



**Joint PAG Meeting
AAS 225th Meeting
Seattle, WA**

January 4, 2015

Astrophysics

Paul Hertz

**Director, Astrophysics Division
Science Mission Directorate**

@PHertzNASA



Visiting Experienced Scientists at NASA HQ

Looking for a few good astrophysicists....

- Seeking one or more experienced scientists
 - to take leave from their U.S. home institution
 - for a 2-year visiting position (can extend up to 6 years)
 - to work in Astrophysics at NASA Headquarters
- Duties include
 - Management of the Astrophysics grants programs;
 - Planning, development, and management of NASA missions;
 - Strategic planning for the future of NASA astrophysics.
- Requires Ph.D. or equivalent, relevant research experience, familiarity with NASA research award programs and/or missions, and the ability to communicate effectively.
- For additional info, talk with any of the Astrophysics HQ staff.

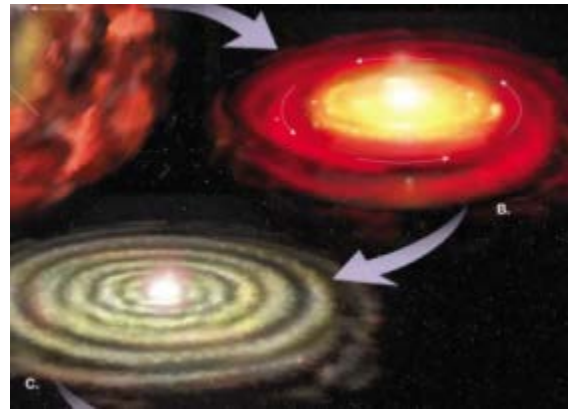
Apply by January 31, 2015

http://jobregister.aas.org/job_view?JobID=46612



Why Astrophysics?

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

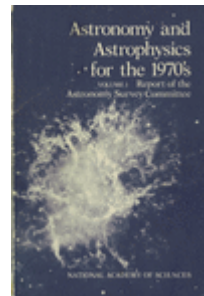


1. How did our universe begin and evolve?

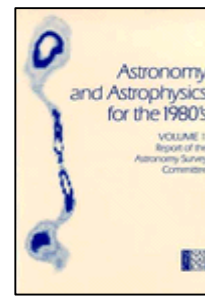
2. How did galaxies, stars, and planets come to be?

3. Are We Alone?

These national strategic drivers are enduring



1972



1982



1991



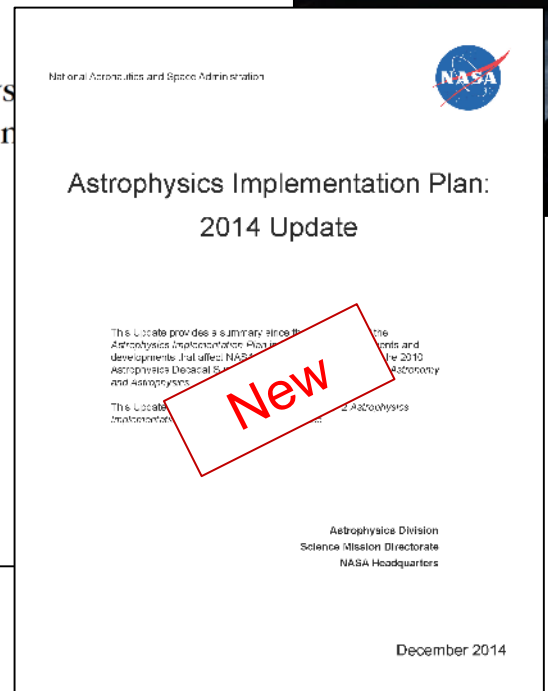
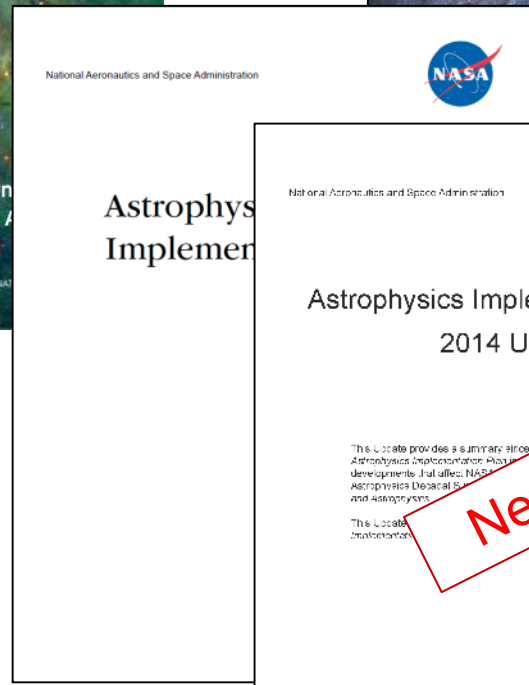
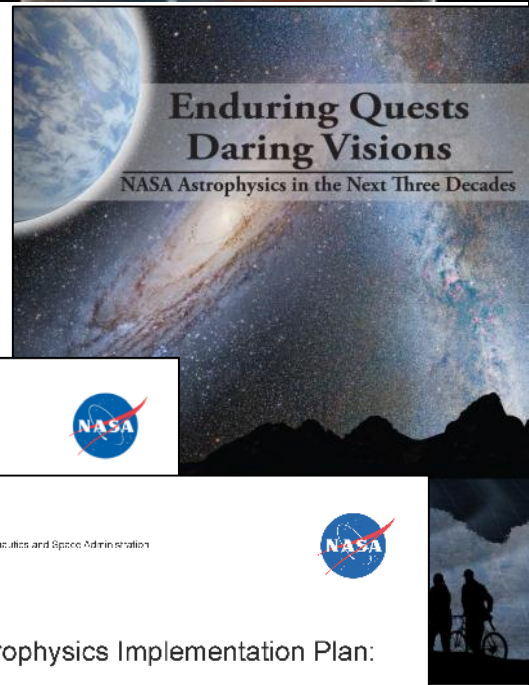
2001



2010



Astrophysics Driving Documents



<http://science.nasa.gov/astrophysics/documents>



Astrophysics Programs

Science Mission Directorate

Astrophysics Division

Astrophysics Research

Support basic and applied research activities, including suborbital flight investigations, as well as the development and maturation of technologies for future strategic and competed missions.

<http://science.nasa.gov/astrophysics/>

Astrophysics Explorers

Provide flight opportunities for focused scientific investigations from space in Astrophysics

<http://explorers.gsfc.nasa.gov/>

Cosmic Origins

Explore the origin and evolution of the galaxies, stars and planets that make up our universe.

<http://cor.gsfc.nasa.gov/>

Exoplanet Exploration

Discover and study planets around other stars, and explore whether they could harbor life.

<http://exep.jpl.nasa.gov/>

Physics of the Cosmos

Probe the origin and destiny of our universe, including the nature of black holes, dark energy, dark matter and gravity.

<http://pcos.gsfc.nasa.gov/>



Astrophysics PAGs

NASA Advisory Council (NAC)

→ NASA / Charlie Bolden

Science Committee

→ SMD / John Grunsfeld

Astrophysics Subcommittee

→ Astrophysics / Paul Hertz

COPAG

ExoPAG

PhysPAG

Program Scientist:
Mario Perez
Mike Garcia

Program Scientist:
Doug Hudgins
Martin Still

Program Scientist:
Rita Sambruna
Wilt Sanders

Program Executive:
Lia LaPiana

Program Executive:
John Gagosian

Program Executive:
Lia LaPiana

Program Manager:
Mansoor Ahmed
(GSFC)

Program Manager:
Gary Blackwood
(JPL)

Program Manager:
Mansoor Ahmed
(GSFC)

Chief Scientist:
Susan Neff
Deborah Padgett
(GSFC)

Chief Scientist:
Wes Traub (JPL)

Chief Scientist:
Ann Hornschemeier
Peter Bertone
(GSFC)



Big Picture

- The FY15 appropriations provides funding for NASA astrophysics to continue its programs, missions, and projects as planned
 - The total funding (Astrophysics including JWST) is \$1.33B, same as FY14
 - Fully funds JWST to remain on plan for an October 2018 launch
 - Funds continued pre-formulation and technology work leading toward WFIRST
 - Restores SOFIA to the budget with a 20% reduction from FY14
 - Provides funding for SMD's education programs
- The operating missions continue to generate important and compelling science results, and new missions are under development for the future
 - Chandra, Fermi, Hubble, Kepler/K2, NuSTAR, Spitzer, Suzaku, Swift, XMM-Newton continued following the 2014 Senior Review
 - SOFIA is in prime operations as of May 2014
 - Missions on track for launch include ISS-CREAM (2015), LISA Pathfinder (2015), ASTRO-H (2015), NICER (2016), TESS (2017), JWST (2018), Euclid (2020)
 - New Explorers being selected (SMEX in 2015, MIDEX in 2017), WFIRST being studied, NASA joining ESA's Athena and ESA's L3 gravitational wave observatory
- Update to the Astrophysics Implementation Plan has been released
- Progress being made against recommendations of the 2010 Decadal Survey
 - NRC Mid Decade Review (with NSF, DOE) to begin in early 2015
 - NASA initiating concepts studies for 2020 Decadal Survey



FY15 Appropriation

Outyears are notional planning from FY15 President's budget request)

| (\$M) | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|--------------|-------|-------|-------|-------|-------|-------|-------|
| Astrophysics | \$617 | \$668 | \$685 | \$634 | \$651 | \$697 | \$993 |
| JWST | \$627 | \$658 | \$645 | \$620 | \$569 | \$535 | \$305 |

- Provides \$77M more than the President's Budget Request for FY15
- Supports the commitment to an October 2018 launch date for JWST
- Includes \$50M for continued preformulation of WFIRST, an increase of \$36M over the Administration request and comparable to FY14
- Includes \$70M for continued SOFIA operations, a reduction of \$14M (17%) from FY14
 - Directs NASA to (a) seek partners to restore SOFIA to its full level, and (b) not terminate missions without a Senior Review
- Includes \$98M for Hubble operations, the same as FY14
- Includes \$38M for scientific ballooning, an increase of \$5M (15%) from FY14
- Includes \$42M for Education SMD-wide as a separate budget line (so E/PO is no longer budgeted as 1% of every mission)
- Does not specify the distribution of funding for the rest of Astrophysics, but the funding is adequate for Astrophysics to execute its program as planned in FY15.
 - Includes support as planned in FY15 for missions under development, operating missions, SMEX AO, R&A, etc.
 - Final budget numbers available when NASA operating plan approved



NASA Astrophysics Budget:

FY04-FY15 Appropriated, FY16-FY19 Notional Planning

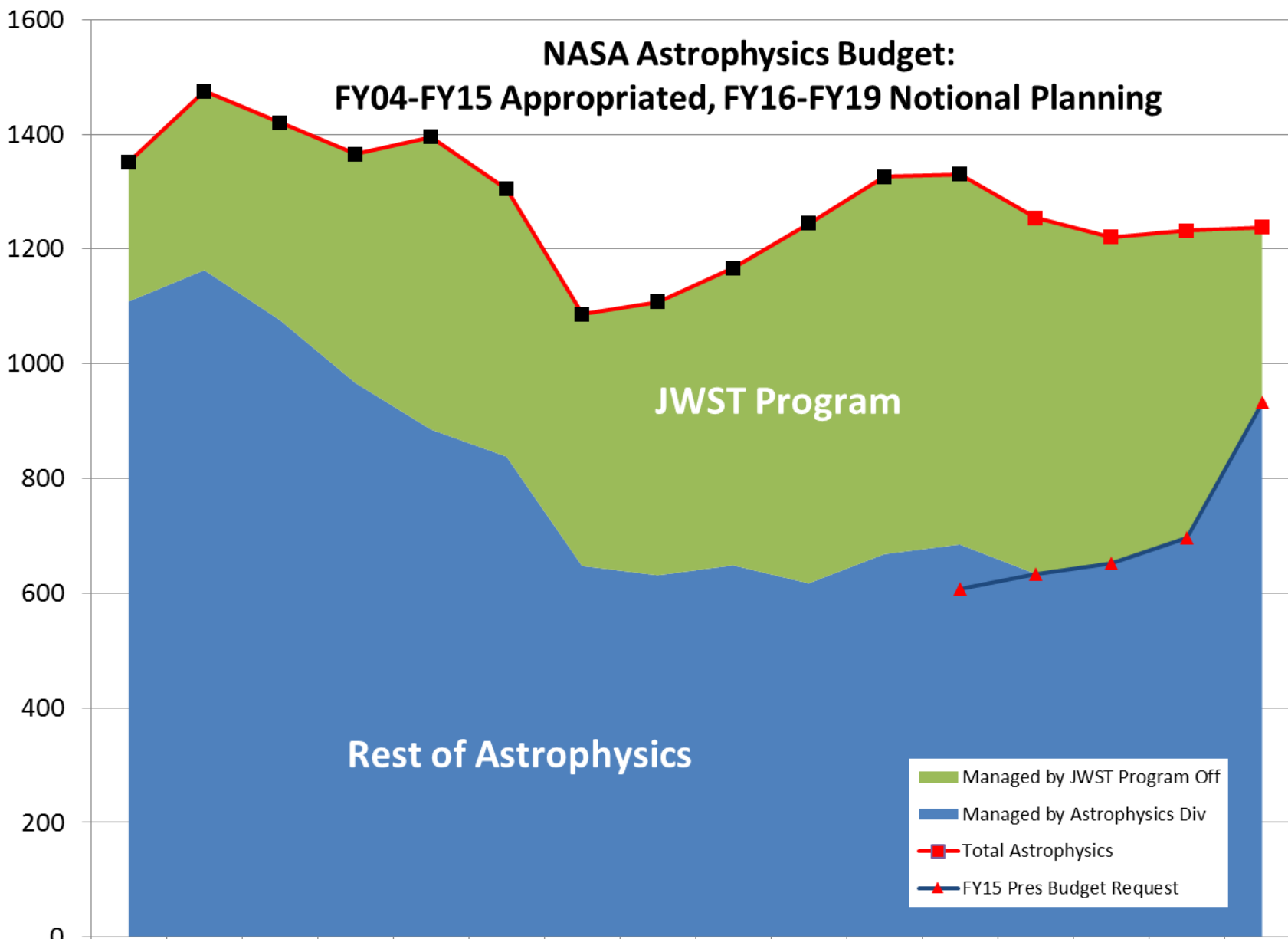
Real Year \$Million

JWST Program

Rest of Astrophysics

- Managed by JWST Program Off
- Managed by Astrophysics Div
- Total Astrophysics
- FY15 Pres Budget Request

FY04 FY05 FY06 FY07 FY08 FY09 FY10 FY11 FY12 FY13 FY14 FY15 FY16 FY17 FY18 FY19





Progress Toward Decadal Survey Priorities

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

| | |
|---|---|
| Large-scale 1. WFIRST | Preformulation and focused technology development for WFIRST/AFTA (a 2.4m version of WFIRST with a coronagraph) are underway to enable a new start NET FY2017. Budget line established for an Astrophysics Decadal Strategic Mission. |
| Large-scale 2. Augmentation to Explorer Program | Astrophysics Explorers planned budget increased to support decadal cadence of AOs including SMEX AO in Fall 2014 and MIDEX AO in late 2016/early 2017. |
| Large-scale 3. LISA | Discussing partnership on ESA's L3 gravitational wave observatory and participating in ESA-led assessments in 2014-2015. Strategic astrophysics technology (SAT) investments plus support of LISA Pathfinder. |
| Large-scale 4. IXO | NASA is pursuing a partnership on ESA's L2 Athena X-ray observatory; the Athena study phase, with U.S. participation, is underway. Strategic astrophysics technology (SAT) investments. |
| Medium-scale 1. New Worlds Technology Development Program | Focused technology development for a coronagraph on WFIRST, strategic astrophysics technology (SAT) investments, and exoplanet probe mission concept studies. Established partnership with NSF to develop extreme precision Doppler spectrometer as facility instrument. Exozodi survey using LBTI. |



Progress Toward Decadal Survey Priorities

The NASA FY14 Appropriation, the President's FY15 Budget Request, and its notional out years support:

| | |
|--|---|
| Medium-scale 2. Inflation Probe Technology Development Program | Balloon-borne investigations plus strategic astrophysics technology (SAT) investments. |
| Small-scale. Research Program Augmentations | Increased annual R&A budget by 10% from FY10 to FY12 and beyond. 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 large-scale decadal priorities. |
| Small-scale. Future Ultraviolet-Visible Space Capability | Strategic Astrophysics Technology (SAT) investments. |
| Small-scale. SPICA (U.S. contribution to JAXA-led) | Not supported as a strategic contribution; candidate for Explorer Mission of Opportunity. |



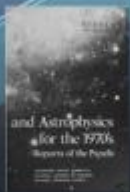
Planning for the 2015-2016 Mid-Decade Review

- The NASA Authorization Act of 2005 requires assessments of NASA's science programs that include mid-decade reviews.
 - The Astrophysics Mid-Decade Review will be during 2015-2016
 - Study will be co-sponsored by NASA, NSF, and DOE (the Agencies)
- Given the funding circumstances that are substantially below those assumed in the Decadal Survey, the committee's review will describe:
 - The most significant scientific discoveries, technical advances, and relevant programmatic changes in astronomy and astrophysics since the Decadal Survey;
 - How well the Agencies' programs address the strategies, goals, and priorities outlined in the Decadal Survey and other NRC reports;
 - Progress toward realizing these strategies, goals and priorities; and
 - Any actions that could be taken to maximize the science return of the Agencies' programs.
- The Agencies are in the process of charging the NRC, and formation of the Study Committee will begin soon.

ASTROPHYSICS

Decadal Survey Missions

1990



1972
Decadal
Survey
Hubble

1999



1982
Decadal
Survey
Chandra

2003



1991
Decadal
Survey
Spitzer

LRD: 2018



2001
Decadal
Survey
JWST

LRD: 2020s



2010
Decadal
Survey
WFIRST



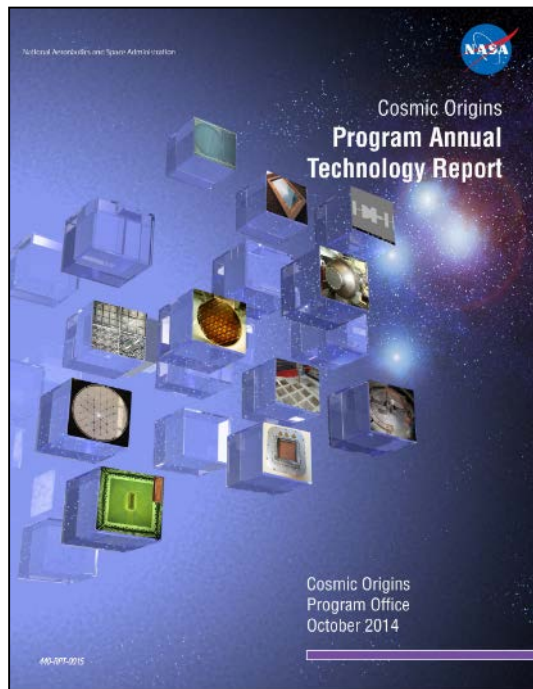
Preparing for the 2020 Decadal Survey Large Mission Concepts

- The 2020 Decadal Survey will prioritize large space missions to follow JWST and WFIRST.
 - To enable this prioritization, NASA needs to provide information on several candidate large space mission concepts for consideration by the 2020 Decadal Survey Committee.
- What information needs to be provided to the Decadal Survey committee to enable prioritization of large missions
 - Science case
 - Strawman design reference mission with strawman payload
 - Technology development needs
 - Cost requirements assessment
- NASA needs to initiate technology development for candidate large missions so that technology will be ready when needed.
 - Technology needs to be sufficiently mature when it is time to start the highest priority large mission in the 2020 Decadal Survey.
 - The next large mission after WFIRST could be started when funding becomes available as WFIRST approaches launch in the early or mid-2020s.

NASA's Astrophysics Division supports technology developments enabling and enhancing efforts to discover how the universe works, explore how it began and evolved, and search for life on planets around other stars

Cosmic Origins (COR)

Explore the origin and evolution of the galaxies, stars and planets that make up our universe



cor.gsfc.nasa.gov

Physics of the Cosmos (PCOS)

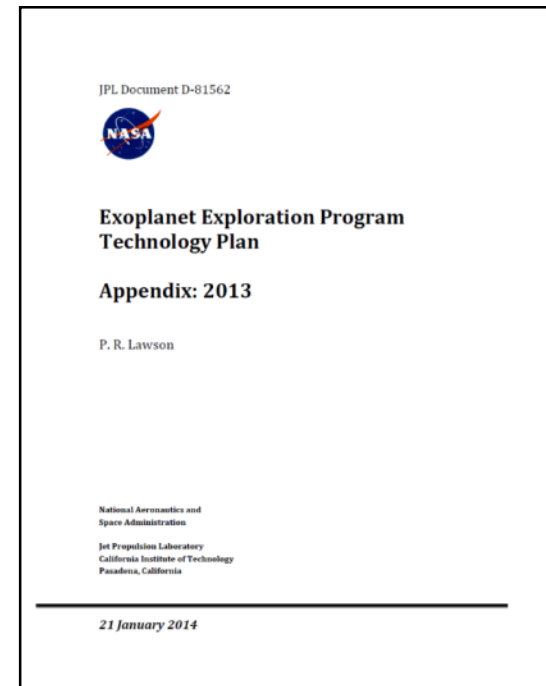
Probe the origin and destiny of our universe, including the nature of black holes, dark energy, dark matter and gravity



pcos.gsfc.nasa.gov

ExoPlanet Exploration (ExEP)

Discover and study planets around other stars, and explore whether they could harbor life



exep.jpl.nasa.gov

Submit a ROSES-14 proposal to APRA or SAT

NOIs due 01/23/2015

Proposals due 03/20/2015



Preparing for the 2020 Decadal Survey Large Mission Concepts

Part A – 2015

- Identify a small set of candidate large mission concepts to study
 - Incorporate community input through the three Astrophysics Program Analysis Groups (PAGs)

Part B – 2016-2019

- Initiate studies
 - Includes community-based Science and Technology Definition Teams
- Conduct studies
 - Includes NASA Center-provided engineering teams
- Identify technology requirements to motivate early technology development
 - Enables funding through existing Astrophysics technology programs
- Deliver results to 2020 Decadal Survey committee

Planning for the 2020 Decadal Survey: An Astrophysics Division White Paper
available at <http://science.nasa.gov/astrophysics/documents>



Preparing for the 2020 Decadal Survey Large Mission Concepts

Part A: Identify a small set (~3-4) of large mission concepts to study

- The community has invested considerable resources in discussing notional classes of mission concepts for consideration as large missions following JWST and WFIRST and in parallel with the ESA-led missions Euclid, Athena, and L3.
 - The 2010 Decadal Survey, *New Worlds New Horizons in Astronomy and Astrophysics*.
 - The 2014 Astrophysics Visionary Roadmap, *Enduring Quests, Daring Visions*.
- NASA has drawn an initial small set of 4 candidate mission concepts from the missions discussed in these strategic documents.
- I am charging the Astrophysics PAGs to solicit community input for the purpose of commenting on the small set, including adding or subtracting large mission concepts; each PAG will submit a report regarding the small set of large mission concepts for consideration by the NAC Astrophysics Subcommittee.
- At its Fall 2015 meeting, the NAC Astrophysics Subcommittee will consider the three PAG reports and submit a report to NASA on the small set of large mission concepts for study.
- The Director of the NASA Astrophysics Division will decide which large mission concepts will be studied as input for the 2020 Decadal Survey.



Timeline to Identify Studies

| | |
|-----------------------------------|--|
| November 2014 | Discussion of this plan with the Astrophysics Subcommittee and the Committee on Astronomy and Astrophysics |
| December 2014 | Presentation of this plan to the Executive Committees of the PAGs |
| January 2015 | Announcement of this process to the PAGs, including formal charges, in a joint PAG meeting prior to the AAS meeting in Seattle |
| January 2015 – Summer 2015 | Community discussion and input led by the PAG Executive Committees. Each PAG will determine an appropriate process for community discussion and input. The PAG process will include input from the broad astronomical community, optionally including open meeting(s) of the PAG. Each PAG will develop a public report for submission to the NAC Astrophysics Subcommittee. |
| Fall 2015 | Meeting of the NAC Astrophysics Subcommittee to consider the three PAG reports and report to NASA on a small set of large mission concepts for study. |
| Fall 2015 | Decision by the Astrophysics Division Director identifying the small set of candidate large mission concepts that will be studied by NASA as input for the 2020 Decadal Survey. |



Preparing for the 2020 Decadal Survey Large Mission Concepts

Part B: Science and Technology Definition Team conducts studies

- Following an open call, a Science and Technology Definition Team (STDT) will be appointed for each mission concept study selected by the Astrophysics Division Director.
 - Each study will be assigned by the Astrophysics Division Director to a NASA Center for execution. The Center will provide a study manager and appropriate engineering support to the STDT.
 - Oversight of each study will be assigned to an Astrophysics Program Office at GSFC (Cosmic Origins/Physics of the Cosmos Program Office) or JPL (Exoplanet Exploration Program Office).
- The STDT will define science objectives and a strawman payload for the mission concept.
 - The STDT will also identify the technology development requirements for the mission concept.
 - The Center study team will develop a design reference mission and conduct a cost assessment, with the participation of the STDT.
- The STDT will issue at least one interim report that includes a draft science case, a draft strawman payload and design reference mission, and technology development requirements.
 - This draft report will be used as input to NASA's technology development funding process.



Preparing for the 2020 Decadal Survey Large Mission Concepts

- It is anticipated that the process will require multiple meetings of the STDT, usually virtual (phone/online) and occasionally in person.
 - It is also anticipated that the process will require several iterations between the STDT and the Center study team to develop a cost-effective design reference mission.
- The STDT will issue a final report that includes a science case with proposed science objectives, a strawman payload, a design reference mission, and technology development required to enable a new mission start.
- NASA will conduct a cost assessment.
- These products will be developed in time to be submitted to the 2020 Decadal Survey Committee at an appropriate point in its study process.



Preparing for the 2020 Decadal Survey Medium-class (Probe) Concepts

Probe-class (medium size) mission concepts

- No decision has been made by NASA at this time on how to provide input to the 2020 Decadal Survey Committee regarding probe-class missions.
- There are multiple paths to identifying probe-class mission concepts, and none have been precluded at this time.
- Each of the STDTs for large mission concepts will be challenged to identify one or more probe-class versions of their mission and to estimate the percentage of the original science case that can be achieved.
- The Mid-Decade Review may provide recommendations to NASA regarding the value of probe-class mission concept studies in advance of the 2020 Decadal Survey.
- Should NASA conduct stand-alone probe-class mission concept studies, they would be initiated no earlier than FY2017.



Charge to the PAGs

- Each of the three Astrophysics Program Analysis Groups (PAGs) – the Cosmic Origins Program Analysis Group (COPAG), the Exoplanet Exploration Program Analysis Group (ExoPAG), and the Physics of the Cosmos Program Analysis Group (PhysPAG) – are charged with reviewing this small set of candidate large mission concepts and suggesting additions, subtractions, and other useful commentary.
- The results of this review shall be reported to the NAC Astrophysics Subcommittee in the form of a report.



Charge to the PAGs (1 of 2)

1. Each PAG, under the leadership of its Executive Committee, shall broadly solicit the astronomy and astrophysics community for input to the report in an open and inclusive manner.
 - To accomplish this, each PAG is empowered to envision and use its own process.
2. Each PAG will consider what set of mission concepts should be studied to advance astrophysics as a whole; there is no desire for mission concepts to be identified as “belonging” to a specific Program or PAG.
 - Each PAG shall keep the number of large mission concepts in the set as small as possible.
 - Each PAG is specifically charged to consider modifications and subtractions from the small set, and not just additions.
3. Each PAG shall produce a report, where it shall comment on all large mission concepts in its small set of large missions, including those in the initial small set and those added or subtracted.
 - The PAGs may choose to work together and submit coordinated or joint reports.



Charge to the PAGs (2 of 2)

4. Each PAG may choose to have a face-to-face meeting or workshop in developing its report; said meeting may be scheduled in proximity to an existing community meeting or conference.
5. Although there is no page limit for the report, each PAG shall strive to be succinct.
6. Each PAG shall submit its report in writing no later than two weeks prior to the Fall 2015 meeting of the NAC Astrophysics Subcommittee (meeting schedule not yet known).



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 Large Mission Concepts

The missing Surveyors

a) CMB Polarization Surveyor

- Based on concepts that have been proposed as a NASA Astrophysics Explorer, as an ESA M-class mission, and as a JAXA strategic mission, a CMB Polarization Surveyor should be realizable as a probe-class mission.
- Therefore a CMB Polarization Surveyor is not included as a candidate large mission concept.

b) GW Surveyor

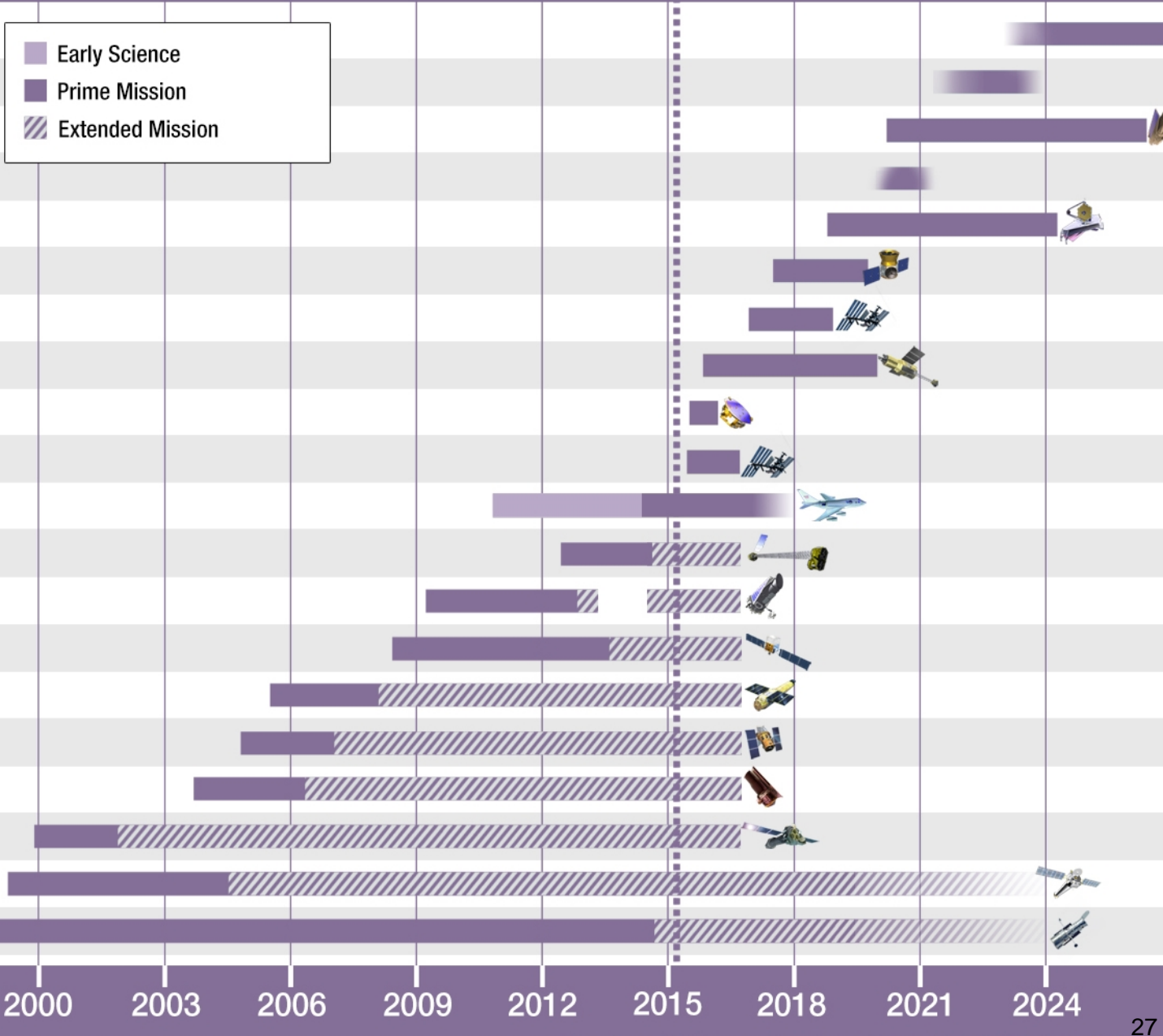
- The Gravitational Wave (GW) Surveyor is the highest ranked large mission after WFIRST in the 2010 Decadal Survey.
- NASA is planning to partner with ESA on its L3 GW observatory. During the current decade, NASA will participate with ESA in the preparatory studies that will lead toward the L3 GW observatory.
- As long as that mission remains viable, NASA's plans for realizing a space-based GW observatory are focused on an ESA-led, NASA-supported L3 mission.
- Therefore a large mission study similar to the ones discussed here is not required for the GW Surveyor.



Astrophysics Timeline

- Decadal Survey Mission
- MIDEX/MO (AO NET 2016)
- Euclid (ESA)
- SMEX/MO (AO 2014)
- JWST (ESA, CSA)
- TESS
- NICER
- ASTRO-H (JAXA)
- ST-7/LPF (ESA)
- ISS-CREAM (South Korea)
- SOFIA (DLR)
- NuSTAR (ASI, Denmark)
- Kepler
- Fermi (DOE, Intl team)
- Suzaku (JAXA)
- Swift (ASI, UK)
- Spitzer
- XMM-Newton (ESA)
- Chandra (SRON)
- Hubble (ESA)

- Early Science
- Prime Mission
- Extended Mission



TIMELINE CY

2000 2003 2006 2009 2012 2015 2018 2021 2024



Backups



SMD Education

- Education is funded in the FY15 NASA Appropriation Act at \$42M SMD-wide as a separate budget line (so E/PO is no longer budgeted as 1% of every mission).
- SMD will compete and consolidate education activities for FY16.
- SMD intends to release a Cooperative Agreement Notice (CAN) soliciting team-based proposals for science education.
- The goal of the NASA SMD Science Education CAN is to meet the following NASA SMD Science Education Objectives: Enabling STEM education, improving U.S. science literacy; advancing National education goals; and leveraging science education through partnership.

- The schedule is as follows:

| | |
|--|----------------------------------|
| Draft CAN Release Date (target) | October 2014 |
| Final CAN Release Date (target) | ~January 2015 |
| Preproposal Conference | ~2 weeks after final CAN release |
| Notice of Intent to Propose Deadline | 30 days after final CAN release |
| Electronic Proposal Submittal Deadline | 90 days after final CAN release |
| Selections Announced (target) | Summer 2015 |
| Projects Begin (target) | October 1, 2015 |



Charge to the PAGs (3 of 2)

While there are no prescriptions for the format of the PAG report (other than being succinct), this Appendix provides some guidelines.

It is suggested that each PAG report include the following:

1. Process followed by the PAG to solicit input from community (meetings, white papers, emails, etc.);
2. Brief description of the community response;
3. Procedure and criteria used for PAG analysis of the community response;
4. Outcome of the analysis and final small set of mission concepts submitted to the NAC Astrophysics Subcommittee; every mission concept that is retained, added, or subtracted must be accompanied by a short rationale; and
5. Any additional considerations for NASA.

Should a PAG wish to provide NASA a list of potential probe-class missions, to inform any future process for considering probe-class mission studies, such a list may be appended to the report.