

Workshop Introduction

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Chair

COPAG Executive Committee

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- Chris Martin, Caltech (Chair)
- Ken Sembach, StScl
- Jonathan Gardner, GSFC
- Chuck Lillie, NGST
- Paul Goldsmith, JPL
- Dave Leisawitz, GSFC
- Lynne Hillenbrand, Caltech
- Juliane Dalcanton, U.Wash.

COPAG Charge (2011)

- Identify a focussed set of mission-enabling technologies relevant to Cosmic Origins future missions
- Provide input to Strategic Astrophysics Technology (intermediate TRL) NRA & selection process by end of 2011, for 2012+ Proposal opportunities. Highest priority.
- Provide input to APRA (low and medium TRL) technology selection process? Topic for discussion.
- Provide input to NASA & NRC Technology Road-mapping
- Make tough choices for highest-value efforts given limited resources
- Provide a nucleus for the community to speak with a coherent voice in technology prioritization

COPAG Activities 2011

- Community meeting -- Jan 2011 AAS
- Regular telecons
- COPAG Web site
- AAS Exploder
- Provide inputs to NRC/NASA Technology Roadmap Process
- Joint COPAG/ExoPAG Meeting -- 26 April 2011
- Community meeting – May 2011 AAS
- Fall community workshop – Sept 22-23, 2011 – StScI

Results of COPAG/ExoPAG Meeting

- 1) ExoPAG/COPAG Cooperation should continue through joint meetings, telecons, and SAGs
- 2) Both groups should study 2 types of representative missions:
 - a) A **4-m aperture monolithic telescope with an internal coronagraph**
 - b) An **8-m aperture segmented telescope that relies on an external occulter** to achieve the high contrast needed to find an exoEarth.
- 3) As a corollary to recommendation 2, both groups need to define a set of science goals that could be achieved with such observatories.

2011 Tasks (Revised)

- SAG1: Science Objectives for a Next Generation UVOIR Flagship Mission (4-8 m)
- SAG2: Determine technology focus areas for a monolithic 4m Aperture UV/Optical/NIR mission with Internal Coronagraph for Exoplanet Imaging
- SAG3: Determine technology focus areas for a segmented 8 m Aperture UV/Optical/NIR mission with External Occulter for Exoplanet Imaging
- SAG4: Determine technology focus areas for future Far IR Instruments

2011 Tasks (Revised)

- **SAG I: Science Objectives for a Next Generation UVOIR Flagship Mission**
- Key Science Drivers
 - What is the dark matter distribution in the local group? – Astrometry
 - What is star formation history of galaxies? – Resolved Stellar Populations
 - How did galaxies form and assemble over time? – High z photometry and integral field spectroscopy of rest-UV.
 - What is the coevolution of galaxies and the IGM? – IGM tomography (QSO absorption) and IGM/CGM mapping (emission)
 - How did stars and planets form?
- Task leads: Hillenbrand, Dalcanton

2011 Tasks (Revised)

- **SAG2: Determine technology focus areas for a monolithic 4m Aperture UV/Optical/NIR mission with Internal Coronagraph for Exoplanet Imaging**
- Cosmic Origins/General Astrophysics Technology Enablers
 - Detectors
 - Optical coatings
 - Gratings
 - Multiplexing elements
 - Lightweight mirrors
- Technologies required to enable a joint mission
 - Uniform coatings with high UV reflectivity (M1 & M2) – Al+MgF₂ or LiF
 - Accommodating induced polarization due to coatings
 - Amplitude & polarization correction
- Task leads: Lillie [Gardner]

SAG2 Activity

- Determine Science Case for 4 m UVOIR mission
 - General astrophysics (COPAG SAG1)
 - Internal Coronagraph for Exoplanet Imaging (ExoPAG)
- Assess the TRL/maturity level of various technologies
- Determine Time/\$\$/investment to reach necessary TRL level to support mission concept development
- Prioritize and develop a portfolio based on one or more Figures of Merit and supporting rationale
 - Ex FOM: Expected increase in “Effective Telescope Aperture” (per Mission \$) by 2018.

2011 Tasks (Revised)

- **SAG3: Determine technology focus areas for a segmented 8 m Aperture UV/Optical/NIR mission with External Occulter for Exoplanet Imaging**
- Cosmic Origins/General Astrophysics Technology Enablers
 - Detectors
 - Optical coatings
 - Gratings
 - Multiplexing elements
 - Lightweight mirrors
- Technologies required to enable a joint mission
 - External occulter
- Task leads: Gardner [Sembach]

SAG3 Activity

- Determine Science Case for 8 m UVOIR mission
 - General astrophysics (COPAG SAGI)
 - External Occulter for Exoplanet Imaging (ExoPAG)
- Assess the TRL/maturity level of various technologies
- Determine Time/\$\$/investment to reach necessary TRL level to support mission concept development
- Prioritize and develop a portfolio based on one or more Figures of Merit and supporting rationale
 - Ex FOM: Expected increase in “Effective Telescope Aperture” (per Mission \$) by 2018.

2011 Tasks (Revised)

- **SAG4: Determine technology focus areas for future Far IR Instruments**
- Technology areas
 - Detectors
 - Spectrometers
 - Transient capabilities
 - Polarimetry
- Lead: Paul Goldsmith, Dave Leisawitz
- Application: 3rd generation SOFIA, others?

SAG4 Activity

- Context:
- Second Generation SOFIA Instruments
 - Submm/FIR polarimeter Mid-IR polarimeter
 - Submm (2-5 THz) imaging heterodyne spectrometer ($R = 10^6$)
 - Multiobject extragalactic spectrometer (reconfigurable pixels)
- Spica: on the surface technology development is too late for baseline schedule (Instrument call in the 1-2 year timeframe).

COPAG Workshop 2 Objectives

1. Highest priority Cosmic Origins science objectives and science measurements
2. Highest priority technologies that support these science measurements
3. Community building
4. New ideas (Disruptive Innovation?):
 - a. New science applications
 - b. New measurement approaches, missions
 - c. New technologies or technology paths

Process / Guidance

- This is not a conference. This is a workshop.
- This is an opportunity to cohere as a community and set strategic directions
- Discussion, questions, confrontations, arguments, hand-wringing, cries of anguish all encouraged.

Provocative Statements/Questions

- ① UVOIR large astrophysics mission (4+ m) is >20 years away?
- ② Next generation flagship UVOIR mission must either make a 100-1000x increase in some capability, or do something complete new, or both?
- ③ A large (4+ m) UVOIR astrophysics mission must be joint with Exoplanet Imaging/Characterization
- ④ The next 2 decades in UV may consist of Explorers and smaller opportunities. Should we consider a Probe-scale mission (~1B\$)?
- ⑤ WFIRST as an example of high-rated mission:
 - Wide-field, imaging+spectroscopy multiplexed
 - 3 core applications: 2 Killer Aps + 1 Gen. Ap
 - Cost ~1.5B\$

Provocative Statements/Questions

- ⑥ Should the community cohere with a single mission concept in 2019, or submit competing visions?
- ⑦ Technology paths must be highly leveraged. Mindful of future industry growth areas.
- ⑧ Astrophysics now multi- λ but technologies still λ -driven. How to reconcile these approaches?
- ⑨ What is role of APRA, SAT, sub-orbital, Explorers, Missions in technology development?
- ⑩ A follow-on to HST requires a “game-changing” science case and technology path, and a coherent community voice behind it.

Workshop Outline

- Day 1- Information and discussion
 - Review Cosmic Origins Science Cases
 - Discuss potential reference mission concepts
 - Review technologies under development
- Day 2 – Technology Roadmap – Discussion
 - Discuss/agree on roadmapping process
 - Discuss/agree on figures of merit
 - Continue discussion of strategies
 - Reorganize COPAG?
 - Add community members to SAGs
 - Assign actions for SAGs