Physics of the Cosmos Program Analysis Group: Status

John Nousek (Penn State University)

NASA APS meeting – NASA HQ – 16-17 Apr 2013
Charter (Terms of Reference)

- PhysPAG is responsible for soliciting and coordinating community input in the development and execution of NASA’s Physics of the Cosmos (PCOS) Program.
- PhysPAG serves as a community-based forum for analysis in support of PCOS objectives, architecture planning, and activity prioritization.
- PhysPAG formally presents findings of its analyses to NASA SMD through the NASA Advisory Council (NAC).
- The Chair of the PhysPAG is drawn from the membership of the NAC Astrophysics Subcommittee.
- The PhysPAG Chair is assisted by an Executive Committee that supports planning and activities of the group.

- Executive Committee:
  - Jason Rhodes, JPL
  - Liz Hays, GSFC
  - Shaul Hanany, Univ. of Minnesota
  - Guido Mueller, Univ. of Florida
  - Jay Bookbinder, Harvard-Smithsonian
  - Angela Olinto, Univ. of Chicago
Agenda – Monterey HEAD – 9 Apr

• 12:30PM – Introduction, John Nousek
• 12:35PM - PCOS in the Astrophysics Implementation Plan, Richard Griffiths, NASA HQ, PCOS Executive Secretary
• 12:45PM - FY13 Activities in the PCOS Program Office and the PhysPAG, Ann Hornschemeier, GSFC, PCOS Project Office
• 12:55 PM – WFIRST in the light of Euclid, Daniel Stern
• 1:05 PM – LISA in the light of eLISA, Guido Mueller
• 1:15 PM – IXO in the light of ATHENA, Jay Bookbinder

Agenda – Denver APS – 16 Apr

• 12:30PM – PCOS/PhysPAG, Ann Hornschemeier, GSFC, PCOS Project Office
• 12:45PM – Inflation Probe in the light of Planck/Suborbital programs, Shaul Hanany
• 12:55 PM – LISA in the light of eLISA, Neil Cornish
• 1:05 PM – Gamma-Ray SAG – the Next Steps, Liz Hays
• 1:15 PM – Cosmic Ray SAG – the Next Steps, Angela Olinto
Topic for Townhalls at HEAD/APS

- The NASA Astrophysics Division has released an Astrophysics Implementation Plan which attempts to implement the Decadal Survey.

- The NAS/NRC Decadal Survey (New Worlds, New Horizons) was based on a situation which has been deeply affected by Federal budget changes and steps taken by other space agencies.

- Paul Hertz (Astrophysics Div. Director) has stated an intention to request the CAA to do a mid-decadal assessment of NASA’s current implementation.

- We will hear a description of the NASA Implementation Plan, and have talks on the status of the Study Analysis Groups, both here and at the Denver APS.
Current Gravitational-Wave Activities

- Preparing Technology Development Plans for two tracks
  1. ESA-led partnership on L2 (TRL5 by 2018)
     - Lasers
     - Telescope
     - Phase Measurement System
     - Micronewton thrusters
  2. NASA-led partnership after Astro2020 (TRL 5 by 2020)
     - Optical bench
     - Gravitational Reference Sensor
- Participating in the eLISA Consortium in support of L2/L3
  - Meetings in October, January and March, preparing a white paper for May 2013 deadline
  - L2/L3 call allows international participation up to 20% of the European contribution
- Concept refinement for future NASA-led partnership
  - Preferred concept is the Space-based Gravitational-wave Observatory Mid (SGO Mid) from the 2012 study.
    - Scaled-down LISA, retaining 3 arms
    - Delivers most of the Astro2010 endorsed science
  - Exploring trade studies for risk and cost reduction

NB: Gravitational waves likely will be detected by LIGO before JWST launches
Current X-ray Study Activities

X-ray observatories in the $1B class that address all or most of the IXO science objectives are feasible for start within this decade, but only if technical risk is controlled through advance development of key technology to TRL-6

• X-ray Technology Development Plan (TDP)
  • Focusing on technology for near term opportunity (probe class mission)
    • 5-10 arcsec mirrors, calorimeters, gratings
      - Cost and schedule to advance these technologies to TRL 6
  • Preparations for FY2014 Probe-class mission study
    – Revisit science case (via X-ray SAG subcommittee)
    – Determine key technical and mission trades using notional mission concepts as starting point
• Discussions with European counterparts about participation in L2/L3 X-ray mission
  – L2 science white papers due in May: European X-ray community is preparing Athena science white paper
  – Potential NASA participation at ~15-20 percent level
Euclid – NASA Contribution

HQ Program Executive: Lia LaPiana
HQ Program Scientist: Richard Griffiths

• NASA’s contribution to ESA’s Euclid mission:
  – Near Infrared Spectrograph and Photometer (NISP) flight subassemblies (detector + ASIC + cryo-cable = ‘triplet’) that meet ESA’s requirements for testing & characterization.
  – Currently in Phase B.

• Euclid Project assigned to JPL under NASA’s PCOS Program:
  – JPL Euclid Project Manager – Ulf Israelsson
  – JPL Euclid Project Scientist – Michael Seiffert

• NASA now has a seat on the Euclid Consortium Board, the Consortium's governing body, and on the ESA Euclid Science Team:
  – 40 U.S. scientists selected to participate in Euclid Science Team with P.I.s Jason Rhodes (JPL), Sasha Kashlinsky (GSFC) and Ranga-Ram Chary (Caltech)

• PCOS Program Office: provides programmatic insight and oversight; worked with NASA HQ on tailoring NPR 7120.5 for Euclid; appointed the Independent Review Team; and provides the Euclid Mission Manager (Tom Griffin).

• Euclid Science Data Center study underway (IPAC)
**LISA Pathfinder**

U.S. study scientist: Ira Thorpe (GSFC)

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Demonstrate essential technology for future space-based GW missions</th>
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<tbody>
<tr>
<td>Scientific Payloads</td>
<td>LISA Test Package (LTP) - Europe</td>
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<td>ST7 - NASA</td>
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<tr>
<td>Measurement Goal</td>
<td>Drag-free flight of test masses with atto-g residual accelerations</td>
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<tr>
<td>Status</td>
<td>LTP – finalizing construction</td>
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<tr>
<td></td>
<td>ST7 – delivered &amp; integrated</td>
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<tr>
<td></td>
<td>Spacecraft – undergoing I&amp;T</td>
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<tr>
<td>Anticipated Launch</td>
<td><strong>2015</strong></td>
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LPF is like shrinking a single arm of LISA into a 30cm payload: no GW sensitivity but many of the same noise sources.

LPF hardware is nearly complete and has been subjected to an extensive ground test campaign. Clockwise from top left: LPF spacecraft, LTP optical bench, LTP laser, LTP electrode housing, ST7 thruster unit.
Technology Prioritization

• The PCOS Program Annual Technology Report (PATR) describes the Program’s technology management activities.
• The PATR summarizes progress on all currently-funded SAT programs.
• The PATR defines priorities for technology investments for the upcoming year. The technology needs are prioritized using a set of criteria (described in the report).
• The PCOS Program Analysis Group (PhysPAG) is the main conduit for collecting technology needs identified by the community.
PhysPAG
John Nousek, PhysPAG chair

PhysPAG Executive Secretary
Richard Griffiths, NASA HQ

PCOS Program Office
Ann Hornschmeier

Chief Scientist, Physics of the Cosmos Program

http://pcos.gsfc.nasa.gov

Deputy Chief Scientist: Alan Smale
HQ Program Executive: Lia LaPiana
HQ Program Scientist: Richard Griffiths
HQ Deputy Program Scientist: Wilt Sanders
BACK-UP SLIDES
## PCOS SAT Technologies Selected for Development Starting in FY12 for 2 Years

<table>
<thead>
<tr>
<th>Title</th>
<th>PI</th>
<th>Institution</th>
<th>Area</th>
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</thead>
<tbody>
<tr>
<td>Development of Fabrication Process for Critical-Angle X-ray Transmission Gratings</td>
<td>M. Schattenburg</td>
<td>MIT</td>
<td>X-ray</td>
</tr>
<tr>
<td>Antenna-Coupled Superconducting Detectors for Cosmic Microwave Background Polarimetry</td>
<td>J. Bock</td>
<td>JPL/Caltech</td>
<td>Inflation</td>
</tr>
<tr>
<td>Directly-Deposited Blocking Filters for Imaging X-ray Detectors</td>
<td>M. Bautz</td>
<td>MIT</td>
<td>X-ray</td>
</tr>
<tr>
<td>Off-plane Grating Arrays for Future Missions</td>
<td>R. McEntaffer</td>
<td>University of Iowa</td>
<td>X-ray</td>
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<tr>
<td>Development of Moderate Angular Resolution Full Shell Electroplated Metal Grazing Incidence X-ray Optics</td>
<td>P. Reid</td>
<td>SAO</td>
<td>X-ray</td>
</tr>
</tbody>
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PCOS SAT Technologies Selected for Development Starting in FY13 for 2 Years

<table>
<thead>
<tr>
<th>Title</th>
<th>PI</th>
<th>Inst.</th>
<th>Area</th>
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<tbody>
<tr>
<td>Next generation X-ray Optics: High Resolution, Light Weight, and Low Cost</td>
<td>W. Zhang</td>
<td>GSFC</td>
<td>X-ray</td>
</tr>
<tr>
<td>Demonstrating Enabling Technologies for the High-Resolution Imaging Spectrometer of the Next NASA X-ray Astronomy Mission</td>
<td>C. Kilbourne</td>
<td>GSFC</td>
<td>X-ray</td>
</tr>
<tr>
<td>Colloid Microthruster Propellant Feed System for Gravity Wave Astrophysics Missions</td>
<td>J. Ziemer</td>
<td>JPL</td>
<td>GW</td>
</tr>
<tr>
<td>Telescope for a Space-based Gravitational Wave Mission</td>
<td>J. Livas</td>
<td>GSFC</td>
<td>GW</td>
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<tr>
<td>Advanced Laser Frequency Stabilization Using Molecular Gasses (co-funded with OCT GCTP)</td>
<td>J. Lipa</td>
<td>Stanford</td>
<td>GW</td>
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</tbody>
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## PCOS Technology Needs Prioritization
From 2012 PATR (top 2 of 4 priorities)

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<thead>
<tr>
<th>Priority</th>
<th>PCOS Technology Needs</th>
<th>Science</th>
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<tbody>
<tr>
<td>1</td>
<td>Large format Mercury Cadmium Telluride CMOS IR detectors, 4K x 4K pixels</td>
<td>Dark Energy</td>
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<td>High-resolution X-ray microcalorimeter: central array (~1,000 pixels): 2.5 eV FWHM at 6 keV; extended array: 10 eV FWHM at 6 keV.</td>
<td>X-ray</td>
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<td>Dimensionally stable optical telescope: stringent length (pm) and alignment (nrad) stability with low straylight</td>
<td>Gravitational Wave</td>
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<td>Metrology laser: 10 yr life, frequency-stabilized, 2W, low noise, fast frequency and power actuators</td>
<td>Gravitational Wave</td>
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<td>Lightweight, replicatable x-ray optics</td>
<td>X-ray</td>
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<td>High resolution X-ray gratings (transmission or reflection)</td>
<td>X-ray</td>
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<td>Large format (1,000-10,000 pixels) arrays of CMB polarimeters with noise below the CMB photon noise and excellent control of systematics</td>
<td>Inflation</td>
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<td>Micronewton thrusters: 10 yr. life, low contamination, low thrust noise</td>
<td>Gravitational Wave</td>
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<td>Lightweight precision mirror mounting structure</td>
<td>X-ray</td>
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<td>2</td>
<td>High throughput anti-reflection coatings with controlled polarization properties</td>
<td>Inflation</td>
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<td>Stable and continuous sub-Kelvin coolers for detectors</td>
<td>Inflation</td>
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<td>High-throughput, light, low-cost, cold, mm-wave telescope operating at low backgrounds</td>
<td>Inflation</td>
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<td>Polarization modulating optical elements</td>
<td>Inflation</td>
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