COPAG Response to Hertz:

Candidate Large Astrophysics Missions Charge

And …

Exploring the Synergies

of a Joint ExoPlanet / UVOIR Mission

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on behalf of the COPAG EC

COPAG Response to Hertz Charge

The Charge to the PAGs:

Solicit community input on which *candidate* large missions should be studied by NASA to enable providing sufficient information for the consideration of these missions by the 2020 Decadal Survey Committee

The Overall Process:

Part A: Identification of a small set of candidate large missions

Part B: Develop the science case & technical information for each candidate mission. This will include a STDT for each, but the detailed process TBD by NASA and not the focus of this charge.

Part A: Identification of Candidate Mission Concepts for Study

Drawn by NASA from the 2010 Decadal Survey New Worlds New Horizons (NWNH) & 2014 Visionary Roadmap, Enduring Quests, Daring Visions

- Far-IR Surveyor – Visionary Roadmap
- Habitable-Exoplanet Imaging Mission – 2010 Decadal Survey
- UV/Optical/IR Surveyor - 2010 Decadal Survey & Visionary Roadmap
- X-Ray Surveyor -- Visionary Roadmap

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The Process

Identification of a small number of *candidate* missions

Limited money for mission studies.

Identification of an additional *candidate* mission for study, probably results in the exclusion of a study for one of the 4 candidates identified in NWNW and/or the Visionary Roadmap.

Considerable EC early discussion about

- How to solicit community input to ensure breadth and inclusiveness
- The number of potential missions that could emerge
- Joint PAG-EC face-to-face meeting
  - Share white papers
  - Plan to identify common (and divergent) viewpoints/ findings
  - Addressed incorporation of common response section in each PAG's report to Hertz (if there are areas of commonality)
  - Encourage cross-participation of EC members in upcoming PAG / SIG meetings
  - Probes - is there cross-PAG support for including a footnote expressing interest in future pursuit of this mission class ?

Recognition of Cross-PAG interests

- X-Ray Surveyor could inform on first SMBHs in first galaxies
- UV/Optical/IR Surveyor potentially synergistic with the Habitable-Exoplanet Imaging Mission

COPAG Response to Hertz Charge

The Process

Methods Used to Obtain Community Input:

- Cosmic Origins Website

  http://cor.gsfc.nasa.gov/copag/rfi/copag-rfi.php

- AAS Session

  Cosmic Origins UV-Vis and FIR sessions (Jan 4)

  ExoPAG/COPAG Joint Meeting (Jan 4)

  Joint PAG Session (Jan 7)

  NASA Town Hall Meeting (Jan 7)

- Cross-PAG telecon and Joint PAG meetings
- COPAG Virtual Town Hall (Mar 10)
- White Papers (posted at above COR url & on SIG2 webpages)
- Science Interest Group (SIG) Meetings

COPAG Virtual Town Hall

- 60 + Participants
- Agenda:
  - Overview of Charge
  - Description of COPAG plans
  - Discussion
- Path Forward:
  - Active solicitation of white papers
  - SIG meetings
    - FIR community: FIR-Surveyor Mission Concept
    - UV-Vis community: UVOIR Mission concepts and synergy with ExoPAG Mission

  Further Town Hall(s)

  summarize findings to date & solicit community response

  date TBD

White Paper Solicitation and Response

- White Paper Proposed Content

  Format: 1 – 2 pages

  - Key Science Question(s)
  - Technical Capabilities Required
  - Compatibility with one of the 4 (starting point) candidate Large Mission Concepts for study
  - New Technologies
  - Large Mission Needed ?

- White Paper Response

  - 34 white papers submitted (http://cor.gsfc.nasa.gov/copag/rfi/copag-rfi.php)
  - Scope:
    - 9 papers on FIR Surveyor
    - 18 papers on UV/O/IR Surveyor
    - 4 papers on Habitable Exoplanet Imager
    - 1 paper on X-ray Surveyor
    - 1 paper on Gravitational Wave mission
    - 2+ papers on process
  - Considerable overlap within the FIR and UVOIR technical concepts

COPAG Preliminary Findings on Candidate Large Missions

- Strong Community Support presented to the EC for the four Candidate Missions Identified in the 2010 Decadal Survey and the Visionary Roadmap
  - Far IR Surveyor
  - Habitable Exoplanet
  - UV/Optical/IR Surveyor
  - X-Ray Surveyor
- COPAG EC findings are subject to NASA boundary conditions. Given those conditions, evidence for broad COR community support for alternate missions was *not* presented to the COPAG EC
- COPAG EC finds strong support for the 4 candidate missions drawn by NASA from the 2010 Decadal Survey and the Visionary Roadmap.

Cross-PAG Preliminary Findings on Candidate Large Missions

- Candidate Missions have cross-PAG science applications and synergies
- Does this Synergy extend to combining Mission Concepts (e.g. HabEx and UVOIR) ?
- Community input: WPs will be part of the final report & a valuable reference for Science & Technology Definition Teams (STDTs) charged with development of detailed science requirements for engineering studies.

COPAG Preliminary Finding on Probe Class Missions

- Certain fundamental science questions can be effectively pursued with a probe class mission.
- Members of the astrophysics community whose science requires a probe class mission have expressed interest in a similar exercise.
- Multiple unsolicited questions / inquiries were received regarding Probe Class Missions while soliciting input regarding Large Mission Candidates.
- Indicating that the broader astrophysical community is interested in knowing that Probe class opportunities will be considered in the 2020 Decadal Survey.

COPAG Schedule for Report Completion

- July 2015: Report draft written
  - Last minute inputs due by July 15 !
- August 2015: Report review at IAU splinter meeting
- Fall/ October 2015: Final report presented to Hertz and the Astrophysics Subcommittee

HabEx and UVOIR -- How much synergy is there really?

- Candidate Missions have cross-PAG science applications and synergies
- Does this Synergy extend to combining Mission Concepts (e.g. HabEx and UVOIR) ?
- Focus on the science requirements for Exoplanets and UVOIR Astrophysics
  - What are the key technology requirements to achieve these goals?
  - Are these technologies *compatible* with the requirements for the other mission ?
- Does a large class space telescope enable science synergies with the 30-40 m class ground based telescopes operating in the 2020 - 2030 era?
- To the extent possible, the HabEx and general UVOIR astrophysics communities in this decade should consider and discuss the science synergies between the next generation space & ground-based telescopes.

HabEx and UVOIR - Science synergy questions

- Size: What science synergies does a large space telescope enable with the 30-40 m class ground-based telescopes operating in the 2020 - 2030 era?
  - What are the key science drivers for telescope size?
- Bandpass: What COR science requires the 912 – 3000 Angstrom bandpass ?
  - What exoplanet science is enabled by the FUV (NUV) bandpass?
- Optimization wavelength: At what wavelength should the telescope be optimized?
  - Diffraction limited at 300 nm (?), 500 nm (?), 800 (nm) ?
- Ultra-precise wavefront control: What COR science is enabled through this capability?
- Instrument Optimization - Imagers
  - What suite best maximizes the COR science return ?
  - What suite best maximizes the Exoplanet science return ?
- Instrument Optimization - Spectrographs
  - What suite best maximizes the COR science return ?
  - What suite best maximizes the Exoplanet science return ?
  - What exoplanet science is enabled by a high(er) resolution spectrograph ?

HabEx and UVOIR -- Expanding the synergy

HabEx – Notional Mission

Mirror: 4 – 8 m Monolith

Contrast: ~10^{-10}

Coronograph bandpass: $0.5 < \lambda < 1.0$ μm

Starshade bandpass: $0.25 < \lambda < 1.0$ μm

Starshade bandpass (?): 90 nm $< \lambda < 1.8$ μm

(1.8μm => strengthen O_2, O_3 biosignature origin claim)

FOV: 1 arcsec

Imaging – Camera

Spectrograph: IFU, R = 70 spectrum of a 30 mag exoplanet

Orbit: L2 or Earth trailing

Optimized for exoplanets, but other uses of instruments possible

UVOIR – Notional Mission

Mirror: 8 -16 m, segmented, obscured primary

Contrast: ~10^{-10} for planet imaging, otherwise less

Bandpass: ~$0.100 < \lambda <$ ~2.0 μm (i.e. HST-like)

Bandpass: 90 nm $< \lambda <$ 2.0 μm – FUV enabled

Instrument Suite:

- Internal coronagraph: IFU, 400 nm $< \lambda <$ 2 μm, FOV 10", 35 milliarsec inner working angle
- UV: IFU spectrometer – $90 < \lambda < 300$ nm, FOV 1'-3 '
  R< 100,000
- Visible: 300 nm $< \lambda <$ 1 μm, FOV: 6 '
- NIR imger & spectrograph: 1 μm $< \lambda <$ 2 μm, FOV 4 '
- Multi-obj spectrograph 300 nm $< \lambda <$ 1 μm, FOV 6 '

Orbit: L2

Temperature: Non-cryogenic; 250-295 K


Cosmic Origins