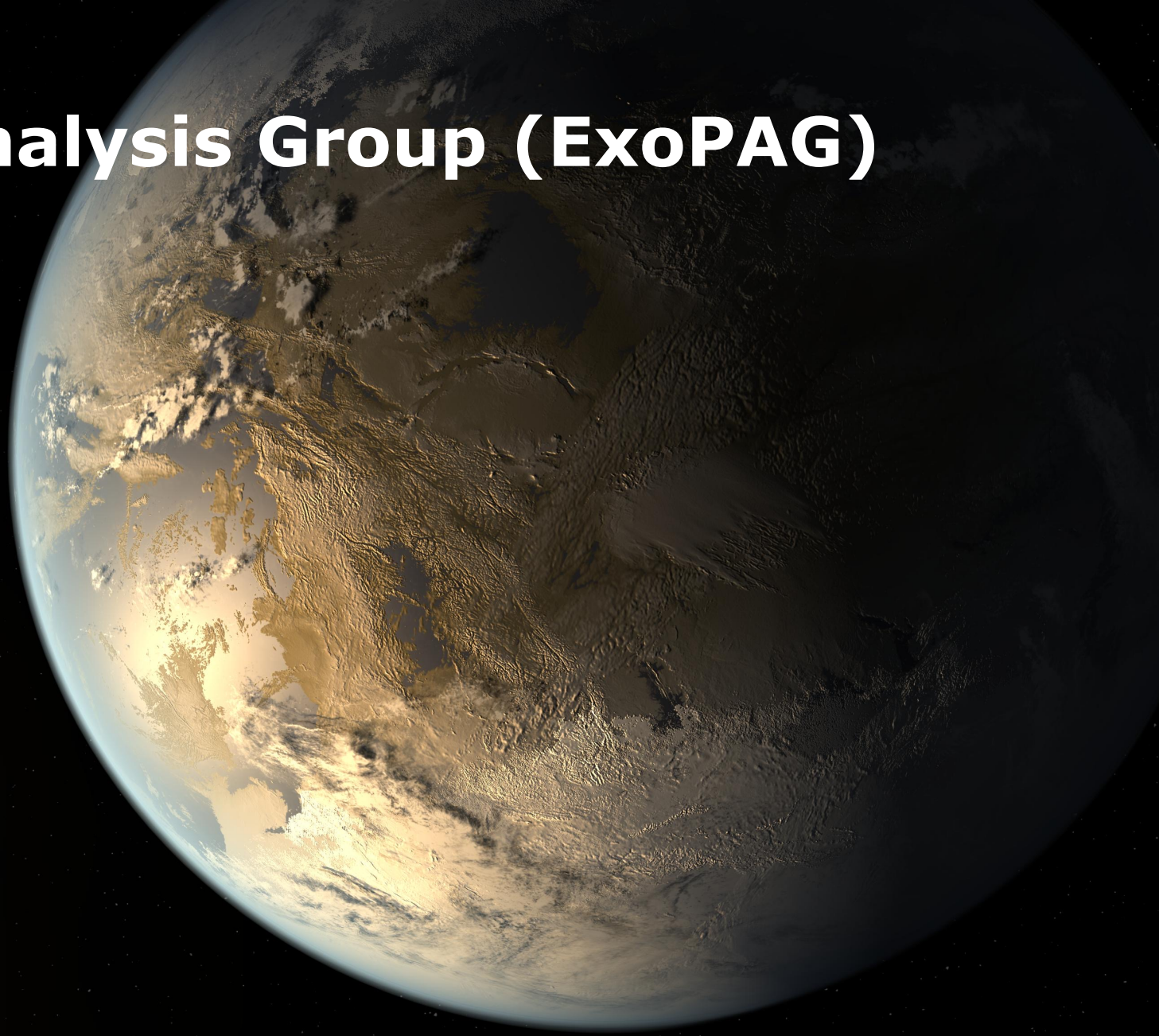
Exoplanet Program Analysis Group (ExoPAG) Report to APAC



Ilaria Pascucci (U. Arizona)
Chair, ExoPAG Executive Committee

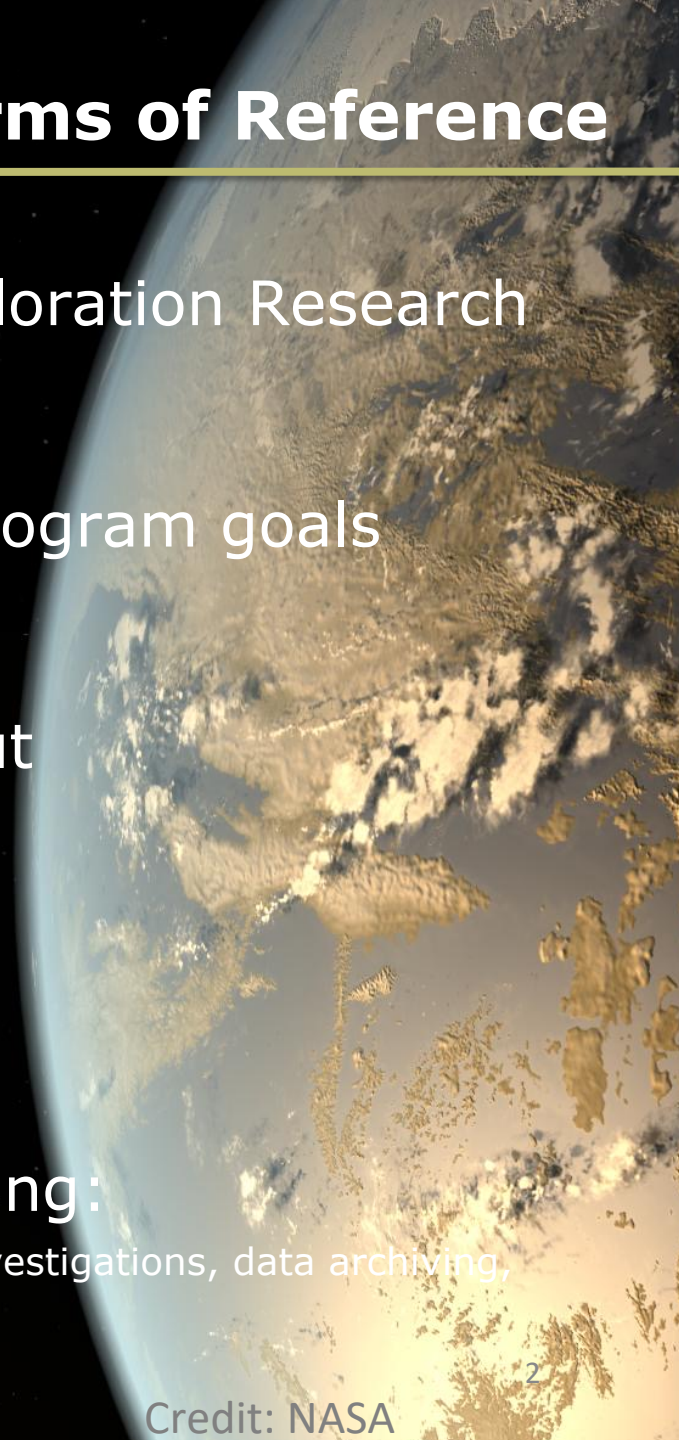
March 20-21, 2024

Credit: NASA

Exoplanet Program Analysis Group: Terms of Reference

- ❑ Articulate & prioritize science drivers for Exoplanet Exploration Research
- ❑ Evaluate capabilities of potential missions to achieve program goals
- ❑ Evaluate the ExEP activities with broad community input
- ❑ Articulate & prioritize new mission technologies
- ❑ Provide findings on all related program activities including:

ground-based observing, theory and modeling programs, laboratory astrophysics, suborbital investigations, data archiving, community engagement



Credit: NASA

ExoPAG ongoing & recent activities I (since the last APAC meeting)

- Organize monthly ExoPAG EC meetings (11/15, 12/13, 02/21), cross-PAG meetings (11/29), rep. to APAC (I. Pascucci)

- Operating Procedures document (J. Gregory and I. Pascucci) posted here:
  https://exoplanets.nasa.gov/internal_resources/2975/ExoPAG-Operating_Procedures.pdf

- ExoPAG 29 meeting, at the 243rd AAS meeting in New Orleans (all EC members)

- Preparing the ExoPAG 30 at the AbSciCon (all EC members)

ExoExplorers Program Update (ExoPAG EC rep.: K. Colon, M. Rice)

The Exoplanet Explorers Science Series, sponsored by the ExoPAG Executive Committee and NASA's Exoplanet Exploration Program, aims to enable the professional development of a cohort of graduate students and/or postdocs in exoplanet research ("ExoExplorers").

- The program entered its fourth year!
  - 2024 ExoExplorers: Z. Ahmed (Stanford), L. Alderson (U. Bristol), G. Bergsten (U. Arizona), M. Leung (Riverside), G. Levine (Yale), J. Mang (U. Austin), F. Nguyen(U. Arizona), A. Polanski (U. Kansas), M. Vincent (U. Hawaii), D. Yahalomi (U. Columbia)
  - 2024 ExoGuides: D. Ciardi (NExScI), J. Teske (Carnegie), H. Wakeford (U. Bristol), A. Vanderburg (MIT)

- The ExoExplorer Steering and Organizing Committees (SC and OC) solicit feedback from the cohorts via an anonymous survey at the beginning and end of the program.

- The SC and OC use this feedback to tailor the program more to the needs of the ExoExplorers

https://exoplanets.nasa.gov/exep/exopag/exoexplorers/exoexplorers-welcome/

ExoPAG ongoing & recent activities III (since the last APAC meeting)

- Active Science Interest Groups (SIGs) and Study Analysis Groups (SAGs):

- SIG2 "Exoplanets Demographics" (Fernandes & Johnson)
- SIG3 "Exoplanets Solar System Synergies", on-going (Meadows & Mandt)

- SAG23 "The Impact of Exo-Zodiacal Dust on Exoplanet Direct Imaging Surveys" (Debes, Rebollido, Hasegawa)
- SAG24 "Exploring the Complementary Science Value of Starshade Observations" (Seager & Shaklan)

SIG 3 Exoplanet/Solar System Synergies Update

Leadership: Victoria Meadows (UW/NExSS/ExoPAG), Kathy Mandt (GSFC/OPAG), Eric Lopez (GSFC)

Goal: To provide a forum for interaction between the Solar System and exoplanet communities on topics of mutual interest that also benefit NASA and the broader scientific community.

Recent Activities:

- SIG3 meetings held on February 20th and March 4th to discuss implementation of new activities
- Working on development of an expertise directory and community-identified papers of interest between the Solar System and exoplanet disciplines

Future Activities

- Starting up a 1 hr "micro-workshop" series with presenters from SS, Exo and Helio giving short common-interest presentations, with ample time for community discussion. Goal is to identify needed areas of cross-disciplinary research, and interdivisional "science gaps" for ExEP.
- Develop a community review paper to explore synergies needed between the science of all four directorates to address initiatives identified in Astro2020 and Origins, Worlds and Life.
- Upcoming presentations and member recruitment at EiOBY III and at the AbSciCon ExoPAG

Credit: NASA

SAG23 "The Impact of Exo-Zodiacal Dust on Exoplanet Direct Imaging Surveys"

(Chairs: Debes, Hasegawa, Rebollido)

- Presentation to the ExoPAG 29 in January
- Presentation to the "Dust Devils-Debris Disks in the Sonoran Desert" conference, March 24-29, 2024
- Draft sections of report are being completed
- Reviews of sections will be ongoing in the spring
- Final report drafting planned for ~May 2024
- Targeting release of final report in early summer

https://exoplanets.nasa.gov/exep/exopag/sag/#sag23

January 6, 2024				
Session 1 (Chair: Ilaria Pascucci)	**Speaker**	**Time (CST)**	**Duration**	**End**
Welcome	Ilaria Pascucci	9:00 AM	0:15	9:15 AM
NASA Headquarters Exoplanet Exploration Program	Hannah Jang-Condell	9:15 AM	0:20	9:35 AM
Exoplanet Exploration Program (ExEP) Office	Gary Blackwood	9:35 AM	0:15	9:50 AM
ExEP Science	Karl Stapelfeldt	9:50 AM	0:15	10:05 AM
NASA Exoplanet Science Institute (NExScI) and NASA Exoplanet Archive Update	David Ciardi	10:05 AM	0:15	10:20 AM
BREAK (30 min)		10:20 AM	0:30	10:50 AM
ExEP Technology Update	Brendan Crill	10:50 AM	0:15	11:05 AM
SAG 22 final report	Natalie Hinkel	11:05 AM	0:15	11:20 AM
Potential SAG on technosignatures	Jason Wright	11:20 AM	0:15	11:35 AM
Potential SAG on atmospheric retrieval HWO	Renyu Hu	11:35 AM	0:15	11:50 AM
NASA's Transform to OPen Science (TOPS) initiative	Jenn Burt	11:50 AM	0:15	12:05 PM
LUNCH BREAK (90 min)		12:05 PM	1:30	1:35 PM
Introducing the 2024 ExoExplorers Cohort	Tiffany Kataria	1:35 PM	0:15	1:50 PM
Session 2 Mini Symposium (Chair: Lily Zhao) TOPIC: Systems Architectures	**Speaker**	**Time (CST)**	**Duration**	**End**
No Evidence for More Earth-sized Planets in the Habitable Zone of Kepler's M versus FGK Stars	Galen Bergsten	1:50 PM	0:25	2:15 PM
The Path to Uncovering the Histories of TESS Circumbinary Planets	Dominic Oddo	2:15 PM	0:25	2:40 PM
Unveiling Orbital Architectures with the TESS-Keck Survey	Alex Polanski	2:40 PM	0:25	3:05 PM
BREAK (30 min)		3:05 PM	0:30	3:35 PM
Session 3 SIG/SAG Update (Chair: Natalie Hinkel)	**Speaker**	**Time (CST)**	**Duration**	**End**
SIG 2: Exoplanet Demographics	Samson Johnson	3:35 PM	0:20	3:55 PM
SIG 3: Exoplanet / Solar System Synergies	Kathy Mandt	3:55 PM	0:20	4:15 PM
SAG 23: The Impact of Exo-Zodiacal Dust on Exoplanet Direct Imaging Surveys	John Debes	4:15 PM	0:20	4:35 PM
SAG 24: Exploring the Complementary Science Value of Starshade Observations	Sara Seager	4:35 PM	0:20	4:55 PM
Adjourn		4:55 PM		

ExoPAG 29 (Jan2024)

Day1: Programmatic talks,
SIG and SAG reports,
discussion of 2 new SAGs

Early career mini-symposium
(more funding to support more early career scientists)

https://exoplanets.nasa.gov/exep/exopag/exopag29/exopag29-overview/

ExoPAG 29 (Jan2024)

Day2: NASA Astrobiology Program, Roman, HWO/START

https://exoplanets.nasa.gov/exep/exopag/exopag29/exopag29-overview/

January 7, 2024				
Session 4 (Chair: Kate Follette)	**Speaker**	**Time (CST)**	**Duration**	**End**
NASA Astrobiology Program	David Grinspoon	9:00 AM	0:30	9:30 AM
Roman - review of accepted exoplanet-focused investigations	Scott Gaudi	9:30 AM	0:20	9:50 AM
Timelines of planetary and astrophysics missions	Stephen Kane	9:50 AM	0:20	10:10 AM
START team: plans and interactions with the ExoPAG community	Courtney Dressing	10:10 AM	0:20	10:30 AM
BREAK (30 min)		10:30 AM	0:30	11:00 AM
Session 5 (Chair: Ilaria Pascucci)	**Speaker**	**Time (CST)**	**Duration**	**End**
Business Meeting: Discuss New SIGs/SAGs, Discuss Potential New Findings, Solicit new suggestions for ExEP or ExoPAG action, Announcements, etc.	Lead: Ilaria Pascucci astro-planetary connections: Diana Dragomir JWST targets: Ian Crossfield Solicit new suggestions/findings: Gary Blackwood	11:00 AM	1:30	12:30 PM
Adjourn		12:30 PM		

Business meeting

- astro-planetary connections
- JWST exoplanet targets
- New suggestions/findings:

Technical/Scientific, Early career engagement, Programmatic

ExoPAG 29: Business meeting

- Discussion of two additional SAGs:

- SAG on Exoplanet Reflectance Spectroscopy for HWO (R. Hu and T. Robinson): compare and converge on the practices for simulation of, and retrieval on, exoplanet reflectance spectra, with a focus on terrestrial exoplanets relevant to HWO

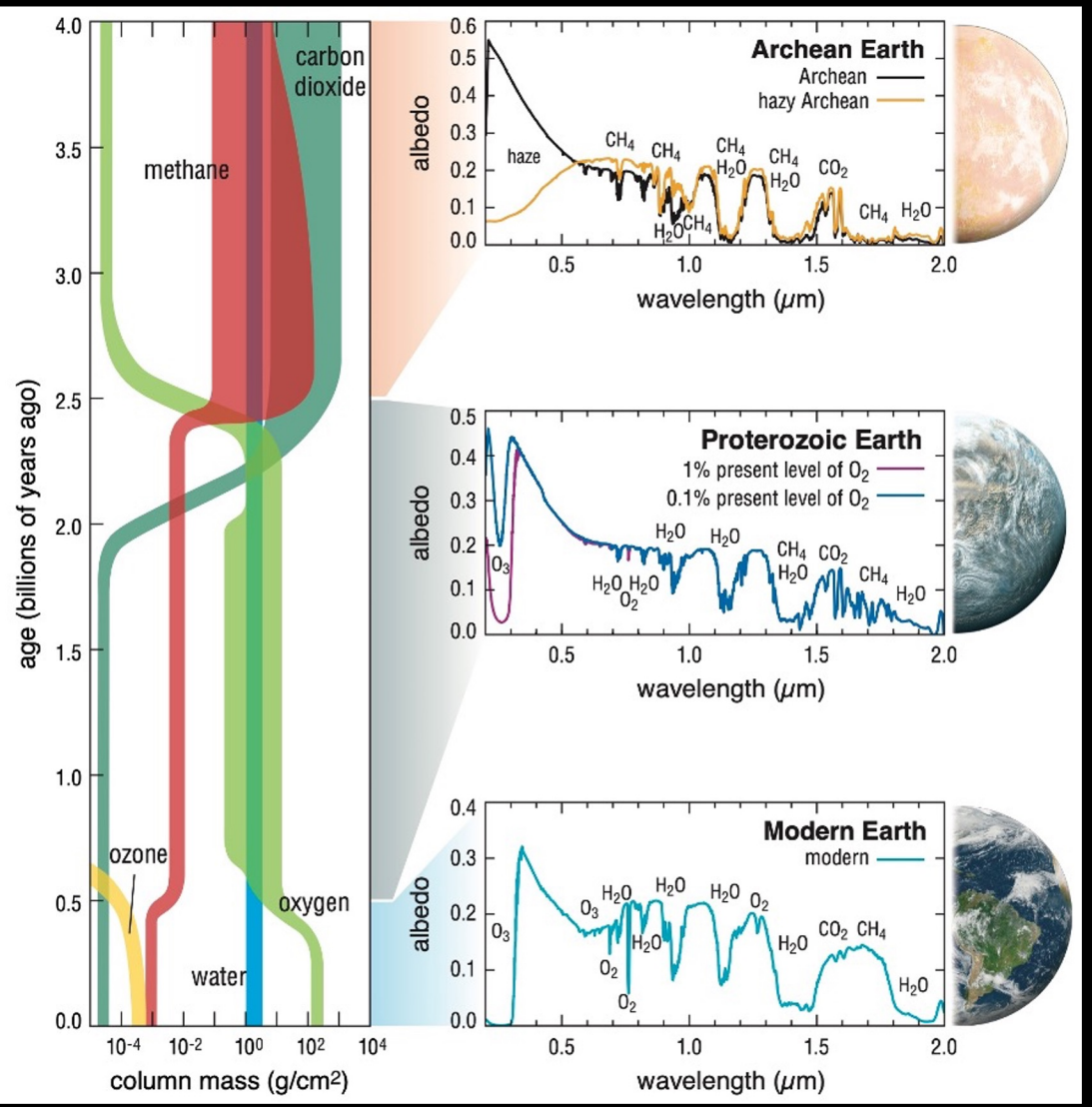
- SAG on Technosignatures (J. Wright): produce analysis and findings on how NASA's efforts in astrobiology, exoplanetary astrophysics, and other areas can better serve the search for technosignatures

https://exoplanets.nasa.gov/exep/exopag/exopag29/exopag29-overview/

A SAG on Exoplanet Reflectance Spectroscopy for the Habitable Worlds Observatory

Renyu Hu and Tyler Robinson

LUVOIR & HabEx Final Reports



MOTIVATIONS:

Spectroscopic measurement capabilities for identifying and characterizing potentially habitable exoplanets are of paramount importance to HWO

Multiple groups in the country and abroad have now built spectral simulation and retrieval tools, and it is essential to validate the tools and have a common understanding on exoplanet reflectance spectroscopy

SAG on Exoplanet Reflectance Spectroscopy

- The SAG will bring together multiple groups in the community to compare and converge on the practices for simulation of, and retrieval on, exoplanet reflectance spectra, with a focus on terrestrial exoplanets relevant to HWO
- The SAG will provide tools and inputs to the START working groups for specific evaluation of HWO science cases
- We anticipate that the activities will commence by Apr 2024 and will continue for 1.5 years
- This study will invite open participation from any group in the science community. Confirmed participants include: Renyu Hu, Mario Damiano, Armen Tokadjian (JPL), Tyler Robinson (University of Arizona), Vikki Meadows, Jacob Lustig-Yaeger (University of Washington, JHU/APL), Avi Mandell, Geronimo Villanueva, Amber Young, Thomas Fauchez, Eleonora Alei, Natasha Latouf (NASA GSFC), Margaret Turnbull (SETI), Lisa Kaltenegger (Cornell), Sascha Quanz (ETH Zurich), Laura Kreidberg (MPIA)
- The study will leverage currently funded efforts including the Astrophysics Decadal Survey Precursor Science teams (Turnbull, Krissansen-Totton), CUISINES model intercomparison framework (Fauchez), and ExoSpec ISFM Work Package (Mandell)

Detailed Objectives

- Compare and cross-validate spectral retrieval tools, including elements as central as opacities, radiative transfer routines, and statistical evaluation algorithms
- Compare and converge on appropriate levels of model complexities (such as the treatment of clouds and radiative transfer model sophistication) based on the expected data characteristics (e.g., wavelength, resolution, SNR)
- Organize a blind retrieval challenge open to the entire community and focusing on reflectance spectroscopy of terrestrial exoplanets
- Achieve common understanding of how the wavelength range, spectral resolution, and prior constraints on the planetary mass impact characterization of different types of terrestrial exoplanets
- Identify key areas of disagreement that could adversely impact HWO science and design
- Identify the best practices for deriving atmospheric constraints from exoplanet reflectance spectra

A SAG on Technosignatures

Jason Wright, Adam Frank, Mark Elowitz, Eddie Schwieterman

MOTIVATION: The search for signs of technological life in the universe ("technosignatures"), also called SETI, has seen rapid growth in its sophistication in recent years, while expanding beyond radio SETI into searches for other forms of technology, such as atmospheric technosignatures in exoplanetary spectra. Importantly, many of the same techniques currently used for biosignature studies, including atmospheric modeling and retrieval and standards for life detection, can also be applied to technosignature searches. As such, there are strong and growing connections between technosignature studies and the fields of exoplanetary research and astrobiology.

The field of astrobiology has been nurtured and matured by NASA for decades, so that it now has a robust portfolio of the study of life in the universe across the Earth Science, Planetary Science, and Astronomy communities. NASA has an opportunity to similarly support the small but vibrant and growing community of technosignature researchers who seek to make NASA's astrobiology portfolio more comprehensive and inclusive of the search for technological life.

This SAG will produce analysis and findings on how NASA's efforts in astrobiology, exoplanetary astrophysics, and other areas can better serve the search for technosignatures, consistent with NASA's goals to understand the prevalence of life in the universe. This SAG will:

1) Find which technosignature investigations should play a role in NASA's exoplanet and planetary science portfolios.

2) Identify the most promising technosignature investigations to prioritize for funding and mission dev.

3) Identify science and technology gaps relevant to technosignature searches

4) Identify existing NASA programs most relevant to technosignature searches

5) Identify best practices for NASA program officers to select and provide guidance for review panelists to grade and discuss technosignature proposals in XRP and other programs.

6) Potential new initiatives to build community and intercommunications with other astrobiology efforts.

ExoPAG 30

May 5, 2024
Providence, RI

The agenda will focus on the search for life in the Solar System and Beyond. One of the main goals will be to identify cross-divisional science gaps and opportunities for progress

Confirmed speakers: Dr. L. Glaze (Director Planetary Science Division), Dr. H. Jang-Condell (Astrophysics, SMD), Dr. E. Mamajek (ExEP science gap list), Dr. V. Meadows (SIG3) , O. Cohen (NExSS)
Invitations sent to VEXAG, OPAG, and MEPAG leads

ExoPAG Actions requested from APAC

The ExoPAG requests APAC to consider the two proposed SAGs:

1. Exoplanet Reflectance Spectroscopy for HWO
2. Technosignatures