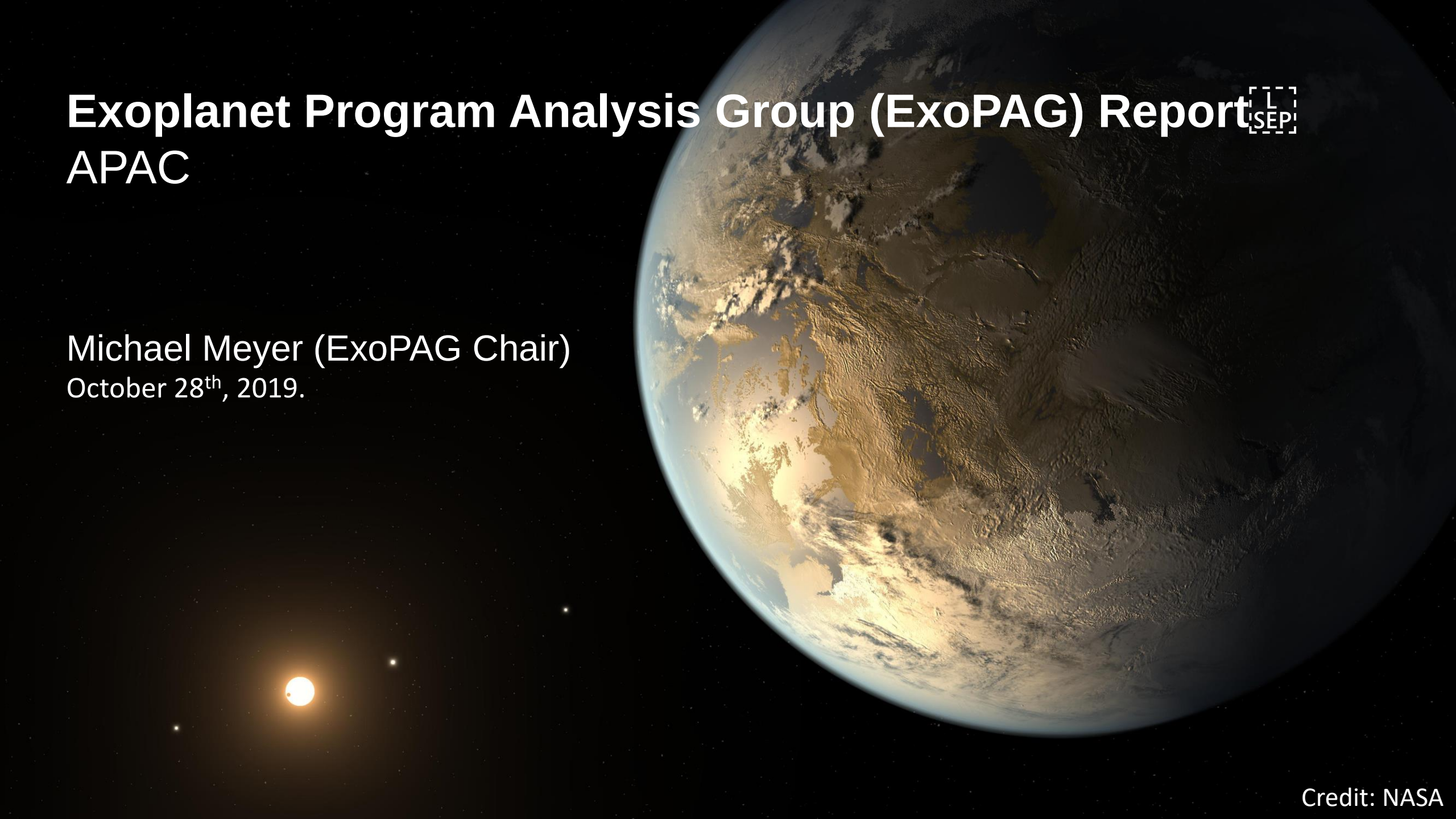
Exoplanet Program Analysis Group (ExoPAG) Report
APAC

Michael Meyer (ExoPAG Chair)
October 28th, 2019.



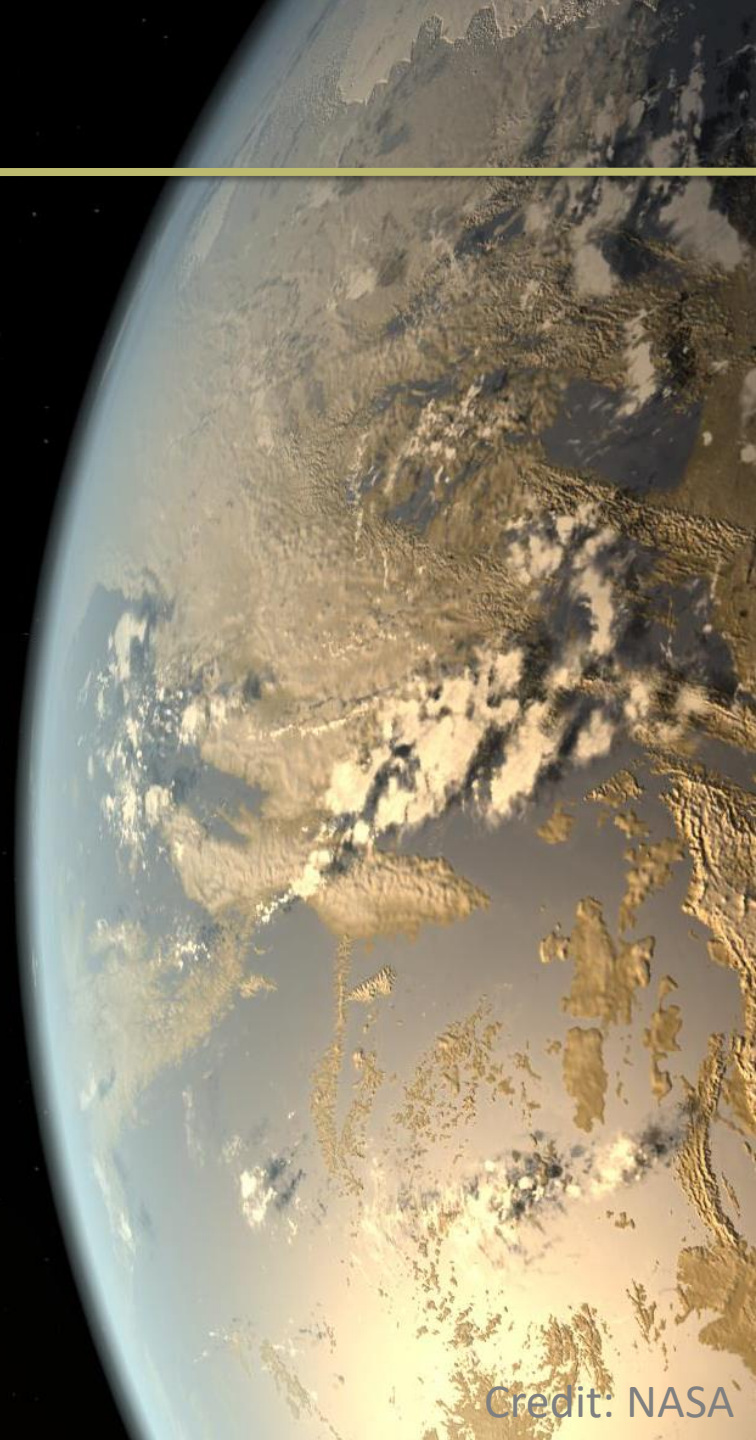
Credit: NASA

ExoPAG Executive Committee

ExoPAG activities and meetings are organized through an Executive Committee

Michael Meyer (Chair)	**University of Michigan**
Tom Barclay	University of Maryland
Jessie Christiansen	NExScI/Caltech
Rebecca Jensen-Clem	UC-Berkeley
Tiffany Kataria	JPL/Caltech
Eliza Kempton	University of Maryland
Josh Pepper	Lehigh University
Dmitry Savransky	Cornell
Chris Stark	Space Telescope Science Institute
Johanna Teske	Carnegie Observatories
Vikki Meadows (Past Chair)	University of Washington
Martin Still (ex officio)	NASA

Selected by NASA for 3-year terms. Calls for membership out now!



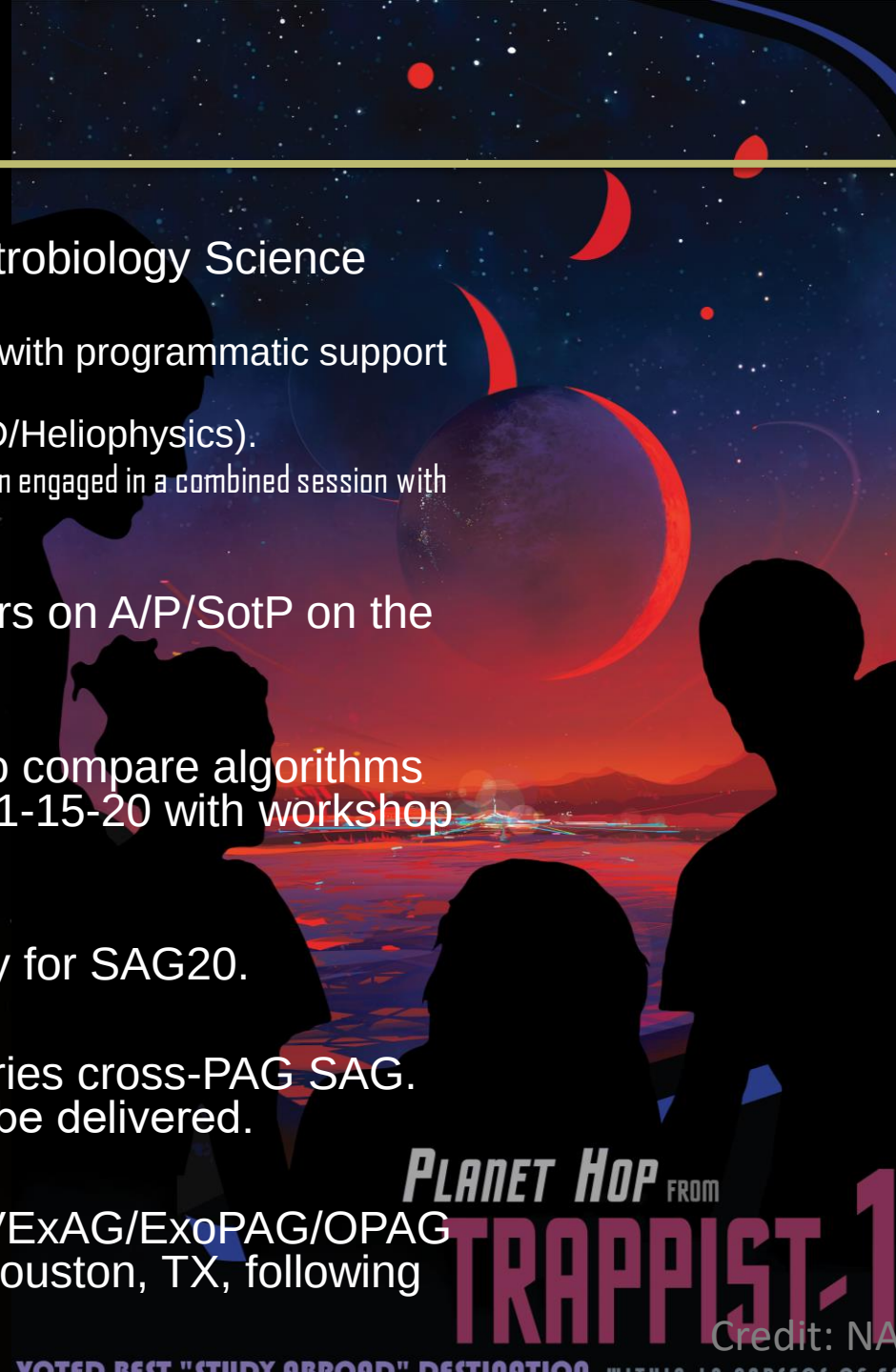
Credit: NASA

2019 Status of SAGs and SIGs

Closeout Year	SAG or SIG	Title	Lead
--	SAG 19	Exoplanet imaging signal detection theory and rigorous contrast metrics (active - closeout expected in early 2020)	Mawet & Jensen-Clem
--	SIG 2	Exoplanet Demographics	Christiansen & Meyer
--	SAG 20	Impact of JWST Delay on Exoplanet Science (closeout expected 2019)	Teske & Deming
	SIG 3	Exoplanet Solar System Synergies	In formulation

ExoPAG Recent Activities

- Held the ExoPAG20 meeting in Seattle, June 23rd, 2019, prior to the Astrobiology Science Conference, 2019:
  - Mini-science symposium on characterization of terrestrial exoplanets, interwoven with programmatic support of that goal.
  - Programmatic theme of interdisciplinarity and cross-divisional activities (APD/PSD/Heliophysics).
  - The EC held a 3 hr Executive Session prior to the ExoPAG20 meeting to brainstorm ideas for SAGs and SIGs and then engaged in a combined session with ExEP to share ideas on key priorities.
- Hosted spreadsheet for community coordination of Decadal White Papers on A/P/SotP on the ExoPAG website (14 papers listed, dozens of co-authors participated).
- Mawet and Jensen-Clem have organized a community data challenge to compare algorithms in finding planets in ground-based direct imaging datasets (extended to 1-15-20 with workshop end of January) as part of close-out SIG19.
- Teske and Deming completed the JWST delay community impact survey for SAG20.
- Meyer and other ExoPAG members participated in the Great Observatories cross-PAG SAG. Meyer led Working Group 2 “Origin of Planets and Life”. Final report to be delivered.
- Meadows and Kataria to serve as ExoPAG reps on the SOC for a joint VExAG/ExoPAG/OPAG conference “Exoplanets in Our Backyard”, to be held Feb 5-7, 2020 in Houston, TX, following OPAG meeting.



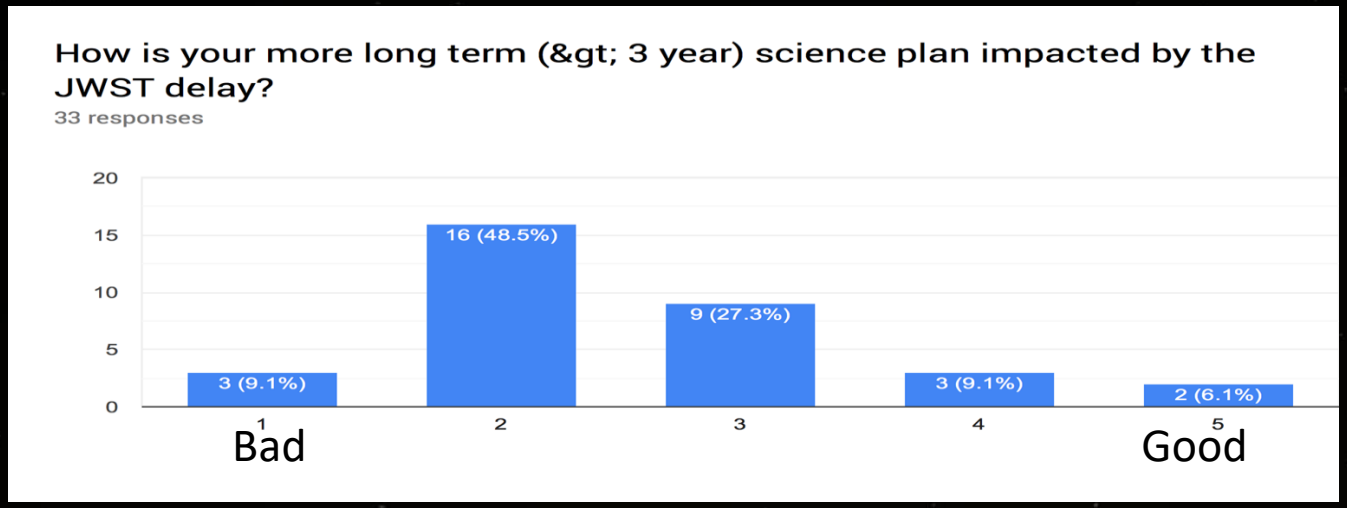
SIG 2 – Exoplanet Demographics

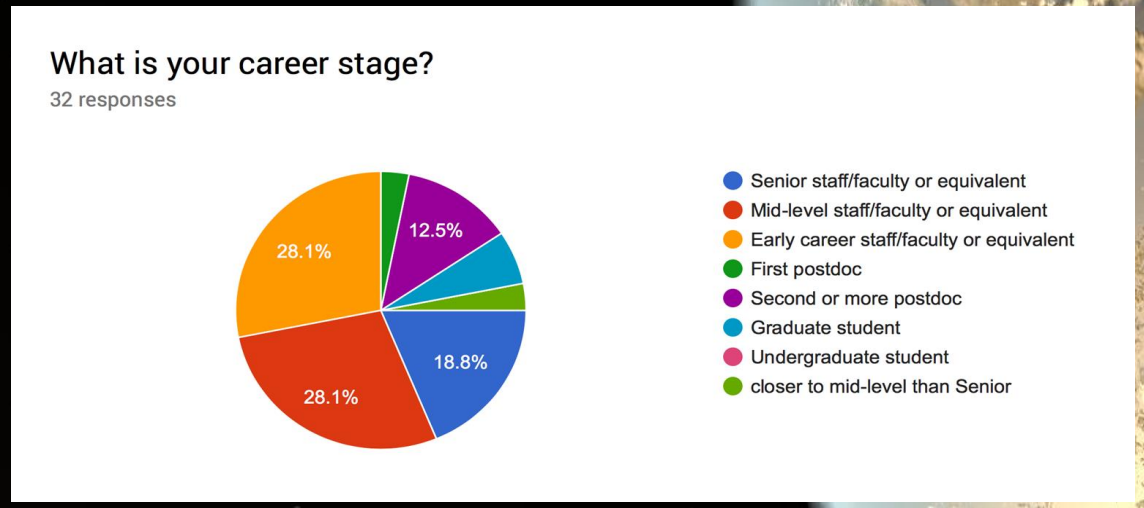
- **Leadership:** Christiansen & Meyer (ExoPAG EC) + 3 community members
- **Motivation:** Exoplanet demographics reveal planet formation, migration and evolution processes, and are key to predicting the yields of future missions.
- **Goal:** To extend the Kepler-centric demographics of SAG13
- **Progress to date:**
  - Monthly telecons discuss new demographic results from multiple techniques (radial velocity, microlensing, transit, direct imaging).
  - Members prepared white paper for Astro2020 call.
  - Drafting report on value of public database of demographic products.
  - Curating a list of open questions/ongoing projects for the community.
  - Proposed mini-symposium for next ExoPAG meeting.

Credit: NA

SAG 20: Strategies for Mitigating the Impact of the JWST Delay on Exoplanet Science

- Leadership: Johanna Teske (ExoPAG EC) and Drake Deming (UMD)
- Survey Results: Adjustments being made by the community to prioritize ground-based observations and theory projects that will ultimately enhance JWST science observations, better target selection, analysis pipelines. Suggestions for mitigation include stepping up confirmation and characterization of TESS planets, community organization for large scale science projects, additional training in data analysis and retrieval, provision of simulated JWST data, and community venues to discuss data analysis techniques.





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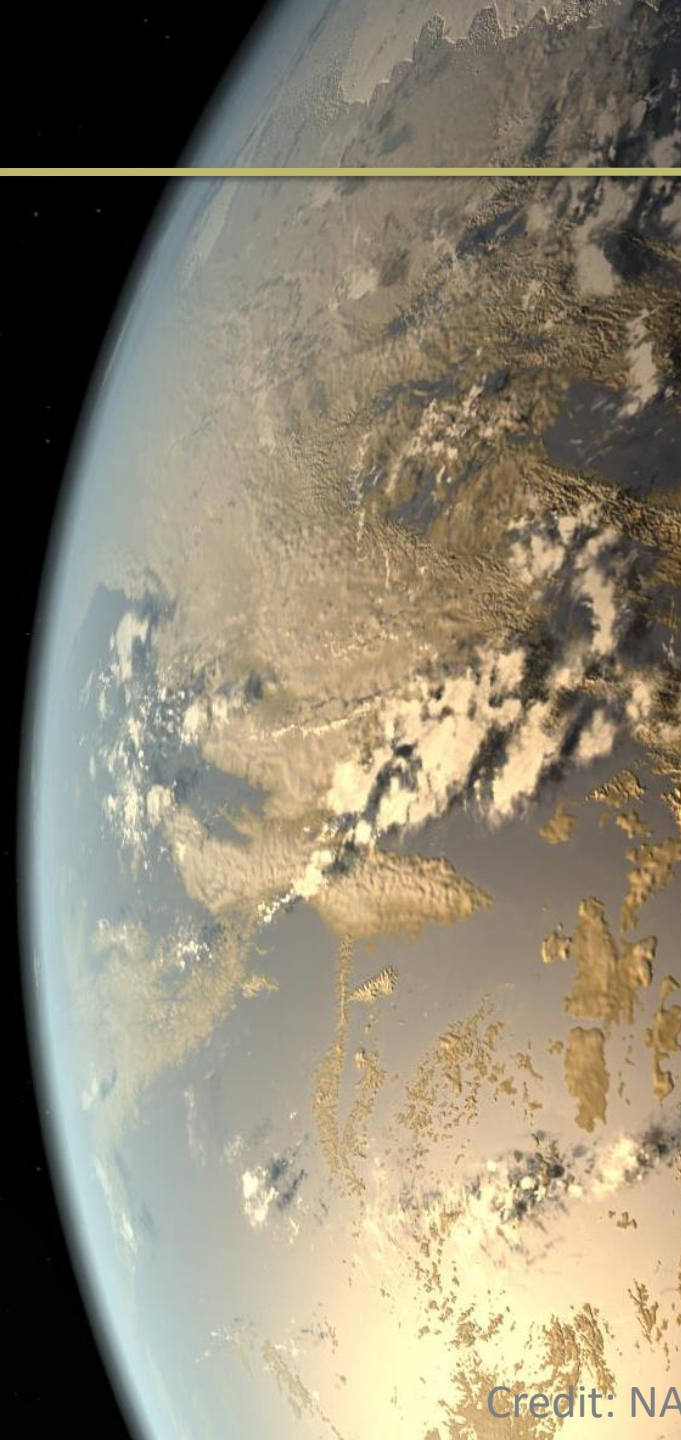
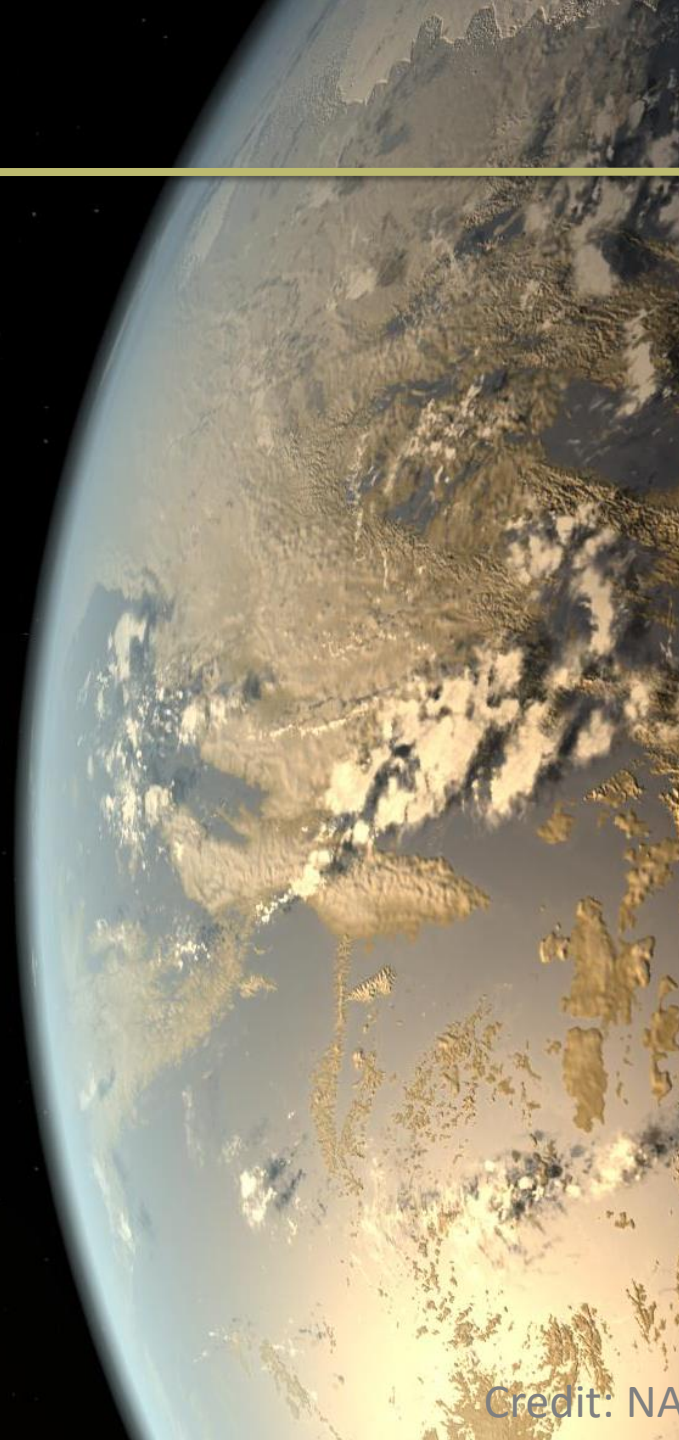
ExoPAG 2019/2020 Future Activities

- Develop new ideas from EC+ExEP Brainstorming.
- Work with ExEP to map the Science Gap List to key areas for ExoPAG inputs. (Start new process to review).
- Develop list of topics for community discussion at ExoPAG21.
  (e.g. discussion of community databases to facilitate NASA activities).
- Continue monthly ExoPAG EC and SIG2 telecons
- Final reports and request closeout SAG-19, SAG-20, & Great Observatories Cross PAG SAG.
- Complete charters and proposals for SIG 3 (Exoplanets & Solar System).
- ExoPAG+VExAG+OPAG on organizing the “Exoplanets in our Backyard” conference in February.
- ExoPAG21 on January 3-4, 2020, prior to AAS in Honolulu, HI.
  - J. Christiansen+SIG 2 to formulate mini-symposium on demographics.
  - Variety of Program & community presentations including students

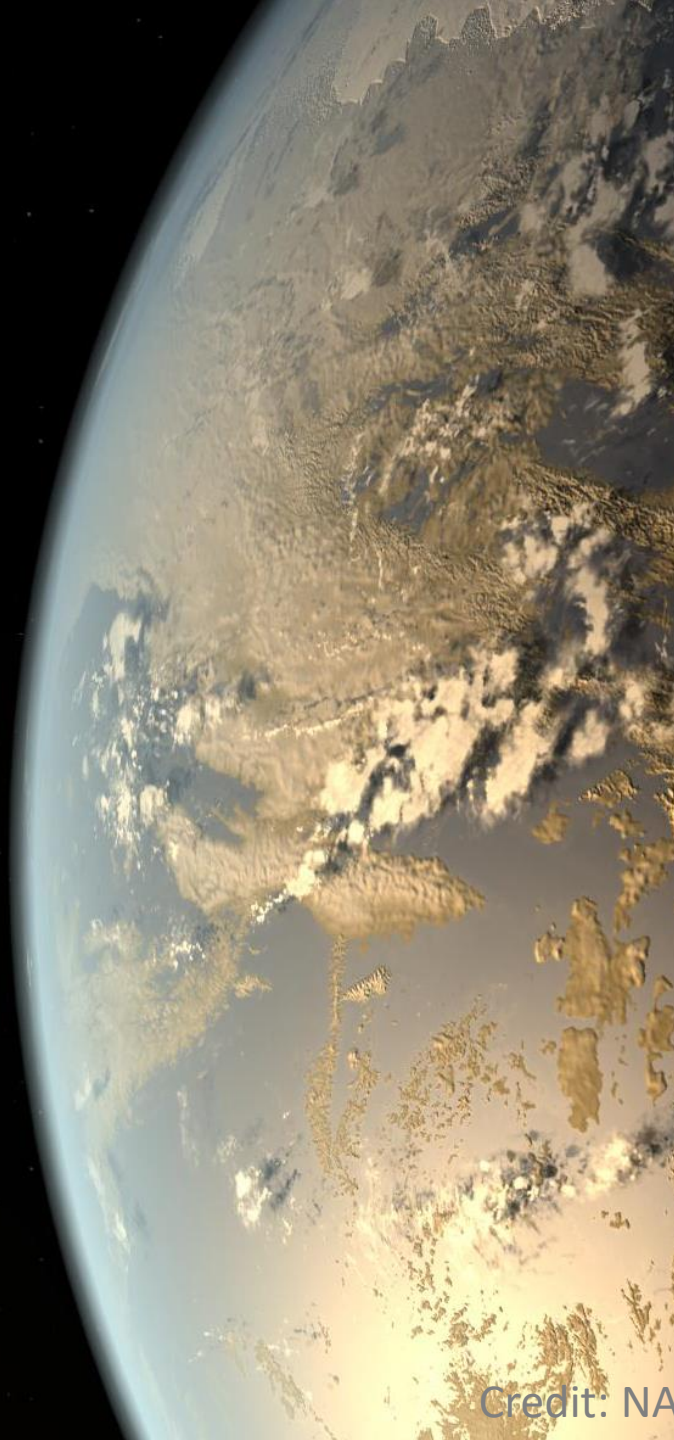


Action Requested by ExoPAG EC

- None at this time.



Backup Slides



ExoPAG 20 Agenda
June 23, 2019 Bellevue, WA
Hyatt Regency Bellevue- Regency Room DEFG

See the ExoPAG website for remote connection info: https://exoplanets.nasa.gov/exep/events/270/exopag-20/
All times are PDT

		Session Chair	**Michael Meyer**
9:00	0:10	Welcome and Introduction to ExoPAG	Vikki Meadows
9:10	0:30	NASA Headquarters Update	Martin Still
9:40	0:15	Report Out On SAG20 (Survey on the Community Impact of the JWST Delay)	Drake Deming (remote)
9:55	0:20	Kepler Occurrence Rates and Eta Earth	Chris Burke
10:15	0:15	SIG2 Exoplanets Demographics Report	Jessie Christiansen
10:30	0:30	**Break**	
		Session Chair	**Jessie Christiansen**
11:00	0:20	ExEP Report on Future of Extreme Precision Radial Velocity	Eric Mamajek
11:20	0:30	Understanding Star-Planet Interactions and Space Weather, from X-ray to Radio	Rachel Osten (Remote)
11:50		**Lunch**	

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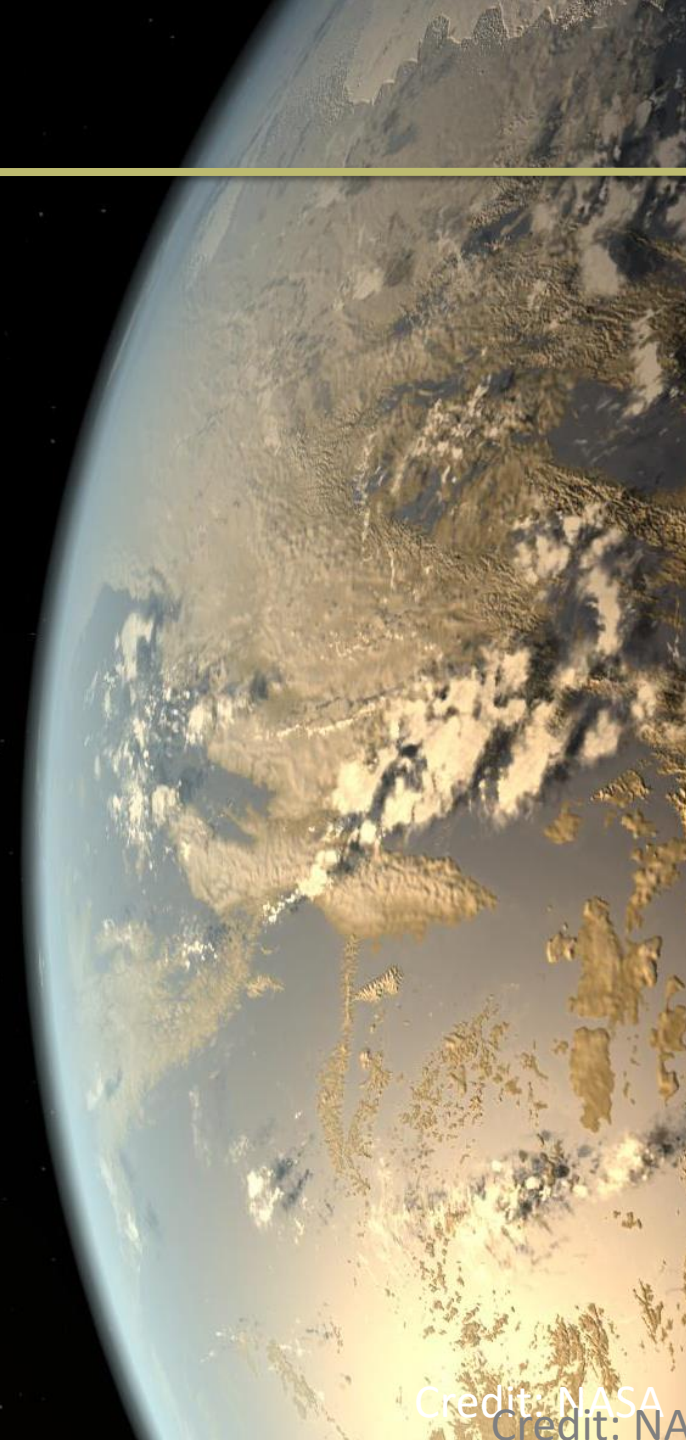
		Session Chair	**Vikki Meadows**
1:00	0:15	Observing Small Planets with JWST, Capabilities and Challenges	Natasha Batalha
1:15	0:15	The Detectability and Characterization of the TRAPPIST-1 Exoplanet Atmospheres with JWST	Jacob Lustig-Yaeger
1:30	1:00	Large Mission Concepts for Future Terrestrial Exoplanet Characterization: Overview and Discussion	Giada Arney, Scott Gaudi, Tiffany Kataria
2:30	0:30	ExEP Technology Report on Coronagraph Testbeds, Starshade, Detectors	Nick Siegler
3:00	0:30	**Break**	
		Session Chair	**Chris Stark**
3:30	0:30	Discussion of Community Needs for Molecular Opacities/Laboratory Astrophysics	Eliza Kempton and Natasha Batalha
4:00	0:40	VExAG/OPAG/ExoPAG Synergies	Vikki Meadows, Stephen Kane, Kathy Mandt
4:40	1:00	Science Gap List Discussion and General Suggestions	Karl Stapelfeldt, Vikki Meadows, Gary Blackwood
5:40		Adjourn	

If you have input on the Science Gap List, or suggestions on new activities or exoplanet community needs for the ExoPAG you can raise them in the 4:40 question session, or write them down in the ExoPAG Suggestions Google Doc, which can be found on the ExoPAG website!

11 Completed Study Analysis Groups (SAGs)

Year	SAG	Title	Lead
2012	1	Debris Disks & Exozodiacal Dust	Roberge
2010	2	Potential for Exoplanet Science Measurements from Solar System Probes	Bennett, Coulter
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.	Bendek
2017	13	Exoplanet Occurrence Rates and Distributions (closed out since last June)	Belikov
2017	15	Exploring Other Worlds: Observational Constraints and Science Questions for Direct Imaging Exoplanet Missions (closed out since June)	Apai
2017	18	Metrics for Direct-Imaging with Starshades (closed out since last June)	Glassman & Turnbull



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?

Recent Progress:

- Computation/crowdsourcing of eta tables
- 11 participants submitted tables so far
- Latest estimates of occurrences of potentially habitable planets seem to be converging (at least to a factor of ~2-3), and explanations for discrepancies are starting to clarify
- Expected product in mid 2017: estimates of occurrence rates

SAG 16: Biosignatures (Shawn DomagalGoldman, 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?

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 onsky datadriven 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.