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

- Operating PCOS missions
- Operating Explorers (PCOS Science)
+ Suborbital (not shown)

Suzaku
Swift
XMM-Newton
Fermi
Chandra

Submm  Optical/UV  X-rays  Gamma-rays
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: LAG RANGE
  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:

<table>
<thead>
<tr>
<th>Name</th>
<th>Institution</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schattenburg, M.</td>
<td>MIT</td>
<td>Development of Fabrication Process for Critical-Angle X-ray Transmission Gratings</td>
</tr>
<tr>
<td>Bautz, M.</td>
<td>MIT</td>
<td>Directly-Deposited Blocking Filters for Imaging X-ray Detectors</td>
</tr>
<tr>
<td>Bock, J.</td>
<td>JPL</td>
<td>Antenna-coupled Superconducting Detectors for Cosmic Microwave Background Polarimetry</td>
</tr>
<tr>
<td>McEntaffer, R.</td>
<td>Univ of Iowa</td>
<td>Off-plane Gratings Arrays for Future Missions</td>
</tr>
<tr>
<td>Reid, P.</td>
<td>SAO</td>
<td>Development of Moderate Angular Resolution Full Shell Electroplated Metal Grazing Incidence X-ray Optics</td>
</tr>
</tbody>
</table>
What else is going on in the PCOS program?

- 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:

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 this 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 https://pcos.gsfc.nasa.gov.

We in the Program Office look forward to continuing our discussion with the community to plan the future of PCOS science. With these changes, the Program Office will have a presence at the AAS Astrophysics meeting in June and the SPIE Instrumentation meeting 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

Ana Heinrichsmeier, PCOS Chief Scientist

The Physics of the Cosmos (PCOS) program spans the fields of astrophysics, 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 focus: scientific measurement of the cosmos. This area represents the need for an observational program to provide information from the cosmos that are beyond the reach of telescopes. In addition, this program provides a basis for new scientific collaboration between the various PCOS program activities.

1. PHYSICS SCIENCE
   - News from the Astrophysics Division at NASA Headquarters
   - Physical Science Report
   - X-ray Astronomy Mission Concept Study
   - Geomagnetic Wind Mission Concept Study
   - New from the Advanced Concepts and Technology Office

2. TECHNOLOGY SCIENCE
   - News from the Advanced Concepts and Technology Office
   - Physical Science Report
   - X-ray Astronomy Mission Concept Study
   - Geomagnetic Wind Mission Concept Study
   - New from the Advanced Concepts and Technology Office

3. TECHNOLOGY MANAGEMENT
   - News from the Advanced Concepts and Technology Office
   - Physical Science Report
   - X-ray Astronomy Mission Concept Study
   - Geomagnetic Wind Mission Concept Study
   - New from the Advanced Concepts and Technology Office

4. PHYSICSPAG
   - News from the Advanced Concepts and Technology Office
   - Physical Science Report
   - X-ray Astronomy Mission Concept Study
   - Geomagnetic Wind Mission Concept Study
   - New from the Advanced Concepts and Technology Office

5. PROGRAM OFFICE
   - News from the Advanced Concepts and Technology Office
   - Physical Science Report
   - X-ray Astronomy Mission Concept Study
   - Geomagnetic Wind Mission Concept Study
   - New from the Advanced Concepts and Technology Office
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
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