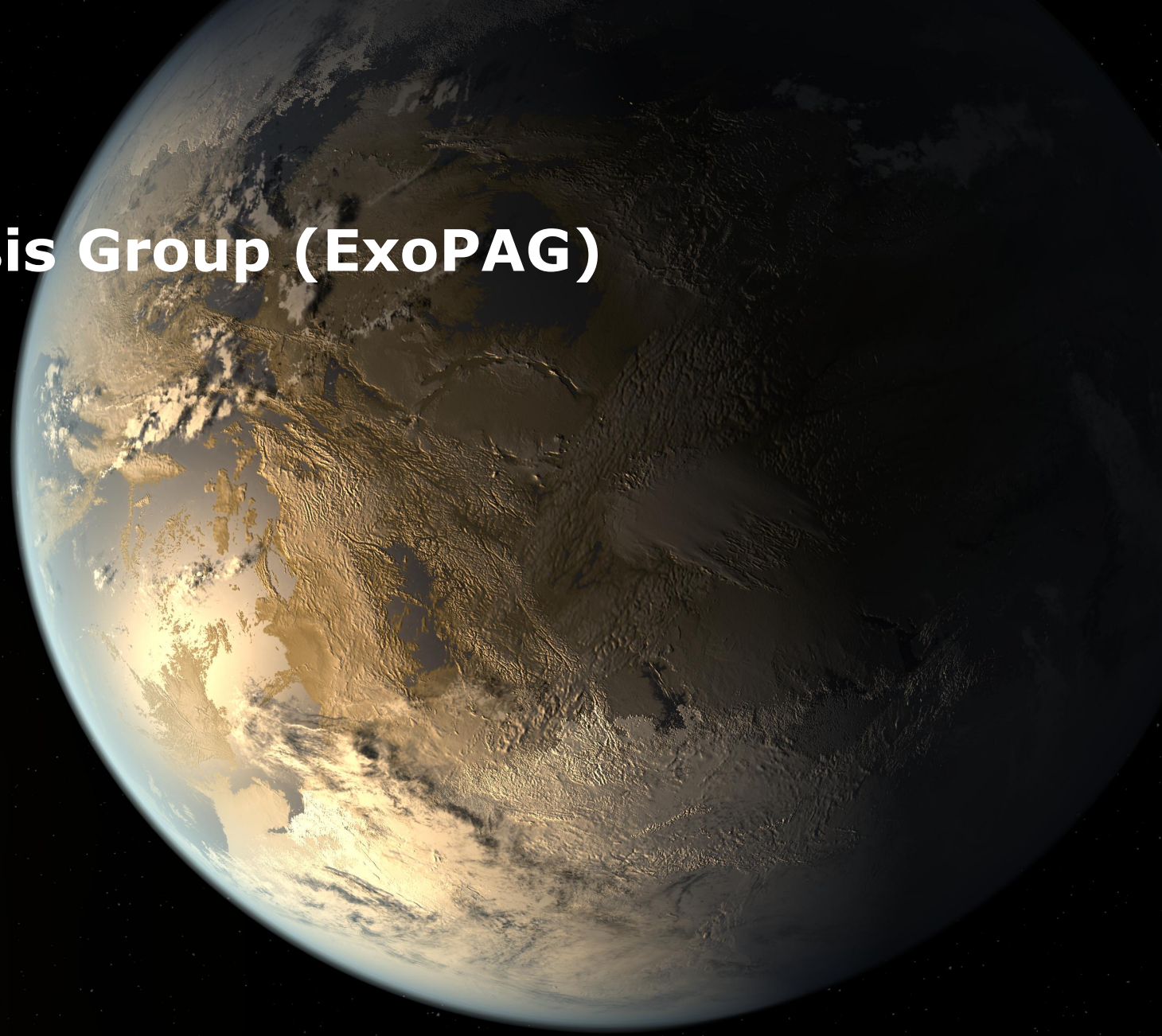
Exoplanet Program Analysis Group (ExoPAG) Report to APAC

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

June 27-28, 2023



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 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

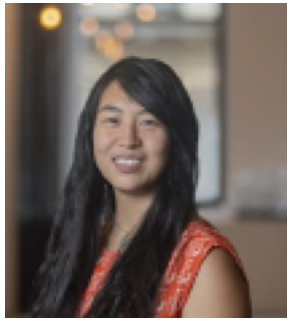
New ExoPAG EC Members

Ian Crossfield
University of Kansas
Exoplanet formation, composition, detection, characterization & instrumentation

Kate Follette
Amherst College
Direct imaging of young exoplanets and circumstellar disks, adaptive optics

Samson Johnson
Jet Propulsion Laboratory
Survey design and yields of the Roman Galactic Bulge Time Domain Survey

Lily Zhao
Flatiron Institute
Data-driven methods for extreme precision radial-velocity and detecting low-mass planets



Malena Rice
Yale University
Planet formation and evolution, stellar spectroscopy, orbital architectures

Natalie Hinkel
SwRI → Louisiana State
Stellar abundances and the chemical interplay between stars and planets

2023 ExoPAG Executive Committee members

Ilaria Pascucci *Chair*	The University of Arizona
Michael Bottom	The University of Hawaii
Ofer Cohen	University of Massachusetts Lowell
Knicole Colon	NASA GSFC
Ian Crossfield	The University of Kansas
Diana Dragomir	University of New Mexico
Kate Follette	Amherst College
Natalie Hinkel	Southwest Research Institute
Samson Johnson	Jet Propulsion Laboratory
Erin May	Johns Hopkins Applied Physics Laboratory
Bertrand Mennesson	Jet Propulsion Laboratory/Caltech
Malena Rice	Yale University
Lily Zhao	Flatiron Institute
Michael Meyer *Past Chair, Emeritus*	University of Michigan
Hannah Jang-Condell, *Executive Secretary, Astrophysics Division*	NASA Headquarters
Douglas Hudgins, *Program Scientist, Exoplanet Exploration Program*	NASA Headquarters
Megan Ansdell, *NASA Planetary Science Division Liaison*	NASA Headquarters
Richard Eckman, *NASA Earth Science Division Liaison*	NASA Headquarters
Galen Fowler, *NASA Heliophysics Division Liaison*	NASA Headquarters

2023 ExoPAG Executive Committee members

Many ongoing and new activities that EC members lead or contribute to…

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

- Organize monthly ExoPAG EC meetings (4/19, 5/17, 6/21), cross-PAG activities (e.g.,TDAMM ToR), rep. to APAC (I. Pascucci)

- Review of applications for new ExoPAG EC members (I. Pascucci and EC review committee)

- Bylaws document in preparation, includes selection process of new EC members, EC voting and voting process within the ExoPAG, formation of new SIGs/SAGs… (J. Gregory and I. Pascucci)

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

- *New Great Observatories* cross-PAG SAG (ExoPAG EC rep.: M. Rice): report in Early 2024 about the scientific advances enabled by a fleet of future Great observatories

- Adaptive Optics Strategic Response workshop, 16-18 May (rep.: M. Bottom): summary of findings on the high-contrast imaging side led by Bottom and Ruane:
https://docs.google.com/document/d/17bHFJWpi-0HxWwTlhEe9Tsj2Bonpr3i_xYYbWySY3R0/edit?usp=sharing

- ExoExplorers Program (rep.: K. Colon): the 3rd year of the Exoplanet Explorers Science Series is close to completion. Cohort of 12 early career scientists from institutions across the US and Canada + 4 international ExoGuides.

ExoExplorers Program Update

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

June 2023

- The third year of the Exoplanet Explorers Science Series ran from January-June 2023.
- The cohort for the third year was composed of 12 early career scientists who come from institutions across the US and Canada (https://exoplanets.nasa.gov/exep/exopag/exoexplorers/exoexplorers/).
- The ExoGuides for this year were Nestor Espinoza (STScI), Yamila Miguel (Leiden University), Ben Montet (University of New South Wales), and Evgenya Shkolnik (Arizona State University) (https://exoplanets.nasa.gov/exep/exopag/exoexplorers/exoexplorers-exoguides/).
- Activities planned by the ExoExplorer Steering and Organizing Committees for the ExoExplorers include science talks by the cohort members that are widely advertised to the broader astronomical community, meetings with the ExoGuides, professional development activities, and social hours. The Steering/Organizing Committees also facilitate introductions and 1-on-1 meetings between ExoExplorers and other professional researchers in related fields.
- There are typically ~50 attendees to the ExoExplorers Science Series (hosted on WebEx).

Two of the major activities ExoExplorers participated in this year are described further below:

The ExoExplorers program held a **discussion panel on balancing science career advancement and DEIA (Diversity, Equity, Inclusion and Accessibility) efforts** for the 2023 cohort members. The panelists were Professor Heather Knutson (CalTech), Professor Gurtina Besla (Univ. of Arizona), Professor Jorge Moreno (Pomona College), and Dr. Alessandra Pacini (CU Boulder (University of Colorado) / NOAA (National Oceanic and Atmospheric Administration)).

The ExoExplorers program held a **multi-day workshop on software development and software publication skills** for the 2023 cohort members, featuring Professor Jason Wang (Northwestern) and Dr. Sarah Blunt (Caltech) the co-developers of the Code/Astro Software Engineering Workshop. Key topics were how to develop software in a reproducible way, and how to create software products that are usable by the broader exoplanet community.

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

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

- Ongoing activities with the Planetary Science Division: Planetary Science Advisory Committee meeting (last meeting June 21-22, 2023) (rep.: N. Hinkel)

- Preliminary agenda for the ExoPAG28 meeting, Sunday, Oct 1st just before the DPS meeting (all EC members)

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

- *APEX/OSIRIS Finding discussed at the 5/17 EC meeting, presentation by the proposers planned for the 8/16 meeting (EC discussion lead: K. Colon)*

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

- SIG2 "Exoplanets Demographics", change in leadership (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)

ExoPAG SIG2 (Fernandes & Johnson)

- The EC assisted in the change of leadership (discussions led by former EC member J. Debes)

- Additional new coordinators and members will be soon solicited by the new leads

- The new leadership will present their updated goals at an upcoming EC meeting

ExoPAG SAG 23

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

Co-leads: J. Debes, Y. Hasegawa, I. Rebollido

SAG23 includes ~38 members working on eight major subject areas

– A Catalog of Dusty Systems around Nearby Stars (lead: Steve Ertel)
– A review of host dust systems (leads: Steve Ertel and William C. Danchi)
– The theory of Exozodi Sources and Dust Evolution (lead: Mark Wyatt)
– Post-Processing and Detection of Extended Sources (leads: Ewan Douglas, Max Millar-Blanchaer)
– Pan-Chromatic Radiative Transfer of Exozodis (lead: Ramya M. Anche)
– Prioritization of Precursor Observational Studies of Debris Disks/Exozodis for future direct imaging missions (leads: Max Millar-Blanchaer, William C. Danchi)
– Prioritization of Precursor Theoretical Studies of Debris Disks/Exozodis for future direct imaging missions (lead: Jess Rigley)
– Update and prioritization of ExEP Gaps relevant to Exozodis (lead: Emily Rickman)
– A Review of the Solar System's Zodiacal Cloud (leads: Neal Turner, Geoff Bryden)

ExoPAG SAG 23

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

Co-leads: J. Debes, Y. Hasegawa, I. Rebollido

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June 2023 update:

– Each subject area has started writing their sections of the final reports

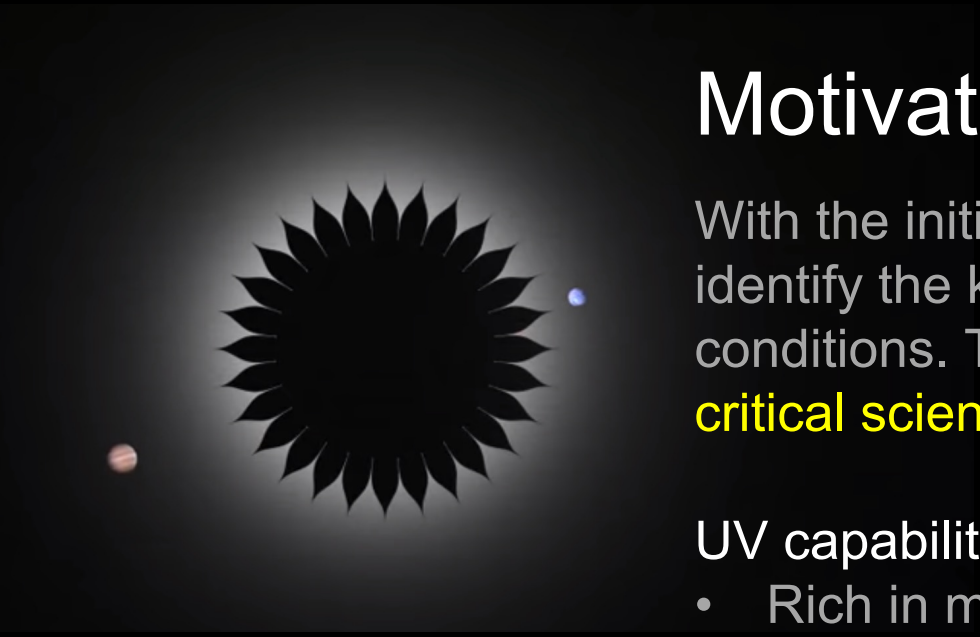
– Presentation submitted to the HWO conference (July, STScI) to update the community

– A (hybrid) **SAG23 workshop** will be held on September 15 at the STScI (more details announced in early July). Main goal: present the status of the SAG analysis and solicit additional inputs from the wider astronomical community

New proposed SAG!

Starshade Science SAG

S. Seager, S. Shaklan



Motivation

With the initiation of the Habitable Worlds Observatory (HWO) we must identify the key measurements needed to establish exoEarth habitable conditions. The Starshade SAG motivation is to elucidate the unique and critical science Starshade enables, complementary to the coronagraph.

UV capability

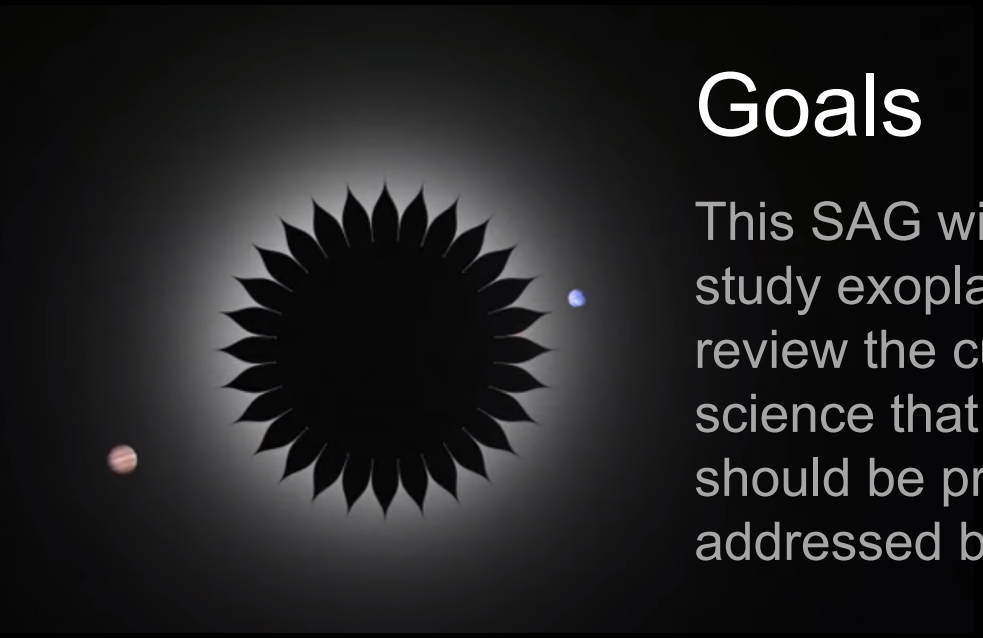
- Rich in molecular diagnostics not accessible at visible and near-IR wavelengths
- Contains the “ozone cut off”

Simultaneous broad-band spectral coverage

- Identification of multiple gases for characterizing the planet types
- Identification of individual gases by more than one spectral feature.

High throughput

- Necessary for gathering spectra of numerous faint exoEarths
- Can efficiently optimize a general observatory schedule
- Enables polarization measurements



Goals

This SAG will bring together an interdisciplinary team of scientists who study exoplanet characterization in order to: consolidate knowledge; review the current gaps in knowledge; and flesh out areas of Starshade science that are unique and complementary to the coronagraph and should be prioritized in the coming years. The goals that will be addressed by this SAG are as follows.

Goals

1. Review the current state of knowledge of exoEarth planetary environmental scenarios and atmospheric properties, with an emphasis on the diversity of planet type and usefulness of a broad wavelength coverage

2. Assess the scientific value of access to the following observations:
   a. Broad, instantaneous spectral bandwidth (~100%)
   b. Unrestricted outer working angle
   c. Low resolution UV spectroscopy down to <= 250nm, with the ability to search for the “ozone cutoff”
   d. High throughput observations.

3. Estimate the exoplanet detection/characterization yield of a notional Starshade for HWO covering 250 nm to 2 um, e.g., to be used in conjunction with a visible-only HWO coronagraph.

4. Identify methods for the critical or complementary role of Starshade for exoplanet characterization, incl: determining the rocky nature of any planet found by the HWO; determining the bulk composition of rocky planet atmospheres; characterizing biosignature gases on potentially habitable rocky planets.

5. Simulate end-to-end Starshade images including exozodi, and perform atmospheric spectral retrieval on the simulated images, to support Goal 4.

6. Starshade point design to support Goals 3-5.

7. Evaluate the merit of both theoretical and observational studies of exoEarths in support of future exoEarth imaging missions. Prioritize which studies can be carried out based on anticipated data from those missions and which ones are needed sooner.

8. Identify near-term and long-term ground-based opportunities to fill in knowledge gaps relevant to future exoplanet studies.

ExoPAG Actions requested from APAC

The ExoPAG requests APAC to consider the proposed **Starshade Science** SAG