiatives

- Pioneers: Established new program for <$20M SmallSats, balloons, ISS payloads
- Exoplanet Research Program (XRP) Consolidation: All exoplanet investigations under XRP, ramping up funding
- Laboratory Astrophysics: Capital equipment purchases eligible for APRA starting in ROSES-20
- FINESST: Doubled funding and selection rate for graduate student program
- Diversity of Proposing Teams: Pilot program for this year's Astrophysics Theory Program (ATP) to require an inclusion plan
- Citizen Science: SMD solicitation for Citizen Science seed funding
- Data Management Plan: Now part of the intrinsic merit evaluation of proposals
- High Risk / High Impact: Assessed for all proposals and forwarded to SMD blue ribbon panel
- Code of Conduct for Peer Reviews: Astrophysics code is now adopted for all SMD reviews
- Inclusion, Diversity, Equity, and Accessibility: Established IDEA taskforce for Astrophysics R&A, implementing recommendations of SMD's Anti-Racism Action Group









Planned Milestones FY21-22

- Complete integration and launch Webb in 2021
- Complete integration and test for IXPE and launch by early 2022
- Achieve Roman Space Telescope critical design review in 2021
- Maintain decadal cadence of four AOs per decade for Astrophysics Explorers and Missions of Opportunity with a SMEX downselect and a MIDEX AO in 2021
- Receive Astrophysics Decadal Survey in 2021
- Achieve SPHEREx critical design review in 2022
- Conduct Senior Review of Operating Missions in 2022
- Generate world-class science from operating missions including Hubble Space Telescope and Chandra X-ray Observatory
- Maintain healthy research program including suborbital-class missions, technology development, data analysis, theoretical and computational investigations, and laboratory astrophysics
- Plan formulation or solicitation for a Probe mission
- Support mission concept studies and technology investments to implement Astrophysics Decadal Survey priorities starting in 2022

COVID-19 Impacts – Missions

Many missions are expected to stay within their cost commitments (known as the ABC or Agency Baseline Commitment, which includes HQ held reserves above project budget)

- ABC is set at Confirmation Review

Some missions have experienced challenges that affect cost and schedule commitments

- In astrophysics, this includes Webb, Roman, and IXPE
- Missions that have been Confirmed since COVID began (e.g., SPHEREx), or will be Confirmed in the future (e.g., future Explorers) have assumed impacts from COVID included within their cost and schedule commitments

To date, challenges to Flagships (Webb, Roman) have been accommodated with no impact to Explorers or R&A

- Challenges to Explorers are accommodated within the Explorers Program

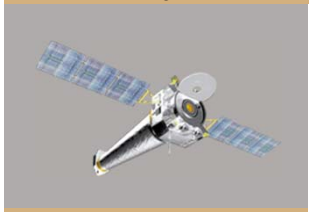
Mission impacts to commitments due to COVID (only missions with commitments)			
Webb	Exceeds schedule	XRISM	Does not exceed
IXPE	Exceeds cost and schedule*	SPHEREx	Included in commitment
GUSTO	Does not exceed	Roman	Exceeds cost and schedule*
Euclid	Does not exceed	* Replan has been completed and approved	

Astrophysics Missions in Operations

Hubble 4/90
NASA Strategic Mission

Hubble Space Telescope

Chandra 7/99
NASA Strategic Mission



Chandra X-ray Observatory

XMM-Newton 12/99
ESA-led Mission

X-ray Multi Mirror - Newton

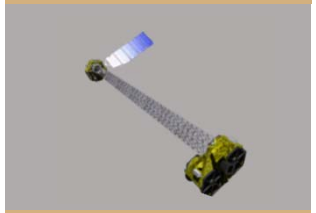
Gehrels Swift 11/04
NASA MIDEX Mission

Neil Gehrels Swift Gamma-ray Burst Explorer

Fermi 6/08
NASA Strategic Mission

Fermi Gamma-ray Space Telescope

NuSTAR 6/12
NASA SMEX Mission

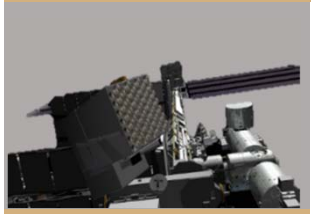


Nuclear Spectroscopic Telescope Array

SOFIA 5/14
NASA Strategic Mission

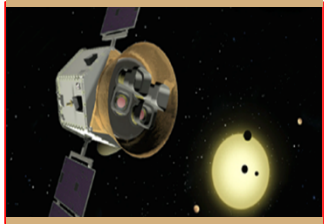
Stratospheric Observatory for Infrared Astronomy

ISS-NICER 6/17
NASA Explorers Miss. of Oppty



Neutron Star Interior Composition Explorer

TESS 4/18
NASA MIDEX Mission



Transiting Exoplanet Survey Satellite

Balloon Program
Four Campaigns per Year

Managed by the Astrophysics Division

Sounding Rockets
Worldwide Campaigns

Managed by the Heliophysics Division

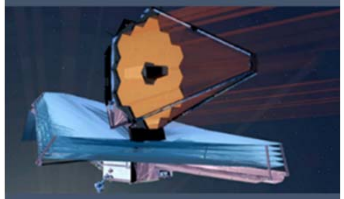
Data Archives
HEASARC, IPAC, MAST, etc.

Managed by the Astrophysics Division

Next Senior Review is in 2022

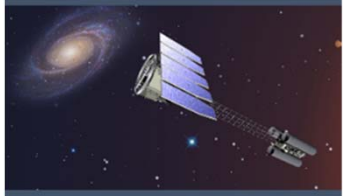
Astrophysics Missions in Development

Webb — 2021
NASA Mission



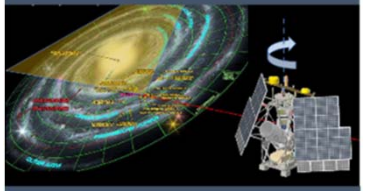
James Webb
Space Telescope

IXPE — 2021
NASA Mission



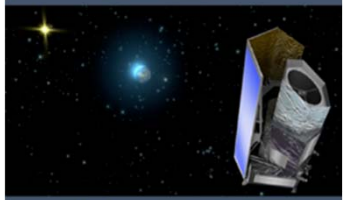
Imaging X-ray
Polarimetry Explorer

GUSTO — 2022
NASA Mission



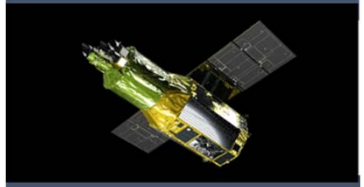
Galactic/ Extragalactic ULDB
Spectroscopic Terahertz Observatory

Euclid — 2022
ESA-led Mission



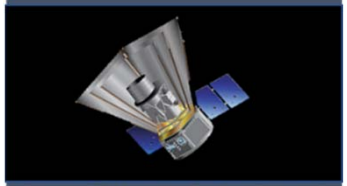
NASA is supplying the NISP
Sensor Chip System (SCS)

XRISM — 2023
JAXA-led Mission



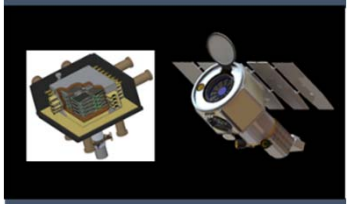
NASA is supplying the SXS
Detectors, ADRs, and SXTs

SPHEREx — 2024
NASA Mission



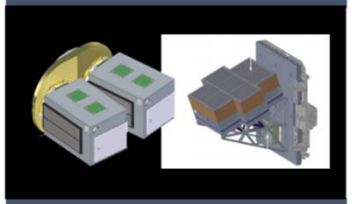
Spectro-Photometer for the History of
the Universe, Epoch of Reionization,
and Ices Explorer

SMEX — ~2025
NASA Mission



COSI or ESCAPE

Mission of Opportunity — ~2025
NASA Mission



Dorado or LEAP

Roman — 2026
NASA Mission

Nancy Grace Roman
Space Telescope

ARIEL — 2029
ESA-led Mission

NASA is supplying the CASE
fine guidance instrument

Launch dates are current project working dates; Agency Baseline Commitment launch date could be later; all impacts of COVID-19 not yet known

Astrophysics and the Moon

NASA Astrophysics has no strategic missions or strategic activities planned for the lunar surface, Gateway, or cis-lunar space

The Astrophysics Decadal Survey was charged to "Consider ongoing and planned activities and capabilities in other organizational units of NASA, including … planned research platforms in Earth orbit and cis-lunar space."

- NASA has sponsored a concept study of a radio observatory on the radio-quiet far side of the Moon, plus other related radio astronomy concepts

All science opportunities for lunar surface, Gateway, and cis-lunar space are open for proposed, competitive, PI-led, peer reviewed astrophysics activities

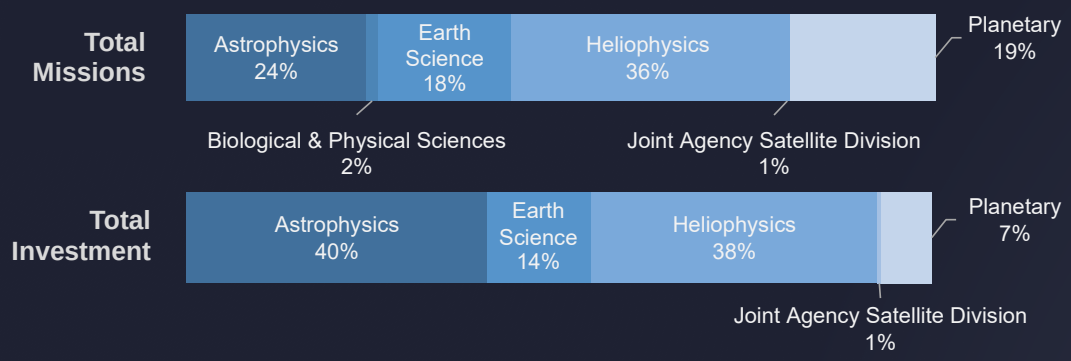
- This includes Payloads and Research Investigations on the Surface of the Moon (PRISM) (open to astrophysics on the lunar surface), Explorers including Missions of Opportunity (open to missions in cis-lunar space), and Pioneers (open to lunar surface and cis-lunar space missions)
- To date, three lunar landed experiments with relevance to astrophysics have been selected: a next generation laser retroreflector for general relativity tests and two technology demonstrations for measuring cosmic radio waves

Upcoming opportunities for discussing and proposing astrophysics on the Moon

- Lunar Surface Science Workshop: Lunar Science with a Robotic Arm (Sep 30)
- PRISM Step 1 deadline (Oct 22)
- Lunar Surface Science Workshop: Landing Sites and CLPS Capabilities (Nov 18)
- PRISM Step 2 deadline (Dec 20)

NASA's Small Satellite Missions at a Glance

SmallSat/CubeSat Missions & Investment by SMD Division

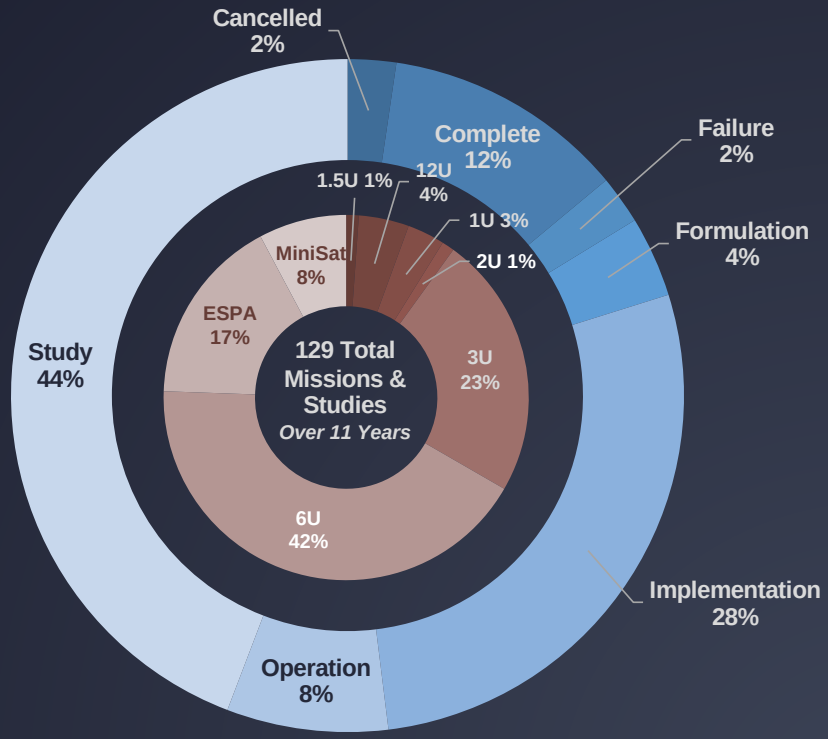


Mission Launch Timelines

$2.27 B
Total Investment over 11 Years

41 SMD SmallSat Missions
(64 Spacecraft)
in Implementation
2021 and beyond

Mission Phase and Satellite Size



Astrophysics Mission Classes

Updated January 29, 2021

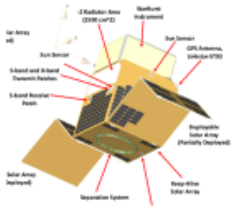
*PI Cost Cap **Includes ISS-attached Experiments

Astrophysics Pioneers

- A new class of small missions offered for first time in ROSES-2020. Include SmallSats, CubeSats >6U, major balloon payloads, modest ISS attached payloads, and lunar surface CLPS payloads. $20M maximum PI cost cap.
- Fills in the gap between existing ROSES investigations (<$10M for APRA) and existing Explorers MO investigations (~$35M for SmallSats).
- Solicited through ROSES; relieves burden of writing full Explorers MO proposal (ROSES 2021 Amendment D.15).

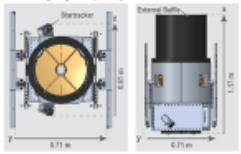
PUEO: A Long-duration Balloon-borne Instrument for Particle Astrophysics at the Highest Energies, PI Abigail Vieregg, U Ch

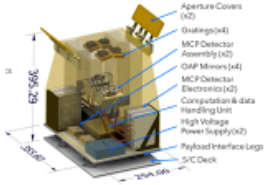
Figure 10: A rendering of the PUEO payload, including a design for the low-frequency drop-down instrument.



StarBurst: Gamma-ray ASM, Simultaneous detection of NS/NS mergers with LIGO, PI Daniel Kocevsk,i MSFC

Pandora: Multiwavelength Characterization of Exoplanets and their Host Stars, PI Elisa Quintana, GSFC



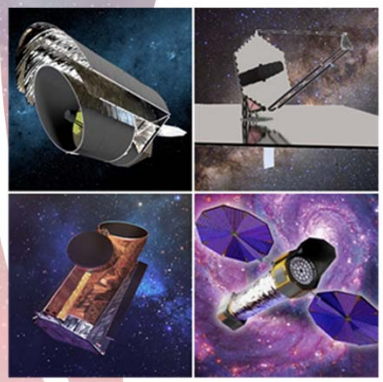


Aspera: IGM Inflow/outflow from galaxies via OVI 10^5K emission line imaging. PI Carlos Vargas, U of A

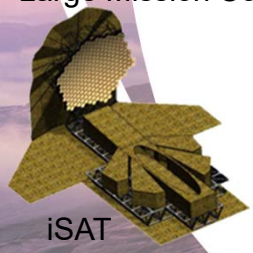
- First four selections in January 2020.
- Teams working on Concept Study Report; first gate decision to proceed will be in January 2022.
- ROSES-2021 due date NET March 2022

Preparing for the Decadal Survey: Technology Development and Risk Reduction Activities

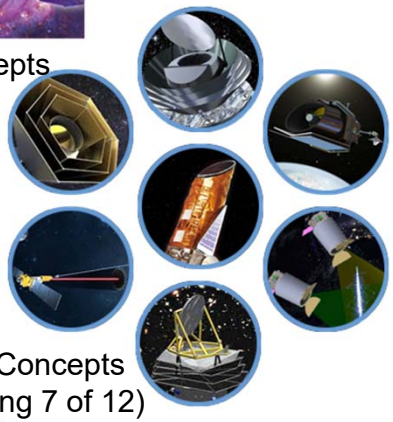
Completed
Large Mission Concept Studies / Probe Mission Concept Studies / In-Space Assembly of Telescopes (iSAT) Study / Large Mission Management Study / STMD Technology Collaborations
Ongoing
Segmented Mirror Technology Program / Binary Star Coronagraph Technology / Deformable Mirrors / Starshade Technology / Extreme Precision Radial Velocity Research and Technology / Detectors (at all wavelengths) / X-ray Mirrors / Cryocoolers
Testbeds (Coronagraph, Ultrastable, X-ray & Cryogenic)
PI-led Strategic Astrophysics Technology (SAT) Advancements



Large Mission Concepts

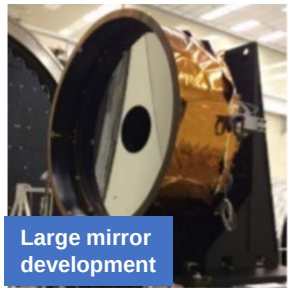


iSAT Concept

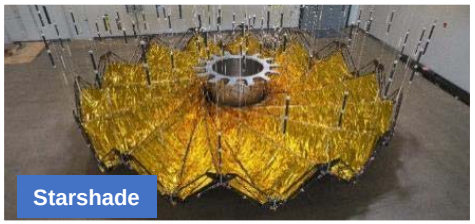


Probe Concepts (Showing 7 of 12)

Coronagraph Testbed

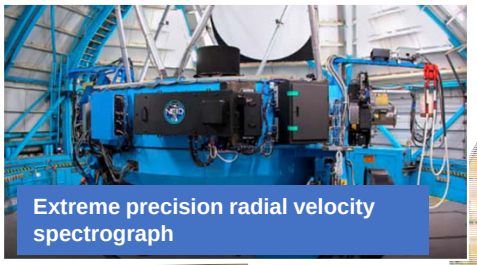


Large mirror development

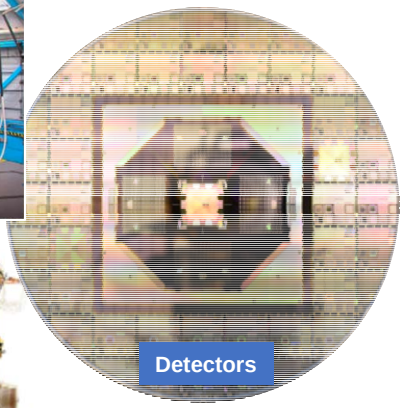


Starshade

X-ray mirror development



Extreme precision radial velocity spectrograph



Detectors

Deformable Mirror

Cryocooler

For more information on technology development activities, see the Astrophysics Technology Development Database (http://www.astrostrategictech.us/)

Hubble Anomaly Timeline

Initial Anomaly

Tiger Team Formation

Troubleshooting

Operations Acceptance Test

Most Probable Root Cause Identified

Return to Science

Root Cause Analysis

Side Switch Planning

Side Switch

6.13.2021 — **07.08.2021** — **07.14.2021** — **07.20.2021**

Anomaly Timeline Details

- **Initial anomaly**
- Handshake timeout - Instruments safed
- Memory dump successful

06.13.2021

- Two successful memory dumps
- **Command to Normal mode successful and operated for 35 minutes before reverting again to safed**

06.14.2021

- No commanding
- **Tiger team formed**
- CMOS 1 to 3 switch permission

06.15.2021

- Held briefings
- **Switched to CMOS 3 unsuccessful normal mode recovery**
- Memory dump failed

06.16.2021

- Tiger team meeting
- Status and Ops briefing
- **Switched to CMOS1**
- **Memory dump failed**

06.17.2021

06.18.2021

- Tiger team meeting
- **CPM/STINT switch check-out on VEST completed**

06.19.2021

- Ops briefing CMOS 1, CMOS 3, and CMOS 2 (different memory Bus)
- **Troubleshooting memory - modules without success**

06.21.2021

- Tiger Team meeting
- **Next step to switch to CPM/STINT-A**

06.24.2021

- Ops briefing
- **Troubleshooting CPM/STINT/PCU A and B chains without and with full tray power cycle without success**

06.25.2021

- Tiger Team meeting
- **Powered Off Regulator B**

"Hubble Returns to Full Science Observations and Releases New Images"