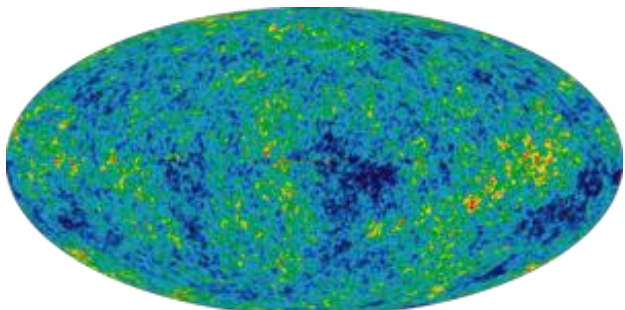




ANN HORNSCHEMEIER

Chief Scientist, Physics of the Cosmos Program

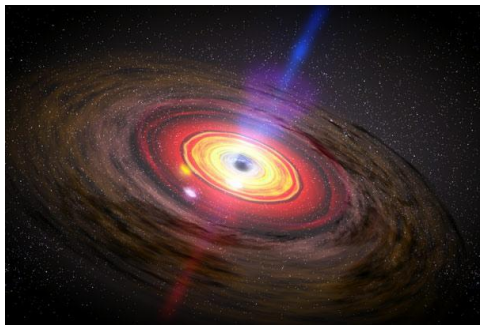
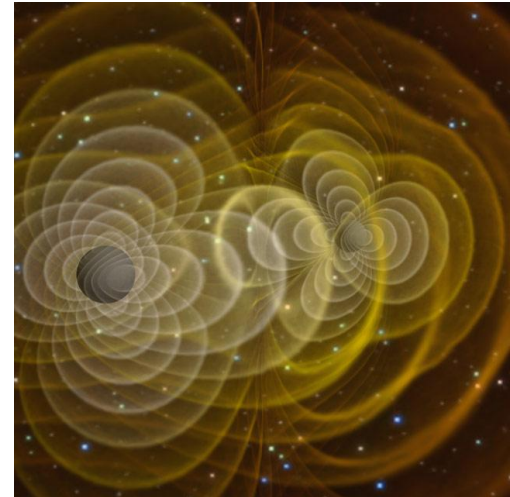
NASA Goddard Space Flight Center



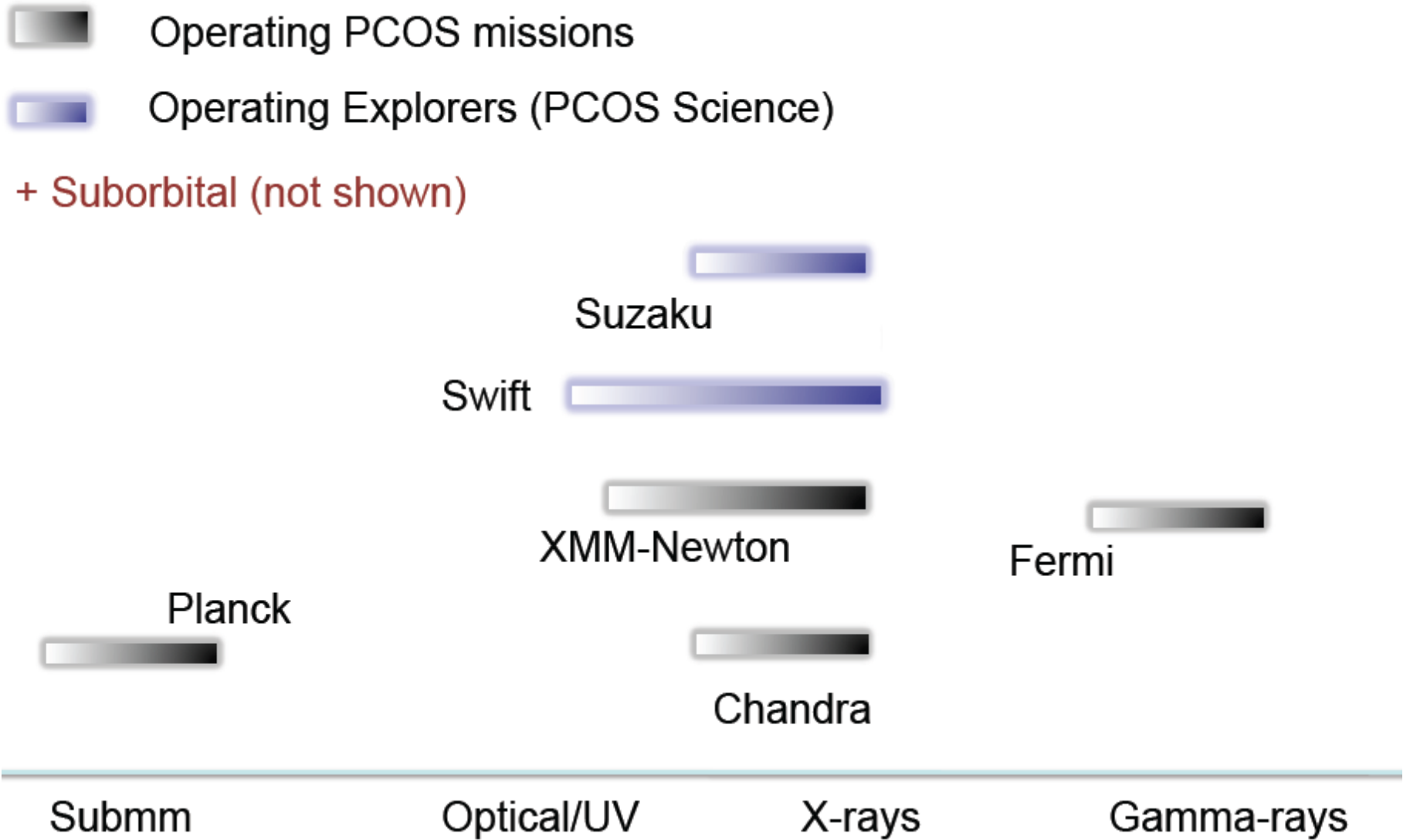
Physics of the Cosmos Science Objectives



- 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
- Explore the behavior of matter and energy in its most extreme environments



Current PCOS Portfolio Across the Electromagnetic Spectrum



PCOS : future missions

- **Provide scientific and technical stewardship for decadal-survey recommended missions:**
 - Of the six highly-ranked medium and large-scale space-based priorities in NWNH, THREE fall within the PCOS science program:
 - Inflation Probe (medium-scale)
 - LISA
 - IXO
 - NOTE: WFIRST is located within the Exoplanet Program and the science of dark energy is within PCOS
- **X-ray and Gravitational Wave Mission Architecture Studies**
 - Explore alternative mission architectures and technical solutions (e.g., instrument concepts, enabling technologies) to accomplish some or all of the LISA and IXO science objectives at lower cost points
 - Reports due to NASA HQ in July 2012

PCOS: Future Missions

X-ray and Gravitational Wave Architecture Studies

GRAVITATIONAL WAVE ARCHITECTURE STUDY

- **Three mission concepts (+1 instrument study) under exploration at the TEAMX mission design facility at JPL:**
 1. No drag-free concept: LAGRANGE
 2. Geocentric orbits: OMEGA
 3. LISA-like: SGO-mid
 4. Low-cost instrument study: OMEGA instrument

X-RAY MISSION ARCHITECTURE STUDY

- **Four mission concepts under exploration at Mission Design Laboratory at GSFC:**
 1. AXSIO – Cost goal: <\$2B
 2. Gratings only - Cost Goal: < \$600M
 3. Calorimeter only – Cost goal: < \$1B
 4. Wide Field only – Cost goal: < \$1B

PCOS: technology development funding

- **NWNH priorities and NASA strategic roadmaps inform technology development funding. For example these were the projects funded by the 2010 ROSES SAT under PCOS:**

Schattenburg, M.	MIT	Development of Fabrication Process for Critical-Angle X-ray Transmission Gratings
Bautz, M.	MIT	Directly-Deposited Blocking Filters for Imaging X-ray Detectors
Bock, J.	JPL	Antenna-coupled Superconducting Detectors for Cosmic Microwave Background Polarimetry
McEntaffer, R.	Univ of Iowa	Off-plane Gratings Arrays for Future Missions
Reid, P.	SAO	Development of Moderate Angular Resolution Full Shell Electroplated Metal Grazing Incidence X-ray Optics

What else is going on in the PCOS program?

National Aeronautics and Space Administration



March 2012

Vol. 2 No. 1

Program Manager's Perspective

Mansoor Ahmed, *PCOS Program Manager*

The PCOS program accomplished a great deal this quarter. The X-ray and Gravitational Wave study teams evaluated the RFI inputs and are formulating notional mission concepts and evaluating each science case relative to the science priorities outlined in the New Worlds New Horizons (NWNH) decadal survey. By this summer, these teams will have determined what fraction of the IXO and LISA science can be achieved at different cost points. The results of these analyses will be presented to the science community, through the National Research Council's Committee on Astronomy and Astrophysics (CAA). Assuming that the CAA will endorse the science case for a particular cost range, the PCOS program will continue working with the community to develop science and mission requirements for the mission concept(s) and define specific technology development plans for the mission concept(s). These studies are critical in program strategic planning and preparations for a mid-decadal review. Interested community members can follow the progress on the study websites: (see "Studies" under pcos.gsfc.nasa.gov)

Following the release of the Program Annual Technology Report (PATR) in December 2011, we are now into our first quarter of the new technology management process. This process was designed to link technology funding to science objectives through discussions with the community about technology needs and a transparent prioritization of those needs by the PCOS program. The PATR is referenced in the call for Strategic Astrophysics Technology (SAT) proposals, which was also released in December 2011. I highly encourage technology developers proposing to the SAT to review the PCOS PATR as part of their process.

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<http://www.nasa.gov>

With the release of the PATR, the next phase of our conversation with the community begins. Each year technology needs from the community are collected in late June, throughout the year we are interested in feedback about needs, priorities, the prioritization criteria and the overall process. I encourage you to join this conversation through participation in the PhysPAG and by visiting the PCOS website at <http://pcos.gsfc.nasa.gov>.

We in the Program Office look forward to continuing our discussions with the community to plan the future of PCOS science. Even with the travel restrictions, the Program Office will have a presence at the AAS Anchorage meeting in June and the SPIE Instrumentation meeting in Amsterdam in July. We are also supporting the PhysPAG workshop in Washington, D.C., in August. Please take advantage of these opportunities for face-to-face discussions even as you engage in other ways.

PCOS Science

Ann Hornschemeier, *PCOS Chief Scientist*

The Physics of the Cosmos (PCOS) program spans the fields of fundamental physics, cosmology, and high-energy astrophysics, and includes a wide range of science goals. Below I give a snapshot of program activities divided by the five core PCOS science areas in our program plan. Note that I highlight a single area of future scientific measurement under each topic, although of course there is significant scientific overlap (e.g., gravitational wave facilities will study the formation and growth of massive black holes, and X-ray facilities will investigate the nature of spacetime around compact objects and constrain cosmological parameters via studies of clusters). Please consider this to be the start of a scientific conversation with your new PCOS program chief scientist.

Test the validity of Einstein's General Theory of Relativity and investigate the nature of spacetime. LISA was named as a top-ranked mission under NWNH large space-based projects. PCOS is currently supporting a study of possible space-based gravitational wave observatories at lower cost points, which involves engineering studies via the TEAM-X facility at JPL; please see Tuck Stebbins report (p. 7). The NASA Advisory Committee Astrophysics Subcommittee (NAC ApS) has also approved a new Gravitational Wave Science Analysis Group

- Three published PCOS newsletters giving updates to the community on the X-ray and GW studies, the technology management process, news from NASA HQ, science updates for operating missions
- PCOS program website (pcos.gsfc.nasa.gov), continues to be the interface between all program and PhysPAG activities and the community:

NASA National Aeronautics and Space Administration
Goddard Space Flight Center

- Goddard Space Flight Center
- Sciences and Exploration Division
- Astrophysics Science Division

PHYSICS OF THE COSMOS

Overview Projects Science Technology Studies Program Office Education

Links

- Documents
- PhysPAG
- Multimedia Library
- Sign up for PCOS News and Announcements

Overview

The Physics of the Cosmos (PCOS) Program lies at the intersection of physics and astronomy. Its purpose is to explore some of the most fundamental questions regarding the physical forces and laws of the universe: the validity of Einstein's General Theory of Relativity and the nature of spacetime; the behavior of matter and energy in extreme environments; the cosmological parameters governing inflation and the evolution of the universe; and the nature of dark matter and dark energy. PCOS takes us beyond Einstein and beyond the Standard Model.

The PCOS Program consists of a suite of operating science missions and possible future missions that focus on specific aspects of these questions. The Chandra and XMM-Newton observatories probe the universe in X-rays using detailed images and spectroscopy to study matter under a broad range of physical conditions. INTEGRAL and now Fermi study the phenomena with

Program News

13 March 2012
Presentation by Robin Stebbins at the NASA Advisory Committee Astrophysics Subcommittee Meeting on February 23, 2012
> [PDF]


13 March 2012
Presentation by Andy Ptak at the NASA Advisory Committee Astrophysics Subcommittee Meeting on February 23, 2012
> [PDF]

5 March 2012

Opportunities to interface with PCOS

- Personnel in the PCOS office listed on the website and in the brochure distributed here
- FY12 Conference/Workshop activity yet-to-come:
 - PCOS/COR joint booth planned for Anchorage, AK in June 2012
 - August 2012 PhysPAG workshop: kick-off for GW, X-ray and Gamma Ray SAGs plus “Dark Energy from Space” session

PhysPAG Workshop 2012
August 14–16, 2012
Washington, D.C. USA
<http://pcos.gsfc.nasa.gov/physpag/>

National Aeronautics and
Space Administration 

**Physics of the
Cosmos (PCOS) Program**

How does the Universe work?


Rita Sambruna,
PCOS Program Scientist

Jaya Bajpayee,
PCOS Program Executive

The Physics of the Cosmos (PCOS) Program addresses questions about the origin and evolution of the Universe, the conditions of matter in extreme environments, and the nature of dark energy and dark matter. PCOS supports a vibrant program in both observational and theoretical research, and technology development for future missions.

The PCOS Program Analysis Group (PhysPAG) provides input to the program and includes all interested members of the community. Visit <http://pcos.gsfc.nasa.gov/> or <http://pcos.gsfc.nasa.gov/physpag/> for more information.

www.nasa.gov



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

- **The Physics of the Cosmos Program Analysis Group (PhysPAG) serves as a forum for soliciting and coordinating input and analysis from the scientific community in support of the PCOS program objectives.**
- **The Program Analysis Groups (PAGs) include all members of the community interested in providing input to NASA on issues of strategic importance via analysis studies**
- **PAGs hold regular public meetings to provide their members the opportunity to hear about their work and voice their input**
- **PAGs report to NASA via the NAC's Astrophysics subcommittee**
- **PhysPAG Executive Committee (EC) members: S. Ritz (Chair), J. Bookbinder, S. Hanany, G. Mueller, E. Hays, J. Rhodes**
- **The EC is NOT the PhysPAG**

PhysPAG and SAGs

- **The PhysPAG identifies specific, well-defined topics for further detailed studies, and sets up taskforces of volunteers to perform the analysis – Study Analysis Groups (SAGs)**
- **PhysPAG has four SAGs in operation or in development:**
 - Inflation Probe SAG (Chair: Shaul Hanany)
 - Gravitational Wave SAG (Chair: Guido Mueller)
 - X-ray SAG (Chair: Jay Bookbinder)
 - Gamma ray SAG (Chair: Liz Hays)

PhysPAG Workshop

August 14-16, 2012

- **The PhysPAG and PCOS program are pleased to announce a summer 2012 workshop whose purposes will be:**
 - Include updates to the community from all three PAGs (PhysPAG, ExoPAG, CoPAG) in scientific and technical areas of interest to the PhysPAG community
 - Public presentation of the reports from the PCOS Gravitational Wave and X-ray Studies
 - Special breakout sessions:
 - Kick-off meetings for the XRSAG, GWSAG and GRSAG
 - “Dark Energy from Space” special one-day symposium
- **LOCATION: WASHINGTON, D.C. AREA (DETAILS TBD)**
- **REGISTRATION will open by the end of April 2012**

**FULL WEBCASTING WILL BE AVAILABLE FOR
THOSE WHO CANNOT ATTEND IN PERSON,
BUT YOU MUST REGISTER (FREE!)**

- **CONSULT: pcos.gsfc.nasa.gov/physpag for more info**