COPAG Decadal Survey Report (Flagship Mission Charge)

Astrophysics Subcommittee Meeting

October 22-23, 2015

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(on behalf of the COPAG and Cosmic Origins Community)

Responding to the Charge: Preparing for the 2020 Decadal Survey

- The COPAG solicited broad community input on the flagship mission candidates in an open and inclusive manner, including a series of face-to-face meetings, a pair of virtual (electronic) town halls, a set of workshops, a call for community white papers, and informal discussions over the past 9 months.
  - All community input was considered and is reflected in our report.

Responding to the Charge: Preparing for the 2020 Decadal Survey

COPAG Community Engagement Activities			
Activity	Location	Date (2015)	Participation
AAS Meeting, Joint PAG Session	Seattle	Jan 4-8	~100 attendees
Virtual Town Hall #1	Electronic	March 10	~50 participants
Joint PAG EC Meeting	Baltimore	March 19	PAG EC members
Call for White Papers	Electronic	March-April	38 white papers received
Far-IR Workshop (SIG#1)	Pasadena	June 3-5	>130 attendees + webex
ExoPAG #12 Meeting	Chicago	June 13-14	COPAG EC representation
UV/Optical Workshop (SIG#2)	Greenbelt	June 25-26	~100 attendees + webex
HEAD Meeting	Chicago	July 1	COPAG EC representation
IAU Meeting, Joint PAG Session	Honolulu	August 7	~70 attendees
Virtual Town Hall #2	Electronic	August 20	~50 participants
AIAA Space 2015 PAG Session	Pasadena	August 31	~50 attendees

Responding to the Charge: Preparing for the 2020 Decadal Survey

- COPAG community white paper solicitation
  - We received a wide range of inputs on science needs, technology, mission drivers.
  - All responses are posted on COPAG website: http://cor.gsfc.nasa.gov/copag/
  - See backup slides for table of papers.
  - All responses were made available to ExoPAG and PhysPAG.
  - Many white papers have common science themes or mission considerations applicable to multiple flagship concept.

Responding to the Charge: Preparing for the 2020 Decadal Survey

- Far-IR Surveyor Workshop, June 3-5 (SIG#1)
  - See http://conference.ipac.caltech.edu/firsurveyor

- Finding the UV/Visible Path Forward: A Community Workshop to Plan the Future of UV/Visible Space Astrophysics, June 25-26, 2015 (SIG#2)
  - See http://asd.gsfc.nasa.gov/conferences/uvvis/

- COPAG received the AURA report "From Cosmic Birth to Living Earths"
  - 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

COPAG Findings

1) The four candidate mission concepts identified by the Astrophysics Division Director, and only these four, are the correct ones for NASA to mature for consideration in the 2020 Decadal Survey.
   - ✓ Far-IR Surveyor
   - ✓ Habitable-Exoplanet Imaging Mission
   - ✓ UV/Optical/IR Surveyor
   - ✓ X-ray Surveyor

(Joint 3-PAG finding)

COPAG Findings (2/9)

2) A Far-IR Surveyor based upon a large, cold, filled-aperture telescope has broad community support, delivers significant increases in sensitivity, spatial resolution, and wavelength coverage over present-day and planned observatories, and is well-suited to addressing key Cosmic Origins science questions envisioned for the 2020s and 2030s.

COPAG Findings (3/9)

3) 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.
   - The needs of both communities should be weighed in assessing the technical and scientific trades that may need to be made for these missions, especially if the two concepts are eventually merged.

(Joint COPAG-ExoPAG finding)

COPAG Findings (4/9)

4) A flagship mission offering high spatial resolution, high sensitivity, and access to the full range of wavelengths covered by HST (91.2 nm – 2 mm) is essential to advancing key Cosmic Origins science goals in the 2020s and 2030s. Improvement in sensitivity at ultraviolet wavelengths between 91.2 and 110 nm is highly desirable.

COPAG Findings (5/9)

5) An X-ray Surveyor having significant imaging and spectroscopic capabilities beyond those planned for the ESA Athena mission has science drivers that are highly synergistic with Cosmic Origins science questions envisioned for the 2020s and 2030s.
   - Even though the COPAG received less input for this mission concept than the other concepts, the COPAG found this concept to be an obvious candidate for study.

COPAG Findings (6/9)

6) Synergies between the needs of the science community and the capabilities of the human space flight program may provide a path for enabling future flagships to be assembled in space and/or have operating lifetimes significantly longer than 5-10 years through servicing or upgrade activities.
   - Treating future flagships as long-lived observatories whose primary infrastructure can be repaired and improved over many years, perhaps even decades, rather than limited life entities (as is the case, for example, with JWST), has broad support and would provide long-term stability for the evolving needs of the COR science community.

COPAG Findings (7/9)

7) There is strong community support for the second phase of this activity – maturation of the four proposed mission concept studies by STDTs competitively selected through a free and open process.
   - The community expects cross-STDT cooperation and exchange of information whenever possible.
   - There is strong consensus that the STDTs contain broad and interdisciplinary representation of the science community.

(Joint 3-PAG finding)

COPAG Findings (8/9)

8) There is no compelling reason to set up an independent review team outside of the STDTs to assess the scientific integrity of the STDTs' Cosmic Origins science assumptions or technical requirements, as is being recommended by the ExoPAG for the characterization of Earth-like exoplanets.
   - The COR science community has articulated its needs, with experts contributing to white papers, concept study documents, workshop proceedings, and peer-reviewed literature. In most cases, these needs can be derived in a very straight-forward manner using known, and widely accepted, results and methodologies.

COPAG Findings (6/9)

9) There is community support for a line of Probe-class missions within the Astrophysics mission portfolio.
   - Recast slightly: There is community support for a line of (probe-class) astrophysics missions that would bridge the mission capability gap between explorers and flagships.
   - COPAG received a wide range of opinions on how probe mission concepts should be developed and whether a charge similar to the flagship mission charge should be issued. In the end, there was no clear COPAG consensus on either point.

(Joint 3-PAG finding)

Additional Considerations

- We encourage NASA to consider finding ways to engage industry at early stages in the development of the four flagship mission concepts in order to tap into the expertise and resources that exist within the industrial sector.
- We encourage NASA, the Astrophysics Subcommittee, and the PAG ECs to foster cross-PAG collaborations whenever possible.
- In future activities of this type, it would be useful to find more proactive ways of engaging the international science community, particularly if NASA expects substantial foreign involvement in the resulting mission(s) or activity.
- All community input collected by the COPAG is available online to support the STDT activities. We encourage the STDTs to tap into this rich set of information so as to minimize duplication of effort. The COPAG is willing to facilitate community engagement during the STDT process if asked to do so by NASA.

Thank You

- Members of the astronomical community, government centers, and industry who shared their comments, concerns, and expertise about flagship missions.
- Members of the PhysPAG and ExoPAG ECs who worked closely with the COPAG EC throughout this process, particularly Alan Boss, Scott Gaudi, Mark Bautz, and Jamie Bock. The COPAG EC appreciates the willingness of the other PAGs to share information and to freely discuss community input in an open and collegial manner.
- Paul Hertz for providing guidance throughout this process, and for giving the community a chance to prepare for the next Decadal Survey in a fair, structured manner.
- Cosmic Origins Program Officers, Drs. Susan Neff and Deborah Padgett, and our NASA HQ Cosmic Origins Program Scientists, Drs. Mario Perez, Michael Garcia, and Kartik Sheth for their expert advice, logistical coordination of PAG activities, and ongoing COPAG activity support.

Backup Slides
Flagship Mission Call for White Papers
(see http://cor.gsfc.nasa.gov/copag/)

White Papers

#	Lead	Title	Concept	Size
1	Andersson	Science Cases for Ultraviolet Polarimetry in the 21st Century	HabEx, UVOIR	"large"
2	Appleton	Mapping Turbulent Energy Dissipation through Shocked Molecular Hydrogen in the Universe	FIR	5m+
3	Ardila	Are Flagships the Best Way to Advance Astrophysics?		
4	Ardila	Cubesats for Astrophysics		
5	Armus	The Dusty Co-evolution of Black Holes and Galaxies: A Science Case for a Large Far-IR Space Telescope	FIR	5m+
6	Baldauf	Actuated Carbon Fiber Reinforced Polymer Mirror Development	UVOIR	10-20m
7	Batcheldor	Astrophysics Enabled by Extreme Contrast Ratio Technologies	HabEx, UVOIR	8m
8	Bauer	FIR-Survey of TNOs and Related Bodies	FIR	5m+
9	Bergin	Unlocking the Secrets of Planet Formation with Hydrogen Deuteride	FIR	5m+?
10	Bradford	A Cryogenic Telescope for Far-Infrared Astrophysics: A Vision for NASA in the 2020 Decade	FIR	5m+
11	Breckinridge	Imaging Polarimetry for ExoPlanet Science & Astrophysics	UVOIR	10-20m
12	Casey	Dust in Distant Galaxies - Overcoming Confusion Noise with a 5m FIR Facility	FIR	5m+
13	Cooray	Far-Infrared Spectral Line Studies of the Epoch of Reionization	FIR	5m+
14	Dalcanton	A Joint Exoplanet & UVOIR Surveyor	UVOIR	>8m
15	Ebbets	The Earliest Epoch of Star-formation in the Very Young Universe	HabEx, UVOIR	>4m
16	France	Characterizing the Habitable Zones of Exoplanetary Systems with a Large Ultraviolet/Visible/Near-IR Space Observatory	UVOIR	10m+
17	Gaensicke	The Bulk Composition of Exo-planets	UVOIR	10m
18	Green	Flagship Missions for the Decadal Review		

19	Heap	Galaxy Evolution Spectroscopic Surveyor (GESS)	Probe	1.5m
20	Heap	Life-Finder	HabEx	4m
21	Kalirai	Precision Ages for Milky Way Star Clusters	UVOIR	10m?
22	Leisawitz	Interferometry Concept for the Far-Infrared Surveyor	FIR-Interferometer	1.5m
23	Lightsey	Importance of Design Reference Missions for Developing the Next Large Mission Concepts		
24	Lillie	An Evolvable Space Telescope for the Far Infrared Surveyor Mission	FIR	10-20m
25	Linsky	Exoplanet Environment Monitor	Probe	
26	McCandliss	Definitive Determination of Galaxy Luminosity Functions at Energies Above the Hydrogen Ionization Edge	UVOIR	10-12m
27	Natarajan	Probing Transient Structures in the Universe	UVOIR	10m?
28	Polidan	An Evolvable Space Telescope for Future UV/Opt/IR Astronomical Missions	UVOIR, FIR	10-20m
29	Polidan	A Rotating Synthetic Aperture (RSA) Space Telescope for Future UV/Opt/IR Astronomical Missions	UVOIR, FIR	18m x 3m
30	Rampazzo	UVOIR Surveyor: The Need for High Resolution, Wide Field, Deep Multi-Wavelength Imaging and IFU Spectroscopy	UVOIR	8-10m
31	Rizzo	Probe Class Missions in the Far Infrared	Probe	
32	Roederer	The Origin of the Elements Heavier than Iron	UVOIR	10m?
33	Roederer	The First Stars and the First Metals	UVOIR	10m?
34	Swain	HabX2: A 2020 Mission Concept for Flagship Science at Modest Cost	HabEx	3m
35	Thorpe	Listening to the Cosmic Dawn!	Grav. Wave	
36	Thronson	A Large-Aperture UVOIR Space Telescope	UVOIR	10m+
37	Tumlinson	Galaxy Fueling and Quenching: A Science Case for Future UV MOS Capability	UVOIR	10-12m
38	Williams	UV/Optical/IR Surveyor: The Crucial Role of High Spatial Resolution, High Sensitivity UV Observations to Galaxy Evolution Studies	UVOIR	8-10m