

Cosmic Origins Program Analysis Group (COPAG)

Virtual Town Hall

Planning for the 2020 Decadal Survey: Activities Related to Large Mission Concepts

K. Sembach (COPAG Chair)

August 20, 2015

1-3 PM EDT

Join WebEx meeting

Meeting number: 640 983 540

Meeting password: cosmicorigins

Join by phone

1-855-244-8681 Call-in toll-free number (US/Canada)

1-650-479-3207 Call-in toll number (US/Canada)

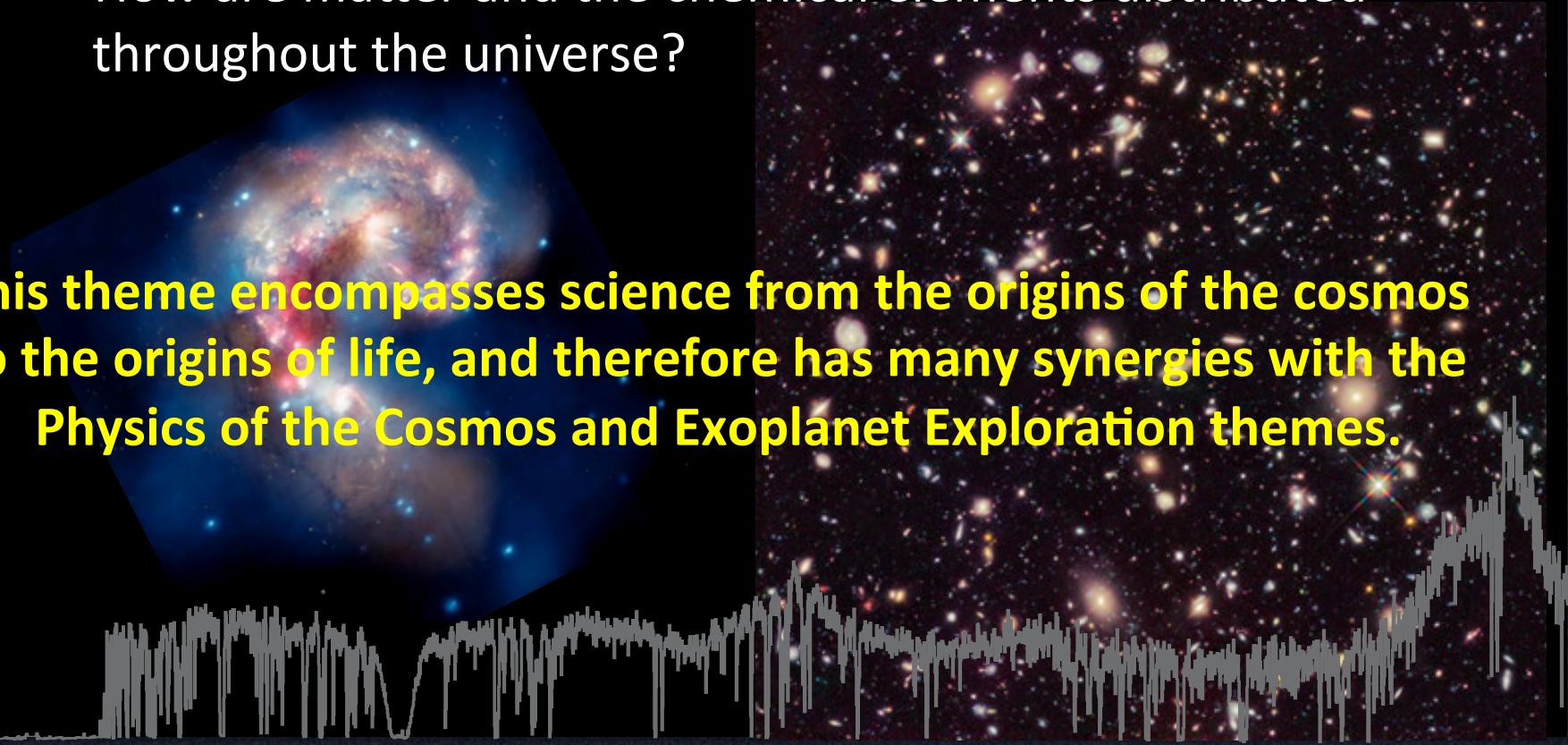
Access code: 640 983 540

Cosmic Origins Questions

- How did we get here?
 - How and when did galaxies form?
 - How do stars form, evolve, and eventually die?
 - How are matter and the chemical elements distributed throughout the universe?



This theme encompasses science from the origins of the cosmos to the origins of life, and therefore has many synergies with the Physics of the Cosmos and Exoplanet Exploration themes.



What Does the COPAG Do?

- Solicit and coordinate community input into the development and execution of NASA's Cosmic Origins (COR) Program
- Analyze this input in support of the planning and prioritization of future exploration within the COR program
- Specific types of tasks include:
 - Articulating and prioritizing key science drivers for COR research
 - Evaluating capabilities of potential missions for achieving COR science goals
 - Providing input and analysis on related activities (e.g., ground-based observing, theory investigations, laboratory astrophysics, suborbital investigations, data archiving, etc) needed to achieve COR science goals
 - Identifying focus areas for technologies needed to advance COR science
- All input is provided to NASA's Astrophysics Division Director and the NASA Advisory Council's Astrophysics Subcommittee

Current COPAG Executive Committee

Name	Institution	Term Expiration
Daniela Calzetti	U. Mass. Amherst	Jan 2017
Dennis Ebbets	Ball Aerospace (retired)	Jan 2017
James Green	U. Colorado	Jan 2017
Matthew Greenhouse	NASA GSFC	Jan 2018
Sally Heap	NASA GSFC	Jan 2017
Lynne Hillenbrand	Caltech	Rotating off Oct 2015
Mary Beth Kaiser	Johns Hopkins U.	Oct 2017
Joseph Lazio	NASA JPL	Oct 2017
Pamela Marcum	NASA ARC	Oct 2017
Ken Sembach - Chair	STScI	Mar 2016

10 members + ex-officio (S. Neff & D. Padgett in COR office, M. Perez & K. Sheth at HQ)

COPAG Executive Committee Members Needed

- “Dear Colleague” letter requesting nominations has been sent to the community.
 - Self-nominations are welcome.
- Expect at least 2 new members to be appointed.
- Appointments are for a period of 3 years.
- Deadline for nominations is September 4, 2015.
- Selections will be announced in early October 2015.

See <http://cor.gsfc.nasa.gov/news/ec-nominations.php>



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): Schedule for Large Mission Studies

Part A – 2015

- Identify a small set of candidate large mission concepts to study
 - Incorporate community input through the three Astrophysics Program Analysis Groups (PAGs)

Part B – 2016-2019

- Initiate studies
 - Includes community-based Science and Technology Definition Teams
- Conduct studies
 - Includes NASA Center-provided engineering teams
- Identify technology requirements to motivate early technology development
 - Enables funding through existing Astrophysics technology programs
- Deliver results to 2020 Decadal Survey committee

Planning for the 2020 Decadal Survey: An Astrophysics Division White Paper
available at <http://science.nasa.gov/astrophysics/documents>



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): The Suggested Mission List

The initial short mission list (alphabetical order):

- **Far-IR Surveyor** – The Astrophysics Visionary Roadmap identifies a Far IR Surveyor as contributing through improvements in sensitivity, spectroscopy, and angular resolution.
- **Habitable-Exoplanet Imaging Mission** – The 2010 Decadal Survey recommends that a habitable-exoplanet imaging mission be studied in time for consideration by the 2020 decadal survey.
- **UV/Optical/IR Surveyor** – The Astrophysics Visionary Roadmap identifies a UV/Optical/IR Surveyor as contributing through improvements in sensitivity, spectroscopy, high contrast imaging, astrometry, angular resolution and/or wavelength coverage. The 2010 Decadal Survey recommends that NASA prepare for a UV mission to be considered by the 2020 Decadal Survey.
- **X-ray Surveyor** – The Astrophysics Visionary Roadmap identifies an X-ray Surveyor as contributing through improvements in sensitivity, spectroscopy, and angular resolution.



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.

Timeline of PAG Activities to Date

- January 3-4, 2015: Brainstorming session at ExoPAG 11
- February 2015: ExoPAG SIG #1 Meeting
- March 10, 2015: COPAG Virtual Town Hall
- March 19, 2015: Joint PAG Executive Committee meeting
- April 11-14, 2015: Am. Phys. Soc. (Baltimore) – PhysPAG
- April 24, 2015: COPAG Call for Community White Papers
- June 2, 2015: ExoPAG Virtual Meeting
- June 3-5, 2015: Far-IR Workshop (Caltech) – COPAG
- June 13-14, 2015: ExoPAG #12 (Chicago) – ExoPAG

Timeline of PAG Activities to Date

- June 13-14, 2015: ExoPAG #12 (Chicago) – ExoPAG
- June 25-26, 2015: UV/Vis SIG #2 Meeting (Greenbelt) – COPAG
- July 1, 2015: Panel discussion during the HEAD meeting (Chicago) – PhysPAG
- July 3, 2015: Joint PAG Chair telecon
- July 13, 2015: Joint PAG Chair telecon with Paul Hertz
- July 14, 2015: ExoPAG Virtual Meeting
- August 7, 2015: Joint PAG Splinter Session at IAU
- August 18, 2015: ExoPAG Virtual Meeting

Responding to the Charge: Preparing for the 2020 Decadal Survey

- Bi-weekly COPAG Executive Committee telecons
- Recent and upcoming activities
 - COPAG representation at the ExoPAG12 meeting in Chicago (June 13-14)
 - COPAG representation at the HEAD meeting in Chicago (July 1)
 - COPAG SIG#1 (Far-IR) workshop in Pasadena (June 3-5)
 - COPAG SIG#2 (UV/Vis) workshop in Greenbelt (June 23-24)
 - COPAG virtual town hall (August 20)
 - Future flagship session at AIAA Space 2015 Conference in Pasadena (August 31)

Responding to the Charge: Preparing for the 2020 Decadal Survey

- COPAG community white paper solicitation earlier this year
 - There was a wide range of inputs received on science needs, technology, mission drivers.
 - All responses are posted on COPAG website:
<http://cor.gsfc.nasa.gov/copag/>
 - All responses have been made available to ExoPAG and PhysPAG and will be referenced in the COPAG report.
 - Many white papers have common science themes or mission considerations applicable to multiple flagships (e.g., UVOIR and X-ray Surveyor science, UVOIR Surveyor & HabEX mission, UVOIR and Far-IR Surveyor science and architectures).

Flagship Mission RFI: White Papers (1/3)

- Science Cases for Ultraviolet Polarimetry in the 21st Century
- Mapping Turbulent Energy Dissipation Through Shocked Molecular Hydrogen in the Universe
- Are Flagships the Best Way to Advance Astrophysics?
- The Dusty Co-evolution of Black Holes and Galaxies: A Science Case for a Large FIR Space Telescope
- Actuated Carbon Fiber Reinforced Polymer Mirror Development
- Astrophysics Enabled by Extreme Contrast Ratio Technologies
- A FIR-Survey of TNOs and Related Bodies
- Unlocking the Secrets of Planet Formation with Hydrogen Deuteride
- Cryogenic Telescope for Far-Infrared Astrophysics: A Vision for NASA in the 2020 Decade
- Imaging Polarimetry for ExoPlanet Science & Astrophysics
- Dust in Distant Galaxies - Overcoming Confusion Noise with a 5m FIR Facility
- Far-Infrared Spectral Line Studies of the Epoch of Reionization
- A Joint ExoPlanet & UVOIR Surveyor
- The Earliest Epoch of Star-formation in the Very Young Universe
- Characterizing the Habitable Zones of ExoPlanetary Systems with a Large UV/Visible/NIR Space Observatory
- The Bulk Composition of ExoPlanets
- Flagship Missions for the Decadal Review

Flagship Mission RFI: White Papers (2/3)

- Life Finder Telescope
- Galaxy Evolution Spectroscopic Surveyor (GESS)
- Precision Ages for Milky Way Star Clusters
- Importance of Design Reference Missions for Developing the Next Large Mission Concepts
- An Evolvable Space Telescope for the Far Infrared Surveyor Mission
- ExoPlanet Environment Monitor
- Definitive Determination of Galaxy Luminosity Functions at Energies Above the Hydrogen Ionization Edge, Covering 11 Billion Years of Evolution
- Probing Transient Structures in the Universe
- An Evolvable Space Telescope for Future UV/Opt/IR Astronomical Missions
- A Rotating Synthetic Aperture Space Telescope for Future UV/Opt/IR Astronomical Missions
- UVOIR Surveyor: The Need for High Resolution, Wide Field, Deep Multi-wavelength Imaging and IFU Spectroscopy
- The First Stars and the First Metals
- The Origin of the Elements Heavier than Iron
- HabX2: A 2020 Mission Concept for Flagship Science at Modest Cost
- Listening to the Cosmic Dawn
- A Large-Aperture UVOIR Space Telescope

Flagship Mission RFI: White Papers (3/3)

- A Large-Aperture UVOIR Space Telescope
- Galaxy Fueling and Quenching: A Science Case for Future UV MOS Capability
- UV/Optical/IR Surveyor: The Crucial Role of High Spatial Resolution, High Sensitivity UV Observations to Galaxy Evolution Studies

Responding to the Charge: Preparing for the 2020 Decadal Survey

- The COPAG received the AURA report “From Cosmic Births to Living Earths”, which is a community-based two year study on future space-based options for UV and optical astronomy to advance understanding of the origin and evolution of the cosmos and the life within it.
 - Study chaired by Julianne Dalcanton (U. Washington) and Sara Seager (MIT)
 - See <http://www.hdstvision.org>
- The COPAG received coordinated community inputs from its UV/Optical and Far-IR Science Interest Groups.
 - See <http://cor.gsfc.nasa.gov/copag/copag.php>

Primary Joint PAG Findings

- The PAGs concur that all four large mission concepts identified by the Astrophysics Division Director as candidates for mission concept maturation prior to the 2020 Decadal Survey should be studied in detail.
 - These include the Far-IR Surveyor, the Habitable-Exoplanet Imaging Mission, the UV/Optical/IR Surveyor, and the X-ray Surveyor.
- Other flagship mission concepts were considered, but none achieved sufficiently broad community support to be elevated to the level of these four primary candidate mission concepts.

Joint Finding Assumptions

- These joint findings assume:
 - 1) Major development of future large flagship missions follows the implementation phases of JWST and WFIRST.
 - 2) NASA will partner with the European Space Agency on its L3 Gravitational Wave Surveyor, participate in preparatory studies, and conduct the necessary technology development leading to the L3 mission, including preparations that will be needed for the 2020 decadal review.
 - 3) Inflation Probe is a probe-class mission to be developed according to the technology and mission planning recommendations in the 2010 Decadal Survey report.

Additional Joint PAG Findings

- There is strong community support for the second phase of this activity – maturation of the four proposed mission concept studies by Science and Technology Definition Teams (STDTs).
 - There is strong consensus that the STDTs contain broad and interdisciplinary representation of the science community, and the most qualified technical experts.
 - The community expects cross-STDT cooperation and exchange of information whenever possible.
 - The community expects a free and open process to be used to competitively select the STDTs.

Additional Joint PAG Findings

- The COPAG and ExoPAG concur that, in order to ensure broad support for the UVOIR Surveyor and the Habitable Exoplanet Imaging Mission within both the exoplanet and cosmic origins communities, significant science capabilities in both topical areas must be baselined for these missions.
- There is community support for a line of Probe-class missions within the Astrophysics mission portfolio.
 - The PAGs are willing to collect input on probe missions from the community as a following strategic planning charge if asked to do so by the Astrophysics Director.

Areas of Non-Consensus

- The PAGs did not reach consensus on combining the Habitable Exoplanet Imaging Mission and the UVOIR Surveyor into a single concept.
 - However, the PAGs find community support for both concepts being studied in detail by the STDTs as noted previously.
 - Cosmic origins community tends to see these missions on a continuum of science capabilities, typically favoring larger (>8m) apertures.
- The PAGs did not reach consensus on the specifics of how future probe-class mission concepts should be developed prior to the 2020 Decadal Survey.
 - However, the PAGs are willing to collect community input if charged with doing so as noted previously.

COPAG-Specific Findings

- Cosmic origins science will require access to flagship-class space missions to make major advancements over present or planned facilities.
- Well-instrumented flagships with broad science capabilities will allow astronomers to adapt to cosmic origins science evolution and pursue unanticipated science investigations.
- Flagship-class space missions will be required for NASA space science to remain competitive with, and complementary to, ground-based ELTs at optical/IR wavelengths in the 2020s and 2030s.

COPAG-Specific Findings

- Access to wavelengths covered by Hubble (120 nm – 2 μm) is essential to advancing key cosmic origins science goals with a future UVOIR flagship.
 - UV wavelength coverage down to the 91 nm is highly desirable.
- A cold ($T < 4\text{K}$), filled-aperture ($D \sim 5\text{m}$), Far-IR (30-300 μm) observatory would have significant cosmic origins science capability advantages over present-day observatories.
- An X-ray Surveyor would make significant contributions to cosmic origins science and would complement observations at UV/O/IR/FIR wavelengths, just as Chandra has done.

COPAG-Specific Findings

- The cosmic origins science community is eager to work with the exoplanet community on a future UVOIR flagship that will serve the science needs of both communities.
 - Exoplanet characterization may drive many of the technical requirements of this flagship, but cosmic origins science will figure prominently in the science program and community support of this mission.

Plans for COPAG Report Plans (Due Oct 8)

- Each PAG report will contain a joint-PAG executive summary with the joint findings noted above.
- Individual PAG reports will expand on those findings as they relate to their respective constituencies.
- The reports will outline the process(es) used to solicit input, and the procedures/criteria used to analyze that input.
- The reports will contain descriptions of the community input received.
- The reports may contain thoughts and analysis on additional input that NASA may wish to consider.

Reference Material

- <http://cor.gsfc.nasa.gov/copag/>
- <https://exep.jpl.nasa.gov/exopag/decadal/>
- <http://pcos.gsfc.nasa.gov/phypag/>