

Exoplanet Program Analysis Group
Report
Astrophysics Subcommittee Meeting
March 15, 2016

Alan Boss
(ExoPAG EC 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
Nick Cowan*	McGill University
Shawn Domagal-Goldman	NASA Goddard Space Flight Center
Amy Lo*	Northrup Grumman Aerospace Sys.
Peter Plavchan*	Missouri State University
Gene Serabyn*	Jet Propulsion Laboratory
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

[*rotating off this spring, replacement process well underway]

ExoPAG Response to Probe Charge

- The **ExoPAG fully supports this effort** by the APD to prepare for a possible medium-class mission line in the next Decadal Survey portfolio, and specifically supports the first option suggested.
- The **first option is preferred**, as it will ensure that at least 10 probe-class concepts will have been given a serious first look.
- These ~10 concept studies should be sufficient to cover the wide-ranging scientific interests of the APD and of its three PAGs.
- They should specify the basic science goals, instrumentation suites, mirror sizes, rough costs and TRLs, etc., sufficient for the Decadal Survey to consider and possibly recommend further, more detailed studies.
- These concept studies will help to level the playing field for principal investigator-led studies at universities or institutions that may not have funding support from NASA centers.
- The **main concern** raised with the first option was whether ~\$100K per study would allow even a rudimentary CATE analysis to be performed prior to a more detailed CATE that might be requested by the Decadal Survey.

Annual Technology Gap List (TGL): Planning for ExoPAG Involvement

- “Initial Look at the Coronagraph Technology Gaps for Direct Imaging of Exo-Earths” (SPIE, 2015, Rhonda Morgan & Nick Siegler, JPL) circulated to ExoPAG EC in September
- *New plan for future ExoPAG community involvement:*
- 1) Winter ExoPAG meeting – recommended TGL presented and input invited from the community – **presented at ExoPAG 13 in Florida**
- 2) Verbal and e-mail input accepted until following May
- 3) TGL is revised based upon the inputs received
- 4) Revised TGL presented at Summer ExoPAG meeting in recommended priority order – **agenda for ExoPAG 14 in California**
- 5) Based on discussions, TGL will be finalized
- 6) Repeat above cycle each year

ExoPAG SAGs Overall Status

- 7 SAGs finished work with final report online
- 4 SAGs actively working
- 1 new SAG proposed – request APS acceptance of its Charter

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

SAG 12.1 Activities and timeline: WFIRST astrometry

- 1) Kick-off (January 2015)
- 2) Astrometry with AFTA workshop at Princeton organized by D. Spergel

We would like to increase the SAG activities by:

- Establish direct collaboration with WFIRST SIT
- Invite the community to participate
- Revisit areas of interest for the SAG
- Establish monthly meetings
- Define SAG 12 completion date before the end of 2016
- Also SAG 12.2: Hipparchos, GAIA & SAG 12.3: Gemini, VLT, etc.

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?

Progress:

- Converged on a consensus for “standard eta bins”
- Computation/crowdsourcing of eta tables
- 6 participants submitted tables so far
- Preliminary comparisons show consistency in some etas as well as disparity in others

SAG 14: Characterization of Stars Targeted for NASA Exoplanet Missions (Keivan Stassun, Chair, and TESS col 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 transiting planets*** ($R < 4 R_{\text{Earth}}$) ***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 still in preparation.

SAG 14: Characterization of Stars Targeted for NASA Exoplanet Missions (Keivan Stassun, Chair)

- In CVZ, TESS observes for 1 year, enabling ***discovery of Earth-like planets in the habitable zones*** of K-type stars and even solar-like G-type stars.
 - There are ~6500 nominal TESS targets in NEP CVZ with spectral types of G2 and later.
- APOGEE: 7 square degree FOV, 200 fibers. At the faint limit of TESS targets, need 3 visits for APOGEE to get $S/N = 100$.
 - Multiple epochs on all stars in order to identify RV variables.
 - Need $450 / 7 = 65$ fields to cover NEP CVZ, times 3 visits each gives $65 \times 3 = 200$ visits.
 - 100 targets per field on average, which leaves about half of the fibers available.
 - 30 nights of observing, or about 30,000 fiber-hours for 100 fibers in average field/visit.
 - SDSS estimates cost of \$2.5M to guarantee the full 30,000 fiber-hours, process the data, deliver shovel-ready stellar parameters and make them fully publicly accessible.
- Deliverables:
 - Rotational velocities to pre-screen for low-activity, likely Doppler stable stars.
 - Also: surface gravities, effective temperatures, detailed chemical abundances.

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

NEW 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 nonbiological 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 this summer under auspices of 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.

APS Action Requested by ExoPAG EC

- NEW SAG 16: Biosignatures (Shawn Domagal-Goldman, Nancy Kiang, and Niki Parenteau, Co-Chairs) – approve Charter
- This Charter was circulated to the APS prior to this meeting

ExoPAG Future Activities

- Continue monthly ExoPAG EC telecons
- Continue work of new and active SAGs – 12, 13, 14, 15, and 16 (new)
- Add three new members to EC
- Hold ExoPAG 14 meeting prior to AAS summer meeting: June 11-12, 2016 in San Diego, CA
- Consider where to hold ExoPAG 15: with AAS at Grapevine, TX, or elsewhere? [Jan. 2017]