Why Astrophysics?

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

- How did our universe begin and evolve?
- How did galaxies, stars, and planets come to be?
- Are we alone?

Enduring National Strategic Drivers

Physics of the Cosmos (PCOS) Program

Cosmic Origins (COR) Program

Exoplanet Exploration Program (ExEP)
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

Gamma rays, 50 to 300 keV
Counts per second

GRB 170817A

LIGO

Gravitational-wave strain
Frequency (Hz)

GW170817

Time from merger (seconds)
PCOS-related: NICER Measuring Neutron Star Equation of State

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

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

**Euclid**
- ESA-led Mission
- 2020
- NASA is supplying the NISP Sensor Chip System (SCS)

**Chandra**
- NASA Strategic Mission
- 7/1999
- Chandra X-ray Observatory

**XMM-Newton**
- ESA-led Mission
- 12/1999
- X-ray Multi Mirror - Newton

**Fermi**
- NASA Strategic Mission
- 6/2008
- Fermi Gamma-ray Space Telescope

**PCOS Missions in Pre-formulation**

**Athena**
- ESA-led Mission
- Late 2020s
- NASA is supplying elements for both instruments

**LISA**
- ESA-led Mission
- Mid 2030s
- NASA is developing technology for both the payload and the mission
Athena
Advanced Telescope for High Energy Astrophysics

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.

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?

www.the-athena-x-ray-observatory.eu
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

**Study Team:**

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

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<th>Name</th>
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<tr>
<td>John Baker</td>
<td>NASA GSFC</td>
<td>Tyson Littenberg</td>
<td>NASA MSFC</td>
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<tr>
<td>Jordan Camp</td>
<td>NASA GSFC</td>
<td>Jeff Livas</td>
<td>NASA GSFC</td>
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<tr>
<td>John Conklin</td>
<td>Univ. of Florida</td>
<td>Kirk McKenzie</td>
<td>NASA JPL</td>
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<tr>
<td>Curtis Cutler</td>
<td>NASA JPL</td>
<td>Michele Vallisneri</td>
<td>NASA JPL</td>
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<tr>
<td>Ryan DeRosa</td>
<td>NASA GSFC</td>
<td>John Ziemer</td>
<td>NASA JPL</td>
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<tr>
<td>William Klipstein</td>
<td>NASA JPL</td>
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**Pre-Formulation Office (Ex Officio):**

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<th>Name</th>
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<tbody>
<tr>
<td>Ira Thorpe</td>
<td>NASA GSFC</td>
<td>Ann Hornschemeier</td>
<td>NASA GSFC</td>
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</table>
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.
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

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