National Aeronautics and Space Administration

# Physics of the Cosmos Newsletter

February 2014 Vol. 4 No. 1

## Welcome to 2014 from the PCOS Program Office

Mansoor Ahmed, *PCOS Program Manager*
Ann Hornschemeier, *PCOS Chief Scientist*

Welcome to the first 2014 Physics of the Cosmos program newsletter. You will find, as compared to the last edition in **August 2013,** that this is a shorter read! The theme for the last newsletter was "PCOS science and technology that is not in the PCOS program" and included updates on suborbital and Explorer activities. If you have suggested areas of focus for a future PCOS newsletter, please contact us (Ann Hornschemeier, *PCOS Chief Scientist* and Mansoor Ahmed, *PCOS Program Manager*) with your suggested themes/ideas.

Contents



The highlights of this newsletter include the European Space Agency's selections of themes for their next large space missions, the L2 and L3 launch opportunities. Please see the **article by Paul Hertz on this topic** as well as related articles on

## NASA Sees 'Watershed' Cosmic Blast in Unique Detail

On April 27, 2013 a blast of light from a dying star in a distant galaxy became the focus of astronomers around the world. The explosion, known as a gamma-ray burst and designated GRB 130427A, tops the charts as one of the brightest ever seen.

A trio of NASA satellites, working in concert with ground-based robotic telescopes, captured never-before-seen details that challenge current theoretical understandings of how gamma-ray bursts work.

Gamma-ray bursts are the most luminous explosions in the cosmos, thought to be triggered when the core of a massive star runs out of nuclear fuel, collapses under its own weight, and forms a black hole. The black hole then drives jets of particles that drill all the way through the collapsing star and erupt into space at nearly the speed of light. The most energetic emission, with billion-electron-volt (GeV) gamma rays, is thought to arise when the jet slams into its surroundings, forming an external shock wave.

The Gamma-ray Burst Monitor (GBM) aboard NASA's Fermi Gamma-ray Space Telescope captured the initial wave of gamma rays from GRB 130427A. In its first three seconds alone, the "monster burst" proved brighter than almost any burst previously observed.

"The spectacular results from Fermi GBM show that our widely accepted picture of MeV gamma rays from internal shock waves is woefully inadequate," said Rob Preece, a Fermi team member at the University of Alabama in Huntsville who led the GBM study.

Read the full article at **http://www.nasa.gov/content/goddard/nasa-sees-watershed-cosmic-blast-in-unique-detail/#.Us9IBfZQ38Q**

This incredible discovery made the cover of Science magazine, accessible at this link: **http://www.sciencemag.org/content/343/6166.cover-expansion**


*As shown on the cover of the January 3, 2014 issue of Science magazine, this image represents an artist's conception of gamma-ray burst (GRB) 130427A, one of the brightest and longest-lived GRBs observed to date. GRBs such as this one occur when the core of a massive star runs out of nuclear fuel, collapses, and forms a black hole that drives a powerful jet of plasma traveling close to the speed of light. Image credit: NASA/Fermi and Sonoma State University/Aurore Simonnet*

the X-ray Probe study (which has been suspended, see **Hornschemeier article**) and the **L3 gravitational wave theme**. We continue to update our technology prioritization process and the **article by Thai Pham** describes that prioritization process and thoughts for the 2014 Program Annual Technology Report. Our PCOS Program Analysis Group (PhysPAG) has grown, actively participating in their separate Science Interest Groups (SIGs), and the **article by John Nousek** reports on their ongoing efforts to engage the scientific community.

We also report on recent science results from our operating missions. **The Fermi result on an extraordinary gamma-ray burst** was featured on the cover of Science magazine recently. **Chandra has pinpointed the age of the Circinus X-1 binary** to be a scant 4,600 years making it the youngest binary identified and providing crucial data on the youth of such objects. **XMM-Newton has discovered a pulsar** that is apparently the missing link between the long-known radio millisecond pulsars and the relatively recently-discovered accretion powered X-ray pulsars. We are in a time of transition for our fourth operating mission, Planck, which was turned off in 2013 and which you may notice is not listed here. Although it is no longer operating, intense data analysis activities continue on the rich Planck data archive. Big press releases are planned for Planck later on in the spring of 2014. Please check back with us for the August 2014 PCOS newsletter for more information on Planck and other topics.

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## The View from NASA Headquarters: The ESA L2 and L3 Mission Decision

Paul Hertz, *Director, Astrophysics Division, NASA Headquarters*

On November 28, 2013, the European Space Agency (ESA) announced selection of the science themes for its Large-2 and Large-3 missions (L2 and L3). The selected theme for L2 is *The Hot and Energetic Universe*, to be addressed by an advanced X-ray Observatory with nominal launch in 2028, while *The Gravitational Universe*, to be addressed by a space-born gravitometer with nominal launch in 2034, was recommended for L3. More information can be found at **http://www.esa.int/Our_Activities/Space_Science/ESA_s_new_vision_to_study_the_invisible_Universe**.

ESA has recently issued a call, on January 20, 2014, for mission concepts for an advanced X-ray mission for L2. A similar call for L3 will be released at a later date.

The selection of the L2 and L3 themes is well aligned with the science objectives of PCOS, as the key questions of both science themes lie at the core of the PCOS program. "How and why does ordinary matter assemble into the galaxies and galactic clusters that we see today, and how do black holes grow and influence their surroundings?" for the L2 theme, and "Searching for ripples in the very fabric of space–time created by celestial objects with very strong gravity" for L3, overlap with the science interests of a large fraction of the PCOS community.

Importantly, both themes are aligned with the science priorities of the 2010 Astrophysics Decadal Survey, ***New World New Horizons*** (NWNH), for its third and fourth ranking large missions, LISA and IXO, respectively. The Decadal Survey also recommended that NASA partner with ESA on possible missions addressing the LISA and IXO science. The Decadal Survey recommends that NASA consult with the community if these missions are not NASA-led or 50–50 partnerships; I have discussed NASA's intent to join these missions as a junior partner with the Committee on Astronomy and Astrophysics (November 4–5), the Astronomy and Astrophysics Advisory Committee (November 13–14), and the NASA Advisory Council's Astrophysics Subcommittee (November 19).

NASA has started informal talks about a possible collaboration with ESA on the L2 X-ray mission. ESA has been so far receptive to a possible collaboration, and the discussion will continue into 2014. The PCOS X-ray Science Interest Group (XRSIG; **http://pcos.gsfc.nasa.gov/sigs/xrsig.php**), led by Jay Bookbinder, has taken the initiative to provide analysis for NASA on possible areas of US contribution to the L2 mission, including mirrors, calorimeters, gratings, a hard X-ray Instrument, a Wide Field Instrument, and other components.

An international partnership on an X-ray mission addressing the IXO science goals allows NASA to fulfill the Decadal Survey priorities for its fourth ranking large mission. As stated by its charter, the previously formed X-ray Astrophysics Probe (XAP) STDT has been disbanded in light of the ESA L2 decision and the NASA desire to partner on the mission.

As we move into 2014, we have much to look forward to in the PCOS Program. Chandra, XMM-Newton, and Fermi continue to operate well above expectations; Planck data are producing spectacular images of the CMB and polarization data promise a rich trove of results; and among the PCOS-related Explorers, the ASTRO-H SXS will be delivered to JAXA, while NICER has completed its PDR and remains on track for a KDP-C confirmation review at the end of January 2014. We look forward to the opportunity to partner with ESA on a new X-ray Observatory, and remain excited about the PCOS prospects in the near and longer-term future.

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## What happened to the X-ray Probe Study?

Ann Hornschemeier, *PCOS Chief Scientist*

You may recall an email from NASA HQ requesting expression of interest in serving on a Science and Technology Definition Team (STDT) whose charter was to study an X-ray Probe mission concept during the 2013–2015 timeframe. The goal was to define a calorimeter-based mission costing less than one billion dollars and to provide a mission concept to NASA HQ to be considered for a possible 2017 start. Of note was a clear

statement in the charter that if the Europeans chose an X-ray theme for their L2 launch opportunity (see articles by Hertz), the study would disband. The formal notification from NASA disbanding the STDT was received on December 12, 2013.

Over the two months of study activity (October–November 2013), minus the loss of 2.5 weeks for a government shutdown, a fair amount was accomplished. We performed several trade studies to see how mirror design could affect mission cost. We took the single-instrument calorimeter mission (N-CAL) concept from the **2012 X-ray Mission Concepts Study** and reduced the mirror in two different ways: first, we reduced the total mirror area by half; second, we reduced the focal length by half, redesigning the mission for those new, smaller sizes. Of course, these mission designs were not optimized for these trade studies, this was intended as a first step in a much longer study. The result was a much-reduced effective area with greater reductions at hard energies for the shorter focal length and greater reductions at softer energies for the reduced mirror diameter. The preliminary conclusion by the engineering team was that neither of these trades resulted in significant cost savings. It appears that there is indeed a substantial entry level cost for any calorimeter mission similar to N-CAL.

NASA has shifted its focus on a future large X-ray mission to discussions with ESA about contributing to L2. On behalf of myself and Jay Bookbinder, the STDT co-chairs, we want to thank the XAP STDT for truly engaging discussions and the engineering team for all of their hard work.

Documents related to this short-lived study are available on the PCOS website (**http://pcos.gsfc.nasa.gov/studies/**), including its **charter** and **team membership**.

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## The ESA L3 Theme: The Gravitational Universe

Tuck Stebbins, *NASA/GSFC*

In late November ESA's Science Program Committee endorsed the selection of "The Gravitational Universe" science theme for L3, the third launch opportunity for a 'Large' class mission in the Cosmic Visions Programme. The white paper for the Gravitational Universe described science very similar to that of the LISA mission concept recommended in ***New Worlds New Horizons***. The white paper also described a straw man mission, called eLISA.

eLISA is a slightly reduced version of LISA, having three spacecraft in earth trailing orbits, two 1 million kilometer-long measurement arms rather than three, drag-free control, 20 cm telescopes and 2 W lasers. The design concept closely follows the long-studied LISA design and uses the key technologies being developed by the ESA-led LISA Pathfinder mission. LPF is scheduled to launch in July 2015.

There is no official timeline at this early date, but the decision document suggests that the L3 timeline will be similar to the L2 timeline, following by 6 years. That would suggest technology development until around 2019, a call for mission concepts in early 2020 and a selection near year end. The 'industrial phase' would start soon thereafter, ending with a launch in 2034.

The US gravitational wave community has been vigorously discussing the consequences of this decision. The Gravitational Wave Special Interest Group (GWSIG) has held one open telecon with Dr. Karsten Danzman, the spokesperson for the eLISA Consortium and another with Dr. Paul Hertz, Director of NASA's Astrophysics Division. Further community-wide discussions are expected at the Tenth LISA International Symposium in Gainesville, FL, May 18–23.

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## Technology Prioritization

Thai Pham, *PCOS Technology Development Manager*

By now you may have heard about—or even browsed over—our third release of the PCOS **Program Annual Technology Report** (PATR). The PATR is our annual summary of the technology development activities for the Program. It summarizes the Program technology gaps (previously referred to as "needs"), presents the results of technology gaps prioritization, and summarizes the status of technology developments funded by PCOS.

The Program Office (PO) has worked with the PCOS Program Analysis Group (PhysPAG) in the past three years to identify technology gaps to prioritize. The primary objective of the prioritization is to inform the proposal call and selection decision for the upcoming year's PCOS Strategic Astrophysics Technology (SAT) program.

The technology gap identification and prioritization process is described in detail in the PATR, but in a nutshell it is as follows: The community identifies the technology gaps by working with the PhysPAG or by submitting inputs to the PCOS website by the end of June each year. Inputs received via our website are forwarded to the PhysPAG to be processed and consolidated into one unified list. The Program Technology Management Board (TMB) reviews and prioritizes these technology gaps in July and recommends investment considerations to NASA Astrophysics via the PATR. Technology gap prioritization is based on science priorities, benefits and impacts, scope of applicability, and timeliness. The 2013 prioritization criteria are shown in **Table 1**. The criteria have evolved (and will surely continue to do so) in response to community and TMB feedback and current programmatic environment. The technology gaps and the resulting prioritization are published each year in the PATR which is released in October.

The 2013 prioritization was done before the European Space Agency (ESA) selection of the "Hot Energetic Universe" theme for the second Large-class mission (L2) which is expected to be pursued with an advanced X-ray observatory. As a result, the L2 selection has impacted the Program's technology development priorities. To support NASA's interest in a pos-

Table 1. Technology Gaps Prioritization

| # | Criterion | Weight | Max Score | Weighted Score | General Description/Question | Score Meaning 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Strategic Alignment | 10 | 4 | 40 | Technology enables or enhances a mission concept that is prioritized by the Astrophysics Implementation Plan (AIP) (which incorporated the recommendations of the Decadal Survey within current budgetary constraints) or current programmatic assessment. | Applicable mission concept receives highest AIP ranking | Applicable mission concept receives medium AIP ranking | Applicable mission concept receives low AIP ranking | Applicable mission concept was not ranked by the AIP but was positively addressed in the 2010 Decadal Survey | Not ranked by the AIP or the 2010 Decadal Survey |
| 2 | Benefits and Impacts | 9 | 4 | 36 | Impact of the technology on a notional mission concept. Degree of unique or enabling/enhancing capability the technology provides toward the science objective and the implementation of the mission. | Critical and key enabling technology; required to meet mission concept objective(s) | Highly desirable technology; significantly enhances science objective(s) and/or reduces need for critical resources | Desirable; offers significant science or implementation benefits but not required for mission success | Minor science impact or implementation improvements | No science impact or implementation improvement |
| 3 | Scope of Applicability | 3 | 4 | 12 | How cross-cutting is the technology? How many mission concepts could benefit from this technology? | The technology applies to multiple mission concepts across multiple NASA programs and other agencies | The technology applies to multiple mission concepts across multiple NASA programs | The technology applies to multiple mission concepts within a single NASA program | The technology applies to a single mission concept | No known applicable mission concept |
| 4 | Time to Anticipated Need | 3 | 4 | 12 | When does the technology need to be ready for a decision point or implementation? | Decision point is now or overdue, and implementation is needed within 7 years (this decade) | Decision point is now or overdue, or implementation is needed in 8 to 12 years (early to mid 2020s) | Decision point is less than 5 years away, or implementation is needed in 13 to 17 years (late 2020s) | Decision point is 10 years away, or implementation is needed 18 years or later (early 2030s) | No anticipated need |

sible collaboration with ESA on their L2 mission, the current SAT call for PCOS has been amended to solicit only proposals for technologies for X-ray astrophysics. These technologies include, but are not limited to, high-resolution microcalorimeters, lightweight replicated optics and precision structures, and high-resolution gratings. These X-ray technologies are in the top two of three priorities recommended in the 2013 PATR. The community is encouraged to submit SAT proposals which are due by March 21, 2014.

A major lesson learned to date is that many technology gaps received in the past were either not very applicable or not relevant to our objective of prioritizing technology gaps to inform the SAT process. Some suggestions for the next technology gap list are as follows:

- Focus on technology gaps associated with missions prioritized in the **Astrophysics Implementation Plan** and any other relevant documents or current programmatic directives (an example is the **Astrophysics Roadmap** which was released in December 2013).
- Don't include gaps that don't require technology development, are not well defined, are redundant (duplicate, similar, or subsets of other gaps), are at TRL 6 or higher, or are not in our charter, such as those associated with launch vehicle, rover, avionics, spacecraft systems, etc.
- Inputs should be submitted as technology capability gaps between the current state-of-the-art and the science objective desired and not as specific implementations.

Having a concise and applicable list of technology gaps will allow us to focus our efforts better and produce a more relevant prioritization list to better inform the SAT program.

We welcome continued feedback and inputs from the astrophysics community in developing next year's technology gaps prioritization. For more information and to provide feedback, please visit the PCOS website at: **http://pcos.gsfc.nasa.gov**.

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## Physics of the Cosmos (PhysPAG) Report

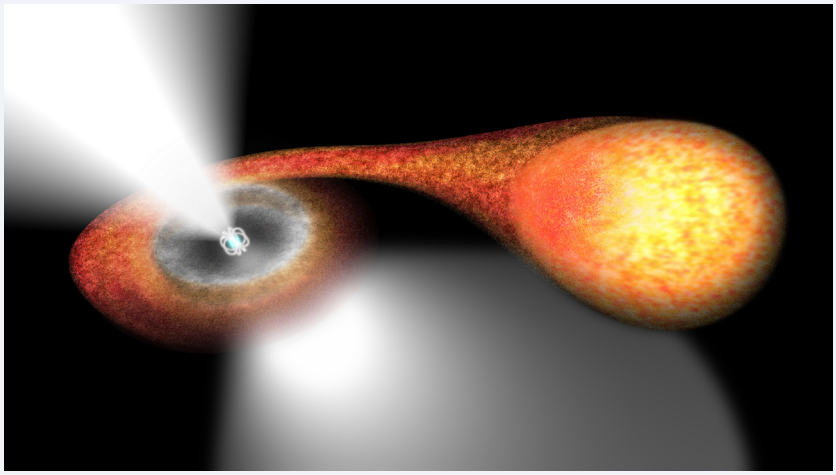
John Nousek, *Chair of the PhysPAG Executive Committee*

The PhysPAG's 2013 activities have centered around preparations for the PhysPAG Town Hall, held on January 5, 2014 at the Gaylord Resort in the National Harbor, MD, with approximately 80 people attending. The CosmicSIG, GammaSIG, and XRSIG also met separately in the morning with approximately 20–50 people in each of the various rooms. The detailed agendas, all the charts for the various SIG meetings, and the full PhysPAG meeting are all available on the **PCOS website**. The agenda included a discussion of the PCOS related technology priorities by Mark Clampin (*PCOS Chief Technologist*) and Thai Pham (*PCOS Technology Development Manager*), a presentation by Paul Hertz (*NASA Astrophysics Director*) on the status of NASA astrophysics activities including potential collaboration with ESA and progress towards decadal

## Volatile pulsar reveals millisecond missing link

For the first time, astronomers have caught a pulsar in a crucial transitional phase that explains the origin of the mysterious millisecond pulsars. These pulsars spin much faster than expected for their old age, and astronomers believe their rotation receives a boost as they accrete matter in a binary system. The newly found pulsar swings back and forth between accretion-powered X-ray emission and rotation-driven radio emission, bringing conclusive evidence for their 'rejuvenation'. The discovery was made possible by the coordinated efforts of ESA's two missions that scan the high-energy sky: INTEGRAL and XMM-Newton.

"With its twofold behaviour, this millisecond pulsar has a similar role to that of the platypus or the echidna in the animal world, which lay eggs but also produce milk to feed their offspring—a living evolutionary link between reptiles and mammals," says Alessandro Papitto from the Institut de Ciències de l'Espai (ICE; IEEC/CSIC) in Barcelona, Spain. Papitto led the team of astronomers that detected this key source, which is located in the globular cluster M28.



*This illustration shows an artist's impression of an X-ray bright pulsar in a binary system with a low-mass star as a companion. When the gravitational pull of the pulsar—which is a very dense object—starts drawing matter from the companion star, the pulsar starts accreting matter via an accretion disc, and emitting X-rays. This emission, supported by the accretion process, is shown as wide, white beams. Copyright: ESA*

Astronomers believe that accretion in a binary system is the mechanism responsible for speeding up millisecond pulsars, which are known to spin much faster than expected for their old age.

Read the full article here: **http://sci.esa.int/integral/52866-volatile-pulsar-reveals-millisecond-missing-link/**

priorities, and reports on activities from chairs of the Science Interest Groups (SIGs).

Exciting news for the PCOS community came on November 28, 2013, when ESA announced that it had selected the Hot and Energetic Universe theme for the L2 launch slot (2028), and the Gravitational Universe theme for the L3 launch slot (2034). Paul Hertz had previously expressed a desire for the US to participate as a junior partner to L2/L3 missions that were relevant to Astrophysics. To facilitate this participation, the XRSIG (chaired by Jay Bookbinder, SAO) held telecons to compile possible US areas of contribution, which were provided to Dr. Hertz. The GWSIG (chaired by Guido Mueller, U.Fla.) similarly held telecons to consider areas of technology development that would complement a future US L3 contribution.

I am happy to welcome Jamie Bock (JPL) as Deputy Chair of the PhysPAG Executive Committee. Jamie will serve as Deputy through 2014, and then become Chair in 2015. I will remain a member of the PhysPAG as an ex officio member until my term ends in December 2015. We are also pleased to welcome five new PhysPAG EC members, listed in the table below along with the full membership of the PhysPAG EC and term expiration dates.

Please don't hesitate to contact me, Jamie, or any member of the Executive Committee on any matter of concern related to the PhysPAG, PCOS, or the Astrophysics Subcommittee. Our function is to solicit and coordinate community input to NASA's Science Mission Directorate, and that function is best served by an active engagement in the interests of the community.

| Name | Affiliation | Expertise | Term Expiration Date |
|---|---|---|---|
| J. Nousek, Chair | Penn State Univ. | X-rays | January 2015 * |
| J. Bookbinder | SAO | X-rays | December 2015 |
| M. Bautz | MIT | X-rays | December 2016 |
| S. Hanany | Univ. of Minnesota | CMB, Suborbital | December 2014 |
| J. Bock | Caltech/JPL | CMB, Suborbital | December 2016 |
| G. Mueller | Univ. of Florida | Gravitational Waves | December 2014 |
| N. Cornish | Montana State Univ. | Gravitational Waves | December 2016 |
| J. Rhodes | JPL | Dark Energy | December 2014 |
| R. Bean | Cornell | Dark Energy | December 2016 |
| A. Olinto | Univ. of Chicago | Astroparticles | December 2015 |
| Eun-Suk Seo | Univ. of Maryland | Astroparticles | December 2016 |
| L. Hays | GSFC | Gamma-rays | December 2014 |
| M. McConnell | Univ. of New Hampshire | Gamma-rays | December 2016 |

* Term to be extended one year as *ex officio* member until December 2015

**Supernova Blast Provides Clues to Age of Binary Star System**

Data from NASA's Chandra X-ray Observatory has revealed faint remnants of a supernova. Sebastian Heinz and his team at the University of Wisconsin-Madison (UW) discovered Circinus X-1 is less than 4,600 years old, making it the youngest X-ray binary system ever seen. This discovery, made in parallel with a radio telescope in Australia, provides scientists unique insight into the formation of neutron stars and supernovas, and the effect of the supernova's explosion on a nearby companion star.

"X-ray binaries provide us with opportunities to study matter under extreme conditions that would be impossible to recreate in a laboratory," Heinz said. "For the first time, we can study a newly minted neutron star in an X-ray binary system."

Astronomers have detected hundreds of X-ray binaries throughout the Milky Way and other nearby galaxies. However, these older X-ray binaries, with ages typically measured in millions of years, only reveal information about what happens much later in the evolution of these systems.

Read the full article at **http://chandra.harvard.edu/press/13_releases/press_120413.html**

*The youngest member of an important class of objects, known as "X-ray binaries", has been found using data from NASA's Chandra X-ray Observatory and the Australia Compact Telescope Array. A composite image of Circinus X-1 shows X-rays in blue and radio emission in purple, which have been overlaid on an optical field of view from the Digitized Sky Survey. This discovery allows scientists to study a critical phase after a supernova and the birth of a neutron star. Image Credit: X-ray: NASA/CXC/Univ. of Wisconsin-Madison/S.Heinz et al; Optical: DSS; Radio: CSIRO/ATNF/ATCA*

# High Energy Astrophysics and Cosmology from Space

**A Mini-symposium Sponsored by**
**the American Physical Society's Division of Astrophysics (APS DAP)**
**APS Meeting at Savannah, GA**
**April 5–8, 2014**

**This mini-symposium is a showcase of PCOS science and PhysPAG activity. This is our follow-on from the 2013 PhysPAG Town Hall at the APS Denver meeting that was sponsored by the APS DAP. Please join us.**

- **Ann Hornschemeier (PCOS Program Office Chief Scientist): "High Energy Astrophysics and Cosmology from Space"**
- **Jay Bookbinder (XRSIG Chair): "Probing the Hot and Energetic Universe—X-rays and Astrophysics"**
- **Shaul Hanany (IPSIG Chair): "CMB Measurements: Looking Forward from Planck2013"**
- **Elizabeth Hays (GammaSIG Chair): "Exploring the Future Science of Space-based Gamma-ray Observations"**
- **Guido Mueller (GWSIG Chair): "Space-based Gravitational Wave Observatories: Learning from the Past, Moving Towards the Future."**
- **Angela Olinto (CosmicSIG Chair): "CosmicSIG Science and Plans"**
- **Jason Rhodes (PhysPAG EC Member): "NASA and Dark Energy"**

**Abstracts are available at http://pcos.gsfc.nasa.gov/physpag/mini-symposium/. Please check website for talk and schedule updates. The approximate duration for this symposium is 90 minutes.**

## Message from the NASA HQ Astrophysics Division Director

Paul Hertz, *Director, Astrophysics Division, NASA Science Mission Directorate*

As astrophysicists, we are fortunate that our most compelling science questions—how does the universe work, how did the familiar sky of galaxies and stars come to be, are we alone—resonate with the American public and Government policy makers who support us. At this time, we are poised to answer these questions scientifically using the suite of large and small space-based observatories spanning the electromagnetic spectrum.

As I described during the NASA Town Hall at the 223rd meeting of the American Astronomical Society in National Harbor, MD, we have made progress towards addressing the priorities of the 2010 Decadal Survey for Astronomy and Astrophysics.

- Preformulation and focused technology development for a 2.4m version of the Wide-Field Infrared Survey Telescope (WFIRST), a mission concept referred to as the Astrophysics Focused Telescope Assets (AFTA), are underway to enable a new start when funding becomes available as the James Webb Space Telescope (JWST) approaches launch, no earlier than FY 2017. Reports from the Science Definition Team and other WFIRST information is available at **http://wfirst.gsfc.nasa.gov/**
- An augmentation has been made to the Explorer program to enable more frequent flight opportunities, including a planned SMEX AO later this year (see the community announcement at **http://explorers.larc.nasa.gov/APSMEX/**).
- Strategic technology investments are being made and partnerships are being discussed with the European Space Agency in their gravitational wave and X-ray observatories.
- Strategic technology investments are being made to advance the medium scale programs.
- Modest augmentations have been made to small programs including the selection of six Theory and Computation Networks (co-funded by NSF).

A goal of the Astrophysics Division is to be prepared to start a new strategic NASA Astrophysics mission to follow JWST as soon as funding becomes available, while continuing to advance Decadal Survey science during the interim.

The FY 2014 appropriations bill for NASA (being voted on as this message is being written) provides $658M for continued development of JWST toward its launch in 2018 and $668M for the rest of NASA astrophysics, including funding for continued preformulation of WFIRST. The FY 2014 budget also includes funding for several new missions including the Transiting Exoplanet Survey Satellite (TESS), the next Astrophysics Explorer mission, the Neutron Star Interior Explorer (NICER), the next Astrophysics Explorer Mission of Opportunity, and the NASA contribution to the European Space Agency's Euclid mission.

The major impacts of the October 2013 Government shutdown included the cancellation of the 2013–2014 Antarctic balloon campaign including three long duration balloon flights; the cancellation of nine SOFIA science flights and a delay in the beginning of Cycle 2; a stand-down in ASTRO-H soft x-ray spectrometer (SXS) integration and test that will result in a ~5 week delivery delay to JAXA; and delays in sending out research funding for those grantees whose awards were scheduled to start or be funded at the beginning of FY 2014.

Major activities planned for 2014 include the Astrophysics Senior Review of flight missions and release of a Small Explorer Announcement of Opportunity targeted for Fall 2014. A task force of the Astrophysics Subcommittee has completed a 30 year visionary roadmap, Enduring Quests, Daring Visions, to address enduring questions in Astrophysics.

My entire Town Hall Presentation from the January AAS meeting, as well as Enduring Quests, Daring Visions, is available at **http://science.nasa.gov/astrophysics/documents/**.

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## PCOS Organization

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## Meet the Einstein Fellows: Laura Blecha

Supermassive black holes are virtually ubiquitous in massive galaxies, and their masses correlate with properties of galactic stellar bulges. Galaxy mergers provide a viable mechanism for this observed co-evolution by simultaneously growing stellar bulges and triggering black hole accretion. Such mergers also result in the formation of black hole pairs, which may themselves merge and be ejected from galaxies via gravitational-wave recoil. Observations of these phenomena can provide crucial information about black hole fueling and feedback in galaxy mergers, as well as the black hole merger rate. Black hole mergers are powerful gravitational wave events that could be detected with pulsar timing arrays or future space-based observatories. However, unambiguous identification of dual and recoiling black holes has often proved challenging.

As an Einstein Fellow, Laura is using hydrodynamic simulations to model the electromagnetic signatures of active black holes during galaxy mergers, motivated by recent discoveries of candidates at an unprecedented rate. Better theoretical models of these signatures are needed to confirm the dual nature of many black hole pair candidates, and the signatures of black hole recoil are more uncertain still. In collaboration with observers, Laura is using the results of modeling to design follow-up observations and future targeted searches for black holes in merging galaxies.

Laura completed her bachelor's degree at Northwestern University and an MPhil degree at Cambridge University in England. She received her PhD from Harvard University. She has been an Einstein and JSI Fellow at the University of Maryland since September 2012.

## Calendar of Upcoming PCOS/PhysPAG Events

| | |
|---|---|
| April 5–8, 2014 | PCOS/PhysPAG Town Hall at the American Physical Society Meeting<br>Savannah, GA |
| August 2014 | PCOS Town Hall at HEAD meeting<br>Chicago, IL |
| October 2014 | Einstein Fellows Symposium<br>Cambridge, MA |
| January 2015 | PhysPAG Town Hall at AAS meeting<br>Seattle, WA |

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