

Exoplanet Program Analysis Group (ExoPAG):

5000 other worlds and counting...



Michael Meyer (U. Michigan)
Chair, ExoPAG Executive Committee

Astrophysics Advisory Committee March 31, 2022

ExoPAG Executive Committee

Michael Meyer (Chair)

University of Michigan

Natasha Batalha

NASA-Ames

Jacob Bean

The University of Chicago

Michael Bottom

The University of Hawaii

Ofer Cohen

University of Massachusetts Lowell

Knicole Colon

Goddard Space Flight Center

John Debes

Space Telescope Science Institute

Tiffany Kataria

JPL/Caltech

Ilaria Pascucci

The University of Arizona

Josh Pepper

Lehigh University

Dmitry Savransky

Cornell

Laura Schaefer

Stanford University

Douglas Hudgins (Astrophysics)

NASA HQ

Hannah Jang-Condell (ExEP DS)

NASA HQ

Doris Daou (Planetary Liaison)

NASA HQ

Richard Eckman (Earth Liaison)

NASA HQ

Gaylan Fowler (Heliophys Liason)

NASA HQ

Thank you for your service...

(New members being finalized now).

Credit: NASA

ExoPAG Recent Activities (since October APAC)

- Community + EC input provided on Science Gap List.
- Reported to PAC in November and February.
- Reviewing proposals/reports for/from SAGs/SIGs
- New APD Cross PAG activities:
 - Astro 2020 Discussions and Statement.
 - Cross PAG SAG on URM in APD Space Science (R. Hickox).
 - Supported APD presence at SACNAS and NSBP.
- Welcome the new 2022 ExoExplorers (T. Kataria)
- Held ExoPAG 25 (virtual) Jan 10-12, 2022.
- EC supporting SOC for Precursor Science Workshops.
- Standing up new SAGs re: Astro 2020 (e.g. met w/ NExSS).
- ExoPAG 26 will take place at AAS in Pasadena, CA in June with mini-symposium on State of the Profession.



PLANET HOP FROM
TRAPPIST-1
Credit: NASA

VOTED BEST "STUDY ABROAD" DESTINATION

January 10, 2022		Jan. 10 Webex Mtg ID: 2763 8	PW: planets
Session 1 (Chair: Ilaria Pascucci)		Speaker	Time (EST)
Welcome		Michael Meyer	12:00 PM
ExEP Program Overview		Gary Blackwood	12:10 PM
ExoExplorers Introduction		Tiffany Kataria	12:25 PM
NN-EXPLORE Update		John Callas	12:40 PM
NExSci Update		David Ciardi	12:55 PM
13 UV Flares Observed on the 25 Myr AU Mic with HST/COS during two transits of AU Mic b		Adina Feinstein	1:10 PM
JWST Exoplanet Science Update		Knicole Colon	1:25 PM
BREAK (20 min)			1:45 PM
Session 2 (Chair: Ofer Cohen)		Speaker	Time (EST)
The K Dwarf Advantage: The Ultraviolet Imperative for Assessing the Habitability of Planets		Tyler Richey-Yowell	2:00 PM
Roman Update		Vanessa Bailey	2:15 PM
High contrast polarimetric imaging as a complement for total intensity circumstellar disk imaging		Kellen Lawson	2:35 PM
SAG 21: The Effect of Stellar Contamination on Space-based Transmission Spectroscopy		Nestor Espinoza & Ben Rackham	2:50 PM
BREAK (20 min)			3:10 PM
Session 3 (Chair: M. Meyer)		Speaker	Time (EST)
Citizen Science		Marc Kuchner	3:25 PM
pterodactyls: A Uniform Search for Young Transiting Planets in TESS Primary Mission FFIs		Rachel Fernandes	3:45 PM
SIG2: Exoplanet Demographics		Jessie Christiansen	4:00 PM
Debris Disk SAG Proposal		John Debes	4:20 PM

January 11, 2022		Jan. 11 Webex Mtg ID: 2761 377 9899 PW: planets	
Astro 2020 Discussion (Chair: Michael Meyer)	Speaker	Time (EST)	Duration
Overview of Astro2020 from an Exoplanet Perspective	Keivan Stassun and Bruce Macintosh	1:00 PM	0:20
Discussion Moderated by ExoPAG EC	Josh Pepper, Michael Bottom, Ofer Cohen, Knicole Colon	1:20 PM	1:10
Break		2:30 PM	
NASA Astrophysics Townhall Meeting (see dedicated webex info)		Join Webex	Meeting #: 2763 383 2584 PW: NASAapd21\$
Update on NASA Astrophysics	Paul Hertz - Director of NASA Astrophysics Division	2:45 PM	1:30

January 12, 2022		Jan. 12 Webex Mtg ID: 2764 508 3981 PW: planets		
Session 4 (Chair: Knicole Colon)		Speaker	Time (EST)	Duration
ExEP NASA Headquarters Overview		Hannah Jang-Condell	12:00 PM	0:30
ExEP Science & Gap List Update		Karl Stapelfeldt	12:30 PM	0:20
ExEP Technology Update		Brendan Crill	12:50 PM	0:30
BREAK (5 min)			1:20 PM	0:05
Session 5 (Chair: Michael Meyer)				
TESS Update		Michelle Kunimoto	1:25 PM	0:30
ExoPAG Business Meeting - New SAGS/SIGS - Discussion of Findings to bring to APD - Review of progress on actions/proposal of new suggestions - matters arising		All	1:55 PM	0:50
Adjourn (end of ExoPAG 25)			2:45 PM	

Current Status of SAGs and SIGs

Close Year	SAG or SIG	Title	Lead
----	SIG 2	Exoplanet Demographics (on-going)	Christiansen & Meyer
----	SIG 3	Exoplanet Solar System Synergies (on-going).	Meadows & Mandt
----	SAG 21	Stellar Contamination on Transit Spectra (final report submitted)	Rackham & Espinoza
----	SAG 22	Exoplanet Host Properties (final report submitted)	Pepper, Stark, & Hinkel
----	SAG XX	Debris Disk Properties of Exoplanet Hosts (proposed)	Debes, Rebollido, & Hasegawa

SIG 2 - Exoplanet Demographics

Chairs: Jessie Christiansen (NExSci/IPAC) & M. Meyer (UM)

- Monthly telecons discuss new demographic results from multiple techniques (radial velocity, microlensing, transit, direct imaging).
- Curating a list of open questions/ongoing projects for the community.
- *Report (V1.0) on value of public database of demographic products, covering all techniques, to be submitted this fall (update at ExoPAG 25).*

SIG 3 ExoSS Goals, Progress, Plans

Chairs: Victoria Meadows (UW/NExSS/ExoPAG), Kathy Mandt (JHU/APL/OPAG)

Goal: To provide a forum for interaction between the Solar System and exoplanet communities on topics of mutual interest, and to work to identify ways in which NASA and the scientific community could enhance these interactions.

Status: The SIG3 is active and open to all.

- Promoted community-led Planetary Decadal activities: List of lists - <https://bit.ly/3fu6ang>
- Monthly SIG3 Tutorial/Journal Club to explain key concepts to each other
- ExoSS Slack Channel – all are welcome! (Email: meadows@uw.edu)
- Gathering community input on key ExoSS synergies: <https://tinyurl.com/yxbnyfwu>
- Recruiting members from diverse science communities (e.g. DPS and PEN).
- ***Promote potential collaboration between the exoplanet and Solar System communities, such as a future Exoplanets in Our Backyard 2 (fall 2022).***

SAG21: the report

- **90+ pages**,
lots of figures (and fun).
- **5 main chapters**
(one per subgroup).
- **40+ major contributors**,
total of 100+ scientists from helio & exo/planetary communities.



SAG21 Summary Questions & Needs

The Sun as the Stellar Benchmark

Science questions

Needs

Relevant findings

What are the **spectral properties of solar photospheric and chromospheric heterogeneities** as a function of time and location?

- Theoretical understanding of spot sizes, locations, lifetimes, and contrasts in the 0.3-5.0 μm range.
- Resolved observations of the Sun, including spots and faculae, over 0.3-5.0 μm at resolutions relevant to space-based transit observations.

1.1, 3.2, 5.1

What are the **spectral properties of solar granules**?

- Validate 3D simulations of solar granulation against optical and NIR observations.

1.1, 3.3

SAG21 Summary Questions & Needs

Surface Heterogeneities of Other Stars

Science questions	Needs	Relevant findings
How are the spectral properties of spots and faculae governed by the fundamental parameters of stars ?	- MHD simulations of magnetic features that provide priors on facular and spot spectra and coverages for different spectral types.	1.2, 4.3
What are the spectral properties of spots and faculae on high-priority exoplanet host stars ?	- Observational constraints of exoplanet hosts, including photometry, spectroscopy, and spectropolarimetry, to use as feedback for stellar models	1.3, 3.2
What is the impact of granulation on precise transit studies?	- Validate 3D granulation simulations against optical and NIR light curves for a range of spectral types.	3.3

SAG21 Summary Questions & Needs

Mapping Stellar Knowledge to Transit Studies

Science questions

Needs

Relevant findings

How do we **translate knowledge** of stellar heterogeneities in other stars **to transit observations**?

- Establish best practices for incorporating stellar heterogeneity in transit studies and atmospheric retrievals, including priors from stellar models of spots and faculae.
- Study planetary transits of the Sun with existing and future datasets as ground truth for exoplanetary transits.
- Collect panchromatic stellar observations, including UV-to-IR spectra and long baseline photometry.
- Use interferometric observations to establish ground truth for photometric variations.

2.1, 2.2, 4.1, 4.2, 5.1, 5.2

What **unique constraints** on stellar heterogeneity are **enabled by transit observations**?

- Maintain publicly accessible and up-to-date tools for modeling active-region occultations.
- Further pursue theoretical work connecting observational signatures in light curves to stellar physical parameters.

2.2, 2.3, 3.1

Final Report for SAG 22: A Target Star Archive for Exoplanet Science

[Natalie R. Hinkel](#),¹ [Joshua Pepper](#),² Christopher C. Stark,³ [Jennifer A. Burt](#),⁴
[David R. Ciardi](#),⁵ [Kevin K. Hardegger-Ullman](#),⁶ [Jacob Lustig-Yaeger](#),⁷ [Ravi](#)
[Kopparapu](#),³ [Lokesh Mishra](#),^{8, 9} [Karan Molaverdikhani](#),^{10, 11, 12} [Ilaria Pascucci](#),¹³
[Tyler Richey-Yowell](#),¹⁴ [E. J. Safron](#),¹⁵ [David J. Wilson](#),¹⁶ [Galen Bergsten](#),¹³
[Tabetha S. Boyajian](#),¹⁷ [J. A. Caballero](#),¹⁸ [K. Cunha](#),⁶ [Alyssa Columbus](#),¹⁹ [Shawn](#)
[D. Domagal-Goldman](#),³ [Chuanfei Dong](#),²⁰ [R. M. Elowitz](#),²¹ Devanshu Jha,²² [Archit](#)
[Kalra](#),²³ [David W. Latham](#),²⁴ [Jacob Luhn](#),²⁵ [Carl Melis](#),²⁶ [Navya Nagananda](#),²⁷
[Eliad Peretz](#),³ [Sabine Reffert](#),²⁸
Kimberly Scarangella Smith,²⁹ [Keivan G. Stassun](#),³⁰ [Angelle Tanner](#),³¹ [Noah Tuchow](#),³²
[Dimitri Veras](#),^{33, 34, 35} and [Jennifer G. Winters](#)²⁴



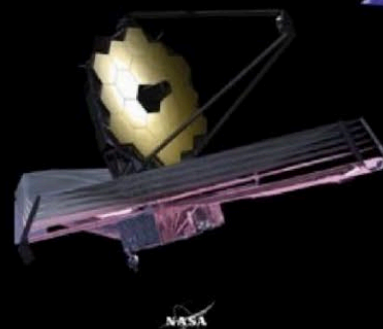
2018

Transiting Exoplanet
Survey Satellite (TESS)



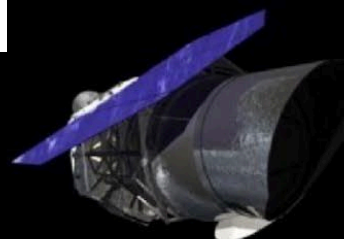
2019

CHARACTERISING EXOPLANETS
Satellite (CHEOPS)



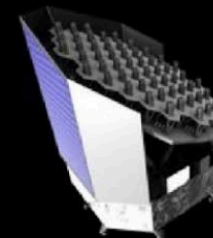
2021

James Webb Space
Telescope (JWST)



2025

Nancy Grace
Roman Space
Telescope



2026

PLANETARY
Transits and
Oscillations
of stars
(PLATO)

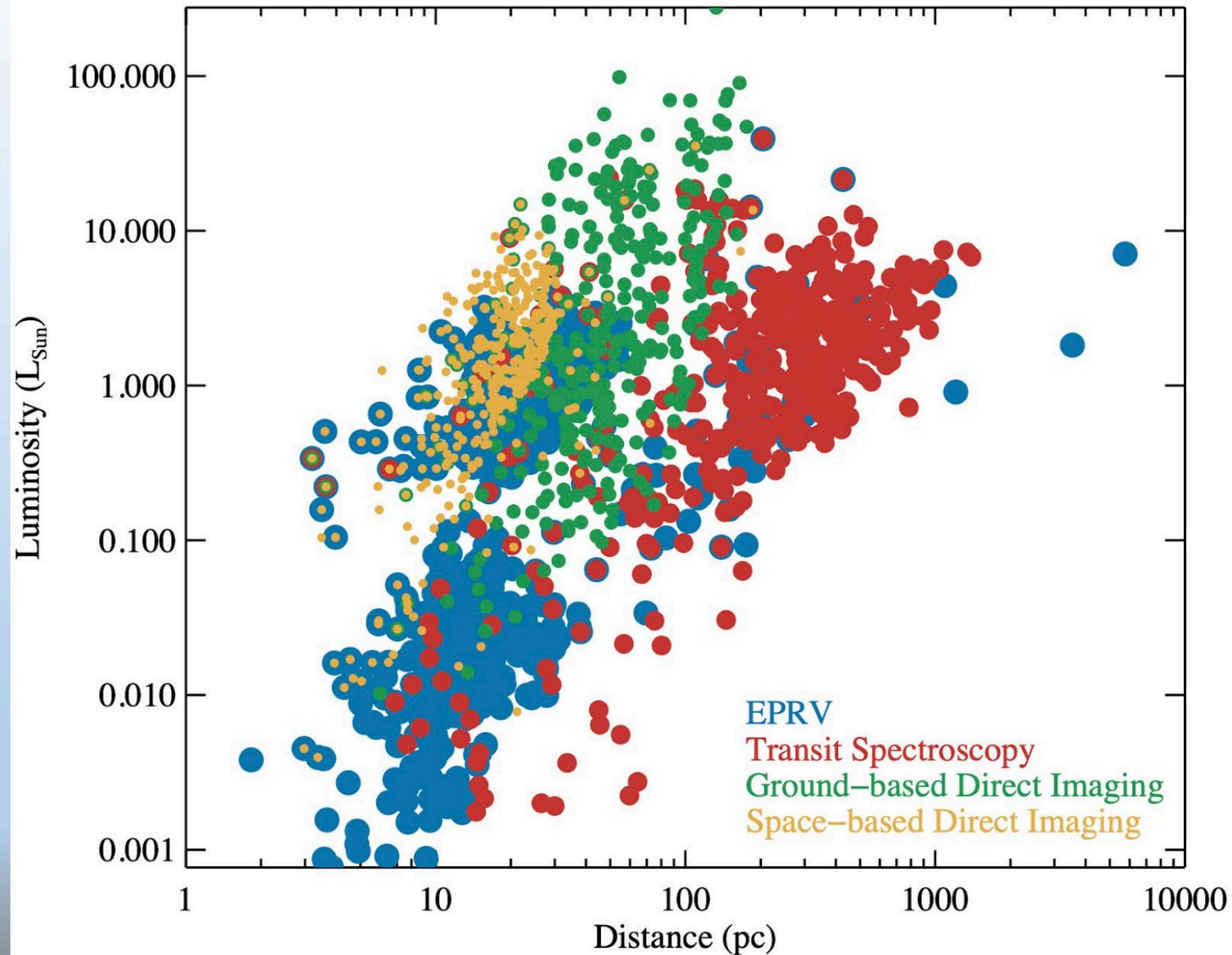


2028

esa

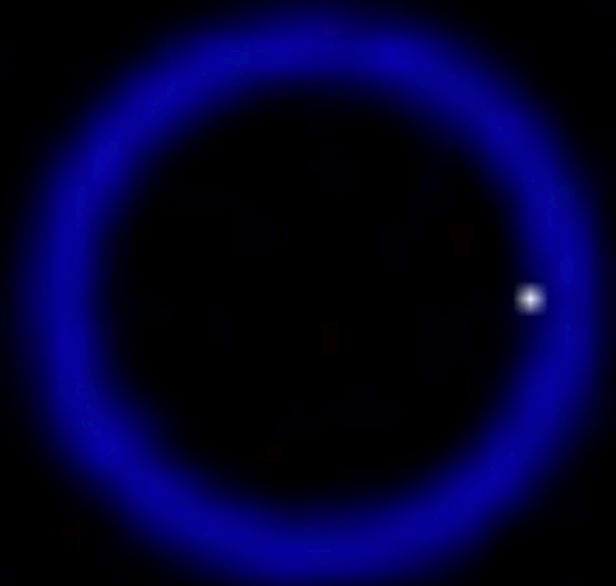
Atmospheric
Remote-sensing
Infrared
Exoplanet
Large-survey
(ARIEL)
+
Contribution
to ARIEL
Spectroscopy
of Exoplanets
(CASE)

Merged Target Lists

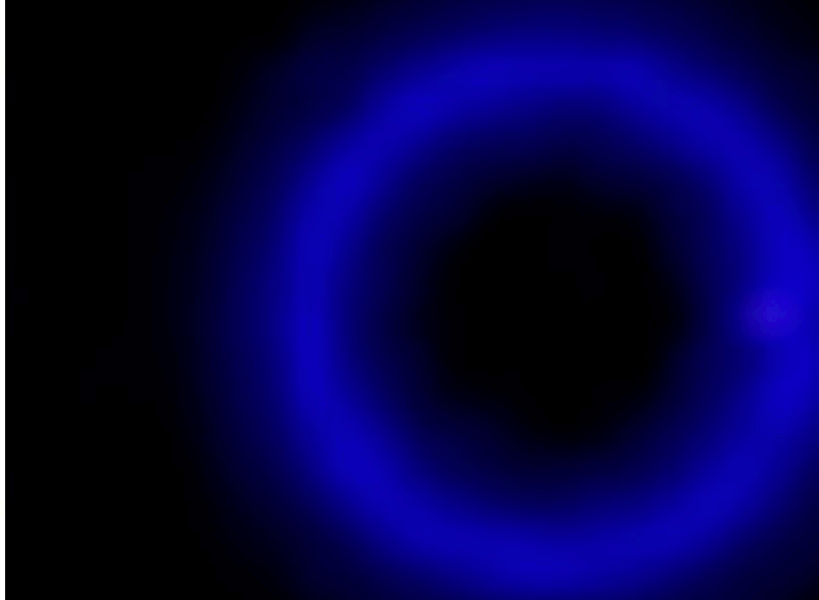


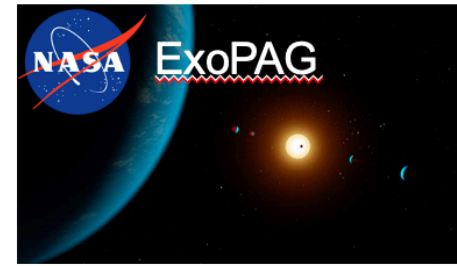
ExoZodis: Opportunity and Adversity

V=5 star
3e-9 Companion at 2.5 AU
5 Zodi disk at 3 AU



Convolved with CGI PSF





A new SAG proposal

- Review the current state of knowledge for warm zodiacal dust in the Solar System, particularly its dust composition and origin, which may be useful for understanding exozodi systems that potentially host planets.
 - i.e. studies of IDPs, dust scattering phase functions, polarimetry of SS dust
- Review the current state of knowledge on the average exozodi level around potential targets of future exo-Earth imaging missions and create a prioritized target list for studies of exozodis.
 - Opportunities for existing observatories such as ALMA, HST, ground-based interferometers?
 - Reconciling hot dust seen in 2 micron interferometric surveys vs. mid-IR surveys
- Explore the limits of empirical and probabilistic models of thermal and scattered light emission from disks and prioritize the techniques and observations which will yield the largest improvement in their performance. Additionally, explore what components of a planetary system are most important for determining exozodi levels, ie. planetary architecture, the presence of outer debris disks, or the presence of inner hot dust.



A new SAG proposal

- Identify methods for extended source detection and image post-processing, that may be relevant for detecting exozodi disks with future missions or in archival data. Provide findings on what works best to retire risks to direct imaging exoplanet surveys, such as whether exozodi disks add more than photon noise in background limited observations.
- Evaluate the merit of both theoretical and observational studies of debris disks and exozodiacal dust in support of future exo-Earth imaging missions. Prioritize which studies can be carried out based on anticipated data from those missions and which ones are needed sooner.
- Identify near-term and long-term ground-based opportunities to fill in exozodi knowledge gaps relevant to future exoplanet and exozodi studies.

Action Requested by ExoPAG EC

- Approve final report for SAG 21.
- Approve final report for SAG 22.
- Recommend accepting TOR for new SAG on exozodi and debris disks.

-
- Back-up Slides

What are “ExoPAG Findings”?:

- Process for whole community to contribute to analyses forwarded to Astrophysics Division leadership as input.
- We do not give “recommendations” but “findings” based on analysis.
- Three findings approved in January 2020 and one in March 2021.
<https://exoplanets.nasa.gov/exep/exopag/exopagFoundingDocuments/exopag-findings/>
- Ideas for new findings solicited from community (e.g. ExoPAG email and at Business Meetings) and discussed at community forum (e.g. Summer ExoPAG).
- Those with community support are reviewed by ExoPAG EC and top 1-3 findings put forward to ExoPAG for a vote (more than 2/3 support needed to “pass”).
- Ideas not adopted (or selected for vote) can be kept and re-discussed in future.
- Affirmation of findings generally scheduled for winter ExoPAG meeting

