Astrophysics Missions in Development

**LISA Pathfinder**
ESA-led Mission
- NASA supplied the ST7/Disturbance Reduction System (DRS)

**ASTRO-H**
JAXA-led Mission
- NASA supplied the Soft X-ray Spectrometer (SXS) instrument

**NICER**
NASA Mission
- Neutron Star Interior Composition Explorer

**TESS**
NASA Mission
- Transiting Exoplanet Survey Satellite

**JWST**
NASA Mission
- James Webb Space Telescope

**Euclid**
ESA-led Mission
- NASA is supplying the NISP Sensor Chip System (SCS)
Astrophysics Missions in Pre-Formulation

WFIRST-AFTA

SMEX / MO – 2019/2020
MIDEX / MO – 2022/2023
WFIRST-AFTA – 2024/2025
Athena – 2028

all launch dates notional
NASA Astrophysics Budget:
FY04-FY15 Appropriated, FY16 Requested, FY17-FY20 Notional Planning

Real Year $Million

JWST Program

Rest of Astrophysics

includes SMD E/PO and SMD STEM activities

Managed by JWST Program Off
WFIRST
Managed by Astrophysics Div
Total Astrophysics
Plan for WFIRST/AFTA Preformulation
Widefield Infrared Survey Telescope using
Astrophysics Focused Telescope Assets

WFIRST/AFTA timeline

WFIRST/AFTA Preformulation

Formulation

Technology Development for WFIRST/AFTA Continues Through Formulation

NRC WFIRST/AFTA Study

Budget Request for WFIRST/AFTA Start

WFIRST/AFTA KDP-A

NRC Mid-decade Study

2012  2013  2014  2015  2016  2017  2018
The NASA FY15 Appropriation, the President’s FY16 Budget Request, and the notional out year budget planning guidance in the President’s FY16 Budget Request, support:

<table>
<thead>
<tr>
<th>Large-scale 1. WFIRST (wide-field infrared survey telescope)</th>
<th>Preformulation and focused technology development for WFIRST-AFTA (a 2.4m version of WFIRST with a coronagraph) underway to enable a new start NET FY2017. Budget line established for an Astrophysics Decadal Strategic Mission.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large-scale 2. Augmentation to Explorer Program</td>
<td>Astrophysics Explorers planning budget increased to support decadal cadence of AOs including SMEX AO in Fall 2014 and MIDEX AO in late 2016/early 2017.</td>
</tr>
<tr>
<td>Large-scale 3. LISA (large GW space observatory)</td>
<td>Partnership discussions for ESA’s L3 gravitational wave observatory; Participating in ESA-led assessment in 2014-2015; Strategic astrophysics technology (SAT) investments; Continued support of LISA Pathfinder.</td>
</tr>
<tr>
<td>Large-scale 4. IXO (large X-ray observatory)</td>
<td>Partnership plans for ESA’s L2 Athena X-ray observatory, Athena study phase, with U.S. participation, is underway; Strategic astrophysics technology (SAT) investments.</td>
</tr>
<tr>
<td>Medium-scale 1. New Worlds Technology Development Program</td>
<td>Focused technology development for a coronagraph on WFIRST-AFTA; Strategic astrophysics technology (SAT) investments; Exoplanet probe mission concept studies; Partnership with NSF to develop extreme precision Doppler spectrometer as facility instrument; Exozodi survey using NASA-developed LBTI.</td>
</tr>
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</table>
## Progress Toward Decadal Survey Priorities

The NASA FY15 Appropriation, the President’s FY16 Budget Request, and the notional out year budget planning guidance in the President’s FY16 Budget Request, support:

| Medium-scale 2. Inflation Probe Technology Development Program | Balloon-borne investigations; strategic astrophysics technology (SAT) investments. |
| Small-scale. Research Program Augmentations | Increased annual R&A budget by 10% from FY10 to FY12 and another 10% from FY14 to FY16. Within R&A: established Theoretical and Computational Astrophysics Networks (TCAN) program with NSF; funding available for astrophysics theory; funding available for lab astrophysics; funding available for suborbital payloads. |
| Small-scale. Intermediate Technology development Augmentation | Established competed Strategic Astrophysics Technology (SAT) program element; directed technology funding for WFIRST and other decadal priorities. |
| Small-scale. Future Ultraviolet-Visible Space Capability | Strategic Astrophysics Technology (SAT) investments. |
| Small-scale. SPICA (U.S. contribution to JAXA-led large infrared space telescope) | Not supported as a strategic contribution; candidate for Explorer Mission of Opportunity. |
ASTROPHYSICS

Decadal Survey Missions

1972
Decadal Survey
Hubble

1982
Decadal Survey
Chandra

1991
Decadal Survey
Spitzer, SOFIA

2001
Decadal Survey
JWST

2010
Decadal Survey
WFIRST
Preparing for the 2020 Decadal Survey
Large Mission Concepts

• Study 3-4 large mission concepts as candidate prioritized large missions
  - Science case
  - Technology assessment
  - Design reference mission with strawman payload
  - Cost assessment

• NASA Plan for Community Input
  - 2015: PAGs gather community input on selecting concepts for study
  - 2016: Appoint STDT and Center study office, STDT assesses technology
  - 2017: Fund technology development through SAT, STDT develops DRM
  - 2018: STDT submits DRM for cost assessment
  - 2019: STDT issues report and provides input to Decadal Survey

• Community workshops (incomplete list)
  - Mar 19, Joint PAG EC meeting, Baltimore
  - Jun 3-5, Far-IR workshop, Pasadena
  - Jun 13-14, ExoPAG meeting, Chicago
  - Jun 25-26, UV-Vis workshop, Greenbelt
  - Jun 29-Jul 1, High Energy workshop, Chicago
  - Aug 7, Joint PAG session @ IAU General Assembly, Honolulu
Preparing for the 2020 Decadal Survey
Large Mission Concepts

The initial short list (in alphabetical order):

- **FAR IR Surveyor** – The Astrophysics Visionary Roadmap identifies a Far IR Surveyor as contributing through improvements in sensitivity, spectroscopy, and angular resolution.

- **Habitable-Exoplanet Imaging Mission** – The 2010 Decadal Survey recommends that a habitable-exoplanet imaging mission be studied in time for consideration by the 2020 Decadal Survey.

- **UV/Optical/IR Surveyor** – The Astrophysics Visionary Roadmap identifies a UV/Optical/IR Surveyor as contributing through improvements in sensitivity, spectroscopy, high contrast imaging, astrometry, angular resolution and/or wavelength coverage. The 2010 Decadal Survey recommends that NASA prepare for a UV mission to be considered by the 2020 Decadal Survey.

- **X-ray Surveyor** – The Astrophysics Visionary Roadmap identifies an X-ray Surveyor as contributing through improvements in sensitivity, spectroscopy, and angular resolution.
Preparing for the 2020 Decadal Survey
Thinking about Probes

• What was done 10 years ago?
    • ROSES call for quick (~9 month) paper concept studies
    • ~9 concepts selected in 2004; total ~$1M ($100K average)
  - Astrophysics Mission Concepts Study (AMCS; 2007)
    • ROSES call for ~1 year concept studies with mission design lab run
    • ~19 ASMC concepts selected in 2007; total $13M ($700K average)
    - Was this effective? Efficient? Appropriately impactful?

• Possibilities this time
  - Real mission concept studies
    • Just like we are doing for large mission concepts
    • How would we select them? Where does funding come from?
  - Paper mission concept studies, with or without mission design lab run
    • Just like AMCS or Origins Probes, but limited to Probes
  - Self selected, self funded
    • Anybody can submit a white paper to the 2020 Decadal Survey

• Awaiting input from the PAG reports
• Suggestion for the Decadal Survey: Recommend a Probe AO
  - Similar to Planetary Science Division’s New Frontiers AO
  - Recent Probe-class missions include
    • Spitzer, Fermi, Kepler
    • New Horizons, JUNO, OSIRIS-Rex (New Frontiers missions)
  - Community identifies to the Decadal Survey mission concepts that could plausibly be done as Probes
  - Decadal Survey prioritizes a short list of mission concepts that should be accomplished on a Probe budget for the Probe AO
  - NASA issues a Probe AO and selects a Probe proposal that is responsive in a compelling manner to Decadal Survey identified science objectives for one of the mission concepts (determined by peer review) and can be accomplished as a Probe (determined by TMC review)
• Funding allotted to Probes “slows down” the large mission(s) that follow WFIRST
• NASA Astrophysics expects to announce a path toward Probe input for the Decadal Survey by the January 2016 AAS meeting