NASA's Physics of the Cosmos Program

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Chair of the Physics of the Cosmos Program Analysis Group

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The PhysPAG

Physics of the Cosmos Program seeks to understand the nature of the Universe. What are its constituents? What are the laws that govern its birth and evolution?

Dark Energy: Probe the nature of dark energy by studying the expansion rate of the universe and the growth of structure

Inflation: Test the theory of inflation by measuring the polarization of the Cosmic Microwave Background.

Black Holes & General Relativity: Probe the properties of black holes and test General Relativity in strong gravity environments using x-ray emission and gravitational waves

Behavior of Matter in Extreme Environments: Explore extreme astrophysical processes with Cosmic rays, X-rays and Gamma-rays

PhysPAG and SIGs

- **PhysPAG has six SIGs in operation:**
  - Inflation Probe SIG (Chair: Amber Miller and Ed Wollack)
  - Gravitational Wave SIG (Chair: Neil Cornish)
  - X-ray SIG (Chair: Jay Bookbinder and Mark Bautz)
  - Gamma ray SIG (Chair: Mark McConnell)
  - Cosmic Ray SIG (Chair: Eun-Suk Seo)
  - Cosmic Structure SIG (Chair: Olivier Doré, Rachel Bean)

SIG Activities*

Inflation Probe SIG

General interest:

US MO participation in Japanese LITEBIRD mission selected for phase A study

SPHEREx SMEX mission concept selected for phase A study (inflation & large-scale structure)

Ongoing activities:

DOE Stage-4 CMB polarization meeting held in Ann Arbor, MI 21-22 September

Upcoming activities:

DOE Stage-4 CMB polarization meeting in Berkeley, CA

Upcoming CORE++ proposal for ESA M5 proposal opportunity

Gravitational Wave SIG

General interest:

LISA Pathfinder shipped 8 October to Kourou. Launch planned 2 December.

Upcoming activities:

SIG meeting at the AAS, Kissimmee, January 2016

SIG meeting at the APS, Salt Lake City, April 2016

LISA Symposium, Zurich, September 2016

*Excluding the main activity for all SIGs this year: The Flagship Mission Studies Report

SIG Activities

X-Ray SIG

General interest:

Two X-Ray polarimetry SMEX mission concepts (IXPE and PRAXys) selected for phase A study

Astrosat, an Indian X-ray/UV/Optical astronomy satellite launched 28 September

Ongoing activities:

'Probing the Universe in Depth and Detail with the X-Ray Surveyor' held in Washington DC 6-8 October

Upcoming activities:

SIG meeting at the AAS, Kissimmee, January 2016

SIG meeting at AAS/HEAD, Naples, April 2016

Gamma-Ray SIG

Ongoing activities:

Develop gamma-ray astronomy roadmap for input to the 2020 decadal survey focusing on probe-class and explorer-class concepts

Upcoming activities:

SIG meeting at the Fermi Workshop, 9-13 November

SIG meeting at the AAS, Kissimmee, January 2016; science requirements for mission concepts

SIG meeting at AAS/HEAD, Naples, April 2016; instrument concepts

SIG Activities

Cosmic-Ray SIG

General interest:

ISS-CREAM completed testing at GSFC and delivered to KSC

CALET (Japanese-led mission for high-energy cosmic-ray electrons) launched in August to ISS

Upcoming activities:

SIG meeting at the AAS, Kissimmee, January 2016

SIG meeting at the APS (TBC) Salt Lake City, April 2016

Cosmic Structure SIG

General interest:

SPHEREx SMEX mission concept selected for phase A study (inflation & large-scale structure)

Ongoing activities:

Set up PCOS web page and email list

Upcoming activities:

Town hall meeting at the AAS, Kissimmee, January 2016

PhysPAG EC membership

Name	Institution	Topical Area	Term end
J. Bock, Chair	Caltech/JPL	CMB	December 2016
M. Bautz, Vice Chair	MIT	X-rays	December 2016
R. Bean	Cornell Univ.	Dark Energy	December 2016
J. Bookbinder	SAO	X-rays	December 2015
J. Conklin	Univ. of Florida	Gravitational Waves	December 2017
N. Cornish	Montana State	Gravitational Waves	December 2016
O. Doré	JPL	Dark Energy	December 2017
H. Krawczynski	Washington Univ. in St. Louis	Gamma-rays	December 2017
M. McConnell	U. of New Hampshire	Gamma-rays	December 2016
A. Miller	Columbia Univ.	CMB	December 2017
J. Nousek	PSU	X-rays	December 2015
A. Olinto	Univ. of Chicago	Astroparticles	December 2015
Eun-Suk Seo	U. of Maryland	Astroparticles	December 2016
E. Wollack	NASA/GSFC	CMB	December 2017

Evaluation for replacement members currently in process

PCOS Gap Technologies

- **PhysPAG reviewed and edited submitted gap technologies**
  - Merged with existing items where applicable to simplify prioritization
  - Made a uniform format for anticipated need date
  - Presented to PCOS TMB who prioritized 22 items

Priority 1

1. High-power, narrow-line-width laser sources.
2. Highly stable, low-stray-light telescope.
3. Large-format, high-spectral-resolution, small-pixel X-ray focal-plane arrays.
4. Affordable, lightweight, high-resolution X-ray optics.
5. Advanced millimeter-wave focal plane arrays for CMB polarimetry.
6. High-efficiency cooling systems covering the range 20K to under 1K.

Priority 2

1. Phase-measurement subsystem (PMS).
2. Millimeter-wave optical elements.
3. Low-stress or stress-free coating for X-ray optical elements.
4. Low-mass, long-term stability optical bench.
5. Fast, low-noise megapixel X-ray imaging array with moderate spectral resolution.
6. High-efficiency X-ray gratings for high-resolution spectroscopy.
7. Gravitational reference sensor (GRS).

Priority 3

1. Very-wide-field focusing instrument for time-domain X-ray astronomy.
2. Ultra-high-resolution focusing X-ray observatory telescope.
3. Advancement of X-ray polarimeter sensitivity with the use of negative-ion gas.
4. Fast, few-photon UV detectors.
5. Lightweight large-area reflective optics.
6. Low-power time-sampling readout.
7. Low-power comparators and logic arrays.
8. Lattice optical clock for Solar Time Delay mission and other applications.
9. High-performance gamma-ray telescope.