NASA Town Hall with bonus material
AAS 235th Meeting | January 5, 2020

Paul Hertz
Director, Astrophysics Division
Science Mission Directorate
@PHertzNASA

Posted at http://science.nasa.gov/astrophysics/documents
Why Astrophysics?

How did our universe begin and evolve?

How did galaxies, stars, and planets come to be?

Are we alone?

Astrophysics is humankind's scientific endeavor to understand the universe and our place in it.
Outline

- Celebrate Accomplishments
  - Mission Milestones
- Committed to Improving
  - Building an Excellent Workforce
  - Research and Analysis Initiatives
- Program Update
  - Research & Analysis, Technology, Fellowships
  - ROSES-2020 Preview
- Missions Update
  - Operating Missions and Senior Review
  - Webb, WFIRST
  - Other missions
- Planning for the Future
  - FY20 Budget
  - Project Artemis
  - Supporting Astro2020
  - Creating the Future
NASA Astrophysics
Celebrate Accomplishments
https://www.nasa.gov/2019
NASA Astrophysics Top Science Headlines
from the past four years (as selected by the NASA HQ staff)

Kepler is first to detect the shock breakout from a supernova
2016 Mar 21

Spitzer detects seven Earth-sized planets orbiting TRAPPIST-1
2017 Feb 22

Fermi detects the gravitational wave source, kilonova GW70817
2017 Oct 6

Kepler discovers that exoplanets are ubiquitous
2018 Oct 30

Chandra finds the missing mass in the warm interstellar medium
2019 Feb 14

Hubble measurement of H0 disagrees with CMB measurement
2019 Jul 16

Hubble detects water in the atmosphere of a HZ exoplanet
2019 Sep 13

Does not include announcements from this meeting
Hubble Space Telescope

30 YEARS OF EXPLORATION

https://www.nasa.gov/content/hubbles-30th-anniversary
NASA'S CHANDRA X-RAY OBSERVATORY  
BY THE NUMBERS

23 trillion  
bytes of data collected

14 meters  
in length—about the size of a school bus

2,700  
trips around Earth

20 years  
(so far) in operation

4,300  
scientists around the world use Chandra

3.6 million  
lines of code written to operate, collect and analyze data

2.4 billion  
kilometers traveled

63.5 hours  
to take one trip around Earth

https://chandra.harvard.edu/20th/
After 16.5 yrs of science exploration on the infrared cosmic frontier as one of NASA’s Great Observatories, Spitzer will end its mission on Jan 30, 2020, 2:30 PST.

Engineering feats extended mission life post-cryo in 2009 and overcame challenges due to Spitzer’s increasing distance from Earth.

NASA TV Press conference: January 22, 2020

Spitzer enabled discovery near and far, to the edge of the universe, yielding 8,700+ refereed papers.

- First detection of light from an exoplanet
- First detection of molecules in exoplanet atmospheres
- Measurement of star formation history of the Universe to $z>2$, looking back $>10$ Gyr
- Measurement of the stellar mass of the Universe to $z>8$, looking back $\sim 13$ Gyr

www.spitzer.caltech.edu/final-voyage

Spitzer’s Scientific Legacy – Mon Jan 6 @ 10:00 AM in Room 320
TESS Completes First Year of Prime Mission, Begins Year 2

1414 planet candidates
  34 confirmed planets
  + many discoveries in astrophysics
36 peer-reviewed publications
  +51 more submitted

Successful Guest Investigators Program
Cycles 1 and 2 for Prime Mission

Extended mission approved!
Cycle 3 proposal deadline 1/16/2020

TESS observed southern hemisphere in Yr 1
Currently observing northern hemisphere for Yr 2
Current Sector: 18 of 26 in Prime Mission
Data from Sectors 1-16 all publicly available at MAST

TESS Town Hall – Mon Jan 6 @ 5:30 PM in Room 306AB
The Super Trans-Iron Galactic Element Recorder (SuperTIGER) instrument is used to study the origin of cosmic rays and was launched on Dec. 15, 2019. (Photo courtesy SuperTIGER team)

• **Upcoming balloon campaigns:** Winter 2019-2020 Antarctica, Spring 2020 New Zealand, Summer 2020 Palestine TX, Fall 2020 Fort Sumter NM, Winter 2020-2021 Antarctica

• **Upcoming sounding rocket campaigns:** 2020 White Sands Missile Range NM, 2021 Australia

[Video courtesy SuperTIGER team](https://www.csbf.nasa.gov/antarctica/ice.htm)
The Astrophysics Division is investing approximately $5M per year in a CubeSat initiative.

- **HaloSat**, PI: Phil Kaaret, U. Iowa
  - **Science Objectives:** HaloSat is mapping soft X-ray oxygen line emission across the sky in order to constrain the mass and spatial distribution of hot gas in the Milky Way.
  - **Technologies:** BCT S/C, COTS detectors, collimators with no optics.
  - **Deployed:** Jul 13, 2018, from ISS
Roman Technology Fellowship Program

• 19 current and recent fellows
• Typically in academia and National Laboratories
• Budget stable at about $1.3 M per year
• $300 K in startup funds for each fellow, over 3 years

2019 Roman Technology Fellows selected in November 2019 (ROSES-2018):

Regina M. Caputo
(Ph.D. 2011), NASA-GSFC, Gamma-ray and Cosmic-ray astrophysics

Sarah N. Heine
(Ph.D. 2014), MIT, Bragg Reflector Optics and Gratings for Polarimetry

Gregory N. Mace
(Ph.D. 2014), UT Austin, Advanced Optics and Spectroscopy Applications

RTF fellows at the RTF Special Session held at the AAS meeting in June 2018: From the left: Erika Hamden (Caltech/U. Arizona), Cullen Blake (U. Pennsylvania), Brian Fleming (U. Colorado), and Abigail Vieregg (U. Chicago)
Astrophysics Community Funding
FY05-FY18 Actual, FY19 Op Plan, FY20-FY24 Request

- R&A Programs
- SAT (technology)
- Postdoc Fellows

$Millions per year
FY05 FY07 FY09 FY11 FY13 FY15 FY17 FY19 FY21 FY23
Astrophysics Strategic Planning

To be updated in 2020 (per GPRAMA)

Astro2020 Decadal Survey underway

2018 update includes:
- Independent reviews of Webb & WFIRST
- Planning for 2020 Decadal Survey

https://science.nasa.gov/astrophysics/documents
NASA Events at the 235th AAS Meeting

Friday, January 3
NASA ExoPAG – 8:30 AM; Hilton Hawaiian Village - Coral Ballroom

Saturday, January 4
NASA ExoPAG – 8:30 AM; Hilton Hawaiian Village - Coral Ballroom
NASA Joint PAG – 1:00 PM; Hilton Hawaiian Village - Coral Ballroom
NASA PhysPAG – 3:00 PM; Hilton Hawaiian Village – Rainbow Room
NASA COPAG – 3:00 PM; Hilton Hawaiian Village - Coral Ballroom

Sunday, January 5
Webb Proposing: Integral Field Unit – 9:30 AM; Room 307B
NASA Great Observatories SAG – 9:30 AM; Room 323A
NASA Town Hall – 12:45 PM; Ballroom AB
Lynx X-ray Observatory – 1:00 PM; Room 303A
Parker Solar Probe – 2:00 PM; Room 313 C
So You Think You Want to be a NASA Mission Principal Investigator? – 2:00 PM; Room 323A
James Webb Space Telescope Town Hall – 6:30 PM; Room 313A

Monday, January 6
NASA Postdoctoral Program Meet and Greet – 7:00 PM; Sheraton Waikiki - Kohala/Kona Room

Tuesday, January 7
NASA PhysPAG Gravitational Wave SIG – 9:30 AM; Room 303A
NASA COPAG IR SIG/OST – 9:30 AM; Room 304AB
Webb Proposing: NIRSpec Micro-Shutter – 9:30 AM; Room 323A
NASA Univ of Learning & Education Efforts – 10:00 AM; Room 321A
NASA PhysPAG MMA SAG – 1:00 PM; Room 303A
NASA Science Engagement Opportunities – 1:00 PM; Room 303B
Habitable Exoplanet Observatory – 1:30 PM; Room 306AB
LISA Preparatory Science – 2:00PM; Room 323B
NASA Cosmic Dawn SAG – 2:00 PM; Room 323C
SOFIA Molecular Clouds and ISM Science – 2:00 PM; Room 324
Visualization of Research Data for the Public Presented by NASA's Universe of Learning – 5:30 PM: Room 307B
SOFIA Town Hall – 7:00 PM; Room 313B

Wednesday, January 8
NASA PhysPAG X-ray SIG – 9:00 AM; Room 303A
Plenary Lecture: The Future of Infrared Astronomy in the Context of Spitzer, SOFIA, and JWST – 11:40 AM;
Multi-Messenger Astrophysics Town Hall – 12:45 PM; Room 313 A
NASA PhysPAG Gamma Ray SIG – 1:00 PM; Room 303A
The NASA Decadal Studies – 2:00 PM; Room 318A
NASA Astrophysics
Committed to Improving
OPEN COMPETITION

COMMUNITY GUIDANCE

EFFECTIVE PARTNERSHIPS

BALANCED PORTFOLIO

OPEN ACCESS

COMMUNITY INVESTMENT

LESSONS LEARNED

PUBLIC COMMUNICATION

PRINCIPLES OF NASA SCIENCE
PI RESOURCES WEBPAGE [1]

ASSURE DIVERSITY OF MISSION PEER REVIEW PANELS

CODE OF CONDUCT FOR SMD-SPONSORED CONFERENCES

DUAL-ANONYMOUS PEER REVIEW

CODE OF CONDUCT & IMPLICIT BIAS TRAINING FOR ROSES PANELS

MISSION PI WORKSHOPS [2]

WEBINAR BY THOMAS ZURBUCHEN ON WRITING SUCCESSFUL MISSION PROPOSALS

NEW AWARD TERMS AND CONDITIONS FOR GRANTS

PROPOSAL WRITING WORKSHOPS AT CONFERENCES

ASTRO2020 STATE OF THE PROFESSION

Building An Excellent Workforce

NASA achieves excellence by relying on diverse teams, both within and external to NASA, to most effectively perform NASA’s work

NASA Science Mission Directorate
• Developed a PI resources webpage at https://science.nasa.gov/researchers/new-pi-resources
• Introduced pre-reviews of mission peer review panels to ensure diversity
• Added a code of conduct requirement for SMD-funded conferences to ROSES 2019
• Included career development positions and associated evaluation criteria as part of AOs
• Implemented a Code of Conduct and implicit bias training for all ROSES peer reviews
• Adopting dual anonymous reviews for all GO programs, and piloting them for other R&A programs, following successful demonstration by STScI for Hubble GO program
• Presented a national symposium by SMD AA Thomas Zurbuchen on lessons learned regarding mission proposal success
• Conducting workshops for potential mission PIs, see https://science.nasa.gov/researchers/pi-launchpad
• Is developing award terms and conditions mandating reporting harassment, similar to NSF’s
• Is presenting information sessions at major conferences, including the Honolulu AAS Meeting, to support people developing their first proposal
• Tasked the Astro2020 Decadal Survey to “Assess the state of the profession. Identify areas of concern and importance [regarding] the future vitality and capability of the astronomy and astrophysics work force. Where possible, provide specific, actionable and practical recommendations to the agencies”

NASA is looking forward to specific, actionable, and practical recommendations
Inspiring Future Leaders

- Achieve excellence by relying on diverse teams, both within and external to NASA, to most effectively perform SMD’s work
- Attract and retain talent by promoting a culture that actively encourages diversity and inclusion and removes barriers to participation
- Encourage development of future leaders, including the next generation of mission principal investigators, through targeted outreach and hands-on opportunities
- Support early-career scientists to build careers working with NASA
- Engage the general public in NASA Science, including opportunities for citizen scientists

So You Think You Want to be a NASA Mission Principal Investigator? – Sun Jan 5 @ 2:00 PM; Room 323A
Mission Principal Investigator Development

Seek to increase the diversity of mission principal investigators and develop the next generation of mission leaders to ensure that new ideas and mission concepts are brought forward

• NASA Science has:
  • Developed a consolidated PI resources webpage at [https://science.nasa.gov/researchers/new-pi-resources](https://science.nasa.gov/researchers/new-pi-resources), which also includes SMD presentation on lessons learned from past selections
  • Introduced a pre-reviews of mission peer review panels to ensure diversity and reduce conflicts of interest
  • Included career development positions and associated evaluation criteria as part Discovery and New Frontiers AOs

• Upcoming activities include:
  • Making videos and slides from the November 2019 workshop available
  • Looking to host two Launchpad Workshops per year

So You Think You Want to be a NASA Mission Principal Investigator? – Sun Jan 5 @ 2:00 PM; Room 323A
NASA Astrophysics Diversity and Inclusion

The NASA Astrophysics Division is actively taking steps to advance diversity, inclusion, and equal opportunity in the NASA workforce and among NASA grantee institutions.

NASA Astrophysics is committed to:

- Setting the expectancy of diversity and inclusion in the composition of: proposal teams, peer review panels, science and technology definition teams, and mission and instrument teams.
- Recruiting diversity on NASA-selected groups (e.g., advisory groups, peer review panels, science teams).
- Recruiting a diverse Astrophysics Division staff.
- Working with the NASA Office of the Chief Scientist and our peer review contractors to address unconscious bias in peer reviews.
- Establishing a Code of Conduct for peer review panel chairs and members
- Sharing best practices in peer reviews with other agencies.
- Observing the demographics of R&A proposers and awardees as an indicator of issues.

The demographics of R&A proposers and awardees – we notice that:

- The inferred gender balance of awardees does reflect that of proposers.
- The inferred gender balance of proposers does not always reflect that of the community.
Science Engagement

**Vision:** As a part of SMD’s Science Activation (SciAct) program, Astrophysics brings the excitement of the science from its portfolio to provide content to help learners of all ages “do” science.

**New NASA Science Engagement Opportunities** – Tue Jan 7 @ 1:00 PM; Room 303B

- Hear from National Academy committee members who assessed NASA’s SciAct program and from NASA SMD, including Kristen Erickson, Paul Hertz, and Hashima Hasan
- Find out about NASA’s Universe of Learning and how you can participate in SciAct as a subject matter expert; come to splinter session or contact Denise Smith (STScI)
- Learn about opportunities to propose citizen science projects to NASA; come to splinter session or contact Marc Kuchner (GSFC)

Astrophysics social media sites have been consolidated under @NASAUniverse; cross cutting NASA science is consolidated under @NASAExoplanets, @NASASolarSystem, @NASASun, etc.
Research and Analysis Initiatives

Dual Anonymous Peer Review
- SMD is strongly committed to ensuring that review of proposals is performed in an equitable and fair manner that reduces the impacts of any unconscious biases

High-Risk/ High-Impact (HR/HI)
- To reinforce SMD’s interest in High-Risk/High-Impact research, a special review process will be implemented in ROSES 2020 to review and select HR/HI proposals

Proposal Selection Metrics for ROSES 2018
- Overall, just under 50% of selections featured new PIs
- Majority of division selection rates were between 25 – 30%, and we are continuing to evaluate

https://science.nasa.gov/researchers/dual-anonymous-peer-review
Success Rate by (Inferred) Gender in Astrophysics Proposal Competitions (Past 5 Cycles)
NASA is strongly committed to ensuring that the review of proposals is performed in an equitable and fair manner that reduces or eliminates unconscious bias.

To this end, motivated by a successful pilot program conducted for the Hubble Space Telescope, all Astrophysics General Observer / General Investigator (GO/GI) proposals will be evaluated using dual-anonymous peer review.

In addition, the NASA Science Mission Directorate will conduct pilot programs in dual-anonymous peer review for non-GO/GI ROSES program elements in 2020.

• One ROSES program element from each Division will be conducted in 2020 using dual-anonymous peer review.
• Proposals submitted to the Astrophysics Data Analysis Program and the Habitable Worlds Program in 2020 will be evaluated using dual-anonymous peer review.

The Astrophysics Division is taking the following steps to ensure a smooth transition to dual-anonymous peer review:

• Create written guidance on how to write an anonymized proposal.
• Host a virtual Town Hall in Spring 2020 to discuss dual-anonymous peer review with the community.
• Run training sessions for panel levelers who provide guidance during dual-anonymous panel deliberations.
• Ensure that mission program staff are available to answer help desk questions about writing anonymized proposals during the run-up to proposal submission.

https://science.nasa.gov/researchers/dual-anonymous-peer-review
Rollout of Dual-Anonymous Reviews

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Request for Information:
Research That Falls in Gap between current SMD Solicitations

• Release Date: Dec 2, 2019
  (Solicitation: NNH20ZDA003L)
• Response Date: Jan 31, 2020
• NASA SMD is soliciting information on research aligned with agency mission and SMD’s Science Plan but falls in a gap between current solicitations, possibly because it’s interdisciplinary or interdivisional.
• Responses will be used by NASA to inform decision as to whether portfolio of current program elements in ROSES needs to be modified and/or expanded to provide the proper avenue for such research.
• Full text of RFI and response instructions on the NSPIRES website.
Strategic Data Management

- SMD will be implementing changes to enable open data, open source code, and open model
- Informed by community input through multiple workshops, RFI, and NASEM reports
- Recognize that this will be a step wise process with the first changes coming in ROSES 2020 and upcoming Senior Reviews
- Periodic evaluation to ensure effectiveness and consistency with current best practices
- Additional information on SMD's data activities is available at: https://science.nasa.gov/researchers/science-data
Keep Informed about NASA

NSPIRES mailing list – information about NASA solicitations
  https://nspires.nasaprs.com/

Cosmic Origins mailing list, Exoplanet Exploration mailing list, Physics of the Cosmos mailing list – information about NASA missions and science
  https://exoplanets.nasa.gov/exep/exopag/announcementList/
  https://pcos.gsfc.nasa.gov/pcosnews-mailing-list.php

NASA Astrophysics Federal Advisory Committees
  Astrophysics Advisory Committee (APAC)
  https://science.nasa.gov/researchers/nac/science-advisory-committees/apac
  NAS Committee on Astronomy and Astrophysics (CAA)
  http://sites.nationalacademies.org/bpa/bpa_048755
  Astronomy and Astrophysics Advisory Committee (AAAC)
  https://www.nsf.gov/mps/ast/aaac.jsp

Sign up to be a panel reviewer:
  https://science.nasa.gov/researchers/volunteer-review-panels
Why Volunteer to Serve on a NASA Peer Review Panel?

• Personal professional development:
  – See how the whole review process works
  – Learn what constitutes excellent proposals
  – Network with your professional colleagues and NASA scientific staff

• Institutional achievement:
  – Improve at competing for NASA money
  – Increase knowledge of NASA's educational programs and research technology

• Investment in the future:
  – Help select the most transformative science
  – Ensure that all proposals receive a fair and competent review

• Sign up to be a panel reviewer:

  https://science.nasa.gov/researchers/volunteer-review-panels
Join the Astrophysics Team at NASA Headquarters

NASA seeks visiting Ph.D.-level scientists to serve as Program Scientists in the Astrophysics Division at NASA Headquarters in Washington, DC. With a budget of $1.5 billion annually, the Division is responsible for the nation’s space-based astrophysics program.

NASA Program Scientists
• Manage scientific research grants programs
• Serve as the Headquarters science lead for missions
• Implement NASA’s response to the 2020 Decadal Survey
• Gain insight into Federal astrophysics policy and programs and the proposal review process
• Run scientific programs with multimillion-dollar budgets

Visiting appointments last two years with renewals up to six years.

Positions are available from June 2020, though the start date is flexible. Applicants should email a curriculum vitae and cover letter as a single PDF file ASAP but no later than March 13, 2020 to hq-astrophysics-ipasearch@mail.nasa.gov. Decisions will be made on a rolling basis. For more information about the position, please contact Dr. Valerie Connaughton at valerie.connaughton@nasa.gov.

Please feel free to speak to any of us from HQ here about this exciting opportunity.

https://jobregister.aas.org/ad/330213f5
NASA Astrophysics Program Update
NASA Astrophysics Program Summary

Supporting Research & Technology
- R&A: ADAP, ATP, XRP, SmallSat Studies, Suborbital & CubeSat Projects
- Technology: APRA, SAT, RTF, Future flagship technologies
- Research support: Balloon project, Astrophysics archives

Operating Missions
- Explorers: Gehrels Swift, NuSTAR, NICER, TESS
- International Partnerships: XMM-Newton
- Strategic Missions: Hubble, Chandra, Spitzer, Fermi, Kepler, SOFIA

Missions in Development or Under Study
- Explorers: IXPE, GUSTO, SPHEREx
- International Partnerships: Euclid, XRISM, Athena, LISA
- Strategic Missions: Webb, WFIRST
NASA’s Astrophysics Program

Large (Flagship) Missions
- Conduct compelling science that only the U.S. has the capability to lead

Medium (Probe) and Small (Explorer) Missions
- Enable more focused or specialized capabilities and science objectives

International Partnerships
- Use scientific synergies between NASA and its international partners for a win-win outcome

Supporting Research and Technology
- Lay the foundation of the NASA science program
- Invest in the US scientific community and National capabilities
- Maximize scientific output of missions
- Develop innovative ideas and next generation technology for future missions
- Develop the next generation of scientists, engineers, and innovators
$1.496 BILLION FY19

**Quick Summary**
- Community support: 20%
- Operating missions: 20%
- Building missions: 55%
- Management: 5%

**Management**
- Incl. STEM Activation: 5%

**Research**
- (ADAP, APRA, ATP, etc.): 7%

**Technology**
- (SR&T, Athena, Lisa, etc.): 7%

**Infrastructure**
- (Balloon Program, Archives, etc.): 4%

**Op. Missions**
- (Incl. GO Programs): 19%

**Explorers**
- (Current and future, incl. GO): 11%

**Development**
- (Webb, WFIRST): 46%
Supporting Research and Technology

Data analysis

Suborbital investigations

Theoretical and laboratory studies
Science by the NUMBERS

RESEARCH
~10,000 U.S. Scientists Funded
~3,000 Competitively Selected Awards
~$600M Awarded Annually

TECHNOLOGY DEVELOPMENT
~$500M Invested Annually

SMALLSATS/ CUBESATS
36 Science Missions
20 Technology Demos

EARTH-BASED INVESTIGATIONS
20 Airborne Missions
8 Global Networks

SOUNDING ROCKETS
16 Science Missions
5 Tech/Student Missions

SPACECRAFT
98 Missions
82 Spacecraft

BALLOONS
10 Science Missions
4 Technology/Student
Astrophysics Research by the NUMBERS

R&A PROGRAMS
>1,000 Proposals Received
26% Success Rate
~$100M Awarded Annually

TECHNOLOGY DEVELOPMENT
~$140M Invested Annually

NEW PIs
>180 Per Year in R&A Prog
>120 Per Year in GO Prog

GO PROGRAMS
>2,000 Proposals Received
19% Success Rate
~$70M Awarded Annually

CUBESATS
6 Current Programs
~1 Launch Per Year

SOUNDING ROCKETS
9 Current Programs
3-4 Launches Per Year

BALLOONS
18 Current Programs
3-6 Launches Per Year
## Supporting Research and Technology
- Astrophysics Research & Analysis (APRA)
- Strategic Astrophysics Technology (SAT)
- Astrophysics Theory Program (ATP) (biennial, not this year)
- Theoretical and Computational Astrophysics Networks (TCAN) (triennial, this year)
- Exoplanet Research Program (XRP) (cross-div)
- Roman Technology Fellowships (RTF)
- FINESST Graduate Student Research Awards

## Data Analysis
- Astrophysics Data Analysis (ADAP)
- GO/GI programs in ROSES for:
  - Fermi
  - NICER
  - NuSTAR
  - Swift
  - TESS

## Mission Science and Instrumentation
- Sounding rocket, balloon, CubeSat, and ISS payloads solicited through APRA
- Astrophysics Science SmallSat Studies (occasional, not this year)
- XRISM Guest Scientists (one time)
- Astrophysics Explorers U.S. Participating Investigators (triennial, this year)

## Separately Solicited
- GO/GI/Archive/Theory programs for:
  - Chandra
  - Hubble
  - SOFIA
  - Webb
- NASA Hubble Fellowship Program
- NASA Postdoctoral Program
FY19 R&A Elements
(excludes GO Programs and SAT)
### Growth in R&A Funding ($M)

#### CubeSat Initiative

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- **FY19 Appropriation**: 26% increase in R&A support since Decadal Survey (FY10 – FY18)
- **FY19 Appropriation**: +17%
- **FY20-FY24 Notional Planning**: Projected 33% increase in R&A support over 6 years (FY19 – FY24)
- **CubeSat Initiative**: FY19 Appropriation

Growth in R&A Funding ($M)
Total Number of Proposals and Average Success Rate

Total R&A funding in FY19 was $108M
Number of Proposals

GO/GI Programs:
- Hubble GO – Cycle 27: 1019 proposals
- Chandra GO – Cycle 21
- NuSTAR GO – Cycle 5
- Swift GI – Cycle 15
- TESS GI – Cycle 2
- Fermi GI – Cycle 12
- NICER GO – Cycle 1
- ADAP (Data Analysis)
- ATP (Theory)
- FINESST (Grad Student Research)
- APRA (Basic Research)
- XRP (Exoplanets Research)
- SmallSat Studies (AS3)
- LISA Preparatory Science
- SAT (Technology)
- Roman Technology Fellowships
- SOFIA Next Gen Instruments
- Segmented Telescope Design

R&A Programs:
- 1085 proposals
Selection Rates

GO/GI Programs:
- Hubble GO – Cycle 27: 18%
- Chandra GO – Cycle 21: 16%
- NuSTAR GO – Cycle 5: 23%
- Swift GI – Cycle 15: 11%
- TESS GI – Cycle 2: 13%
- Fermi GI – Cycle 12: 21%
- NICER GO – Cycle 1: 27%
- ADAP (Data Analysis): 27%
- ATP (Theory): 30%

R&A Programs:
- FINESST (Grad Student Research): 0%
- APRA (Basic Research): 11%
- XRP (Exoplanets Research): 13%
- SmallSat Studies (AS3): 24%
- LISA Preparatory Science: 30%
- SAT (Technology): 33%
- Roman Technology Fellowships: 32%
- SOFIA Next Gen Instruments: 40%
- Segmented Telescope Design: 67%

GO/GI Programs: 26%
R&A Programs: 19%
### New PIs (not funded by same Program within 5 Years)

<table>
<thead>
<tr>
<th>Program</th>
<th>GO/GI Programs: 32% new PIs</th>
<th>R&amp;A Programs: 70% new PIs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hubble GO – Cycle 27</td>
<td>30%</td>
<td>71%</td>
</tr>
<tr>
<td>Chandra GO – Cycle 21</td>
<td>17%</td>
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<td>NuSTAR GO – Cycle 5</td>
<td>12%</td>
<td>46%</td>
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<td>Swift GI – Cycle 15</td>
<td>78%</td>
<td>88%</td>
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<tr>
<td>TESS GI – Cycle 2</td>
<td>14%</td>
<td>58%</td>
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<tr>
<td>Fermi GI – Cycle 12</td>
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<tr>
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</table>
Exoplanet Research Program (XRP)

Changes to the program in ROSES-19:

• Heliophysics and Earth Science joined the program
• Review managed collaboratively by all four divisions
• Selections are funding-blind (i.e. not tied to specific Divisions)
• 20 percent more proposals than last year!

Changes coming in ROSES-20:

• Consolidation of exoplanet proposals into XRP
  o Within Astrophysics (Appendix D): Exoplanet-related proposals from ADAP, ATP, etc. will move into XRP
    o Funding will move between programs to enable this
    o Exoplanet-related proposals will still be permitted in TCAN
  o Within Planetary Science (Appendix C): Exoplanet proposals in Habitable Worlds will move into XRP (better definition of the line between the two)
• Additional cross-divisional collaboration encouraged (Heliophysics and Earth Science participation, in particular)
Transition of NASA Astrobiology Institute (NAI) into Research Coordination Networks (RCNs)

The NAI concluded at the end of 2019; five RCNs will focus on different interdisciplinary science questions

Researchers may elect to become a member of one or more RCNs once they have received funding for a relevant project

New ROSES funding opportunity: Interdisciplinary Consortia for Astrobiology Research (ICAR)

Proposals that describe a multi-million dollar, five-year project with an interdisciplinary approach to a single, compelling question in astrobiology

For projects larger than the scope of the individual research programs, but within the scope of the Research Coordination Networks.

Cycle 1 RCNs: NExSS, PCE3, ECM

Step 1 proposals due – January 31, 2020
Step 2 proposals due – April 3, 2020

Selected proposals will become part of the Research Coordination Network

Calls will occur every two years and will stagger RCN topics
Suborbital & CubeSat Funding

- Particle Astrophysics
- X-rays
- -rays
- Vis
- UV
- Sub-mm
- Far-IR
- CubeSats
- Headroom for future selections
NASA’s Astrophysics CubeSat Initiative

The Astrophysics Division is investing approximately $5M per year in a new CubeSat initiative.

HaloSat, our first CubeSat, is in orbit and is producing excellent data.
Five Astrophysics CubeSats in Development

- **CUTE**, PI: Kevin France, CU
- **Science Objectives:** The Colorado Ultraviolet Transit Experiment (CUTE) will take medium resolution UV spectra of 14 hot Jupiters during transit, in order to measure atmosphere being ablated away. **Technologies:** BCT S/C, COTS telescope and camera. **Launch:** Dec 20 on LandSat-9

- **SPARCS**, PI: Eygenya Shkolnik, ASU
- **Science Objectives:** Determine rate, strength and 2-band color of bright UV flares from 25 M dwarfs, effect on habitability? **Technologies:** BCT S/C, δ-doped CCD, UV dichroic. **Launch:** September 2021

- **SPRITE**, PI: Brian Fleming, CU
- **Science Objectives:** Determine ionization rate of IGM from galaxies and AGN, trace feedback within galaxies driven by star-forming regions, using low-resolution imaging UV spectrograph. **Technologies:** in house S/C, UV coatings, next-gen MCP. **Launch:** Fall 2022

- **BurstCube**, PI: Jeremy Perkins (GSFC)
- **Science Objectives:** Rapid localizations for LIGO/Virgo detections with short GRBs; Search of g-ray transients. **Technologies:** Dillingr derived bus, Fermi-GBM like detectors. **Launch:** Fall 2021

- **CUTE**, PI: Kevin France, CU
- **Science Objectives:** GRB/Transient detection in 0.2-20keV with coded mask. **Technologies:** CMOS x-ray CCD. **Launch:** FY2024

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- **Science Objectives:** Rapid localizations for LIGO/Virgo detections with short GRBs; Search of g-ray transients. **Technologies:** Dillingr derived bus, Fermi-GBM like detectors. **Launch:** Fall 2021

- **BlackCat**, PI: Abe Falcone, Penn St.
- **Science Objectives:** GRB/Transient detection in 0.2-20keV with coded mask. **Technologies:** CMOS x-ray CCD. **Launch:** FY2024
## Astrophysics Technology Program Elements

### Technology Inception & Experimentation
**APRA/RTF**
- 46 projects awarded in 2019
- Solicitations planned in FY20, delayed 9 months
- Average award: $600K (3-5 years)
- Average selection rate: 28%
- Portfolio:
  - Supporting 19 Balloons and 10 Sounding Rockets Payloads
  - Detectors across wavelengths
  - Mirrors, coatings and gratings
- Total: $50 M per year

### Technology Maturation
**SAT & ISFM**
- Unified solicitation and selection starting in FY19 for the three Astrophysics themes. Portfolio has 49 active projects for a total of $28 M per year.
  - 12 new projects awarded in FY19
  - Next solicitation planned in FY20, currently TBD
  - Average award: $1.6M (3 years)
  - Average selection rate: 30% (in FY19, historically is 29%)

### Directed Technologies
- WFIRST Coronagraph
- Exoplanets Probes: Exo-C & Exo-S
- LISA
- Athena
- Euclid
- NN-Explore – NEID
- SmallSats and CubeSats

- Total: $85 M in FY19

### Pre-Decadal Initiatives
- In-Space Assembled Telescope (iSAT)
- Coronagraph and UltraStable Testbeds
- Starshade Technology
- Four Large Mission Concepts – Technology Roadmaps
- Ten Probe Mission Concepts
- Segmented Mirror Telescope Program (STMP)

- Total: $25 M in FY19
Astrophysics Technology Program Elements

Technology Inception & Experimentation
APRA/RTF

- 46 projects awarded in 2019
- Solicitations planned in FY20, 9 months
- Average award: $600K (3-5 years)
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- Portfolio:
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- Total: $50 M per year

Astrophysics Technology Funding FY13-FY19

- WFIRST Coronagraph
- Exoplanets Probes: Exo-C & Exo-S
- LISA
- Athena
- Euclid
- NN-Explore – NEID
- SmallSats and CubeSats
- Total: $85 M in FY19

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Directed Technologies Pre-Decadal Initiatives

- Technology Inception & Experimentation
  - APRA/RTF
- Technology Maturation
  - SAT & ISFM

- In-Space Assembled Telescope (iSAT)
- Coronagraph and UltraStable Testbeds
- Large Mission Concepts – Technology Roadmaps
- Probe Mission Concepts
- Segmented Mirror Telescope Program (STMP)
- Total: $25 M in FY19
Integrated Strategic Technology Portfolio


Database of Astrophysics technology projects: [http://www.astrostrategictech.us/](http://www.astrostrategictech.us/)
Graduate Student Research Awards

NASA Earth and Space Science Fellowship (NESSF) program name is changing to Future Investigators in NASA Earth and Space Science and Technology (FINESST) in 2019 to more accurately capture the nature of awards.

Historically Astrophysics has funded 24 NESSF / FINESST fellows at any given time. With 150-200 proposals received annually, the selection rate has been ~6%.

Community input has led to us doubling the Astrophysics NESSF / FINESST program effective in 2019.

Astrophysics will now be funding 45-48 NESSF / FINESST Fellows at any given time. The selection rate will be ~10%.
NASA Hubble Fellowship Program

It has been thirty years since the first Hubble Fellows were selected.

Fellows are asking for the assurance of parental leave and the option of saving for their eventual retirement with the assistance of their employer.

- Fellows who are employees of their host institutions typically have these benefits.
- Stipendiary fellows to do not receive employee benefits even though the NHFP is willing to pay the full cost of the employee benefits package.

The Space Telescope Science Institute (STScI) and NASA are proposing a change to the requirements for NHFP host institutions.

Starting with academic year 2022-2023, in order to host new NASA Hubble Fellowship Program (NHFP) Fellows, host institutions must offer their NHFP Fellows the opportunity to be employees. Employee status is being required to afford NHFP Fellows the same leave, vacation, retirement and health benefits (as applicable) given by these institutions to their postdoctoral fellows hired on grants or contracts as employees. Host institutions are also encouraged, but not required, to offer Fellows the option of choosing to be a stipendiary fellow rather than an employee if that is a better match to the Fellow’s needs.

STScI is soliciting comments from host institutions. Direct any questions or comments on this policy to nhfp@stsci.edu by March 18, 2020.
## Astrophysics ROSES-20 Due Dates

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The XRISM Guest Scientists and U.S. Participating Investor programs are new this year.
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**XRP has been expanded to include all exoplanet research. Exoplanet research is no longer solicited in ATP and ADAP.**
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ATP is **not** being solicited this year.
TCAN is **being** solicited this year.
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APRA and RTF have new due dates in the Fall.
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ADAP and the GO/GI programs will be conducted using dual anonymous peer review.
NASA Astrophysics Missions Update
Astrophysics Operating Missions

- **Hubble** (4/90): NASA Strategic Mission
- **Chandra** (7/99): NASA Strategic Mission
- **XMM-Newton** (12/99): ESA-led Mission
- **Spitzer** (8/03): NASA Strategic Mission
- **Gehrels Swift** (11/04): NASA MIDEX Mission
- **Fermi** (6/08): NASA Strategic Mission
- **Kepler** (3/09): NASA Discovery Mission
- **NuSTAR** (6/12): NASA SMEX Mission
- **SOFIA** (5/14): NASA Strategic Mission
- **ISS-NICER** (6/17): NASA Explorers Miss. of Oppty
- **TESS** (4/18): NASA MIDEX Mission

- **Hubble Space Telescope**
- **Chandra X-ray Observatory**
- **X-ray Multi Mirror - Newton**
- **Spitzer Space Telescope**
- **Neil Gehrels Swift Gamma-ray Burst Explorer**
- **Fermi Gamma-ray Space Telescope**
- **Nuclear Spectroscopic Telescope Array**
- **Stratospheric Observatory for Infrared Astronomy**
- **Neutron Star Interior Composition Explorer**
- **Transiting Exoplanet Survey Satellite**

**Mission ending Jan 30, 2020**
All missions were extended for three years. The next Senior Review for Astrophysics Operating Missions will be in 2022.

- Hubble: No change to budget guideline
- Chandra: Selected overguides: Audit fees, labor & GO (inflation)
- TESS: Extended mission w/ full funding & continued GO program
- Swift: Selected overguides: New tools for Targets of Opportunity and Ultraviolet-Optical Telescope
- Fermi: Operations w/out Department of Energy
- NICER: Extended mission w/ reduced ops & new GO program
- NuSTAR: Phase out legacy science and replace with GO science
- XMM-Newton: No change

Not in 2019 Senior Review: Kepler, SOFIA, Spitzer
SOFIA
Stratospheric Observatory for Infrared Astronomy

• SOFIA’s 5-year prime mission ended at the end of FY19 (Sep 30, 2019)
• NASA conducted two reviews of the SOFIA project in 2019 aimed at increasing the science productivity of SOFIA in FY20 and beyond
  ○ Review of SOFIA’s maintenance and operations paradigm
  ○ Review of SOFIA’s science progress and science prospects
• Summary of reviews and NASA response posted at: https://science.nasa.gov/astrophysics/documents
• Based on the reviews, SOFIA project is making change to improve productivity:
  ○ 8 hour flights for Cycle 8 for the months when the observing conditions are poor (Spring, Fall).
  ○ A larger fraction of observing time doing legacy programs – 5 diverse “pilot legacy” programs selected. If successful, project may do more and larger legacy programs.
  ○ Maximizing and emphasizing collection of high-quality data.
    • Efforts include: maximizing time in the stratosphere, strict/robust technical evaluation, prioritizing collection of large, and homogeneous data sets, exploring different operational models for SOFIA to maximize observing during the time of the year when observing conditions are optimal.
  ○ Starting Cycle 8, SOFIA will adopt a policy for finishing priority 1 & 2 programs, once started.
• HIRMES, the next SOFIA science instrument, continues development
  ○ After a continuation review in Dec 2018, delivery anticipated Dec 2020.
Astrophysics Missions in Development

- **IXPE** (NASA Mission, 2021): Imaging X-ray Polarimetry Explorer
- **GUSTO** (NASA Mission, 2021): Galactic/Extragalactic ULDB Spectroscopic Terahertz Observatory
- **XRISM** (JAXA-led Mission, 2022): NASA is supplying the SXS Detectors, ADRs, and SXTs
- **SPHEREx** (NASA Mission, 2023): Spectro-Photometer for the History of the Universe, Epoch of Reionization, and Ices Explorer
- **WFIRST** (NASA Mission, Mid 2020s): Wide-Field Infrared Survey Telescope
- **Euclid** (ESA-led Mission, 2022): NASA is supplying the NISP Sensor Chip System (SCS)
- **ARIEL** (ESA-led Mission, 2028): NASA is supplying the CASE fine guidance instrument
Webb
The James Webb Space Telescope

An international mission to seek first light of stars and galaxies in the early universe and explore distant planets

Seeking Light from the First Stars and Galaxies
Exploring Distant Worlds—Exoplanets & the Outer Solar System

Led by NASA, in partnership with ESA and CSA

Science program defined through peer-review, including future key projects
Observations spanning a wide variety of Astrophysics are already in the works through the Guaranteed Time Observers programs and the Early Release Science program
Webb
The James Webb Space Telescope

- Science payload completed three months cryogenic testing at end of 2017
- Spacecraft and sunshield integration completed January 2018
- Spacecraft element including sunshield completed environmental testing May 2019
- Science payload and spacecraft integration completed August 2019
- Test deployment of sunshield completed November 2019
- Environmental testing of full observatory in Spring 2020
- Webb overrun covered using offsets from Astrophysics Probes
Fully Tensioned Sunshield
(November 2019)

Webb Town Hall
Sunday Jan 5
6:30 PM in Room 313A
Science Program

• Cosmology: Dark energy and the fate of the universe – wide field surveys to measure the expansion history and the growth of structure

• Exoplanet Demographics: The full distribution of planets around stars through a microlensing survey

• Astrophysics: Wide-field infrared surveys of the universe through General Observer and Archival Research programs

Technology development for the characterization of exoplanets through a Coronagraph Technology Demonstration Instrument
WFIRST: Wide-Field Infrared Survey Telescope

WFIRST is fully funded in FY20

Nov 2019 — Completed Preliminary Design Reviews

Early 2020 – Complete Confirmation Review and begin Implementation (Phase C)

2020: Flight hardware being developed: mirror being figured, detectors being fabricated, spacecraft subsystems being delivered, coronagraph demo unit in testbed

2021 – Complete Critical Design Reviews

Mid-2020s – Launch

WFIRST field-of-view is 100x Hubble field-of-view

WFIRST is 100 to 1500 times faster than Hubble for large surveys at equivalent area and depth
Wide-Field Infrared Survey Telescope

• NASA continuing work on WFIRST as planned
  • Work continues under CR in anticipation of FY20 appropriation; both Senate and House bills include robust support for WFIRST
  • WFIRST remains on the plan approved at the beginning of Phase B: Lifecycle cost range remains $3.2B -$3.9B, launch range remains late 2025 - 2026
  • Formal cost and schedule commitments, including Headquarters held reserves to increase confidence level to 70%, will be made at Confirmation in early 2020

• Major milestones completed in 2019:
  • Completed Preliminary Design Reviews for all primary mission elements (Wide Field Instrument, Coronagraph, Optical Telescope, Instrument Carrier, Spacecraft)
  • WFIRST mission passed Preliminary Design Review (gate for entering Phase C)
  • Additional major contracts awarded: Instrument Carrier (NGIS), Science Operations Center (STScI), numerous spacecraft components
  • Long-lead hardware making excellent progress; telescope refiguring proceeding as expected; several flight candidate detectors already in hand

• Work Plan for 2020
  • NASA confirmation of mission; enter implementation phase (Phase C)
  • Significant engineering test unit fabrication and testing
WFIRST is for You

All WFIRST observing time is available through open competition
• Some WFIRST observing time will be used for the core dark energy and exoplanet surveys mandated by the Astro2010 Decadal Survey
• Some WFIRST observing time will be used for additional GO-driven key projects using WFIRST’s unique wide-field imaging, spectroscopic, and time domain capabilities
• Some WFIRST observing time will be used for smaller, individual GO programs
• Some WFIRST observing time will be used for the Coronagraph technology demonstration
• All data will be available to the community with no period of limited access

WFIRST observing program will be based on community input
• Both NASA and STScI will be convening community groups to provide input on balance among observing programs and on trades during development, integration, and test

WFIRST General Observers / Archival Researchers Program
• Use WFIRST for conducting wide-field infrared surveys of the universe
• Use data from WFIRST legacy surveys to conduct compelling astrophysics investigations
• Calls for proposals to be issued before launch and subsequently

WFIRST Coronagraph Participating Scientist Program
• Develop observing plans for demonstrating coronagraph capabilities
• Work with instrument team to process data from tech demo observations
• Call for proposals to be issued well before launch
Imaging X-ray Polarimetry Explorer (IXPE)

- IXPE Project successfully completed Critical Design Review (CDR) held on June 25-28 at Ball Aerospace.
- SpaceX Falcon 9 chosen as the launch vehicle for IXPE mission.
  - Falcon 9 launch from KSC (~28.5 degree latitude) will execute a major orbital plane change to IXPE science-required zero degree orbital inclination.
- Critical vibration re-testing of modified engineering Modular Mirror Assembly (MMA) successfully completed at MSFC.
- Development of Italian X-ray detector units (DU) is ongoing, with the delivery of first flight DU in December 2019
- Instrument and spacecraft integration beginning in Spring 2020
- Launch currently planned for April 2021
GUSTO Suborbital Explorer

GUSTO (Galactic/Extragalactic ULDB Spectroscopic Terahertz Observatory), led by PI Chris Walker (University of Arizona), is an Astrophysics Explorer (MO) balloon mission and is an advanced version of the STO-2 balloon payload.

GUSTO uses large-scale surveys & spectral diagnostics of the Interstellar Medium (ISM) to answer key questions about the full Life Cycle of the ISM and massive star formation.

~300 dedicated SOFIA flights would be required to equal the GUSTO survey

Milestones:
- Mission Preliminary Design Review: Nov 15, 2018
- Confirmation Review (KDP-C): Mar 12, 2019
- Pre Ship Review / Mission Readiness Review: Jul 2021
- Launch from McMurdo Station, Antarctica: Dec 2021
• Passed the Integrated Systems Preliminary Design Review which was held in Japan in March 2019.
• Resolve instrument currently integrated in flight Dewar in Japan, preparing for environmental testing.
• Remaining US-built hardware to be delivered to JAXA in stages throughout 2020.

• Call for US Performance Verification phase Participating Scientists planned for ROSES 2020.
• XRISM launch, by JAXA, currently planned for early 2022.
Euclid

Science Program Includes
• Dark Energy and Dark Matter
• Initial conditions of the Universe
• Conduct deep NIR survey to explore high redshift
• Relationship between dark matter and baryons

ESA led mission with NASA partnership
• Completed mission CDR in November 2018
• NASA completed all flight hardware Sensor Chip Systems deliveries in June 2019 for the NISP instrument focal plane
• Mission In Assembly, Integration and Test phase
• Mission Launch ~ June 2022

Science Participation
• US Euclid Science teams integrated into Euclid Consortium science planning activities
• General US science participation to be through archival data research after Euclid data products release

Near Infrared Spectrometer and Photometer - fully populated focal plane includes NASA provided 16 (2K x 2K each) Sensor Chip Systems
Spectro-Photometer for the History of the Universe Epoch of Reionization and Ices Explorer (SPHEREx)

Science Highlights include:
- Survey the entire sky every 6 months
- Optical and infrared survey mission (96 bands/pixel)
- Observe hundreds of millions of galaxies
  - Measure redshifts to probe the statistical distribution of inflationary ripples
  - Measure spatial fluctuations in the Extragalactic Background Light to support studies of the origin and history of galaxy formation.
- Survey Galactic Molecular Clouds for water and organic molecules (H$_2$O, CO, CO$_2$, CH$_3$OH)

• PI: James Bock (Caltech)
• Launch: 2023
• Prime Mission: 2 Years
Partner Mission of Opportunity: ARIEL

**Contribution to ARIEL**

**Spectroscopy of Exoplanets**

**PI Mark Swain (JPL)**

CASE detectors and electronics would provide fine guidance for ARIEL; blueward data (0.5μm-2μm) enables studies of aerosols (clouds and hazes) which are important for the energy budget of the atmosphere.

**ARIEL: ESA M4 mission for Infrared Spectroscopy of Exoplanet Atmospheres**

**PI Giovanna Tinetti (UK)**

Launch in 2028 to L2 for 4-yr mission; primary mirror 1.1m x 0.7m; CASE photometry complements AIRS spectroscopy 2μm-8μm.

ARIEL is next step beyond Kepler and TESS; will obtain spectra of hundreds of warm transiting exoplanets to study atmospheric chemistry and energy budget.
LISA Update

• The LISA mission successfully passed ESA’s Mission Confirmation Review (MCR) in November 2019.

• One of NASA’s contribution, the Charge Management System, developed at UFl, has passed its technology readiness level 5 review with flying colors in November 2019
  • The CMS TRL 4 device was delivered to U. Trento where it was integrated with the torsion pendulum for system-level testing of charge control
  • This is the 1st delivery of NASA to Europe

• The NASA LISA Science Study Team (NLST) was refreshed with the addition of 7 new members:
  
  Jeremy Darling (U Colorado / CASA)
  Matthew Digman (Ohio State)
  Kayhan Gultekin (Michigan)
  Zoltan Haiman (Columbia)
  Xin Liu (U. Illinois)
  Krista Lynne Smith (Stanford / SMU)
  Marcelle Soares-Santos (Brandeis)

• Many thanks to former members C. Hogan, B. Kamai, and G. Mueller*

*now member of the LISA Core Team
Astrophysics Explorers Program

Small and Mid-Size Missions

Missions of Opportunity

Proposals in hand!
Astrophysics Science SmallSat Studies

• NASA selected 9 Astrophysics Science SmallSat Studies in ROSES 2018. These studies were reported out at a special session of the June 2019 AAS meeting in St. Louis.

• The 2019 Astrophysics Explorers Mission of Opportunity AO includes SmallSats and CubeSats launched using rideshare on ESPA or ESPA Grande; proposals are currently under evaluation along with other Small Explorer and Explorer Mission of Opportunity proposals.

• A second Astrophysics Science SmallSat Studies solicitation is included in ROSES 2019; proposals are currently under evaluation.

• NASA has selected 6 Astrophysics CubeSats through ROSES/APRA:

  Astrophysics Results from CubeSats and SmallSats
  Monday Jan 6 @ 2:00 pm in Room 317B
FY20 Appropriation

• FY20 appropriation for NASA Astrophysics (including Webb Telescope) is $1.73B; up by $233M from FY19 appropriation and by $532M from FY20 President’s Budget Request
• Fully funds Webb for replan to March 2021 launch readiness date
• Fully funds WFIRST through KDP-C and into Phase C
• Specifies funding levels for Hubble, SOFIA, and the Astrophysics Research Program
• Provides adequate funding to continue with the rest of the planned Astrophysics programs and projects including:
  • Operating missions with GO programs as planned following the Senior Review
  • Development of Explorers missions (IXPE, GUSTO, SPHEREx) and international contributions (Euclid, XRISM, ARIEL, Athena, LISA)
  • Initiation of Phase A studies for selected SMEX and MO proposals from the 2019 Announcement of Opportunity
  • Continued technology development for the future
Artemis Phase I: To the Lunar Surface by 2024

- Artemis I: First human spacecraft to the Moon in the 21st century
- Artemis II: First humans to orbit the Moon in the 21st century
- Artemis Support Mission: First high-power Solar Electric Propulsion (SEP) system
- Artemis Support Mission: First pressurized module delivered to Gateway
- Artemis Support Mission: Human Landing System delivered to Gateway
- Artemis III: Crewed mission to Gateway and lunar surface

Commercial Lunar Payload Services
- CLPS-delivered science and technology payloads

Early South Pole Mission(s)
- First robotic landing on eventual human lunar return and In-Situ Resource Utilization (ISRU) site
- First ground truth of polar crater volatiles

Large-Scale Cargo Lander
- Increased capabilities for science and technology payloads

Humans on the Moon - 21st Century
First crew leverages infrastructure left behind by previous missions

LUNAR SOUTH POLE TARGET SITE
Astrophysics and Artemis

All science opportunities enabled by Project Artemis will include astrophysics

- Commercial Lunar Payload Services (CLPS)
  - 14 U.S. companies selected to bid on specific task orders to deliver NASA payloads to Moon’s surface
  - All payload calls include astrophysics; two astrophysics payloads selected to date
    - Internal NASA call: Low-frequency Radio Observations from the Near Side Lunar Surface instrument (PI: Robert MacDowall, GSFC)
    - ROSES call: Next Generation Lunar Retroreflectors (PI: Douglas Currie, University of Maryland)
    - Both are among five payloads manifest on Intuitive Machines Lander for NET July 2021

- Astrophysics Explorers Missions of Opportunity
  - 2019 AO included opportunities enabled by Project Artemis
  - Future calls will solicit proposals that leverage Artemis capabilities, such as Gateway as a platform and cis-lunar communications infrastructure, to conduct compelling astrophysics investigations

Most important criterion for all proposals that leverage Artemis remains the astrophysics science merit
Decadal Survey Planning

- NASA’s highest aspiration for the 2020 Decadal Survey is that it be ambitious
  - The important science questions require new and ambitious capabilities
  - Ambitious missions prioritized by previous Decadal Surveys have always led to paradigm shifting discoveries about the universe

Town Hall – Implementing Astro2020
Tuesday, 12:45 pm, Ballroom AB
BALANCED MISSION PORTFOLIO

FLAGSHIP
National priority, civilization scale science

LARGE
High priority, low risk

MEDIUM
Medium priority with moderate risk

SMALL
Focused, higher risk with limited budget

CLASS A
Great Observatory

CLASS B
Probe

CLASS C
MIDEX

CLASS D
SMEX
+ SmallSats (Class D Tailored)

Suborbital-class (Research Class)
Medium Mission Concepts (Probes)

Probes are strategic missions that have had a strong impact on astrophysics, either through a focused investigation or as a broadly-capable observatory.

NASA funded probe studies are available at https://science.nasa.gov/astrophysics/2020-decadal-survey-planning

NASA’s independent assessment of probe studies by the Probes Cost Assessment Team (PCAT) is available at https://science.nasa.gov/astrophysics/2020-decadal-survey-planning

Options for 2020 Decadal Survey

• Do not recommend a medium mission in Astro2020
• Recommend specific probe(s) as medium-size strategic missions
• Recommend several specific science concepts for an AO (similar to New Frontiers)
• Recommend an unconstrained AO (i.e., Super-Explorer)
Astrophysics
Decadal Survey Missions

1972 Decadal Survey
Hubble

1982 Decadal Survey
Spitzer

1991 Decadal Survey
Chandra

2001 Decadal Survey
JWST

2010 Decadal Survey
WFIRST
Why Flagships

Flagships enable paradigm shifting science
Flagships drive US capabilities and contribute to US leadership
Flagships create stakeholder support that drives the NASA budget

“NASA should continue to plan for large strategic missions as a primary component for all science disciplines as part of a balanced program.”
– Powering Science: NASA's Large Strategic Science Missions (NASEM, 2017)
Flagship Fraction of Astrophysics Budget

All dollars inflated to FY18$. Development only, no ops.

- Large mission fraction (left scale)
- Inflation adjusted Astrophysics budget (right scale)
- Current planning budget (without WFIRST beyond FY19)
- What if WFIRST is funded as needed on top of FY20 President’s Budget Request?
Large Mission Concepts

“NASA should ensure that robust mission studies that allow for trade-offs (including science, risk, cost, performance, and schedule) on potential large strategic missions are conducted prior to the start of a decadal survey. These trade-offs should inform, but not limit, what the decadal surveys can address.” – Powering Science: NASA’s Large Strategic Science Missions (NASEM, 2017)
Large Mission Concepts

NASA’s independent assessment of large mission concept studies by the Large Mission Concept Independent Assessment Team (LCIT) is available at [https://science.nasa.gov/astrophysics/2020-decadal-survey-planning](https://science.nasa.gov/astrophysics/2020-decadal-survey-planning)

Links to the concept study reports are posted at [https://science.nasa.gov/astrophysics/2020-decadal-survey-planning](https://science.nasa.gov/astrophysics/2020-decadal-survey-planning) and at [https://www.greatobservatories.org/](https://www.greatobservatories.org/)
NASA Astrophysics Budget

**Fiscal Years (FY) 2024 to 2032**

- **FY24**: $0.9B (Current program including Webb operations and 4 Explorers/decade)
- **FY26**: $1.45B
- **FY28**: $5B/decade for strategic initiatives
- **FY30**: $1.6B
- **FY32**: $1.8B

**Average of recent* appropriations**
- $1.1B
- $2B/decade for strategic initiatives

**Average of recent* appropriations plus inflation**
- $1.6B
- $5B/decade for strategic initiatives

**Runout of FY20 Budget Proposal**
- $1.45B
- $7B/decade for strategic initiatives

**Current program including Webb operations and 4 Explorers/decade**
- $0.9B

**Average of recent* appropriations**
- $1.6B
- $5B/decade for strategic initiatives

* Does not include FY20 appropriation
Decadal Survey Goal

• NASA’s highest aspiration for the 2020 Decadal Survey is that it be ambitious
  • The important science questions require new and ambitious capabilities
  • Ambitious missions prioritized by previous Decadal Surveys have always led to paradigm shifting discoveries about the universe
  • If you plan to a diminishing budget, you get a diminishing program
    • Great visions inspire great budgets

Carpe Posterum
The Future

This is an exciting time for Astrophysics – we are pursuing the answers to the biggest questions

- How did the universe begin and evolve?
- How did galaxies, stars, and planets come to be?
- Are we alone?

Astrophysics is multiwavelength and multimessenger

- NASA has 10 operating astrophysics missions*
- NASA is developing 11 astrophysics missions*

The community will select NASA’s future observatories through the 2020 Decadal Survey and through peer review of competed missions (like Explorers)

NASA is ready to realize the community’s priorities

* includes partner-led missions
## Astrophysics Program Content (FY20 Request)

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| Out-years | 106 | 222.8 | 83.4 | 40.2 | 45.0 | 54.2 | 17.9 | 19.1 | 4.5 | 12.7 | 12.7 | 28.9 | 24.3 | 222.8 | 98.3 | 85.2 | 39.3 | 20.6 | 23.4 | 23.4 |

- **Astrophysics**: 850.4, 1,191.6, 844.8, 902.4, 965.2, 913.5, 907.7
- **Cosmic Origins**: 211.2, 222.8, 185.3, 173.9, 181.7, 121.7, 121.7

The table above outlines the budget allocations for the Astrophysics and Cosmic Origins programs from FY 2018 to FY 24, with additional out-year data provided for planning purposes.
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