

# Joint PAG Executive Committee Meeting

March 19

Meeting Slides

# Upcoming Meetings

- April 11-14, Am. Phys. Soc. (Baltimore) - PhysPAG
  - SIGs and PCOS mini-symposium
- Early May – Virtual Town Hall – COPAG
- \*May/June – Virtual Town Hall (2 hour) – Joint PAG
  - Specific questions to be drafted
- \*June 3-5, Far-IR Workshop (Caltech) – COPAG
- \*Late June, UV/Optical Workshop (TBD) – COPAG
- \*June 13-14, ExoPAG #12 (Chicago) - ExoPAG
  - Half to full day to be spent on charge (2<sup>nd</sup> day)
- \*June 29-July 1, HEAD (Chicago) – PhysPAG
  - Need to register for HEAD meeting, but don't need to be member
- August 3-14, IAU, (Honolulu) – Joint PAG (chairs + overview)
  - FM11, FM14, or others (present status rather than ask for input)
  - Special session or splinter meeting? (June 15 deadline)
- August, Virtual Town Hall – Joint PAG
  - Chance to present overview of report to community

\*PAG reports related to charge

# The 4 missions

- Far-IR Surveyor, architecture TBD
  - A) 4-6m filled aperture, single-dish, cold
  - B) 10m+ segmented
  - C) 10m+ equivalent interferometric system
  - Imagers, spectrographs

# The 4 missions

- HabEX
  - 4-8m monolith
  - Needs  $\sim 10^{-10}$  contrast
  - Coronagraph, wavelength of 0.5-1.0 micron
  - And/or starshade, wavelength of 0.25-1.0 micron
  - Camera
  - IFU, R=70 spectrum of 30m exoplanet
  - 1" FOV
  - Optimized for exoplanets, but other uses of instruments possible
  - L2 orbit or Earth-trailing

# The 4 missions

- Large UVOIR Surveyor
  - 8-16m (likely segmented, obscured primary)
  - HST-like bandpass (91nm – ~2 microns)
  - Suite of imagers/spectrographs
  - Need  $\sim 10^{-10}$  contrast for planet imaging (coronagraph and/or starshade), less contrast for other studies

# The 4 missions

- X-ray Surveyor
  - Angular resolution better than 1''
  - 3 sq. m effective area
  - High-resolution spectroscopy (few thousand) over a broad band
  - FOV  $\sim 5'$
  - Wavelength range  $\sim 0.1-10$  keV

# Probes?

- Should be part of process of planning for next decadal survey
  - Could be done outside of this particular flagship process
- Need to have NASA define probes
- Need to understand costing of probes
- Do probes need mission-funded technology development?

ExoPAG Slide Excerpts from the  
Astrophysics Subcommittee Meeting  
(Gaudi)



# Current EC Membership.

Rus Belikov

Nick Cowan

**Jonathan Fortney**

**Scott Gaudi** (*Chair*)

**Dave Latham**

Amy Lo

Peter Plavchan

Gene Serabyn

**Remi Soummer**

Maggie Turnbull

Lucianne Walkowicz

Doug Hudgins (*Ex officio*)

**Wes Traub** (*Ex officio*)

NASA Ames

Amherst College

U.C. Santa Cruz

Ohio State

SAO

Northrop Grumman

Missouri State U.

JPL

Space Telescope Sci. Inst.

Global Science Institute

Adler Planetarium

NASA Headquarters

JPL

# Future EC Membership.

**Alan Boss** (Chair)

**Rus Belikov**

**Nick Cowan**

**Amy Lo**

**Peter Plavchan**

**Gene Serabyn**

**Maggie Turnbull**

**Lucianne Walkowicz**

**Martin Still** (*Ex officio*)

**New ExEP Program Chief Scientist** (*Ex officio*)

**Carnegie DMT**

**NASA Ames**

**Amherst College**

**Northrop Grumman**

**Missouri State U.**

**JPL**

**Global Science Institute**

**Adler Planetarium**

**NASA Headquarters**

# **ExoPAG Meta-goal:**

***Develop a holistic, broad, unified, and coherent exoplanet plan for the next decade, with community consensus, focusing on areas where NASA can contribute.***

# **SIG #1: Toward a Near-Term Exoplanet Community Plan.**

**The goal of this Science Interest Group is to begin the process of developing a holistic, broad, unified, and coherent plan for exoplanet exploration, focusing on areas where NASA can contribute. To accomplish this goal, the SIG will work with the ExoPAG to collect community input on the objectives and priorities for the study of exoplanets. Using this input, it will attempt develop a near term (5-10 year) plan for exoplanets, based on the broadest possible community consensus. The results of this effort will serve as input to more formal strategic planning activities that we expect will be initiated after the mid-decadal review, in advance of the next decadal survey.**

**Introductions at ExoPAG 8+9, sessions at ExoPAG 10 + 11, one stand alone meeting (February 10+12, 2015).**

# Characterizing Transiting Planet Atmospheres through 2025

N.B. Cowan, T. Greene et al. (ExoPAG SAG-10)

- JWST will characterize the atmospheres of dozens of short-period planets with transits, eclipses & phases
  - A dedicated survey mission is necessary to obtain transit spectra for the hundreds-thousand of bright TESS hot Jupiters and warm sub-Neptunes
- JWST will provide tantalizing constraints on a few HZ rocky planets transiting M-Dwarfs
  - Future flagship missions must be able to constrain the habitability of these worlds

# **ExoPAG's Response to Paul's “Large Mission” Charge.**

- The ExoPAG had already initiated the process of building consensus for an “Exoplanet Roadmap” through the SIG #1 activities.**
- The ExoPAG will respond to Paul's charge under the auspices of this SIG.**

# Inputs to date.

- Talks, brainstorming, and discussion at ExoPAGs 8, 9, 10, 11, and stand-alone meeting.
- NASA Astrophysics Roadmap.
- Solicited (and unsolicited) input from a several dozen members of the community.

## SIG #1 Meeting Collated Suggestions

Suggestions
how: can we construct candidate list for target list (from RV, or do we need astrometry)
how: dedicated precision radial velocity instrument on 10m-class telescope
how: false positives (strategy for screening)
how: high-resolution UV spectrograph instrument with capabilities much greater than HST.
how: Optical and IR spectroscopic instruments on Spitzer, JWST, and future large space missions
how: probability of a rocky planet in HZ actually being habitable (define as potentially habitable)
how: TPF-I as a capstone mission
how: transit characterization mission
how: understand the astrophysical limits of precision radial velocity, high resolution, large aperture, optical + near-IR
how: unresolved Doppler shift spectra?
how: what are the true capabilities for ground-based VLTs for direct imaging?
how: what is Eta_Earth? Or at least assume for mission designs
how: what will ELTs do for HZ earths orbiting M stars?
how: yield goal (how many stars do we need to look at)
how: 2015 is too early to be presuming anything about mission size, narrow down after considering all of the options
how: a large (\$8B-\$10B) mission will be dead on arrival for 2020-2030, due to "JWST hangover", need to consider alternatives
how: a mission must do direct spectroscopy of earth analogs to be relevant when launched, need to start now for US leadership role
how: boost R&A grants by a factor of ~3
how: bring in planetary scientists
how: Can we sell a mission that doesn't look for and characterize Earth-like planets?
how: consider aperture as metric for comparison with other science
how: convince the entire community (get observing time)
how: dedicated exoplanet Explorer (\$300-\$400M) program every few years, allows one to be nimble
how: develop a consensus program with a modest flagship plus modest "Probe" class options
how: develop a menu of options of increasing costs and capabilities: occulter for WFIRST/AFTA -> 4-m class -> 12-16-m class.
how: direct imaging mission: go as big as possible, without creating a budget crises (starving R&A)
how: direct imaging mission: where to set the bar for the minimum justifiable science, is that affordable?
how: discuss with COPAG
how: don't put all our eggs in the "spectra of Earth-twin" to sell a mission
how: don't constrain the budget too much early on (let the science lead, then marshal resources to that goal)
how: even a dedicated mission can be tuned to various science programs, and incorporate other science goals
how: exoplanet community must unite behind WFIRST-AFTA + coronagraph
how: Far IR surveyor, LUVVOIR surveyor, Habitable Exo-planet Imaging Mission, X-ray surveyor
how: go for big goal, or make sure you also harvest all of the low hanging fruit (how do you prioritize)
how: how do we allocate observing time between science objectives?
how: how do we not become a non-fractured community?
how: how to avoid mission creep (assess needs)
how: how to get mission selected (engage entire community early on)



## SIG #1 Meeting Collated Suggestions

how: large DI mission questions: launch vehicle? UV+coronagraph compatibility? Starshade viable, and demonstrable?
how: major missions: have to demonstrate that they are capable of a broad range of science
how: make sure the dedicated technology advances other (broader) science
how: maximize probability of actually flying a mission
how: national or agency priority (get buy in from entire agency)
how: need an intermediate mission category (\$500M - \$1B), enable an image-based astrometry or transit spectroscopy mission?
how: not realistic to do spectroscopy of exo-Earths using an internal coronagraph
how: probes are cost-capped, not science constrained
how: put all of our eggs in one basket for a large flagship mission, or study more affordable 2-4m missions
how: serving the entire community, time needs, yield goal
how: support theoretical models on planet formations, atmospheres, climate, bio-signatures, etc.
how: technology for $10^{-10}$ contrast imaging with segmented apertures appears unlikely to be ready in time for Astro2020
how: viability: technology, multiple communities, other science mission can do
how: what missions do we recommend for technology development
how: when is the next flagship mission?
what: K2, TESS, PLATO, GAIA: precision radial velocity follow-up
what: earth analogs: R=100 spectroscopy, 30 magnitude objects, 0.2" from a 5th magnitude star.
what: find Rosette stone planets that tie together the different characterization techniques
what: fundamental parameters of the star (ages)
what: get orbits of the planet (eccentricity), ensure they stay in HZ, etc.
what: host star parallaxes, astroseismology
what: how much risk do we accept when searching for habitable planets
what: is Kepler + WFIRST a good enough survey, or do we need an other mission?
what: look at planets that are not habitable (is the census from WFIRST and Kepler enough)
what: mass loss rates from exoplanet host stars
what: Measure compositions of exoplanet atmospheres, build robust codes to understand the physical and chemical processes
what: measurements of the UV, extreme-UV, and X-ray
what: need spectra of stars (UV), for stellar environment
what: need UV measurements of planetary systems
what: planet formation imager? Mid- to far-IR for young systems
what: precision RV census and masses of planets orbiting the closes FGKM stars for potential HZ targets for DI mission
what: tie habitable planets to those with direct imaging (M-dwarfs); be smart about what has been done from transit searches
what: to understand climate, need mid IR (to confirm habitability and surface temperature)
what: wavelengths do we absolutely have to have, for habitability, and what Resolution
why: Are specific exoplanets habitable?
why: are we alone?
why: characterize exoplanets and solar system planets: interiors, compositions, radii, bulk metallicity, P-T profile, magnetic fields
why: characterizing systems (not just a single planet), Exo-Zodi, dynamics, disks, holistic understanding of the full planetary system
why: comparative planetology

## SIG #1 Meeting Collated Suggestions

why: demographic measurements of planets, host stars and host environments
why: Eta_* other planet types (not just Earths) (Hot Earth, super-Earth, etc.) Get also from WFRIST and Kepler
why: Exo-planet science also doesn't end with a single spectra of an Earth-twin
why: go smaller and smaller, ultimately characterize, biology
why: how do exoplanets form?
why: how do planet system form? (formation and evolution, this is part of cosmic origins)
why: how does planet atmosphere depend on star, formation, evolution
why: language: use broader language than Earth-twin, or planet. Use planetary system, characterize Earth-like planets, etc.
why: leverage from diversity (need to characterize more than just a bunch of Earths)
why: properties of host stars: demographics, masses, radii, ages
why: put Earth in context, not just search for Earth-twin
why: search for habitable conditions is primary, and actually finding Earth-like comes after
why: synergy with planetary science
why: understand all planets as a species
why: understand atmosphere is important to understand habitability (chemistry and processes)
why: understand habitability planets as a system (geology, integration of the entire planet)
why: understanding exoplanets in general in order to inform our understanding of habitable zone planets
why: what are exoplanets like?
why: what are the architectures of multi-planet systems?
why: what are the demographics of moons, belts, cometary systems, and protoplanetary debris disks?
why: what are the environments of planets in the universe and over cosmic time?
why: what happens to habitable planet when star goes off main sequence
why: what is habitability mean (not just Earth-like), what are the implications for bio-signatures
why: what planets are out there?
why: where is the closest habitable, earthlike zone planet?

# SIG #1 Stand-alone Meeting

- February 10+11, 2015 at JPL.
- Roughly 45 people attended in person and remotely.
- Talks, break-out sessions, brainstorming and group discussions.
- Afternoon of February 11 devoted to Paul's charge.
- Consensus building.
  - Start the process of developing a consensus on Whys and Whats.
- Define path forward.
  - Identify questions and topics for future discussions.

# Takeaways.

- 1. There was a general consensus that a broad range of apertures and architectures for direct imaging missions should be studied, encompassing both the nominal concepts of the HabEx and LUVOIR missions.**
- 2. There were discussions about how the STDT or STDTs that study these direct imaging missions should be organized. There was a diversity of opinions as to whether there should be completely separate teams for HabEx and LUVOIR (including separate science and design teams), or a joint science team with two design teams, or one science and one design team.**
- 3. There was discussion about whether we should attempt to prioritize the various direct imaging mission concepts, or whether we are even capable prioritizing those missions.**

# Notional Timeline.

- **January 2014: Initial discussion at ExoPAG 9.**
- **March 2014: APS approves SIG #1.**
- **June 2014: Brainstorming session at ExoPAG 10.**
- **January 2015: Brainstorming session at ExoPAG 11, Paul's charge.**
- **February 2015: First dedicated SIG #1 Meeting, brainstorming & consensus building.**
- **March 2015: Joint PAG EC meeting.**
- **April-May 2015: SIG #1 telecons.**
- **June 2015: Consensus building at ExoPAG 12.**
- **July-September 2015: Telecons, stand-alone meeting (?), writing, circulating, finalizing report(s?).**
- **October 2015: Deliver Hertz report to APS.**
- **November-December 2015: Circulate and finalize SIG #1 report.**
- **January 2016: Deliver final SIG #1 report at ExoPAG 13.**

# Future.

- **ExoPAG12:**
  - Hilton Chicago,
  - June 13+14, 2015
  - Weekend before AbSciCon
- **SIG #1/Hertz Charge activities**
  - I will stay on the ExoPAG as an Ex Officio member to guide the SIG #1/PH Charge activities through completion.
  - Virtual meetings
  - ExoPAG 12
  - Stand alone meeting (?)
- Let us know if you have input, or would like to contribute to these efforts!
- Email me: [gaudi@astronomy.ohio-state.edu](mailto:gaudi@astronomy.ohio-state.edu)
- More information on website, including email list:  
<http://exep.jpl.nasa.gov/exopag/>

COPAG Slide Excerpts from the COPAG  
Virtual Town Hall  
(Sembach)

# COPAG Virtual Town Hall

March 10, 2015

Note: This webex session is being recorded  
and will be publicly available.



# COPAG Executive Committee

- Daniela Calzetti (University of Massachusetts)
- Dennis Ebbetts (Ball Aerospace, retired)
- James Green (University of Colorado)
- Matt Greenhouse (NASA/GSFC)
- Sara Heap (NASA/GSFC)
- Lynne Hillenbrand (Caltech)
- Mary Elizabeth Kaiser (Johns Hopkins)
- Joseph Lazio (NASA/JPL)
- James Lowenthal (Smith College)
- Pam Marcum (NASA/Ames)
- Kenneth Sembach (Chair) – STScI

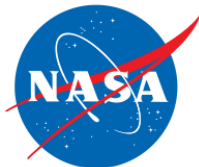
## Ex-officio

- Susan Neff & Deborah Padgett (GSFC Cosmic Origins Program Office)
- Mario Perez (NASA HQ)



# Background (Hertz AAS Presentation): Preparing for the 2020 Decadal Survey

- The 2020 Decadal Survey will prioritize large space missions to follow JWST and WFIRST.
  - To enable this prioritization, NASA needs to provide information on several candidate large space mission concepts for consideration by the 2020 Decadal Survey Committee.
- What information needs to be provided to the Decadal Survey committee to enable prioritization of large missions
  - Science case
  - Strawman design reference mission with strawman payload
  - Technology development needs
  - Cost requirements assessment
- NASA needs to initiate technology development for candidate large missions so that technology will be ready when needed.
  - Technology needs to be sufficiently mature when it is time to start the highest priority large mission in the 2020 Decadal Survey.
  - The next large mission after WFIRST could be started when funding becomes available as WFIRST approaches launch in the early or mid-2020s.



# Background (Hertz AAS Presentation): PAG Involvement

**Part A:** Identify a small set (~3-4) of large mission concepts to study

- The community has invested considerable resources in discussing notional classes of mission concepts for consideration as large missions following JWST and WFIRST and in parallel with the ESA-led missions Euclid, Athena, and L3.
  - The 2010 Decadal Survey, *New Worlds New Horizons in Astronomy and Astrophysics*.
  - The 2014 Astrophysics Visionary Roadmap, *Enduring Quests, Daring Visions*.
- NASA has drawn an initial small set of 4 candidate mission concepts from the missions discussed in these strategic documents.
- [Paul Hertz is] charging the Astrophysics PAGs to solicit community input for the purpose of commenting on the small set, including adding or subtracting large mission concepts; each PAG will submit a report regarding the small set of large mission concepts for consideration by the NAC Astrophysics Subcommittee.
- At its Fall 2015 meeting, the NAC Astrophysics Subcommittee will consider the three PAG reports and submit a report to NASA on the small set of large mission concepts for study.
- [Paul Hertz] will decide which large mission concepts will be studied as input for the 2020 Decadal Survey.



# Background (Hertz AAS Presentation): Charge to the PAGs

## Charge to the PAGs (subset):

1. Each PAG, under the leadership of its Executive Committee, shall broadly solicit the astronomy and astrophysics community for input to the report in an open and inclusive manner.
  - To accomplish this, each PAG is empowered to envision and use its own process.
2. Each PAG will consider what set of mission concepts should be studied to advance astrophysics as a whole; there is no desire for mission concepts to be identified as “belonging” to a specific Program or PAG.
  - Each PAG shall keep the number of large mission concepts in the set as small as possible.
  - Each PAG is specifically charged to consider modifications and subtractions from the small set, and not just additions.
3. Each PAG shall produce a report, where it shall comment on all large mission concepts in its small set of large missions, including those in the initial small set and those added or subtracted.
  - The PAGs may choose to work together and submit coordinated or joint reports.

# What the COPAG Will Be Doing in Response to this Charge

- Collecting Cosmic Origins community input for the four missions in NASA's shortlist
  - Science cases
  - Technology needs
  - Comments on the four strawman missions
- Identifying any other large missions having broad community support for Cosmic Origins science
- Summarizing that input for each of these missions for the Astrophysics Subcommittee (Final report due October 2015)
- Working with the PhysPAG and ExoPAG in responding to this charge when possible (collecting/sharing input, joint reports)

# What the COPAG Will Not Be Doing in Response to this Charge

- Prioritizing these flagship missions
  - This is the work of the Decadal Survey Committee
- Advocating for specific mission concepts
  - Focus on capabilities, science drivers, science synergies, technology tall poles,
- Advocating for smaller missions
  - Only large (>\$1B) missions are being considered (i.e., no Probes, Explorers)
  - Other avenues for input are (or will be) available
- Performing Technical Trade Studies
  - This is the work of the STDTs in Part B of Paul Hertz's charge
  - Input collected will inform the STDT studies

# Request for White Papers

- The COPAG wants your input
- White paper solicitation
  - [http://cor.gsfc.nasa.gov/copag/rfi/Large\\_missions\\_white\\_paper\\_solicitation-01Mar2015.pdf](http://cor.gsfc.nasa.gov/copag/rfi/Large_missions_white_paper_solicitation-01Mar2015.pdf)
  - Length = 1-2 pages
  - Due April 24, 2015
  - PDF, MS Word, or ASCII format
  - All white papers will be posted on the COPAG website:  
<http://cor.gsfc.nasa.gov/copag/rfi/copag-rfi.php>
  - Submit papers (or questions) to:  
[COPAG\\_Contact@bigbang.gsfc.nasa.gov](mailto:COPAG_Contact@bigbang.gsfc.nasa.gov)

# Next Steps

- COPAG will hold another virtual town hall to discuss the community input it has received
  - May 2015 timeframe
  - Date/time and webex details will be posted on the COPAG website
- COPAG Science Interest Groups will help to collect community input through their activities
  - SIG#1 (Far-IR, Leads: David Leisawitz / Paul Goldsmith)
  - SIG#2 (UV-Optical, Lead: Paul Scowen)
- The COPAG Executive Committee is available to answer questions about this process. Contact us at ([COPAG\\_Contact@bigbang.gsfc.nasa.gov](mailto:COPAG_Contact@bigbang.gsfc.nasa.gov))



PhysPAG Slide Excerpts from the  
Astrophysics Subcommittee Meeting  
(Bock)

# Physics of the Cosmos

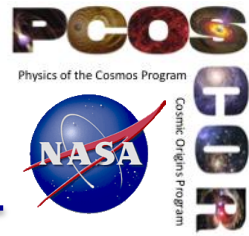
## Report for the Astrophysics Subcommittee

### 17 March 2015

**Jamie Bock**

**Mark Bautz**

# 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

\*new member

# PhysPAG and SIGs

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

# Status and Schedule on Large Missions

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- **March**
  - SIGs have started collecting community input
  - Develop list of questions and issues the PhysPAG wants to address in its report
- **April - June**
  - Community input phase
  - Parallel work on PhysPAG report outline
  - Parallel joint PAG meetings
- **July – September**
  - Write PhysPAG report
  - Coordinate PhysPAG report with other PAGs

# Large Mission PhysPAG Themes\*

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- **Far-Infrared Surveyor**
  - How and when did the first supermassive blackholes form?
  - Evolution of galaxies and their supermassive black holes
  - Multi-messenger studies with GW events
  - Technology synergies with Inflation Probe and X-ray detectors and optics
  - Intensity mapping measurements of large-scale structure
- **Habitable Exoplanet Imaging Mission**
- **UV/Optical/IR Surveyor**
  - Evolution of galaxies and their supermassive black holes
  - Understand the physics of supernovae and feedback on evolution of galaxies
  - Understand the physical state, composition and kinematics of baryons in the cosmic web
  - Multi-messenger studies with GW events
  - Follow-on studies of large-scale structure measurements
- **X-Ray Surveyor**
  - How and when did the first supermassive blackholes form?
  - Evolution of galaxies and their supermassive black holes
  - Test strong GR by probing behavior of matter in the vicinity of supermassive black holes
  - Measure the spin distribution of supermassive black holes in the local Universe
  - Determine the properties of matter at the highest densities and pressures in neutron stars
  - Understand the physics of supernovae and feedback on evolution of galaxies
  - Understand the physical state, composition and kinematics of baryons in the cosmic web
  - Multi-messenger studies with GW events

# Questions and Reactions from PhysPAG SIGs

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- **X-ray Surveyor**
  - How are X-ray Surveyor's science goals related to those of Athena?
- **Gravitational-Wave L3 Mission**
  - Given that LISA is the highest priority unfinished business from the last decadal and does not appear on the list, how should strong and timely support for a GW mission be achieved?
  - The GW community requests that an implementation study for L3 be conducted concurrently with the other decadal studies
- **Inflation Probe**
  - Community generally agrees this is a probe-class mission, however
  - Mission development needs to be supported for 2020 Decadal survey preparation
  - Technology program needs to be supported and re-evaluated by mid-decadal panel
- **Probe Mission Line**
  - Strong interest in probe line for PhysPAG science
  - Strong interest in developing studies to support a competed probe-class mission line
  - PhysPAG example probe missions: Inflation Probe, Gamma-Ray Probe, Cosmic-Ray Probe, X-Ray Probe

# Questions and Reactions from PhysPAG SIGs

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# Upcoming community events

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- **April 2015, American Physical Society meeting, Baltimore, MD**
  - PCOS table within display hall
  - PCOS mini-symposium on Tuesday, April 14, 2015
  - GammaSIG mini-symposium “Future MeV Gamma-Ray Science and Missions”
  - Space-based GW oral session on Monday
  - GWSIG meeting on Saturday evening at 6PM
  - CosmicSIG meeting ...
- **June 29-July 1, 2015 “Special HEAD meeting”**
  - X-Ray and Gamma-Ray SIG discussions planned
  - Last venue for community input
- **August 2015, IAU-AAS meeting in Honolulu**