Exoplanet Program Analysis Group (ExoPAG) Report

Astrophysics Advisory Committee (APAC) Meeting
October 18, 2017

Alan Boss
(ExoPAG Chair)

ExoPAG EC Membership

Alan Boss (Chair) **-> ?**   Carnegie Institution

Daniel Apai   University of Arizona

David Ciardi   NASA Exoplanet Science Institute

Shawn Domagal-Goldman   NASA Goddard Space Flight Center

Tiffany Glassman   Northrup Grumman Aerospace Sys.

Eliza Kempton   Grinnell College **-> U. Maryland**

Dimitri Mawet   Jet Propulsion Laboratory

Michael Meyer   University of Michigan

Tyler Robinson   **Northern Arizona University**

Chris Stark   Space Telescope Science Institute

Johanna Teske   Carnegie Observatories **-> DTM**

Scott Gaudi (Past Chair, Ex officio)   Ohio State University

Martin Still (Ex officio)   NASA Headquarters

Completed 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
2017	12	Scientific potential and feasibility of high-precision astrometry for exoplanet detection and characterization (final presentation at ExoPAG #15, January 2017)	Bendek
2017	13	Exoplanet Occurrence Rates and Distributions	Belikov
2017	15	Exploring Other Worlds: Observational Constraints and Science Questions for Direct Imaging Exoplanet Missions	Apai
2017	18	Metrics for Direct-Imaging with Starshades	Glassman & Turnbull

Study Analysis Groups Closing Out

Year	SAG	Title	Lead
2017	14	Characterization of Stars Targeted for NASA Exoplanet Missions	Stassun

Active Study Analysis Groups (SAGs)

Year	SAG	Title	Lead
--	16	Exoplanet Biosignatures (close out expected at ExoPAG #17 in January 2018)	Domagal-Goldman
--	17	Community Resources Needed for K2 and TESS Planetary Candidate Confirmation (close out expected at ExoPAG #17 in January 2018)	Ciardi & Pepper
--	19	Exoplanet imaging signal detection theory and rigorous contrast metrics (in progress)	Mawet & Jensen-Clem

ExoPAG Study Analysis Groups (SAGs) Overall Status

- 11 SAGs finished work or closed out

- 3 SAGs actively working – 2 close to finished

- 1 SAG ready to be closed out: SAG 14 on Characterization of Stars Targeted for NASA Exoplanet Missions (Keivan Stassun, chair)

ExoPAG Recent Activities

- Held ExoPAG #16 meeting prior to KepSciCon in Mountain View, CA on June 18, 2017

- Many suggestions made for expanding ExEP/ExoPAG/community communications

- July, September, and October EC telecons discussed these suggestions and made plans for their implementation where feasible

- Plan to continue these "send and receive" sessions at future exoplanet meetings

2018 Technology Selection and Prioritization Process

ID	Activity	Last year	This year
1	Technology needs input window opens	06/08/16	06/18/17
	email all three PAGs: Technology Gap Lists, input forms, process explanation		06/19/17
	presentation at June ExoPAG	06/12/16	06/18/17
2	Technology window closes	08/26/16	08/28/17
3	Technology Gap Selection and Prioritization Criteria Review by APD Program Offices	09/08/16	08/25/17
4	Selection and Prioritization Criteria Review by ExoTAC	09/21/16	09/05/17
5	Technology Gap Assessment Review by APD Program Offices	10/07/16	09/18/17
6	**Technology Gap Assessment Review by ExoTAC**	**10/21/16**	**10/16/17**
7	Technology Gap Lists inform TDEM Amendment	mid-Nov	mid-Nov
8	Technology Amendment released through NSPIRES	mid-Dec	mid-Dec
9	ExEP Technology Plan Appendix updated and released	01/02/17	12/01/17
	Presentation at January ExoPAG	**01/02/17**	**01/07/18**
10	TDEM Proposal Deadline	03/17/17	03/15/18
11	TDEM Awards Selected	Aug 2017	Aug 2018

ExoPAG Future Activities

- Continue monthly ExoPAG EC telecons
- Finish work of remaining SAGs – 16, 17, and 19
- Continue to review ExEP Technology Gap List planning process – November EC telecon
- Hold ExoPAG #17 meeting prior to AAS meeting in National Harbor, MD on January 7-8, 2018
- ExoPAG #17 features a 3 hour mini-science symposium on JWST Exoplanet Science, Transit Spectroscopy, and Synergies – January 8
- Joint PAG session with Paul Hertz and STDTs

APAC Action Requested by ExoPAG EC

- Accept close out of SAG 14: Characterization of Stars Targeted for NASA Exoplanet Missions (Keivan Stassun, Chair, and TESS co-I for Target Selection)
- No final report to be submitted
- Need for this report has evaporated

Backup Slides

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

[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* ($R < 4 \, R_{Earth}$) *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 on hold.

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?

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

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)

SAG 19 – Exoplanet Imaging Signal Detection Theory and Rigorous Contrast Metrics
(Dimitri Mawet and Rebecca Jensen-Clem, Co-Chairs)

- Go back to the basics of Bayesian Signal Detection Theory (SDT), i.e., H0:signal absent / H1:signal present hypothesis testing.

- Rebuild a solid set of usual definitions used for or in lieu of "contrast" in different contexts, such as astrophysical contrast or ground truth, instrumental contrast used for coronagraph/instrument designs, and the measured on-sky data-driven contrast.

- Identify what we can learn and apply from communities outside our field (e.g. medical imaging: receiver operating characteristic (ROC) curve).

- Define precise contrast computation and ROC curve computation recipes, a new "industry standard".

- Identify how the new metrics and recipes can be used to define confidence levels for detection (H1) and subsequently error bars for photometric, spectroscopic, astrometric characterization.

- Perform a community data challenge before and after applying our proposed set of standardized SDT rules and recipes, and apply lessons learned.