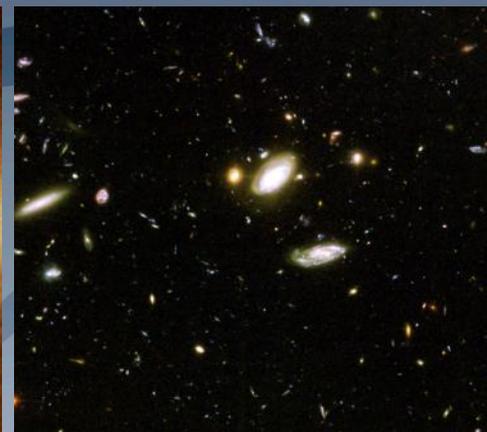


# Astrophysics



## Briefing to the X-ray Surveyor STDT

Washington, DC

November 14, 2016

**Paul Hertz**

Director, Astrophysics Division

Science Mission Directorate

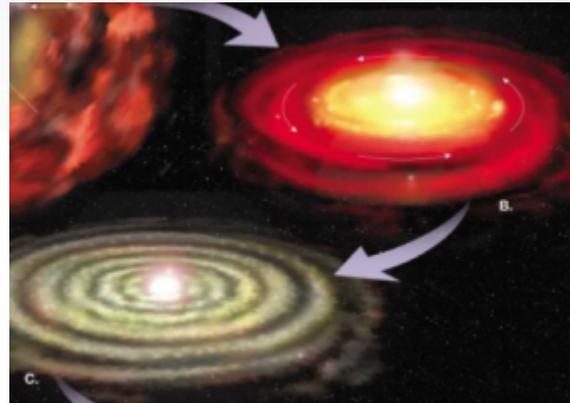
[@PHertzNASA](https://twitter.com/PHertzNASA)

# Why Astrophysics?

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



1. How did our universe begin and evolve?

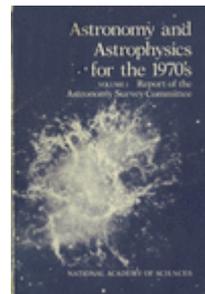


2. How did galaxies, stars, and planets come to be?

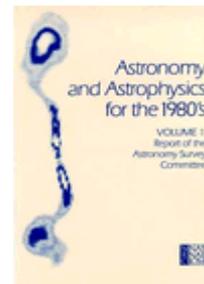


3. Are We Alone?

These national strategic drivers are enduring



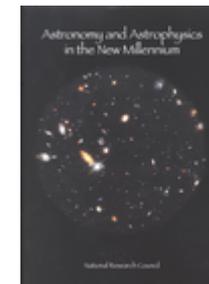
1972



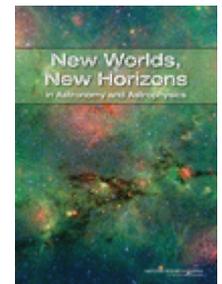
1982



1991



2001



2010



# ASTROPHYSICS

## Decadal Survey Missions

Launch 1990



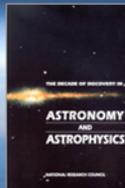
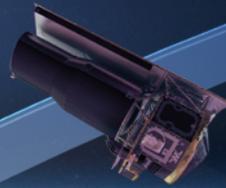
**1972**  
Decadal Survey  
*Hubble*

Launch 1999



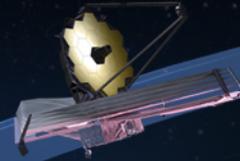
**1982**  
Decadal Survey  
*Chandra*

Launch 2003



**1991**  
Decadal Survey  
*Spitzer, SOFIA*

Launch 2018



**2001**  
Decadal Survey  
*JWST*

Launch mid-2020s

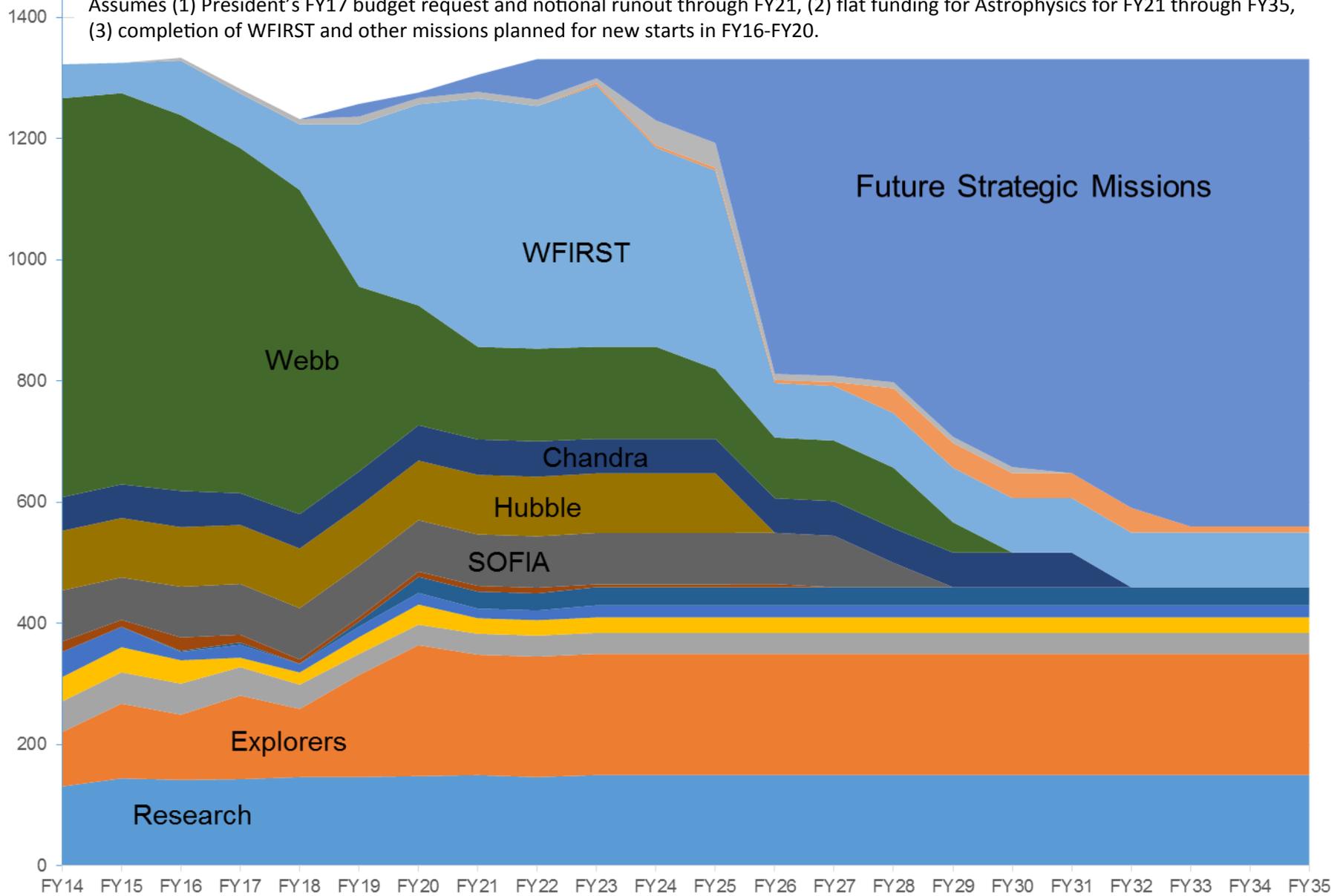


**2010**  
Decadal Survey  
*WFIRST*

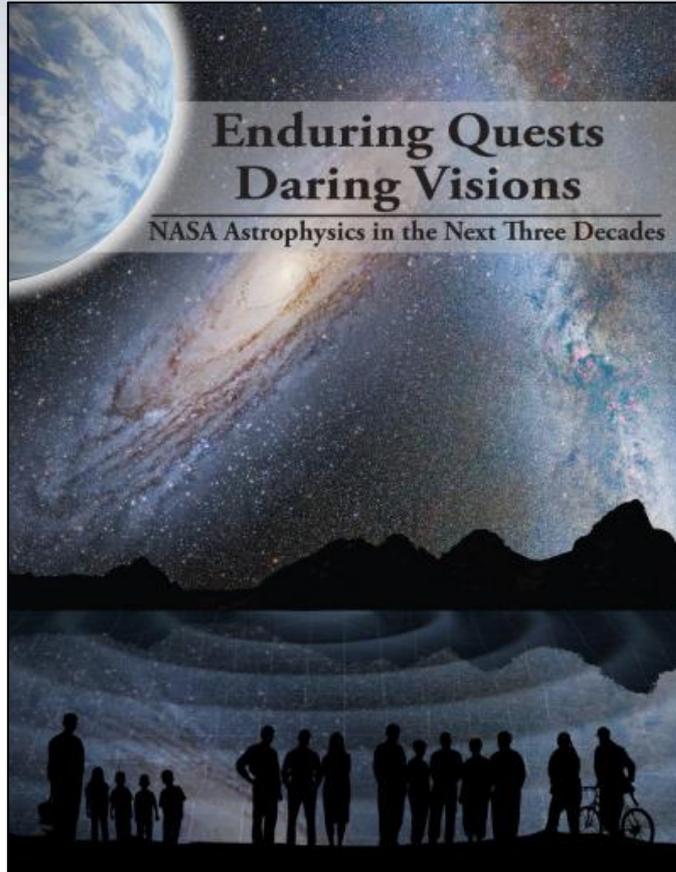
# The Landscape after WFIRST (notional)



Assumes (1) President's FY17 budget request and notional runout through FY21, (2) flat funding for Astrophysics for FY21 through FY35, (3) completion of WFIRST and other missions planned for new starts in FY16-FY20.



# A Community-driven Vision for the 2030s



- Far IR Surveyor / Origins Space Telescope
- Habitable Exoplanet Imaging Mission
- Large UV/Optical/IR Surveyor
- X-ray Surveyor

These four missions were endorsed by the Program Analysis Groups (PAGs) and recommended by the NAC's Astrophysics Subcommittee as the four mission concepts that NASA should study in preparation for the 2020 Decadal Survey.

# Correcting Five Myths about the Large Mission Concept Studies



- This is not a competition and HQ will not select among the studies.
- This is not an AO proposal or a Phase A study.
- NASA will not build the design you come up with even if the Decadal Survey recommends your mission.
- A precise cost estimate is neither expected nor achievable.
- The Center and the Program Office are not in charge of the study; the Community Chairs are responsible for the final product.

# Success Criteria



NASA defines a successful outcome of these studies to be four compelling and executable mission concepts, which will subsequently be prioritized by the 2020 Decadal Survey.

**COMPELLING:** Worthy of a Decadal Survey recommendation (i.e., worth spending billions of \$\$ for the science return)

- Strong science motivation with well articulated objectives
- Groundbreaking science to be performed in the 2030s
- Synergies with existing/planned major ground- and space-based observatories

**EXECUTABLE:** Technically feasible with a believable path to technology maturation

- Architecture, mission design, + payload in the STDT report is notional.
- NASA has never launched the mission design that was specified in the Decadal Survey.
- Precise costing is neither expected or achievable.
- Feasible technology roadmap is essential.

# Science comes first



- First objective: A compelling science case for addressing critical science questions in the following decades
- Only then: The technical parameters necessary to achieve these goals, which will include:
  - Design Reference Mission, including notional payload.
  - Technology assessment and roadmap.
  - Notional time to mature technology and develop mission.
- And at the very end: Cost and schedule assessment, major technical issues, and risk reduction plans as a function of science capability.

# Thoughts on the Decadal Process



- The US astronomical community will want and expect X-ray Surveyor to be a paradigm-changing mission.
- NASA will not build a large strategic observatory such as X-ray Surveyor simply in order to have a large X-ray mission in orbit.
- Think boldly.
- Do not ignore Athena.
- Your job is to:
  - Seduce your peers in the astronomical community with science.
  - Produce a compelling science case that motivates the technical requirements.
  - Produce a robust technology development roadmap.
  - All of the above, along with the Decadal Survey priorities, will help NASA make this mission concept sellable to stakeholders in OMB and on the Hill.

# Thoughts on the Decadal Process



- NASA does not control what the Decadal Survey will want to see in terms of technology development.
- None of the large mission concepts considered by the 2000 Decadal Survey (e.g., Con-X) had mature and well-funded technologies.
  - Then the NASA Authorization Act of 2008 directed that the National Academies “include independent estimates of the life cycle costs and technical readiness of missions assessed in the decadal survey wherever possible.”
- The 2010 Decadal Survey (over)interpreted the law to cost out every technology development risk and add it to the overall IXO cost.
  - The CATE has evolved since 2010 as it has been used for each Decadal Survey since then (2011 Planetary Science, 2013 Heliophysics, 2017 Earth Science).
- NASA is already having discussions with the National Academies to ensure that the 2020 Decadal Survey does what is reasonable and right.

# Thoughts on the Decadal Process



- Discussions with Aerospace at the “Pause and Learn” were helpful
  - A mission concept might get a red risk because its technology is not ready for Phase A (TRL 5).
  - However a mission concept in conjunction with a technology development plan (cost and schedule) might not get a red risk.
  - Conclusion: Acknowledgement of technology needs and a plan to retire them is just as critical as a killer science case and a feasible Design Reference Mission.
- So, what is the right thing for the STDT to produce?
  - It is right to have a **credible technology development roadmap** and to have taken steps toward it over the coming years before the Decadal.
  - NASA is investing now for X-ray Surveyor optics; there are several paths that can realize lightweight, high-resolution optics; multiple technologies are being pursued with funding.
  - Nobody expects NASA to have built a 4m<sup>2</sup> optic before the Decadal Survey.
  - Highly detailed optical designs may not be necessary at this pre- pre-phase A stage; think existence proof, not final design.

- Formulation
- Implementation
- Primary Ops
- Extended Ops

Spitzer  
8/25/2003

Kepler  
3/7/2009

WFIRST  
Mid 2020s

LISA Pathfinder (ESA)  
12/3/2015

Webb  
2018

Euclid (ESA)  
2020

XMM-Newton (ESA)  
999

TESS  
2017

Chandra  
7/23/1999

# Questions?

Swift  
11/20/2004

NuSTAR  
6/13/2012

Hubble  
4/24/1990

Fermi  
6/11/2008

ISS-CREAM  
2017

ISS-NICER  
2017

SOFIA  
Full Ops 5/2014