



Astrophysics



Physics of the Cosmos: An Update

American Astronomical Society

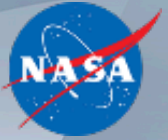
January 8, 2018

Rita Sambruna

PCOS Program Scientist

Astrophysics Division, NASA HQ

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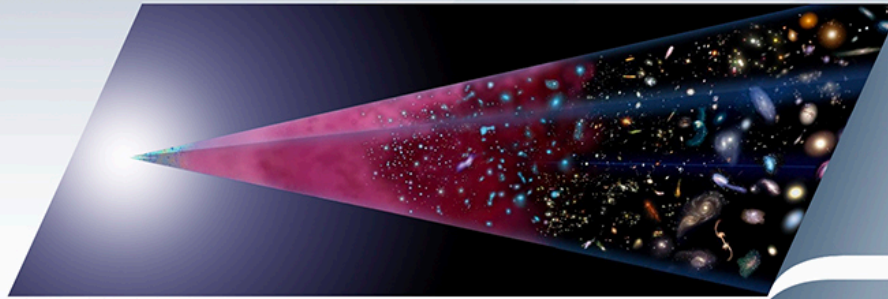


Why Astrophysics?

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



How did our universe begin and evolve?



Physics of the Cosmos (PCOS) Program



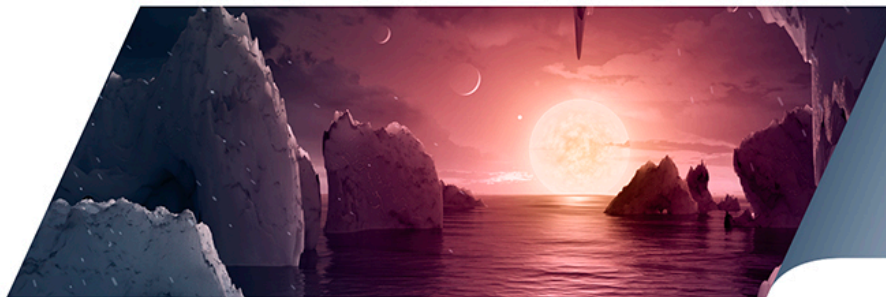
How did galaxies, stars, and planets come to be?



Cosmic Origins (COR) Program

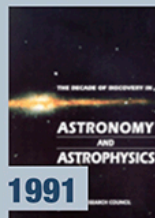
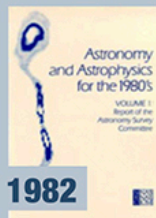


Are we alone?



Exoplanet Exploration Program (ExEP)

Enduring National Strategic Drivers



PCOS Activities

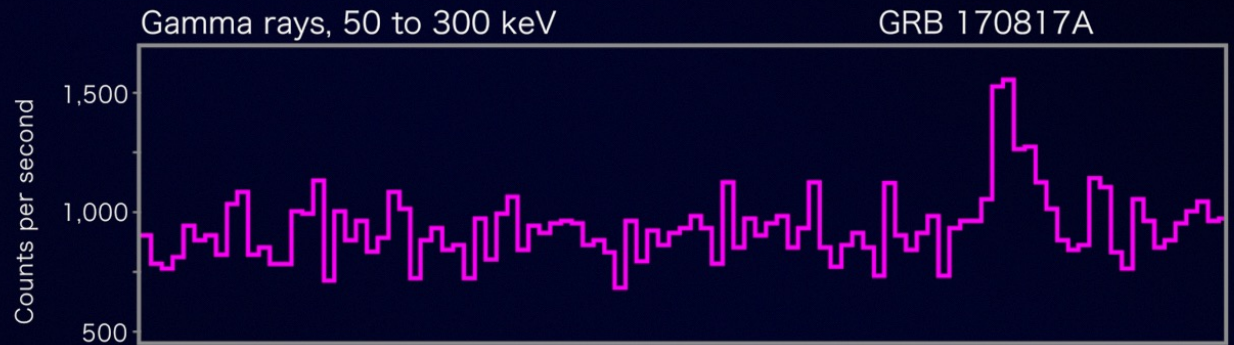


- PCOS activities are managed by the PCOS Program Office at NASA's Goddard Space Flight Center. These include:
 - Mission concept studies oversight
 - Strategic technology maturation oversight
 - Community Interface via the PhysPAG
- The PCOS Program Office also hosts the LISA and Athena Study Office which oversees science and technology activities for NASA's contribution to these ESA-led missions

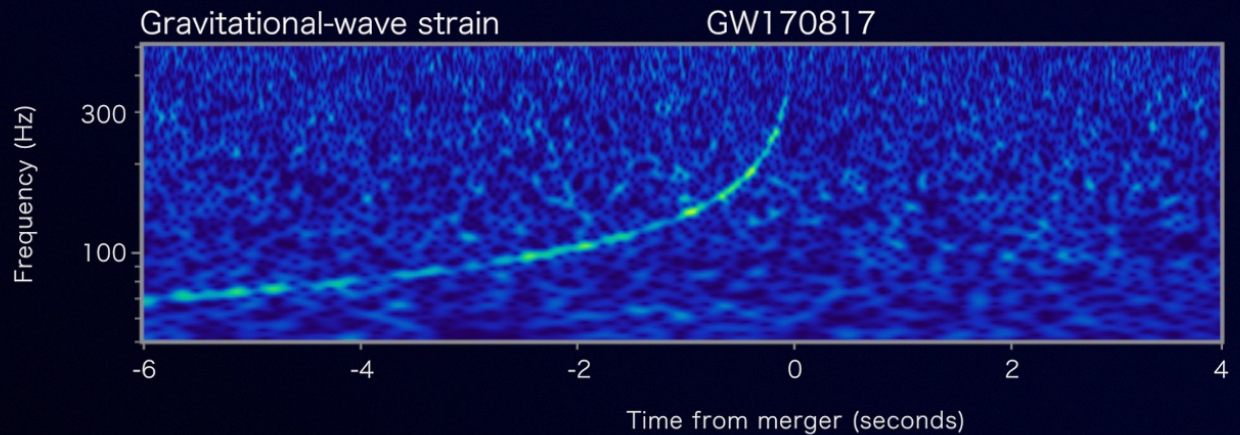
A PCOS Science Highlight of 2017: GW170817 / GRB170817a



Fermi



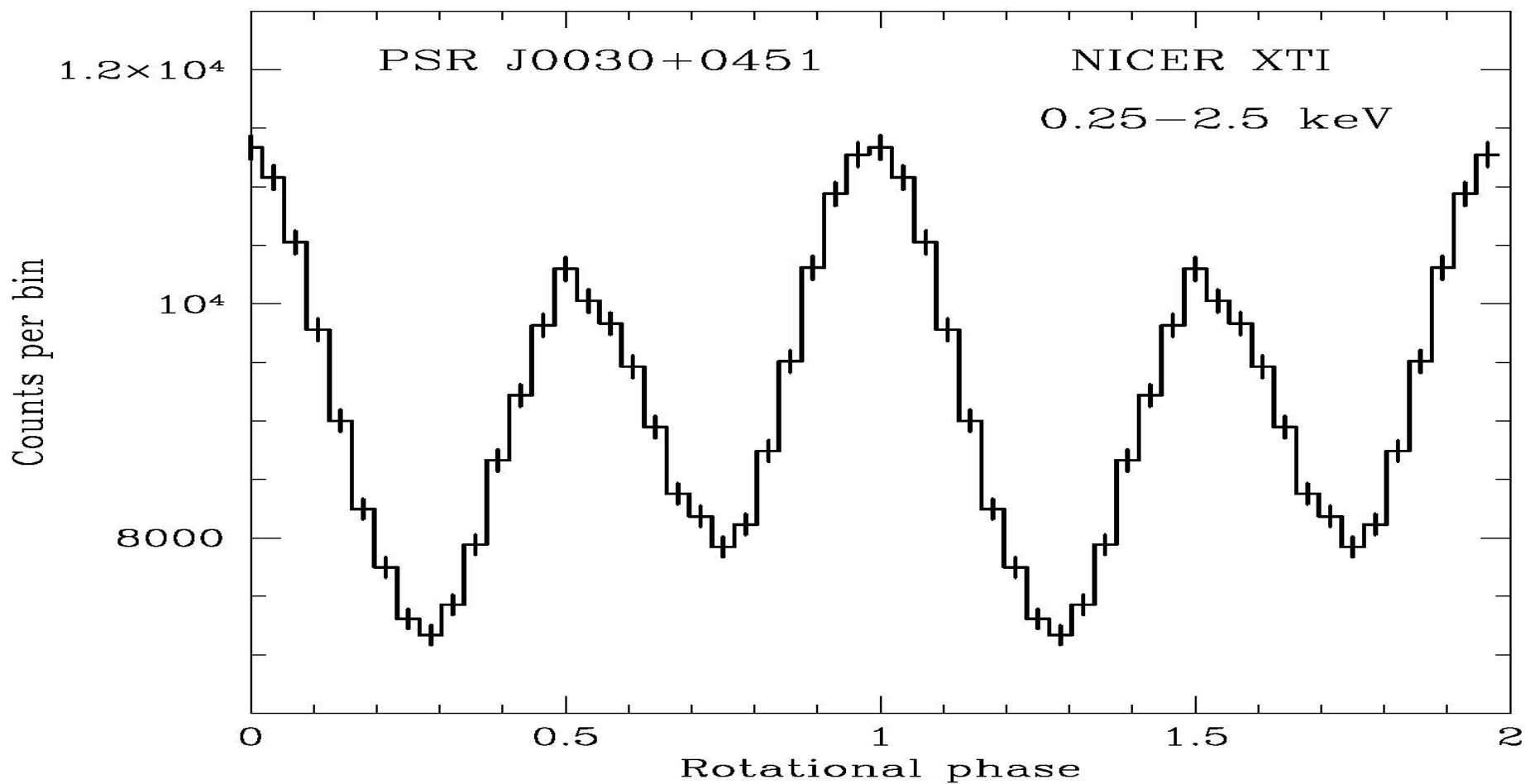
LIGO



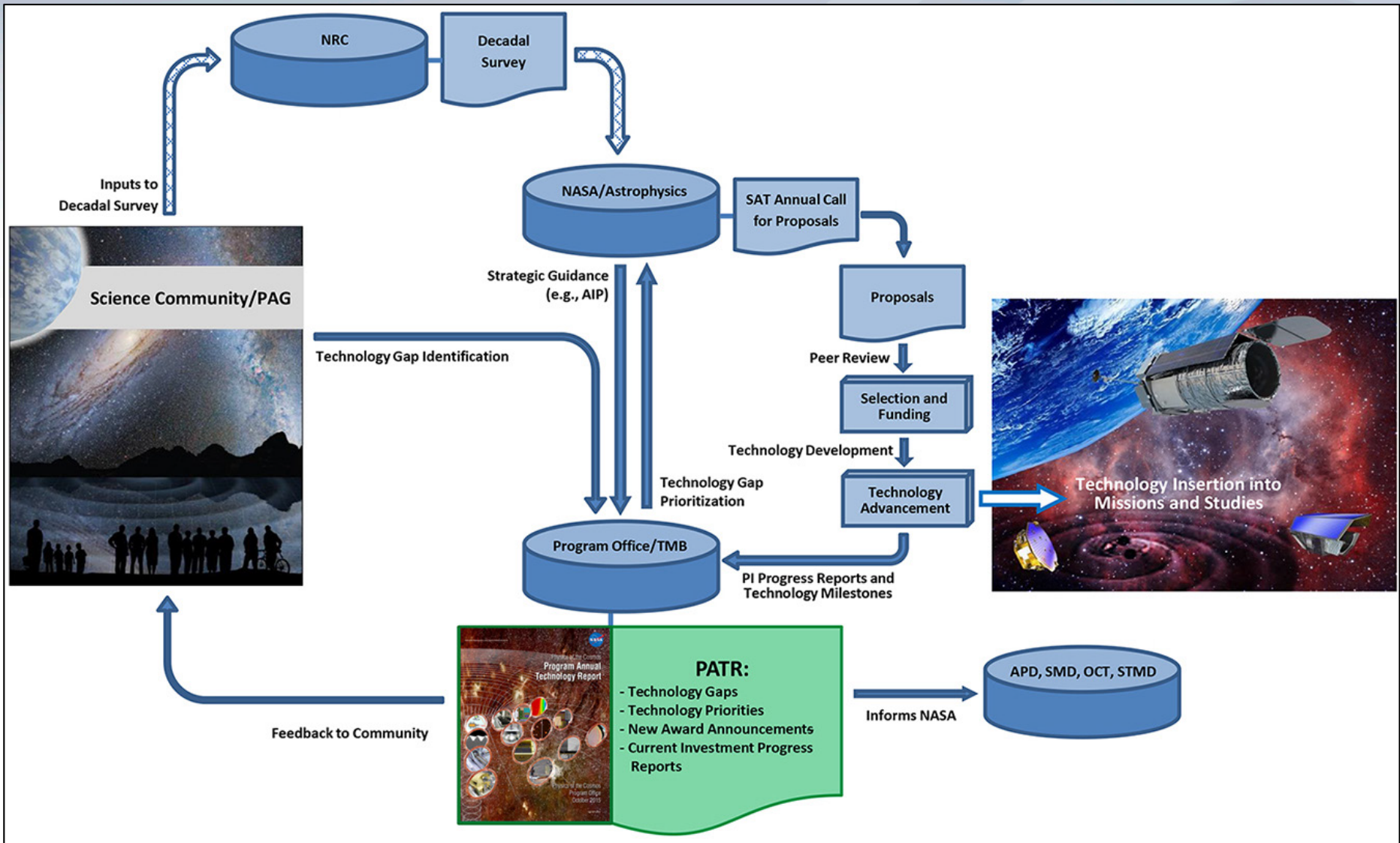
PCOS-related: NICER Measuring Neutron Star Equation of State



NICER special Session Tuesday, Jan 9, 10-11:30am
National Harbor iV



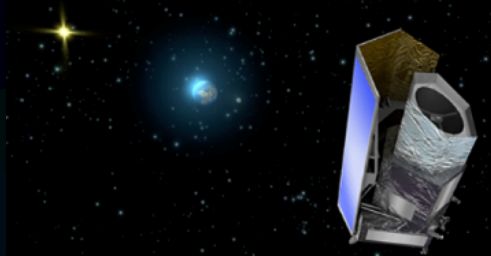
PCOS Technology Maturation and Mission Development



PCOS Missions

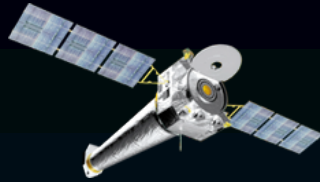
See update by P. Hertz at the NASA Townhall, Wednesday 12:45pm

Euclid 2020
ESA-led Mission



NASA is supplying the NISP
Sensor Chip System (SCS)

Chandra 7/1999
NASA Strategic Mission



Chandra X-ray Observatory

XMM-Newton 12/1999
ESA-led Mission



X-ray Multi Mirror - Newton

Fermi 6/2008
NASA Strategic Mission



Fermi Gamma-ray
Space Telescope

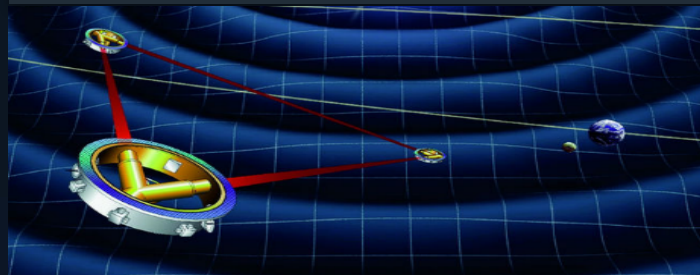
PCOS Missions in Pre-formulation

Athena Late
2020s
ESA-led Mission



NASA is supplying elements for
both instruments

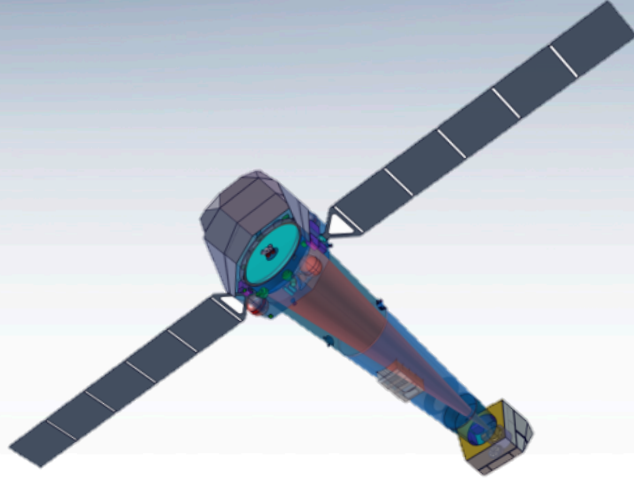
LISA Mid 2030s
ESA-led Mission



NASA is developing technology for
both the payload and the mission

Athena

Advanced Telescope for High Energy Astrophysics



Second ESA Cosmic Vision Large mission

- L-class with NASA/JAXA participation
- Decadal Survey recommendation
- Large X-ray mirror, X-ray Integral Field Unit (XIFU) and Wide Field Imager (WFI) instruments

Launch Date: 2028

Breakthrough Capabilities:

- High Throughput, High spectral resolution X-ray Astronomy, Wide FOV
- 10x Chandra area, 100x improved non-dispersive spectral resolution, 5x FOV.

Enabling Technologies: Silicon pore optics, 3000+ pixel μ -calorimeter (XIFU), large DEPFET array (WFI)

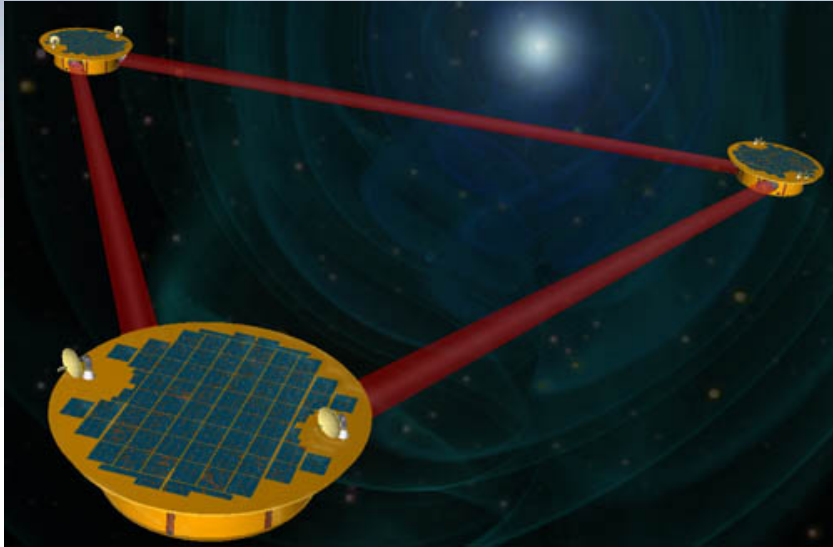
Science Objectives: The Hot and Energetic Universe: How does ordinary matter assemble into the large scale structures that we see today? How do black holes grow and shape the Universe?

CURRENT STATUS:

- Selected as second Large mission in ESA Cosmic Visions Program.
- Currently in 2-year Study Phase.
- NASA budgeting for a \$100M-\$150M hardware contribution, plus a U.S. GO program and a U.S. data center.
- NASA will contribute to both the X-IFU and the WFI instruments.
- NASA and ESA are discussing other possible NASA contributions to the observatory.
- NASA and U.S. community participating in Athena Science Study Team (including its Science Working Groups) and Instrument Teams.
 - Randall Smith (CfA) is NASA nominated member to ESA Athena Science Study Team
- Athena team will expand at Adoption in 2020; NASA anticipates this will provide an opportunity to expand U.S. community involvement.

LISA

Laser Interferometer Space Antenna



CURRENT STATUS:

- Selected as Third ESA Cosmic Vision Large Mission in June 2017
 - Phase 0 ended December 2017
 - Phase A starts January 2018
- NASA has established a LISA Study Office at GSFC.
- NASA is funding five US-based technologies with the aim of reaching TRL 5/6 by Adoption (nominally 2022-2024).
- NASA and U.S. community participating in LISA Science Study Team and the LISA Consortium.
 - Kelly Holley-Bockelman (Vanderbilt), David Shoemaker (MIT), and Robin (Tuck) Stebbins (Colorado) are NASA nominated member to ESA LISA Science Study Team
- NASA established a NASA LISA Study Team to interface with NASA LISA Study Office, LISA Consortium, and Decadal Survey
 - Chair is Kelly Holley-Bockelman (Vanderbilt)

Third ESA Cosmic Vision Large mission

- ESA mission with NASA participation
- Decadal Survey recommendation
- Space-based gravitational wave observatory

Launch Date: 2034

Science Objective: Study astrophysical phenomena and the universe using gravitational waves

U.S.-based Technologies in Development:

- Lasers
- Telescopes
- Microthrusters
- Phasemeters
- Charge Management System

<https://lisa.nasa.gov/>

NASA LISA Study Team Membership



* US reps to ESA Science Study Team

Study Team:

Jillian Bellovary	CUNY-Queensborough	Brittany Kamai	Caltech
Peter Bender	Univ. of Colorado	Joey Key	U. Washington, Bothel
Emanuele Berti	Univ. of Mississippi	Shane Larson	Northwestern
Warren Brown	SAO	Sean McWilliams	West Virginia Univ.
Robert Caldwell	Dartmouth	Guido Mueller	Univ. of Florida
Neil Cornish	Montana State U.	Priyamvada Natarajan	Yale
Mike Eracleous	Pennsylvania State U.	David Shoemaker*	MIT
Craig Hogan	Fermilab	Deirdre Shoemaker	Georgia Tech
Kelly Holley-Bockelman* (Chair)	Vanderbilt Univ.	Robin (Tuck) Stebbins*	Univ. of Colorado

Core Team:

John Baker	NASA GSFC	Tyson Littenberg	NASA MSFC
Jordan Camp	NASA GSFC	Jeff Livas	NASA GSFC
John Conklin	Univ. of Florida	Kirk McKenzie	NASA JPL
Curtis Cutler	NASA JPL	Michele Vallisneri	NASA JPL
Ryan DeRosa	NASA GSFC	John Ziemer	NASA JPL
William Klipstein	NASA JPL		

Pre-Formulation Office (Ex Officio):

Ira Thorpe	NASA GSFC	Ann Hornschemeier	NASA GSFC
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LISA Preparatory Science

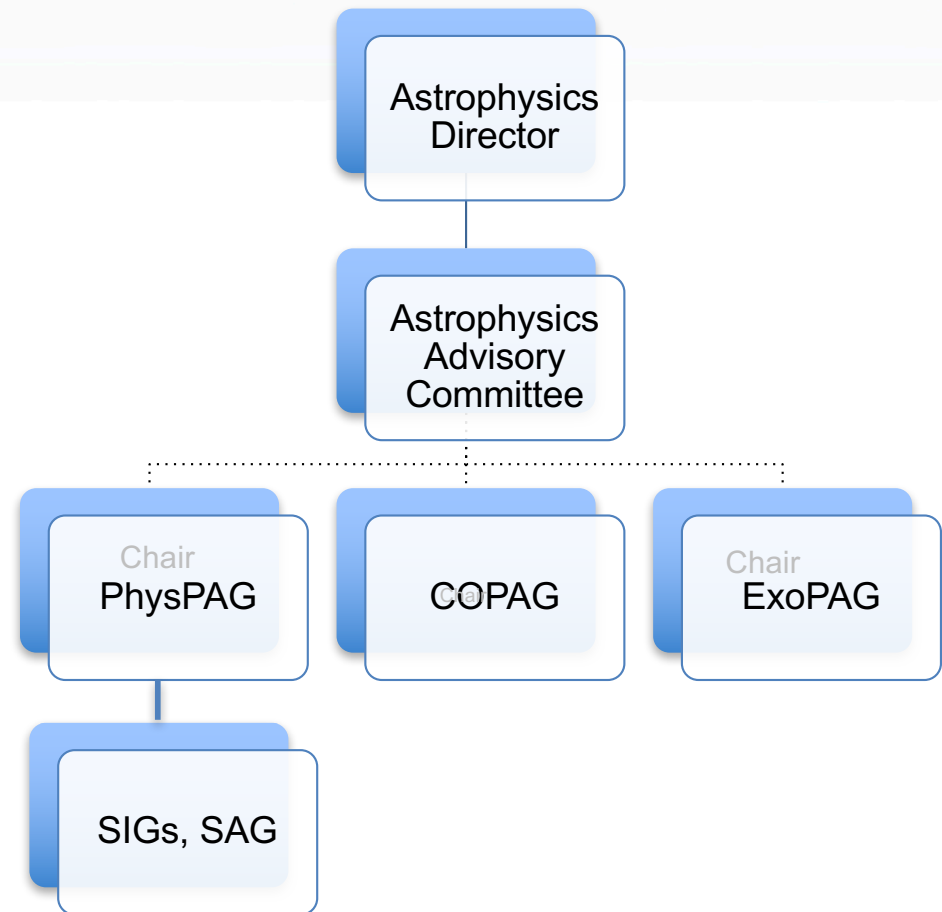


- The LISA Preparatory Science (LPS) is a new program element of ROSES-2018, being issued February 15, 2018.
- The LPS Program will provide support for US investigators involved in analysis and interpretation of simulated LISA data.
 - It is **not** intended to support hardware work, which is funded separately, or to develop mission concepts.
- Proposals to the LPS Program may request support for:
 - Performing high-fidelity simulations of the expected waveforms for LISA sources;
 - Developing data analysis and statistical techniques useful for the extraction of scientific measurements from LISA data (e.g., parameter estimators, etc.);
 - Developing prototype data analysis tools, including innovative approaches to instrument simulation, that take into account the anticipated LISA mission performance;
 - Evaluating the capability of LISA data to enable astrophysics investigations;
 - Conducting astrophysics investigations that prepare for the analysis and interpretation of LISA data.
- Proposals will need to clarify how the proposed project fits in or augments ongoing efforts at the Study Office or at the LISA Consortium



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. PCOS is starting a SAG on Multi Messenger Astrophysics (see J. Conklin talk)
- Science Interest Groups (SIGs) are longer-standing discipline fora.
 - IPSIG
 - GWSIG (meeting today)
 - XRSIG (meeting today)
 - GammaSIG (meeting today)
 - CRSIG
 - CoSSIG



PhysPAG Executive Committee



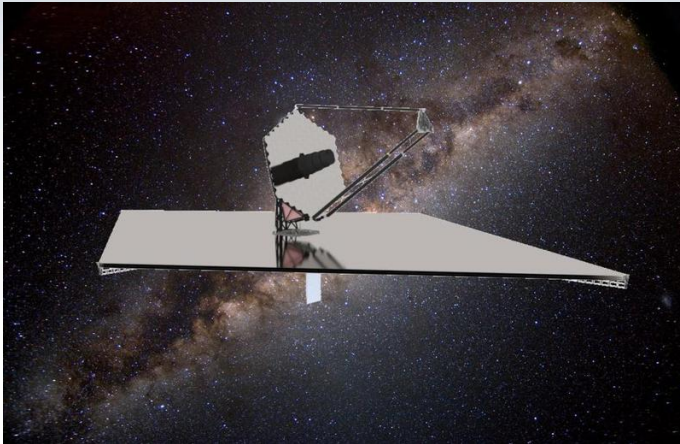
Name	Institution	Discipline	End of term
M. Bautz (current Chair)	MIT	XRSIG	March-18
J. Conklin (incoming Chair)	Univ. of Florida	GWSIG	Dec-19
H. Krawczynski	Washington Univ. in St. Louis	GRSIG	Dec-18
R. Kraft	SAO	XRSIG	Dec-18
I. Moskalenko	Stanford	CRSIG	Dec-18
J. Beatty	Ohio State Univ.	CRSIG	Dec-19
S. Gueric	GWU	GRSIG	Dec-19
K. Holley-Bockelmann	Vanderbilt	GWSIG	Dec-19
J. Tomsick	Berkeley	GRSIG	Dec-19
Kevin M Huffenberger	Florida State Univ.	CoSIG / IPSIG	Dec-20
James E Rhoads	GSFC	CoSIG	Dec-20
Graça Rocha (Vice Chair)	JPL	IPSIG / CoSIG	Dec-20
Abigail G Vieregg	Univ. of Chicago	IPSIG / CR SIG	Dec-20
Nicolas Yunes	Montana State Univ.	GWSIG	Dec-20

We thank the members rotating off in December 2017 for their service:
R. Bean, A. Miller, O. Dore, E. Wollack

Preparing for the 2020 Decadal Survey



- Large Mission Concept Studies

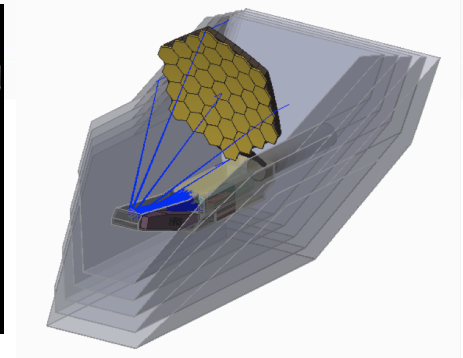
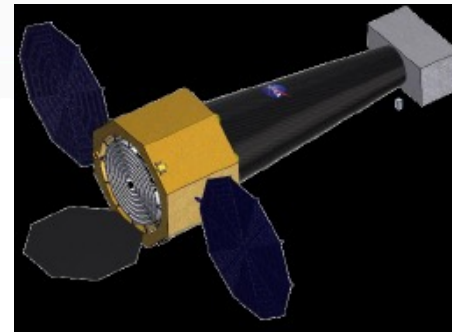
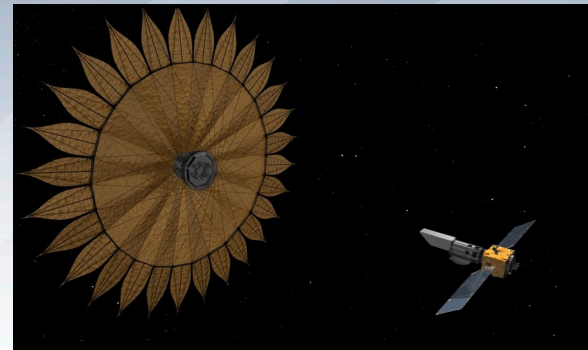


HabEx

LUVOIR

Lynx

OST



- Medium (Probe) Concept Studies

- Cosmic Dawn Intensity Mapper (A. Cooray)
- Cosmic Evolution through UV Spectroscopy Probe (W. Danchi)
- Galaxy Evolution Probe (J. Glenn)
- **High Spatial Resolution X-ray Probe** (R. Mushotzky)
- **Inflation Probe** (S. Hanany)
- **Multi-Messenger Astrophysics Probe** (A. Olinto)
- Precise Radial Velocity Observatory (P. Plavchan)
- Starshade Rendezvous Mission (S. Seager)
- **Transient Astrophysics Probe** (J. Camp)
- **X-ray Timing and Spectroscopy Probe** (P. Ray)

<https://science.nasa.gov/astrophysics/2020-decadal-survey-planning>

Special Sessions on Decadal Studies



- **Tuesday, January 9:**
 - **Large Scale Studies, 10-11:30am**
 - **Probe studies, 2-3:30pm**
- And associated Poster session**

Potomac Ballroom D

**Also see individual meetings for LUVOIR,
Habex, OST**