National Aeronautics and Space Administration

Astrophysics

Physics of the Cosmos Program




PCOS Update
AAS HEAD Meeting
April 5, 2016

Daniel Evans
NASA Headquarters

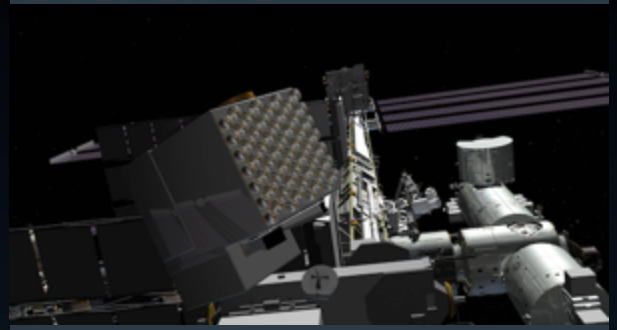
Astrophysics - Big Picture

- **The FY16 appropriation and FY17 President's budget request provide funding for NASA astrophysics to continue its programs, missions, projects, and supporting research and technology.**
  - JWST remains on course for an October 2018 launch.
  - WFIRST formulation began in February 2016.
- **Our operating missions continue to generate important and compelling science results, and new missions are under development for the future.**
  - 5 SMEX and MO concept studies selected in 2015; MIDEX AO in 2016.
- **We are making progress toward meeting the recommendations of the 2010 Decadal Survey.**
  - NRC Midterm Assessment (with NSF, DOE) underway; report expected in May 2016.

Astrophysics Missions in Development

NICER
3/2017

NASA Mission



Neutron Star Interior Composition Explorer

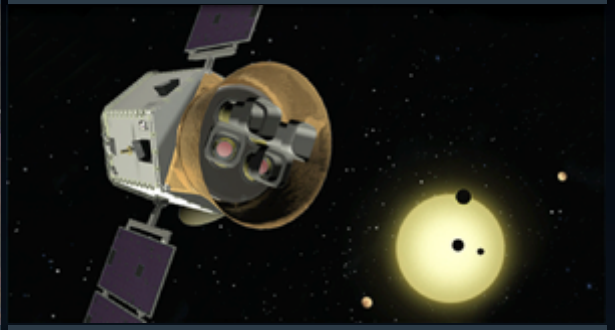
CREAM
7/2017

NASA Mission

Cosmic Ray Energetics And Mass

TESS
8/2017

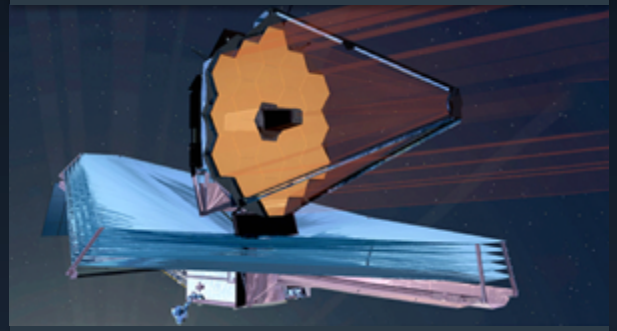
NASA Mission



Transiting Exoplanet Survey Satellite

JWST
10/2018

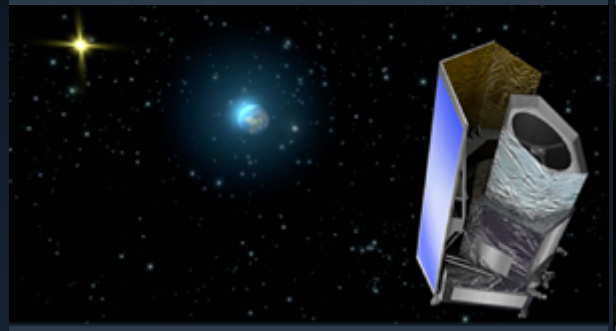
NASA Mission



James Webb Space Telescope

Euclid
2020

ESA-led Mission



NASA is supplying the NISP Sensor Chip System (SCS)

WFIRST
Mid 2020s

NASA Mission

Wide-Field Infrared Survey Telescope


Formulation
Implementation
Primary Ops
Extended Ops
Spitzer
8/25/2003
Kepler
3/7/2009
LISA Pathfinder (ESA)
12/3/2015
WFIRST
Mid 2020s
Euclid (ESA)
2020
JWST
2018
Chandra
7/23/1999
XMM-Newton (ESA)
12/10/1999
TESS
2017
NuSTAR
6/13/2012
Swift
11/20/2004
Hitomi/ASTRO-H
(JAXA)
2/17/2016
Fermi
6/11/2008
Hubble
4/24/1990
CREAM (on ISS)
2017
NICER (on ISS)
2017
SOFIA
Full Ops 2014

2016 Senior Review –
NASA Response Expected May/June

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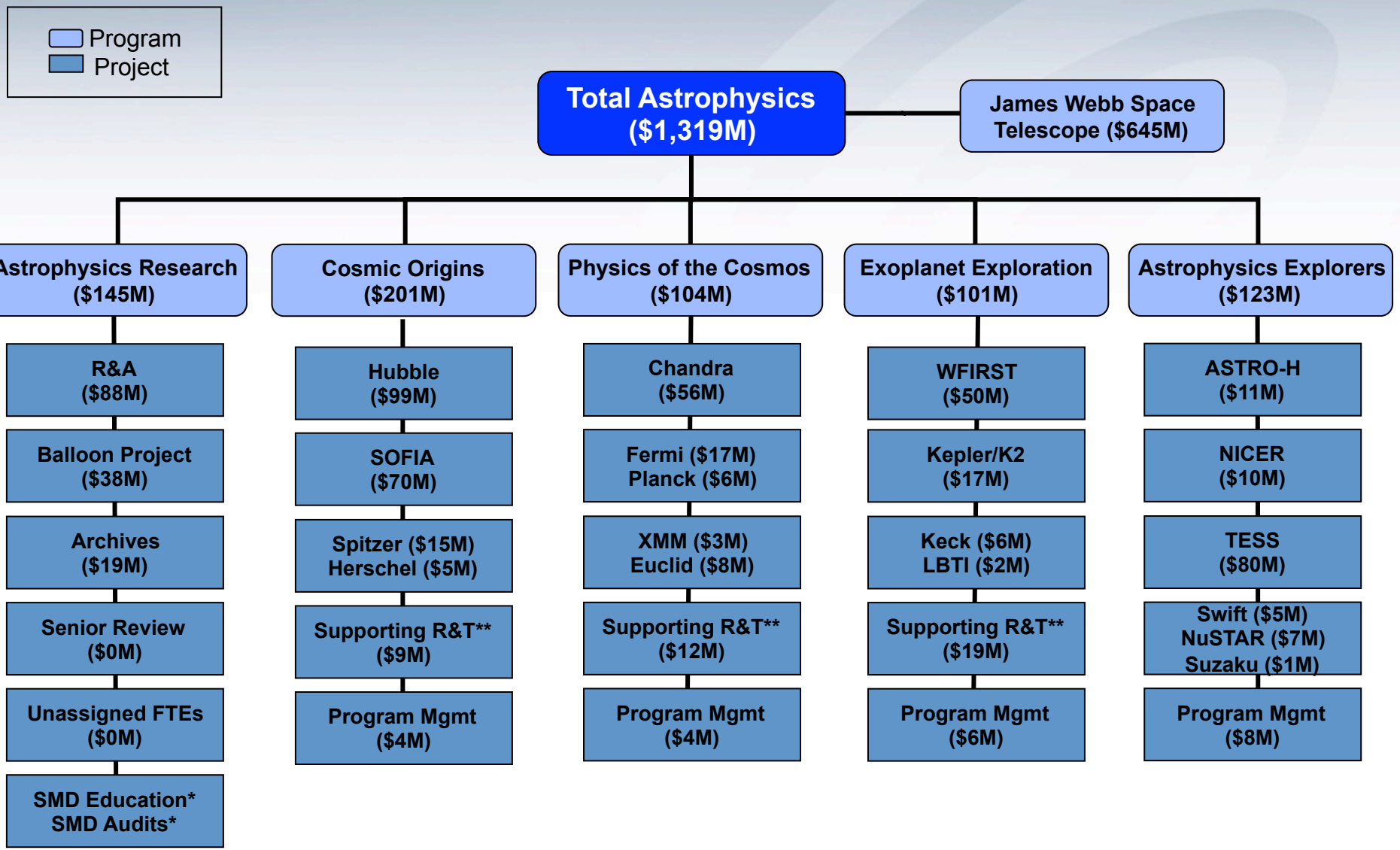
Current PCOS Activities

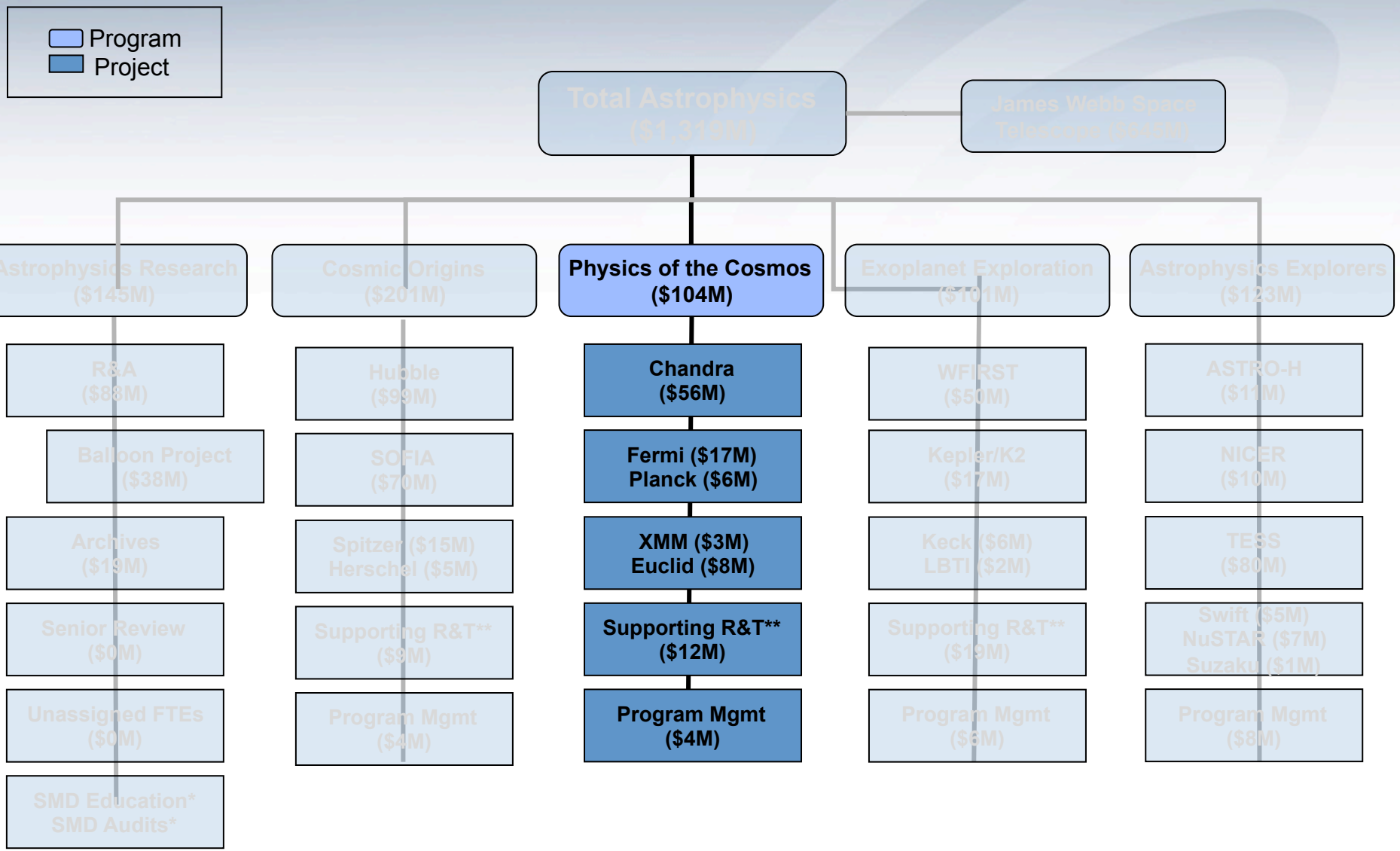
Astrophysics Programs - FY15 Appropriations



* subtracted from total

** SR&T includes SAT, Fellows, ST-7/LPF, Athena, EPDS/NN-EXPLORE, NExScI, NAI, mission studies

Astrophysics Programs - FY15 Appropriations

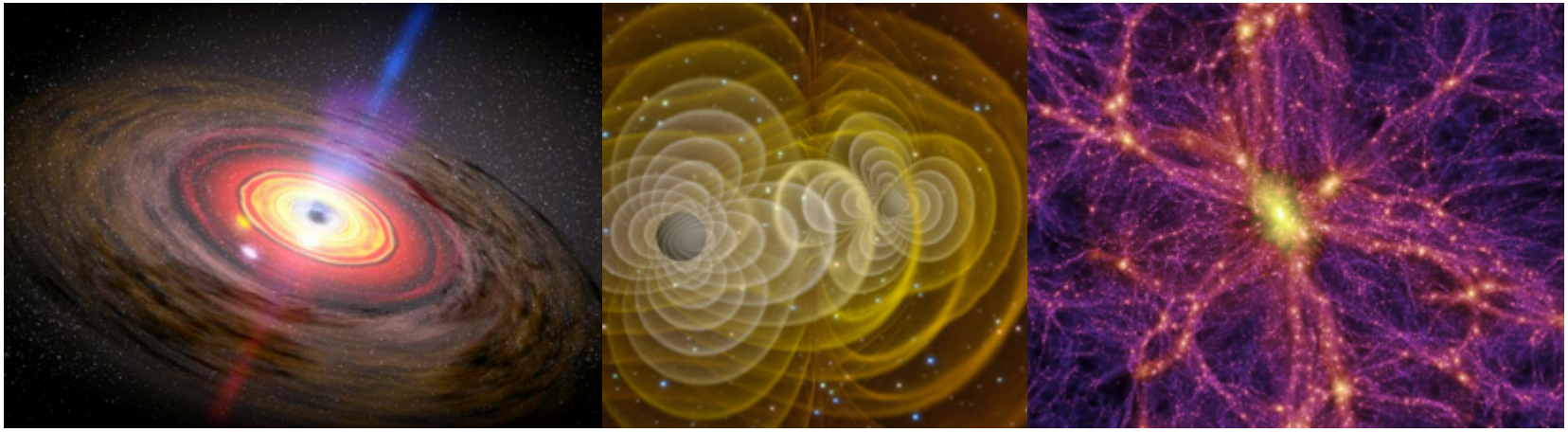


* subtracted from total

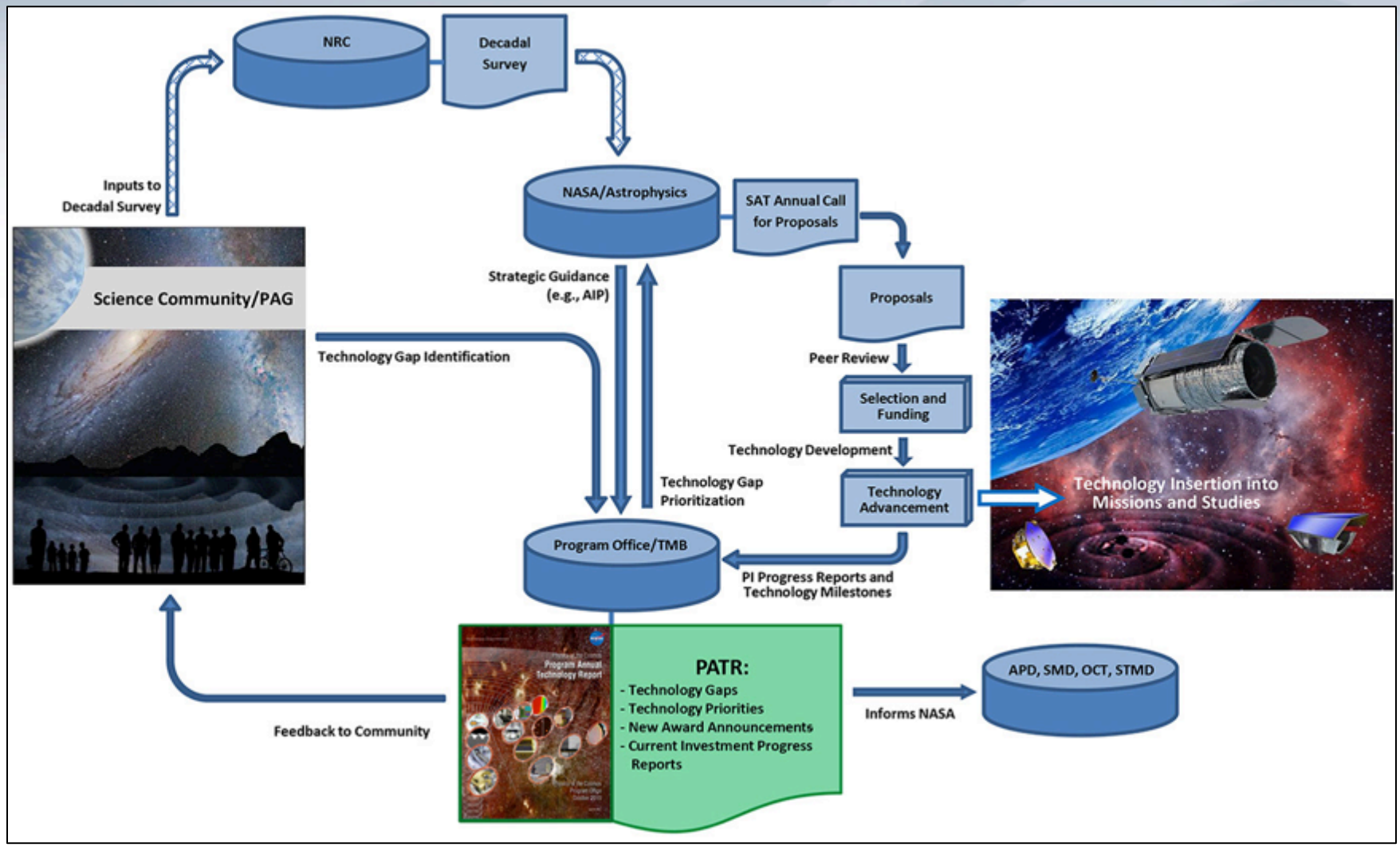
** SR&T includes SAT, Fellows, ST-7/LPF, Athena, mission studies

PCOS Science Objectives

- Expand our knowledge of dark energy.
- Precisely measure the cosmological parameters governing the evolution of the universe and test the inflation hypothesis of the Big Bang.
- Test the validity of Einstein's General Theory of Relativity and investigate the nature of spacetime.
- Understand the formation and growth of massive black holes and their role in the evolution of galaxies.



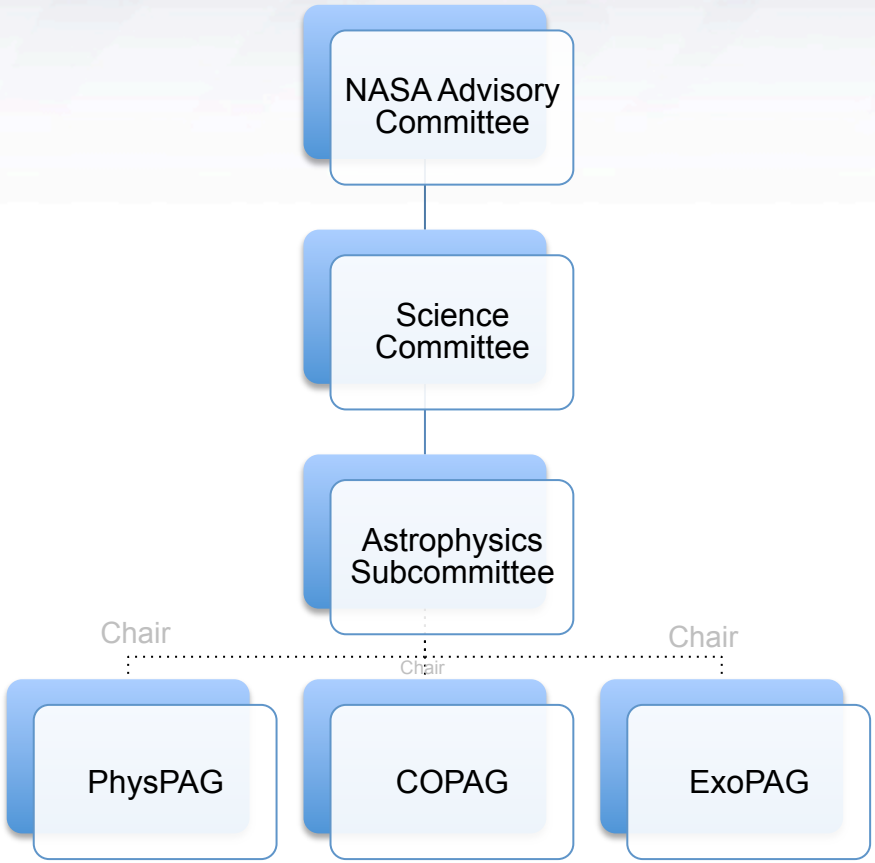
PCOS Technology Maturation and Mission Development



The next deadline for technology gap input is June 1st.

Communicating with NASA Astrophysics via the Program Analysis Groups (PAGs)

- The Physics of the Cosmos Program Analysis Group (PhysPAG) coordinates input and analysis from the scientific community in support of the PCOS program objectives.
- Study Analysis Groups (SAGs) conduct specific analyses.
- Science Interest Groups (SIGs) are longer-standing discipline forums.
  - IPSIG (next meeting at APS)
  - GWSIG (next meeting at APS)
  - XRSIG (Town Hall tonight)
  - GammaSIG (Town Hall yesterday)
  - CRSIG (next meeting at APS)
  - CoSSIG



PhysPAG EC Members

Name	Affiliation	Area of Expertise	Term Ends
J. Bock, Chair	Caltech/JPL	CMB	Dec 2016
M. Bautz	MIT	X-ray astrophysics	Dec 2016
R. Bean	Cornell University	Dark Energy	Dec 2016
N. Cornish	Montana State University	Gravitational Waves	Dec 2016
M. McConnell	Univ. of New Hampshire	Gamma-ray astrophysics	Dec 2016
Eun-Suk Seo	Univ. of Maryland	Particle astrophysics	Dec 2016
J. Conklin	Univ. of Florida	Gravitational Waves	Dec 2017
O. Doré	JPL	Dark Energy	Dec 2017
H. Krawczynski	Washington University	Gamma-ray astrophysics	Dec 2017
A. Miller	Columbia University	CMB	Dec 2017
E. Wollack	NASA/GSFC	CMB	Dec 2017
I. Moskalenko	Stanford University	Particle astrophysics	Dec 2018
R. Kraft	SAO	X-ray astrophysics	Dec 2018

Expect a new call for PhysPAG EC membership in August, 2016

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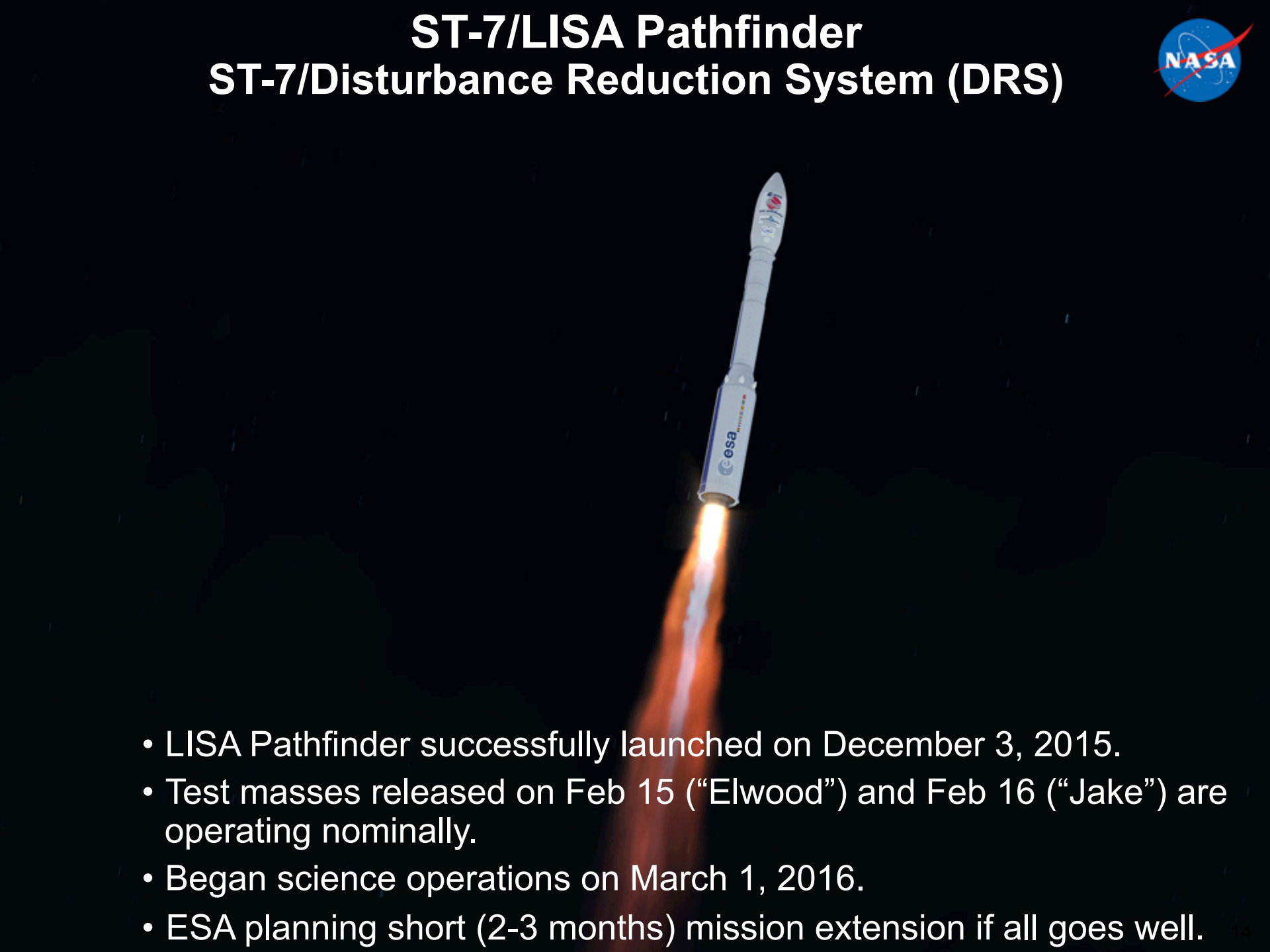
PCOS Mission Update

ST-7/LISA Pathfinder
ST-7/Disturbance Reduction System (DRS)



- LISA Pathfinder successfully launched on December 3, 2015.
- Test masses released on Feb 15 (“Elwood”) and Feb 16 (“Jake”) are operating nominally.
- Began science operations on March 1, 2016.
- ESA planning short (2-3 months) mission extension if all goes well.

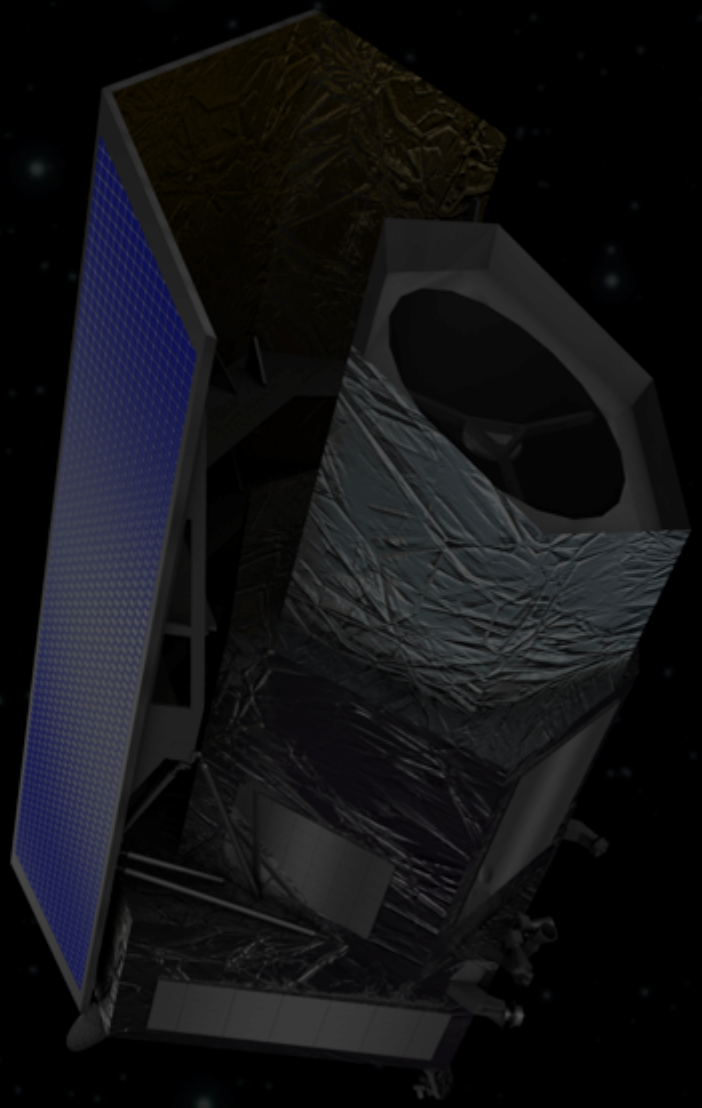
NASA's L3 Study

- NASA intends to partner with ESA on the ESA-led L3 gravitational wave mission with launch in 2034.
- NASA has formed an L3 Study Team (L3ST), drawing membership from members of the US astrophysics community.
- The goals of the L3ST are:
  1. Analyze the options for NASA participation in the L3 mission and work with the European L3 consortium on proposals to ESA; and
  2. Prepare a report to the 2020 Decadal Survey on NASA's participation, including possible options, in the L3 mission as a minority partner.
- The L3ST Charter and list of selected members can be found at **http://pcos.gsfc.nasa.gov/studies/L3**.
- See also:
  - Update by John Conklin, this session.
  - LIGO Plenary by Laura Cadonati, today at 1:30pm.
  - Gravitational Waves session, tomorrow at 8:30am.

Euclid

A visible and near-infrared telescope to explore cosmic evolution

- ESA Cosmic Vision 2015-2025 Mission, M-Class with NASA participation.
- Launch Date: December 2020
- Euclid will look back 10 billion years into cosmic history.
- Optimized for weak lensing, galaxy clustering, and BAO studies.
- Currently in implementation phase.
- JPL has taken delivery of the first flight detectors.
- NASA replan was completed on February 26, 2016 which has the first flight detectors being delivered to ESA in March 2017.



Athena
Advanced Telescope for High Energy Astrophysics

- ESA L-class mission with NASA participation.
- Launch date: 2028
- Large X-ray mirror, X-IFU and WFI instruments.
- 10x Chandra area, 100x improved non-dispersive spectral resolution, 5x FOV.
- NASA budgeting for a $100M-$150M hardware contribution, plus a US GO program and a US data center.
- NASA will provide the sensor array for the X-ray Integral Field Unit (calorimeter)
- NASA and ESA are discussing other possible NASA contributions, such as:
  - A contribution to the WFI.
  - Use of the NASA XRCF for Calibration.
  - Contribution to science data center (U.S. node).
- For more information, speak to Mike Garcia (NASA HQ Athena Program Scientist)

US Athena Team Involvement

- Athena Science Study Team
  - Chartered by ESA (10 members)
  - Randall Smith, US member
- ASST Science Working Groups
  - Set up by ASST
  - Now 119 US members
  - 24 selected for NASA travel funding
- NASA hosts annual meetings of US SWG co-Chairs, presentations on PCOS website.

- Proposals Summer 2016
- Athena X-IFU
  - PI Didier Barret, IRAP
  - Rich Kelley, GSFC, US co-I
  - Jon Miller, Science Team
  - TBD Proportional access to Science Team.
  - Access to GTO time
- Athena WFI (under discussion)
  - PI Kirpal Nandra, MPE
  - David Burrows, Penn St., possible US co-I

PCOS-Related: Hitomi

- JAXA mission with substantial US instrument contributions.
  - Soft X-ray telescope mirrors (SXT-S and SXT-I)
  - X-ray Calorimeter Spectrometer Insert (CSI), including Adiabatic Demagnetization Refrigerator (ADR) and ADR Controller
  - Aperture Assembly
  - X-ray Electronics Box (X-box)
  - High Temperature Superconducting Leads
- Launched: Feb 17, 2016.
- JAXA found that communication with the X-ray Astronomy Satellite "Hitomi" (ASTRO-H), launched on February 17, 2016 (JST), failed from the start of its operation originally scheduled at 16:40, Saturday March 26 (JST).
- JAXA has set up emergency headquarters, headed by the President, for recovery and investigation.
- JAXA is leading the investigation and is consulting with NASA from a technical and policy perspective.
- NASA fully supports JAXA and stands prepared to assist as requested going forward.
- Special Session this afternoon at 2pm.

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Preparing for the 2020 Decadal Survey

Large Mission Concept Studies

- NASA has commissioned Mission Concept Studies for the:
  - Far Infrared Surveyor (COR)
  - Habitable Exoplanet Imaging Mission (ExEP)
  - Large Ultraviolet, Optical, and Infrared Surveyor (COR)
  - X-ray Surveyor (PCOS)
- The four Large Mission Concept Studies will inform the 2020 NRC Decadal Survey.
- NASA defines "full success" as delivery to the Decadal Survey Committee of four compelling and executable concepts so that the science of all four large missions can be adequately prioritized by the 2020 Decadal Survey.
- STDTs appointed in March, 2016.
- The role of the study teams is to make the best case for the concepts.
- See also: upcoming talk by Jessica Gaskin
- See also: XRSIG Town Hall tonight
- See also: X-ray Surveyor Happy Hour, 5:30pm tonight

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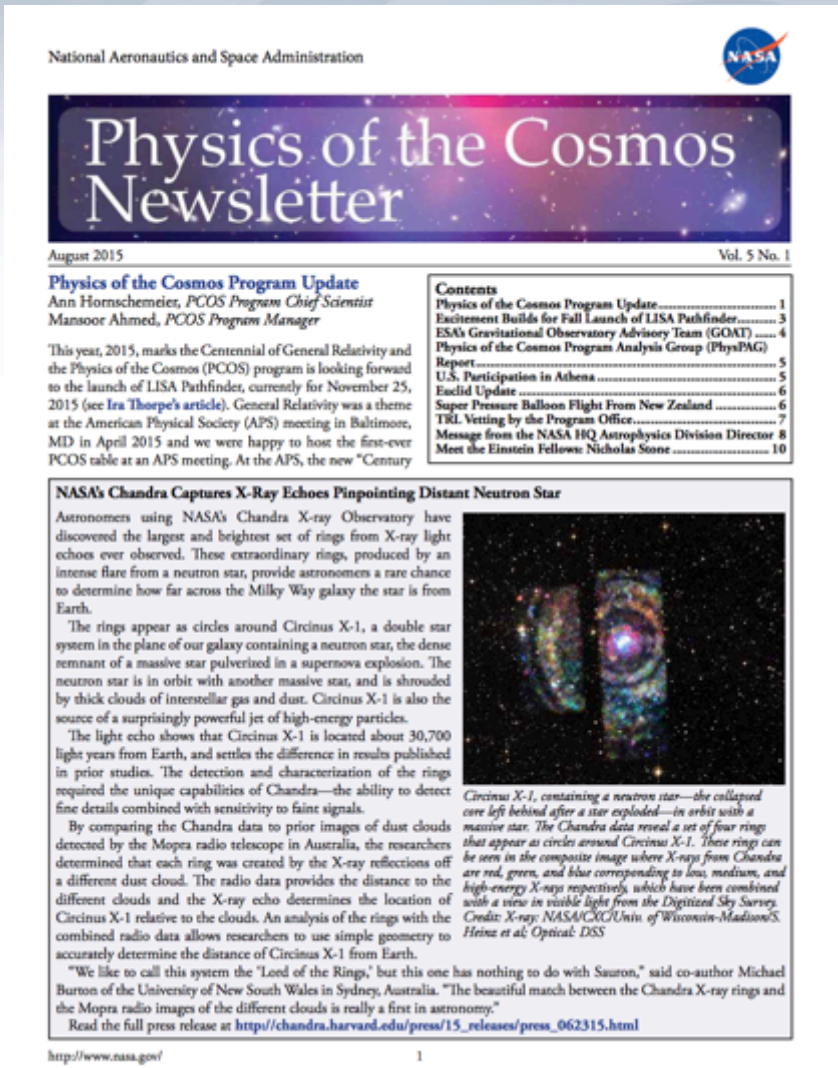
Getting Involved, and Getting in Touch

Keeping up with PCOS

- http://pcos.gsfc.nasa.gov
- View the latest newsletter.
- Sign up to the PCOS email list.
- Sign up to be included on SIG emails.
- Members of NASA PCOS Team present at this meeting:
  - Peter Bertone
  - Dan Evans
  - Wilt Sanders



National Aeronautics and Space Administration

Physics of the Cosmos Newsletter

August 2015 Vol. 5 No. 1

Physics of the Cosmos Program Update

Ann Hornschemeier, *PCOS Program Chief Scientist*
Mansoor Ahmed, *PCOS Program Manager*

This year, 2015, marks the Centennial of General Relativity and the Physics of the Cosmos (PCOS) program is looking forward to the launch of LISA Pathfinder, currently for November 25, 2015 (see Ira Thorpe's article). General Relativity was a theme at the American Physical Society (APS) meeting in Baltimore, MD in April 2015 and we were happy to host the first-ever PCOS table at an APS meeting. At the APS, the new "Century

Contents

NASA's Chandra Captures X-Ray Echoes Pinpointing Distant Neutron Star

Astronomers using NASA's Chandra X-ray Observatory have discovered the largest and brightest set of rings from X-ray light echoes ever observed. These extraordinary rings, produced by an intense flare from a neutron star, provide astronomers a rare chance to determine how far across the Milky Way galaxy the star is from Earth.

The rings appear as circles around Circinus X-1, a double star system in the plane of our galaxy containing a neutron star, the dense remnant of a massive star pulverized in a supernova explosion. The neutron star is in orbit with another massive star, and is shrouded by thick clouds of interstellar gas and dust. Circinus X-1 is also the source of a surprisingly powerful jet of high-energy particles.

The light echo shows that Circinus X-1 is located about 30,700 light years from Earth, and settles the difference in results published in prior studies. The detection and characterization of the rings required the unique capabilities of Chandra—the ability to detect fine details combined with sensitivity to faint signals.

By comparing the Chandra data to prior images of dust clouds detected by the Mopra radio telescope in Australia, the researchers determined that each ring was created by the X-ray reflections off a different dust cloud. The radio data provides the distance to the different clouds and the X-ray echo determines the location of Circinus X-1 relative to the clouds. An analysis of the rings with the combined radio data allows researchers to use simple geometry to accurately determine the distance of Circinus X-1 from Earth.

"We like to call this system the 'Lord of the Rings,' but this one has nothing to do with Sauron," said co-author Michael Burton of the University of New South Wales in Sydney, Australia. "The beautiful match between the Chandra X-ray rings and the Mopra radio images of the different clouds is really a first in astronomy."

Read the full press release at http://chandra.harvard.edu/press/15_releases/press_062315.html

Circinus X-1, containing a neutron star—the collapsed core left behind after a star exploded—in orbit with a massive star. The Chandra data reveal a set of four rings that appear as circles around Circinus X-1. These rings can be seen in the composite image where X-rays from Chandra are red, green, and blue corresponding to low, medium, and high-energy X-rays respectively, which have been combined with a view in visible light from the Digitized Sky Survey. Credit: X-ray: NASA/CXC/Univ. of Wisconsin-Madison/S. Heinz et al; Optical: DSS

http://www.nasa.gov/ 1