Exoplanet Program Analysis Group Report

Astrophysics Subcommittee Meeting
July 21, 2016

Alan Boss
(ExoPAG Chair)

ExoPAG EC Membership

Alan Boss (Chair)	Carnegie Institution
Daniel Apai	University of Arizona
Rus Belikov	NASA Ames Research Center
David Ciardi	NASA Exoplanet Science Institute
Shawn Domagal-Goldman	NASA Goddard Space Flight Center
Tiffany Glassman	Northrup Grumman Aerospace Sys.
Dimitri Mawet	Jet Propulsion Laboratory
Tyler Robinson	University of California, Santa Cruz
Maggie Turnbull	Global Science Institute
Lucianne Walkowicz	Adler Planetarium
Scott Gaudi (Past Chair, Ex officio)	Ohio State University
Martin Still (Ex officio)	NASA Headquarters
Karl Stapelfeldt (Ex officio)	Jet Propulsion Laboratory

ExoPAG Study Analysis Groups (SAGs)

Year	SAG	Title	Lead
2010	1	Potential for Exoplanet Science Measurements from Solar System Probes	Bennett, Coulter
2012	2	Debris Disks & Exozodiacal Dust	Roberge
2013	5	Exoplanet Flagship Requirements and Characteristics	Noecker, Greene
2015	8	Requirements and Limits of Future Precision Radial Velocity Measurements	Latham, Plavchan
2015	9	Exoplanet Probe to Medium Scale Direct-Imaging Mission Requirements and Characteristics	Soummer
2015	10	Characterizing the Atmospheres of Transiting Planets with JWST and Beyond	Cowan
2014	11	Preparing for the WFIRST Microlensing Survey	Yee
--	12	Scientific potential and feasibility of high-precision astrometry for exoplanet detection and characterization	Bendek
--	13	Exoplanet Occurrence Rates and Distributions	Belikov
--	14	Characterization of Stars Targeted for NASA Exoplanet Missions	Stassun
--	15	Exploring Other Worlds: Observational Constraints and Science Questions for Direct Imaging Exoplanet Missions	Apai
--	16	Exoplanet Biosignatures	Domagal-Goldman

ExoPAG Study Analysis Groups (SAGs) Overall Status

- 7 SAGs finished work with final report online
- 5 SAGs actively working
- 3 new SAGs being developed and proposed:
- SAG 17 on TESS/K2 planet confirmations – David Ciardi and Joshua Pepper, Co-Chairs -- proposed
- SAG 18 on star shade metrics – Tiffany Glassman and Maggie Turnbull, Co-Chairs -- proposed
- SAG 19 on direct imaging/coronagraph metrics – Dimitri Mawet, Chair -- in development

SAG 12: Scientific Potential and Feasibility of High-Precision Astrometry for Exoplanet Detection and Characterization (Eduardo Bendek, Chair)

- **Key questions and goals that this group will address are:**
- **1) What is the scientific potential of astrometry for different precision levels?** Which planet types, confirm planet candidates.
- **2) What are the technical limitations to achieving astrometry of a given precision?** Technical challenges, observational strategies or post processing to improve the astrometry.
- **3) Identify mission concepts that are well suited for astrometry.** Next mission after GAIA that will make exoplanet science possible? What are the requirements for such a mission?
- **4) Study potential synergies with current and future European astrometry missions**. What are the available astrometric facilities to follow-up on GAIA (exoplanet-related) discoveries? Are they sufficient?

SAG 13: Exoplanet Occurrence Rates and Distributions (Rus Belikov, Chair)

Key objectives and questions:

1. Propose standard nominal conventions, definitions, and units for occurrence rates/ distributions to facilitate comparisons between different studies.
2. Do occurrence estimates from different teams/methods agree with each other to within statistical uncertainty? If not, why?
3. For occurrence rates where extrapolation is still necessary, what values should the community adopt as standard conventions for mission yield estimates?

Recent Progress:

- Computation/crowdsourcing of eta tables
- 11 participants submitted tables so far
- Latest estimates of occurrences of potentially habitable planets seem to be converging (at least to a factor of ~2-3), and explanations for discrepancies are starting to clarify
- Expected product in early 2017: estimates of occurrence rates

SAG 14: Characterization of Stars Targeted for NASA Exoplanet Missions (Keivan Stassun, Chair, and TESS co-I for Target Selection)

[TESS = Transiting Exoplanet Survey Satellite]

SAG 14 has prepared a preliminary analysis of potential benefits of a pre-launch spectroscopic survey of TESS targets:

- Primary TESS goal: discover ***50 Earth-sized transisting planets*** ($R < 4\ R_{Earth}$) ***whose masses can be measured*** by follow-up radial-velocity measurements.
  - Analysis of activity-driven RV jitter in TESS targets shows that, even in most stringent worst-case scenario, TESS is certain to deliver the above mission science requirement.
  - A pre-launch spectroscopic survey of TESS targets could help ensure an even larger yield on the above goal by identifying an even larger sample of low-activity, Doppler stable target stars.
- SAG 14 report is in preparation.

SAG 15: Exploring Other Worlds: Observational Constraints and Science Questions for Direct Imaging Exoplanet Missions
(Daniel Apai, Chair)

Charge:

1) What are the most important science questions in exoplanet characterization, apart from biosignature searches?
2) What type of data (spectra, polarization, photometry), with what quality (resolution, signal-to-noise, cadence), is required to answer these science questions?

Progress:

- SAG15 underway and on track
- Team, timeline, process, milestones identified
- Up-to-date status and documents: eos-nexus.org/SAG15/
- Currently finishing work on list of high-level science questions
- Target date for completion Spring 2017
- Report + refereed publication are foreseen
- Interactions with WFIRST and Large Mission STDTs important

SAG 16: Biosignatures (Shawn Domagal-Goldman, Nancy Kiang, and Niki Parenteau, Co-Chairs)

Science Goals

We seek to answer 3 broad questions:
1) What are known remotely-observable biosignatures, the processes that produce them, and their known non-biological sources?
2) How can we identify additional biosignatures, and a more comprehensive framework for biosignature assessment?

3) What are the requirements for detecting these biosignatures to different levels of confidence?

Plan is to hold a 3-day workshop July 27-29, 2016, along with the NASA Astrobiology Institute (NAI) and Nexus for Exoplanet System Science (NExSS), draft a SAG report and a peer-reviewable paper by October 2016, invite review and commentary from the community, and submit final SAG report by March 2017.

NEW SAG 17 – Community Resources Needed for K2 and TESS Planetary Candidate Confirmation (David Ciardi and Joshua Pepper, Co-Chairs)

- SAG 17 will study and enumerate the resources needed by the community to effectively and efficiently validate as many K2 and TESS candidates as possible, and propose methods to allow the community to coordinate and self-organize the process.
- Specific goals of SAG 17 include the following:
- Identify needed follow-up observations for K2 and TESS including but not limited to imaging, spectroscopy, and time-series follow-up
- Identify telescopes, instrument, and financial resources available to the US community
- Identify how archival resources can be utilized (e.g., Gaia)
- Identify how the community can be organized and communication facilitated particularly with regards TESS full frame images, candidate identification, single transiting events, and candidate prioritization.
- Identify needs to ensure efficient and effective characterization with JWST (and WFIRST)
- Identify connections to other SAG efforts (e.g., SAGs 15 and 16)

NEW SAG 18 – Metrics for Direct Imaging with Starshades

(Tiffany Glassman and Maggie Turnbull, Cog Chairs)

- We propose to identify the areas of starshade performance where standardized metrics would be beneficial, and to create rigorous definitions of key terms, data processing techniques, and performance requirements.
- There have been informal definitions of contrast as the amount of residual starlight at the location of an exoplanet of interest and of suppression as the total amount of residual starlight entering the telescope.
- How can contrast or suppression be used as metrics of starshade performance (pros and cons)?
- How should contrast be defined?
- How should suppression be defined?
- What contrast limit is required to detect a planet of a given magnitude at the inner working angle (IWA)?

ExEP Technology Needs and Prioritization Process

ID	Activity	Date
1	Technology Needs Input Window Opens	06/08/16
	Email to the ExoPAG: Technology Gap Lists, Input Forms, process explanation	
	Presentation at June ExoPAG	06/12/16
2	Technology Window Closes	08/26/16
3	Prioritization Criteria Concurred by the ExEP	09/15/16
4	Technology Gaps Prioritized by the ExEP	10/20/16
5	Technology Gap Lists Inform TDEM Amendment	mid-Nov
	Technology Amendment released through NSPIRES	mid-Dec
6	ExEP Technology Plan Appendix Updated and Posted	12/22/16
	Presentation at Winter ExoPAG	01/02/17
7	TDEM Proposal Deadline	03/17/17
8	TDEM Awards Selected	Aug 2017

- Enabling technologies only (vs. enhancing) - requires ExEP iteration with community members
- PCOS/COR Technology team involved in every step; ExEP involved in their prioritization process

ExoPAG Future Activities

- Continue monthly ExoPAG EC telecons
- Continue work of five active SAGs – 12, 13, 14, 15, and 16
- Begin work of new SAGs 17 and 18 (if approved)
- Continue developing plan for new SAG 19
- Consider SAG 20 on Far-IR exoplanet science
- Review ExEP Technology Gap List planning
- Hold ExoPAG 15 meeting prior to AAS winter meeting: January 2-3, 2017 in Grapevine, TX

APS Actions Requested by ExoPAG EC

- NEW SAG 17 – K2/TESS Planet Confirmations (David Ciardi and Joshua Pepper, Co-Chairs) – approve Charter?
- NEW SAG 18 – Starshade Metrics (Tiffany Glassman and Maggie Turnbull, Co-Chairs) -- approve Charter?
- Both Charters were circulated to the APS prior to this meeting