Mercury Exploration Assessment Group (MExAG)

March 05, 2024

Carolyn Ernst, MExAG Chair

Johns Hopkins Applied Physics Laboratory

MExAG Steering Committee 2023–2024

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Shoshana Weider
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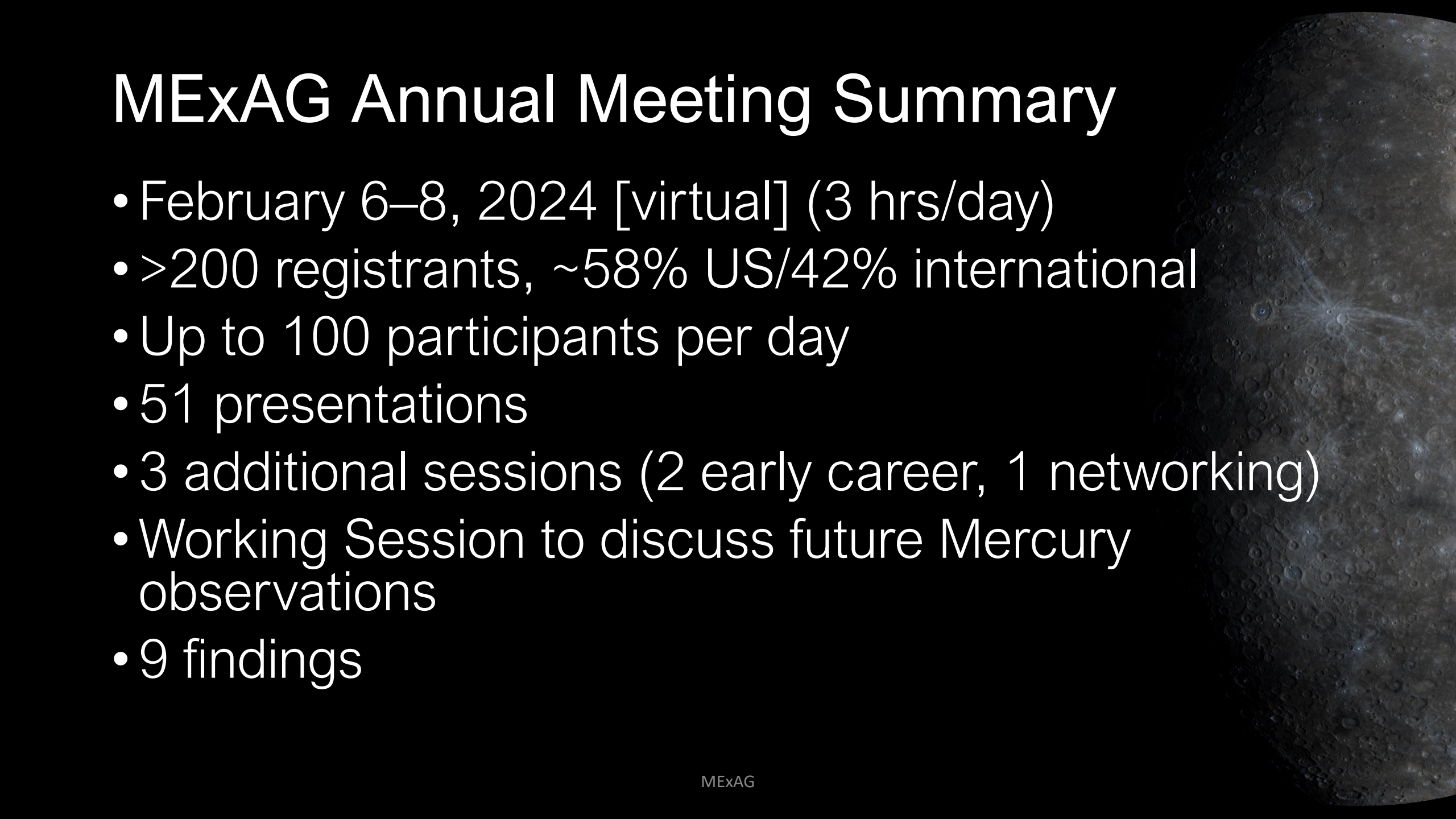
NASA Liaison

★ Term ending in June

MExAG Annual Meeting Summary

- February 6–8, 2024 [virtual] (3 hrs/day)
- >200 registrants, ~58% US/42% international
- Up to 100 participants per day
- 51 presentations
- 3 additional sessions (2 early career, 1 networking)
- Working Session to discuss future Mercury observations
- 9 findings



Mercury's Moment

- NASA has made significant investments in building Mercury expertise through the MESSENGER mission and analysis of the data it collected. The U.S. currently has a vibrant and engaged Mercury community.

- The U.S. Mercury community is excited for BepiColombo's arrival at Mercury and is eager to continue collaborations with our international colleagues.

- There is a high level of support for Mercury science in the OWL.
  - 8 of 12 Priority Question chapters feature Mercury (and it had a cameo in 2 more)
  - 7 of the sub-questions focus on Mercury
  - 20 Strategic Research topics focus on Mercury
  - More than two dozen mentions of the need for samples and in situ measurements of Mercury
  - A flagship-level Mercury Lander mission was judged to have exceptional scientific merit, based on its ability to address priority science questions

- Mercury missions are few and far between.
  - Four decades elapsed between Mariner 10 and MESSENGER.
  - There are no post-Bepi Mercury missions in the foreseeable future.
  - Cruise times are long (comparable to going to the outer solar system).

- How can we maintain a healthy and engaged U.S. Mercury community beyond the timeframe of BepiColombo's orbital mission?

Mercury Community Findings (1)

MExAG urges NASA to follow the prioritized budgetary decision rules recommended in the 2023 Origins, Worlds, and Life (OWL) Decadal Survey for programmatic reductions during times of constrained budgets. In particular, MExAG supports protecting a healthy Discovery Program via:

- Ensuring each competitively selected mission can proceed through the development process on its own merits;
- Protecting the cadence of new Discovery missions in the 2023–2032 decade.

Discovery missions are the only avenue for NASA-led Mercury exploration in the next decade and any delays or reductions in the Discovery AO cadence will disproportionately impact opportunities for exploration of the innermost planet and the health of the Mercury community.

Mercury Community Findings (2)

MExAG encourages NASA to consider ways to maintain a healthy and engaged Mercury research community beyond the timeframe of BepiColombo's orbital mission. MExAG suggests the following as potential options (many of which would benefit the entire planetary science community):

- MExAG encourages NASA to initiate a directed study of a candidate Mercury Lander flagship mission concept. The OWL judged that a flagship-level Mercury Lander has exceptional scientific merit. Yet, there has never been a flagship-level mission concept or science definition team study of a Mercury Lander.
- MExAG encourages NASA to enhance existing funding mechanisms, or create new mechanisms, aimed directly at developing mission concepts and related technologies.
- MExAG encourages NASA to support workshops that foster collaborations among technologists, engineers, and planetary scientists.

See full finding text in Backup.

BepiColombo Findings (1)

MExAG encourages NASA to work with the Mercury community to generate and share Mercury-related public outreach content for release prior to, and during, the time of BepiColombo orbital insertion (December 2025). MExAG is ready to help facilitate sharing the excitement of Mercury science and exploration to the general public.

BepiColombo Findings (2)

MExAG encourages NASA to consider Mercury-focused proposals in Planetary programs such as DDAP, SSW, SSO, and EW, as well as in Heliophysics (e.g., HRS) and cross-division programs (e.g., XRP), as having high-strategic priority in the lead-up to, and during, the BepiColombo orbital mission. Such prioritization would continue to leverage NASA's significant investments in building Mercury expertise through the MESSENGER mission and analysis of the data it collected as well as support the U.S.-based Mercury community to prepare for, and leverage, BepiColombo's measurements. Given the limited number of NASA-funded Interdisciplinary Scientist (IDS)/Guest Investigators (GIs) on the BepiColombo mission, ROSES program elements remain the main pathway for Mercury science funding from NASA.

BepiColombo Findings (3)

MExAG encourages NASA to protect the funding set aside for future selections of the BepiColombo Guest Investigators Program. Due to the current challenging planetary science/NASA funding climate and limited opportunities to develop near-term missions to Mercury, engaging with an active Mercury mission is critical to the U.S.-based Mercury community, and provides an important avenue to build and maintain international partnerships in planetary science. Given that the BepiColombo nominal orbital mission is slated to begin in December 2025, support for the Guest Investigator Program is time-sensitive and should not be postponed.

Earth-based Observation Findings (1)

MExAG encourages NASA to continue working with key ground-based facilities to address procedural/logistical obstacles that create serious challenges for proposals to make Earth-based observations of Mercury. Ground-based observations are the only means by which we can directly observe Mercury between missions, provide important supporting observations to missions, and lead to discoveries that can inform future missions. It is vital to a healthy Mercury community that proposals to observe Mercury are not at a disadvantage due to logistical hurdles.

Earth-based Observation Findings (2)

MExAG strongly encourages NASA to consider Mercury science in the development of future ground-based planetary radar facilities. As noted in the Planetary Decadal Survey and the Cross-Disciplinary Deep-Space Radar Needs Study, such facilities are a critical element in the observations that lead to pre-cursor science for future Mercury missions. MExAG encourages NASA to work with other stakeholders (NSF, DoD, international partners) to start laying out a plan for the next-generation planetary radar, identifying all the domestic and international partners and responsibilities, and considering broader participation from the entire planetary community to provide input regarding science needs.

New Frontiers Findings (1)

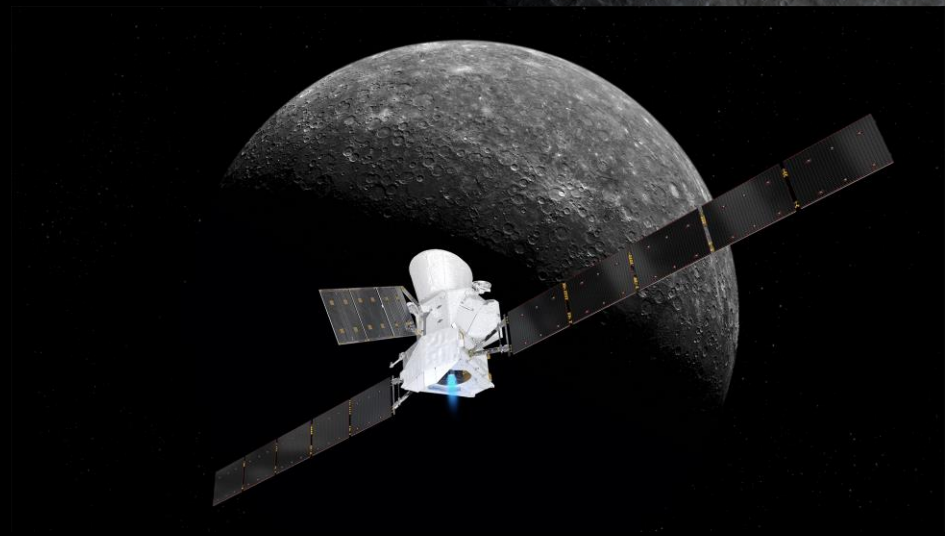
MExAG supports NASA's initiative to task the Committee on Astrobiology and Planetary Sciences (CAPS) with reviewing the mission themes for the upcoming New Frontiers (NF) 5 and 6 calls. Advancements in both science and technology have occurred in the years since the 2011 Vision and Voyages Decadal Survey. Given the rarity of opportunities for New Frontiers missions, it is critical to ensure the mission themes are aligned with the latest planetary science priorities.

New Frontiers Findings (2)

MExAG urges NASA to implement a transparent mechanism for a mid-decade re-evaluation of the NF mission themes for NF7 (and, if the opportunity has not yet been announced, NF6). Additionally, MExAG encourages NASA to consider allowing proposals for New Frontiers missions that address aspects of the flagship mission concepts recommended by the 2023 Origins, Worlds, and Life Decadal Survey. This approach could enable the accomplishment of flagship-level scientific objectives under a New Frontiers-level budget, analogous to how a Discovery mission concept may be proposed to address portions of New Frontiers-level scientific goals (e.g., Lucy, Io Volcano Observer).

Upcoming Mercury Events

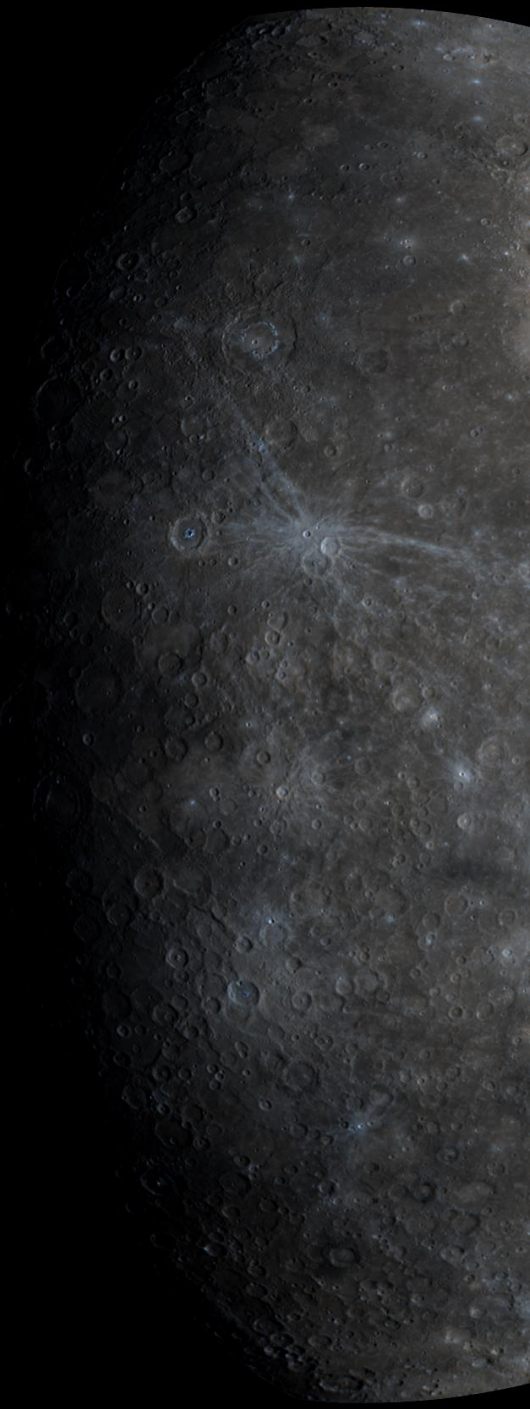
- LPSC 2024, March 11–15, 2024 (MExAG meetup Tuesday)
- Mercury 2024, June 4–7, 2024 in Kyoto, Japan
- BepiColombo:
  - **Mercury Flyby 4, September 5, 2024**



MExAG: https://www.lpi.usra.edu/mexag

Twitter: @ExploreMercury

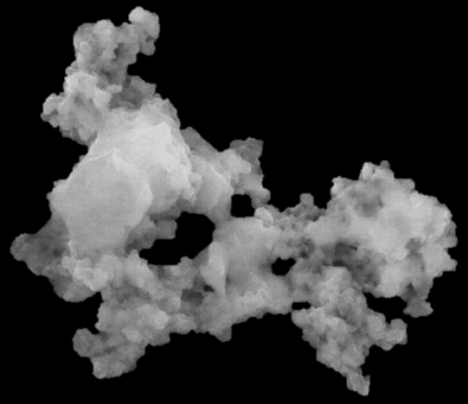
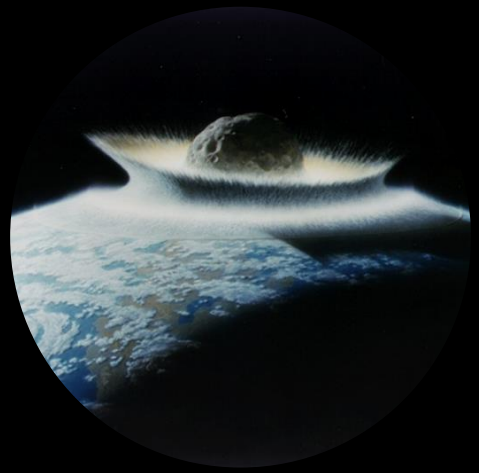
Additional MExAG Materials



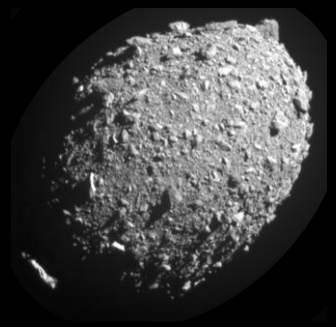
Mercury Community Findings (2 – full text)

MExAG encourages NASA to consider ways to maintain a healthy and engaged Mercury research community beyond the timeframe of BepiColombo's orbital mission. MExAG suggests the following as potential options (many of which would benefit the entire planetary science community):

- MExAG encourages NASA to initiate a directed study of a candidate Mercury Lander flagship mission concept. This study would help to ensure a well-developed Mercury flagship mission concept is ready for the next Decadal Survey. The 2023 Decadal Survey documents that a flagship-level Mercury Lander has exceptional scientific merit based on its ability to address priority science questions. Yet, there has never been a flagship-level mission concept study or science definition team study of a Mercury Lander.
- MExAG encourages NASA to enhance existing funding mechanisms, or create new mechanisms, aimed directly at developing mission concepts and related technologies. Targeted calls for Mercury-specific efforts could help to maintain a strong Mercury research community during the long intervals between Decadal Surveys, and the increasingly long intervals between New Frontiers and Discovery AOs.
- MExAG encourages NASA to support workshops that foster collaborations among technologists, engineers, and planetary scientists. Such collaborations could help to advance mission concept studies and identify key technology gaps.



Lori Feaga, SBAG Steering Committee Chair
Department of Astronomy, University of Maryland, College Park

March 5, 2024

NASA Planetary Science Advisory Committee (PAC)

www.lpi.usra.edu/sbag/

Government funding acknowledged

Summary of recent SBAG activities for the PAC

- International Steering Committee member solicited and selected from applicants
  - Announcement made during January community meeting
  - Motoo Ito (Japan, with Hayabusa, Hayabusa 2, MMX, and Destiny+ experience)

- Revising the SBAG Goals Document (last revision was 2020)

- Held our community meeting (SBAG #30) January 30 – February 1, 2024 in hybrid format at the Drake Building at the Univ of Arizona
  - 84 in-person attendees over 3 days, with additional 90-100 online per session
  - Large early career (EC) turnout
    - 2 EC invited talks, 10 EC lightning talks, 8 EC travel stipends
  - 10 findings (3 immediate priority concerns raised here, 4 others with potential inter-disciplinary relevance, and 3 more specific to the SBAG community)

Finding #1 – DSN Criticality, Maintenance, and Upgrades

SBAG urges NASA to take immediate action to ensure the long-term maintenance and expanded future capacity of the Deep Space Network.

NASA's Deep Space Network (DSN) provides critical communications support for an increasing number of spacecraft beyond near-Earth orbit for science and exploration. As spacecraft instrument technology advances and human spaceflight to the Moon resumes, the requests for usage of this aging infrastructure and the requested uplink and downlink data volumes will grow. Yet, DSN capacity is not currently planned to increase in concert. While the Lunar Exploration Ground Sites (LEGS) facilities are expected to reduce the load on DSN from Artemis, DSN capacity is still anticipated to be insufficient compared to future demands. Additionally, deferred system maintenance for existing DSN assets poses a risk to the network's current capacity. The long-term health and capability of the DSN are critical to current and future planetary science, including small body science, and SBAG supports expanding the capabilities of this national resource as soon as possible.

Finding #2 – Capitalize on Apophis's Earth Flyby Opportunities

SBAG advocates that NASA prioritize efforts to observe and characterize asteroid 99942 Apophis (2004 MN4) before, during, and after its April 13, 2029 close approach with the Earth, including leveraging domestic partnerships and international collaborations, along with ground-based observational campaigns, to collect pre-, during, and post-Earth encounter data to the greatest extent possible.

Apophis' close Earth flyby provides a once-in-a-7,500 year naturally occurring opportunity to investigate, quantify, and understand the consequences of planetary tides on the evolution of asteroids and glean important information about Apophis' interior structure, which is otherwise impossible to obtain. The opportunity to observe Apophis prior to this historic event is important to complement the data that will be collected by OSIRIS-APEX after Apophis' close approach to Earth, thus substantially improving our understanding of asteroid dynamics and structure. Addressing these knowledge gaps is crucial for defending the Earth from a future impactor.

Finding #3 – Launch Opportunities for Janus

SBAG urges NASA to find a launch opportunity to scientifically compelling targets for the Janus mission.

NASA SMD is now in the custody of the capable Janus spacecraft pair, and it is in NASA's hands to decide how the spacecraft, originally designed to fly by near-Earth binary asteroid systems, should be used. Janus represents an important and exciting scientific resource for our community. In addition to promising science return, Janus will demonstrate the capabilities of low-cost spacecraft for small body exploration. We urge NASA to explore all avenues for possible launch opportunities, taking advantage of already designed and built spacecraft. More broadly, we reiterate the request for NASA to communicate the criteria required for missions in storage to be returned to an active flight program status.

Findings of potential cross-AG interest

#7. SBAG urges NASA and other agencies to continue working together on a plan for new and upgraded radar facilities for planetary science to replace the loss of Arecibo considering the capability gaps and facility needs identified in the Interagency Deep Space Radar Study Report.

#8. SBAG requests that NASA promptly conveys the New Frontiers and Discovery program opportunities, including their relative prioritization, as decisions are made.

#9. SBAG strongly advocates for NASA to continue and expand its programs for training the next-generation planetary science workforce.

#10. SBAG encourages NASA to continue and expand its support for open science by enhancing infrastructure, providing clear guidance on data and software archiving, and engaging the community through training and feedback opportunities.

Other SBAG updates

- Our full list of SBAG #30 Findings can be found at: https://www.lpi.usra.edu/sbag/findings/

- The Technology Lead and 2 at large members are rotating off the Steering Committee in August. Steering Committee member applicants will be solicited over the coming months through various channels. Selections will be announced at SBAG #31 (Summer 2024).

Summary

- SBAG appreciates the support from the PAC and NASA on the various findings and initiatives we bring forth as a voice of the small bodies community.
- SBAG is behind the Decadal Report 100% and will continue echoing the scientific priorities and needs of the community in accordance with OWL.
- SBAG supports the efforts of cross-AG IDEA and Ocean Worlds Working Groups.
- Finding #1 – SBAG urges NASA to take immediate action to ensure the long-term maintenance and expanded future capacity of the Deep Space Network.
- Finding #2 – SBAG advocates that NASA prioritize efforts to observe and characterize asteroid 99942 Apophis (2004 MN4) before, during, and after its April 13, 2029 close approach with the Earth.
- Finding #3 – SBAG urges NASA to find a launch opportunity to scientifically compelling targets for the Janus mission.

Supporting slides

The Steering Committee

Justin Atchison (JHU/APL), Technology Lead
Olivier Barnouin (JHU/APL)
Dani DellaGiustina (Univ of AZ)
Lori Feaga (Univ of MD), Chair
Henry Hsieh (PSI)
Motoo Ito (JAMSTEC), International Rep
Prajkta Mane (LPI)
Joe Masiero (IPAC/Caltech), Planetary Defense Lead
Dan Mazanek (NASA LARC), Human Exploration Lead
Darryl Seligman (Cornell Univ), Early Career Secretary
Timothy Titus (USGS, Flagstaff)
Flaviane Venditti (Univ of Central FL)
Anne Verbiscer (Univ of VA)

Thomas Statler NASA Headquarters Liaison

Steering Committee selects the Chair and Steering Committee members from among nominations & applications. Requests go out to national and international newsletters and the SBAG listserv. General membership is open to anyone.
Next call for Steering Committee Members will be in late spring 2024.

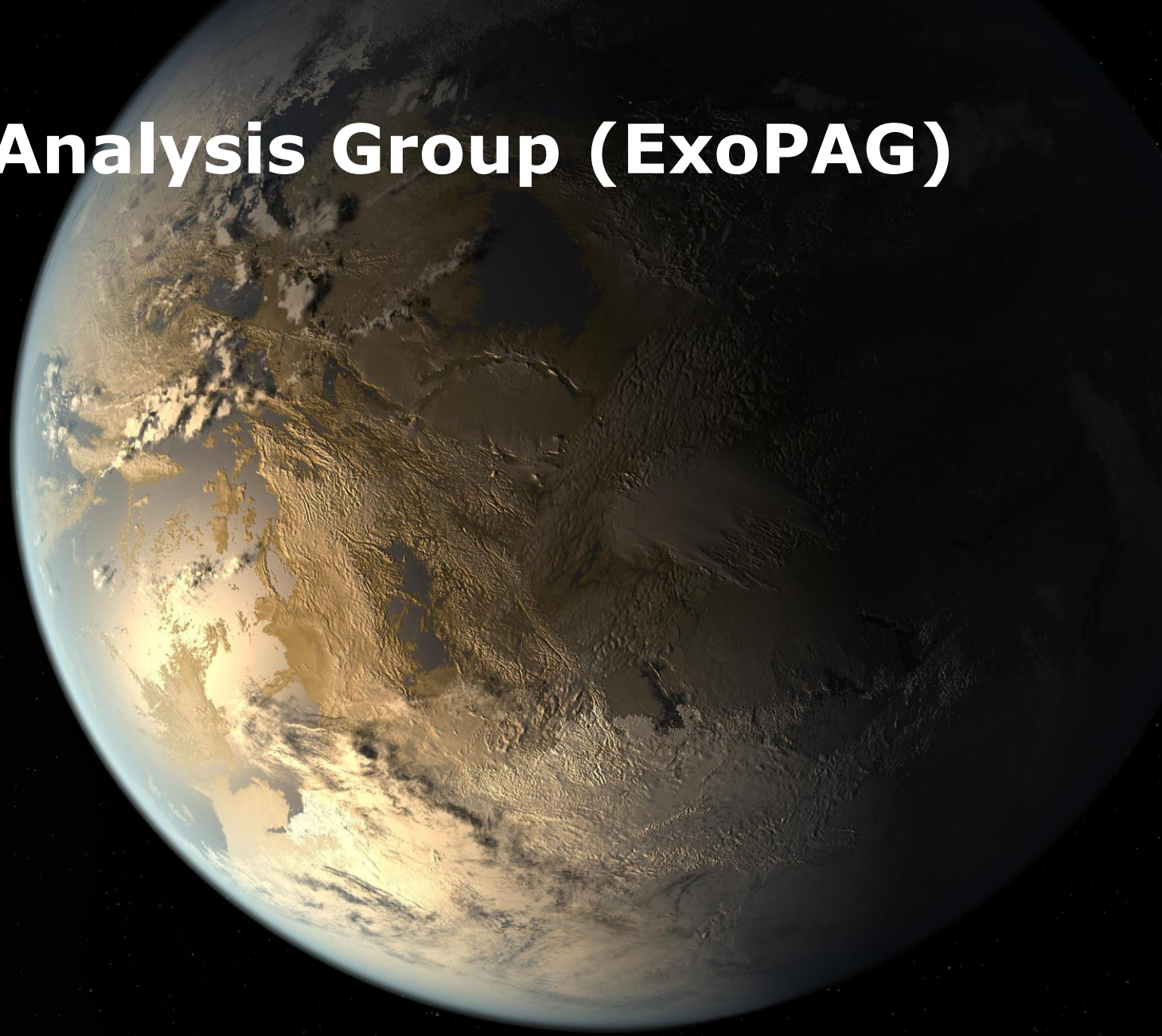
SBAG 28: Findings 4-6

#4. SBAG encourages NASA to prepare for and support international collaborations, especially through Participating Scientist Programs, with other ongoing and future international small body and planetary defense missions.

#5. SBAG encourages NASA to develop an opportunity within the mission program structure or planetary R&A programs to support precursor science investigations to further the understanding of critical topics in small body exploration in advance of the arrival of several small body missions at their targets.

#6. SBAG encourages NASA to release a SIMPLEx lessons learned document to the community.

Exoplanet Program Analysis Group (ExoPAG) Report to PAC



Natalie Hinkel (LSU)
Representative for the ExoPAG
Executive Committee

March 2024

Credit: NASA

ExoPAG: Roles and Responsibilities

- Articulate & prioritize science drivers for NASA's Exoplanet Exploration Program (ExEP) – the program within NASA's Astrophysics Division that's responsible for setting priorities, designing strategies/tactics to achieve program goals
- Evaluate capabilities of potential missions to achieve goals
- Evaluate the ExEP activities with broad community input
- Articulate and 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
- Host meetings (ExoPAG##) twice a year to bring the community together

Credit: NASA

ExoPAG 28

- ExoPAG28 was held in advance of DPS (Oct 2023, Texas).
- Programmatic updates from NASA HQ, ExEP (science & technology), NASA Exoplanet Archive, SIG/SAG updates, etc.
- Then focus talks on timely issues that are relevant to to the attendees.

https://exoplanets.nasa.gov/exep/events/461/exopag-28/

October 1, 2023

Session 1 (Chair: Natalie Hinkel and Diana Dragomir)	Speaker
Welcome + overview of SIGs and SAGs	Ilaria Pascucci
Planetary Science and Astrobiology Decadal Survey	Robin Canup and Phil Christensen (Co-Chairs-Remote)
Exoplanet Program Office + Science	Karl Stapelfeldt
The ExoExplorers Program	Tiffany Kataria (remote)
What do exoplanet atmospheres tell us about planet diversity?	Sarah Moran
BREAK (20 min)	
NASA Headquarters Exoplanet Exploration Program	Josh Pepper, Megan Ansdell
What do we know about Venus as an exoplanet analog?	Giada Arney (remote)
What do we know about Titan as an exoplanet analog?	Jason Barnes
What do we know about Uranus as an exoplanet analog?	Leigh Fletcher
LUNCH BREAK (90 min)	

Session 2 (Chair: Ian Crossfield)	Speaker
Planet formation and migration in the Solar System, as constrained by the small body record	Will Grundy (remote)
Planet formation and migration processes constrained by exoplanet observations	Andre Izidoro
What can stellar compositions tell us about exoplanet compositions?	Romy Martinez
Geochemical evolution of terrestrial planets and biosignatures (HabWorlds)	Josh Krissansen-Totton (remote)
Star-planet interactions: Atmospheric escape in the Solar System and applicability to exoplanets (lessons from the Maven mission)	Michael Chaffin
Earth as an exoplanet: Relevant for detection of ExoEarth Candidates (HabWorlds)	Eddie Schwieterman

ExoPAG 28

- Because ExoPAG28 was before DPS, we had many excellent invited talks from the planetary science community.
- Interest from the exoplanet community and from the executive committee in having one of the semi-annual ExoPAG meetings in connection with a large planetary science/interdisciplinary meeting (e.g., DPS, AbSciCon…)
- Integrate the ExoPAG meeting within the conference program (as opposed to a standalone meeting like the DPS and more often at AAS meetings)
- Advertise meetings earlier, more broadly, and to a diverse community
- Targeted funding for cross-disciplinary exoplanet science

https://exoplanets.nasa.gov/exep/events/461/exopag-28/

SIG3 "Exoplanets Solar System Synergies"

Chairs: Vikki Meadows & Kathy Mandt

- Gathering community input on key ExoSS synergies: https://tinyurl.com/yxbnyfwu. They are focusing on key impediments to cross-disciplinary collaborations and potential solutions, scientific areas of high priority for synergistic study, what SS scientists need from the exoplanet community and vice versa.

- ExoSS Slack Channel – news updates, paper-sharing, collaborations, all are welcome! 170 members (If you would like to join: meadows@uw.edu)

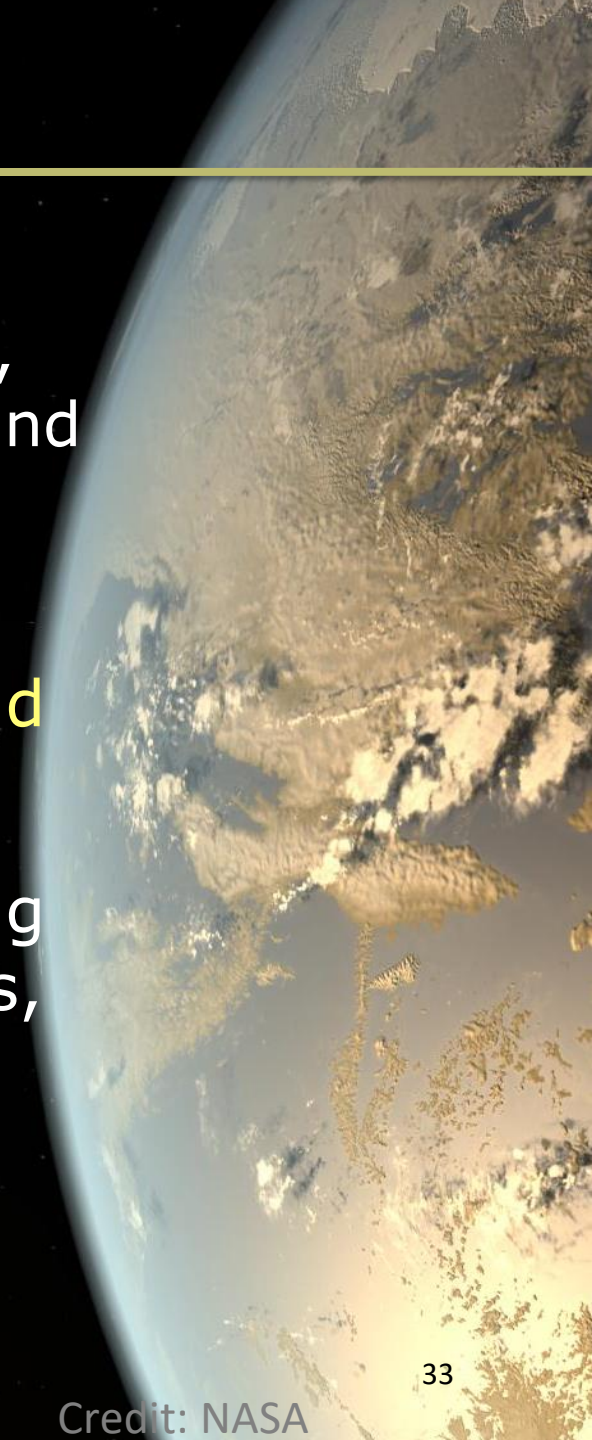
- Run monthly SIG3 Tutorials that explain key concepts within the different communities. Talks have been recorded and are available here: http://nexss.info/community/exoss-synergy

- Helped coordinate speakers for the ExoPAG28

- Upcoming: Develop a community review paper that will find overlaps and synergies, and link the science initiatives of Astro2020 and Origins, Worlds and Life 2023

ExoPAG: Overlap with the PAC

- Exoplanet research is inherently an interdisciplinary field that requires input and knowledge from planetary science, cosmochemistry, geology, Earth science, (astro)biology, and much more!
- It is the goal of the ExoPAG to strengthen the connections/collaborations between the astrophysics and planetary science communities in exoplanet science.
- Currently working on improving opportunities for inviting planetary science speakers (early career, mission teams, etc), creating opportunities for OPAG and VEXAG, dive into more theory that connects planetary science and exoplanets, explore ExEP science gaps on SS bodies,



Credit: NASA

ExoPAG30

ExoPAG30 will be before AbSciCon (May 5th 2024, Rhode Island) -- may include talks from OPAG, two cross-AG working groups, and "brain dates".

BREAK (20 min)		10:40 AM
The search for Life in the Solar System	Lori Glaze (Director Planetary Science Division)	11:00 AM
VEXAG: the potential for past habitability on Venus and science gaps	Noam Izenberg (Chair, Applied Physics Laboratory) or Debra Buczkowski (Deputy Chair, APL)	11:30 AM
MEPAG Mars Exploration Analysis group: searching for life on Mars - science gaps	Yingst (Chair, PSI)	11:50 AM
Brain dates 1 [**Pre-Event Planning**: Prior to the event, participants are invited to list topics they are knowledgeable about and topics they wish to learn more about on a dedicated platform or app associated with the event **OR the EC comes up with a list of topics**]	Focus on open science Qs not proposals (small groups with half astro and half planetary). Put together a list of themes	12:10 PM
LUNCH BREAK (90 min)		12:30 PM
ir: TBD)	**Speaker**	**Time (CDT)**
NExSS overview and WGs focusing on the search for life beyond Earth	Ofer Cohen or other Leads	2:00 PM
Cross AG IDEA working group	Maggie McAdam (NASA Ames) & Parvathy Prem (APL)	2:20 PM
OPAG goals in relation to habitability in the outer Solar System	Amanda Hendrix (Chair, PSI)	2:40 PM
Cross-AG Ocean Worlds Working Group (OWWG)	Cynthia Phillips or Michael Bland	3:00 PM

redit: NASA

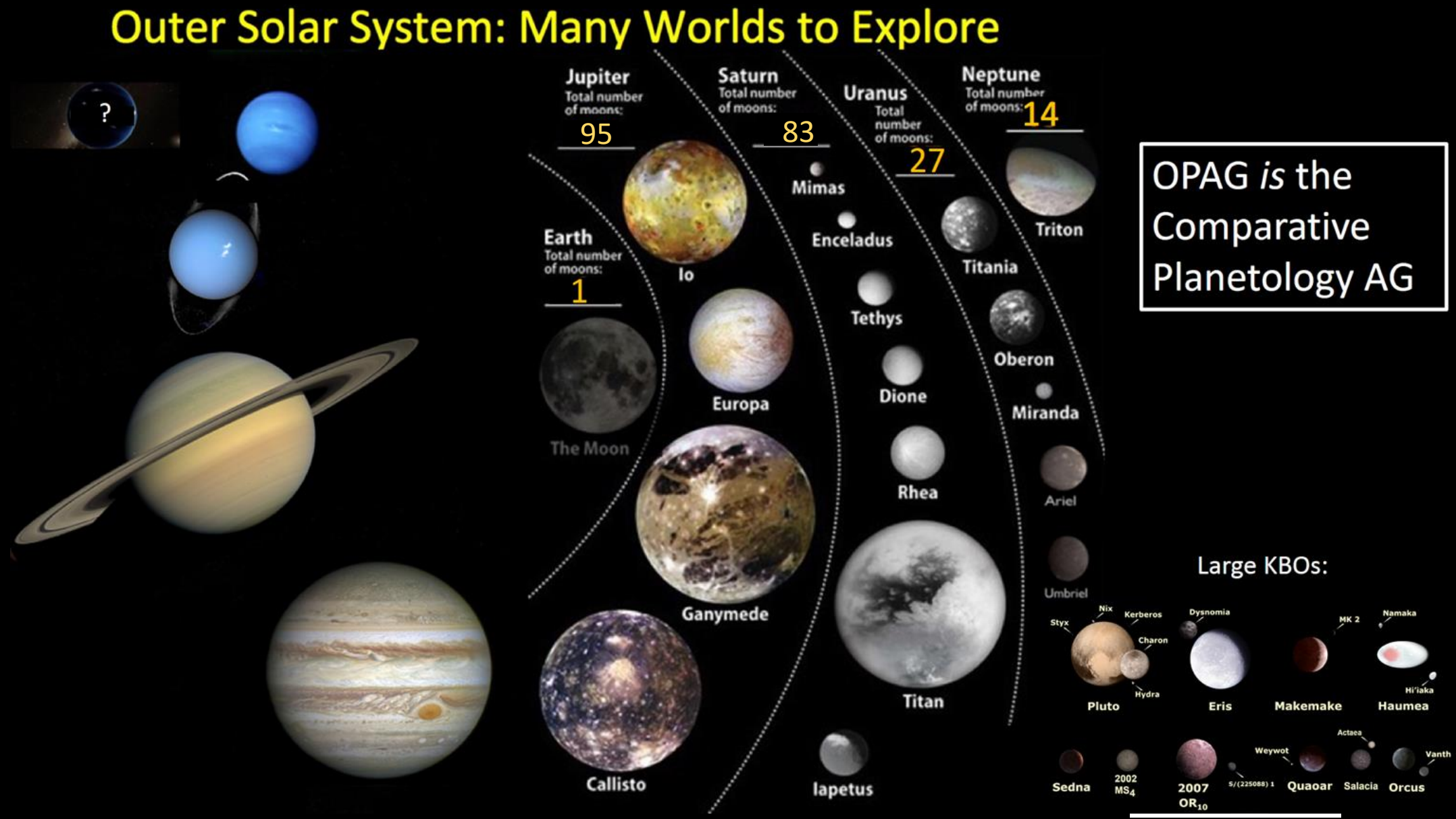
PS Decadal Survey

- As one of the PAC AGs, the ExoPAG wanted to express support for the PS Decadal Survey science priorties and the top line science budget.
- Feedback from multiple stakeholders inside and outside of NASA is that they do not see the PSD science community uniting behind our Decadal Survey priorities (e.g., as compared to the Astrophysics community) and thus, the top line science budget
- While we understand that there might be concern for the overall budget, we believe its important to back the planetary science indicated as the most crucial, influential, and timely in the Decadal Survey.

Credit: NASA

OPAG Update to the Planetary Science Advisory Committee (PAC)

Amanda Hendrix, OPAG Chair, PAC Meeting, 05 March 2024



OPAG *is* the Comparative Planetology AG

Findings from November 2023 OPAG community meeting (1)

1. PSD budget advocacy.

Research and Analysis (R&A) funding is critical for maintaining a vibrant early career community, and is particularly important to the entire community during this challenging budgetary environment. Furthermore, a balanced Planetary Science Directorate (PSD) portfolio is a significant priority.

Finding. OPAG thanks Dr. Glaze for her commitment to prioritize the funding of R&A at no less than 10% of the PSD budget. The OPAG community stands behind Dr. Glaze's efforts to maintain a balanced PSD portfolio, and strongly supports Dr. Glaze's dedication to maintaining a balanced program and budget, with Mars Sample Return not exceeding more than 35% of the PSD budget in any given year, per the *Origins, Worlds, and Life* (OWL) Decadal Survey's recommendation.

2. UOP Core Science Team.

The Uranus Orbiter and Probe (UOP) mission should get started in earnest, in line with OWL prioritization as the highest-ranked next flagship for this decadal period. While science goals for a UOP mission have been laid out in several mission studies and OWL, the prioritization of these goals needs to be accomplished in order to move forward with decisions on instrument payloads and mission timing. In particular, because some of these goals may impose requirements on arrival timing, studies (e.g., on trajectories, launch windows and Uranus arrival) need to be performed in the near-term in parallel with science goal prioritization to assess feasibility.

Finding. OPAG supports establishment of a funded UOP core science team to be selected and begin work as soon as possible. The core science team should be selected from scientists from a diverse suite of institutions and from a range of career levels, with the function to outline prioritized science goals for the UOP mission. OPAG fully supports a transparent process and clear understanding of the roles of the core science team as well as how the core science team would be selected and what their potential roles will be in the long-term during instrument selections, and mission development/operation.

Findings from November 2023 OPAG community meeting (2)

Finding 3. New Frontiers.

Considering the most recent delay, the final New Frontiers 5 (NF5) Announcement of Opportunity (AO) is slated for No Earlier Than (NET) 2026, placing final selection (end of Step 2) NET 2028. OPAG shares the HQ concerns that NF5 currently reflects the priorities of the *Visions and Voyages* (V&V) Decadal Survey even though the NET time for selection occurs halfway through the purview of the current OWL Decadal Survey. **OPAG endorses the current HQ plan to ask the Committee on Astrobiology and Planetary Science (CAPS) to augment the NF5 mission list with OWL-recommended mission concepts from the NF6 lists as soon as possible, and strongly encourages that NF7 targets also be considered.** For instance, Triton was not included on the OWL NF6 list solely because the assumed NF6 launch window did not align with a Jupiter Gravity Assist; the delays, advances, and developments since then have potentially invalidated this constraint.

The NF5 delay has been very challenging on the OPAG community, and it should be noted that NF is the primary—and potentially only—funding path for competed outer planets missions.

It is also important to highlight that, according to OWL, the recommended NF6/7 mission concepts will necessitate an increased cost cap. Furthermore, the most recent NF5 community announcement stated a potential cost cap that represented a significant reduction (inflation-adjusted) as compared to NF4, and that makes it difficult to propose a mission to ***almost*** any of the targets on the current list. Launch window opportunities for outer planets targets additionally need strong consideration given the shift in timelines.

In addition, relaying critical AO parameters, such as target list, radioisotope power systems (RPS) availability, cost cap, international (e.g., ESA) contribution policies, launch vehicle options with performance curves and costs, and launch readiness date (LRD) range, to the community as early as possible is extremely important to proposal teams.

Finding. The NF5 AO should include considerations for 1) an upward-adjusted cost cap and 2) inclusion of outer planets targets from the New Frontiers 6 and 7 target lists from the OWL Decadal Survey. The NF5 opportunity has been delayed enough that targets on the NF7 list may have launch opportunities not previously considered. OPAG strongly encourages NASA to release likely AO parameters through community announcements as soon as possible, even if that means that AO parameters would be released gradually or in stages. OPAG also encourages NASA to release the draft and final AOs as soon as possible so that the release does not get pushed far into 2026 or beyond, given the importance of NF to the outer planets workforce.

Findings from November 2023 OPAG community meeting (3)

Finding 4. Research Coordination Networks.

Research Coordination Networks (RCNs) are a mechanism for community collaboration designed to accelerate astrobiology research by facilitating communication, coordination, and synergy among NASA-funded research teams. In order for these efforts to be effective, financial support for both leadership and its members is essential.

Finding. OPAG encourages NASA to provide stand-alone, sustained, and flexible financial support to RCN co-leads, alongside administrative assistance as recommended by the Planetary Science Advisory Committee (PAC) in their November 2023 meeting. We further recommend explicit guidance be given in ROSES calls that funding can be included for RCN participation as part of proposal budgets.

Statements of Support & Concern from November 2023 OPAG community meeting (1)

- **Strong support for Europa Clipper.** OPAG continues to strongly endorse Europa Clipper and commends the team - and NASA HQ support - on tremendous progress as it moves to launch in October 2024. There is concern within the OPAG community that overages in the Phase E operations budget might adversely affect the science budget during cruise. It is important that investigation teams are supported sufficiently during cruise to prepare for science operations and analysis during tour; pre-launch science investigation development has been inadequately supported, making support during cruise crucial to ensure optimum science once tour begins.
- **Strong support for Dragonfly.** OPAG was pleased to hear from Dr. Glaze and Dr. Turtle that Dragonfly passed their Preliminary Design Review (PDR) in March 2023 and received strong support during the recent Agency Program Management Council (APMC) briefing held on November 16, 2023, authorizing the project to proceed with Phase C activities. We recognize that NASA HQ is postponing formal confirmation until release of the FY25 President's Budget in mid-2024, and **strongly urge the final confirmation review to be held as soon as possible after that release.** The OPAG community is concerned that any further delays may continue to adversely affect Dragonfly's launch readiness date, which has now slipped three times post- selection, to July 2028.
- **Strong support for Radioisotope Power Systems.** RPS is an enabling technology without alternatives for a number of high priority PSD missions - especially for outer planets missions such as UOP. Thus, we request NASA to continue to work with the Department of Energy (DOE) to ensure that sufficient RPS units will be constructed and fueled in a timely manner in support of these missions to match their power needs.

Statements of Support & Concern from November 2023 OPAG community meeting (2)

- **Support for Thermal Protection Systems.** TPS technologies fulfill critical needs for outer planet atmospheric entry probes to Saturn and Uranus, and could enable an aerocapture-based mission architecture for UOP. Furthermore, TPS plays a critical role on sample return missions, protecting the return capsule during Earth atmospheric entry. We support NASA's investments to date in developing this TPS capability and in particular maturing Heatshield for Extreme Entry Environment Technology (HEEET) to Technology Readiness Level (TRL)-6. OPAG recognizes that development and production of woven-TPS such as HEEET are carried out in close collaboration between NASA and industry partners. Significant delays in probe missions introduce time gaps that could adversely impact or atrophy production capabilities of our industry partners. Losing production capability would have a significantly negative impact on the readiness of this mission enabling capability, and possibly a decline in TRL.
- **Concern about potential future merger of SSW, EW and SSO into SSS.** The OPAG community was concerned about the idea of potentially merging Solar System Workings (SSW), Emerging Worlds (EW) and Solar System Observations (SSO) into a Solar System Science (SSS) program, and is glad to hear that such a merger will not occur in ROSES24. Concerns included how the review panels for such a program would be structured and the need for transparency in the review process. Furthermore, the community is aware that the No Due Date (NoDD) experiment has not been resolved yet, nor the issue of why proposal submission rates have dropped in recent years, and whether they will continue to do so. The community feels that introducing another large alteration to the ROSES program would be disruptive at this time.

Statements of Support & Concern from November 2023 OPAG community meeting (3)

Workforce Initiatives. OPAG thanks Dr. Christina Alston for her presentation on the Colorado Diversity Initiative, that demonstrates how an individual or group dedicated to Equity, Diversity, Inclusion, and Accessibility (EDIA) can help make a difference.

• OPAG endorses the PAC finding (June 20223) that advocates for an outward-facing EDIA- coordination position at NASA. OPAG supports the concept that EDIA efforts could be most effective if guided and managed from a central EDIA expert or office; having a designated person at the SMD or PSD level responsible for EDIA programs would project a sense of long- term priority for EDIA values and would also provide a clearly identified externally-facing responsible authority.

• OPAG notes that the OWL Decadal Survey recommended workforce surveys every 3-5 years, and that it has been three years since the last workforce survey of the planetary science community (the 2020 survey funded by the DPS). The OPAG steering committee would be pleased to work with NASA and the Cross-AG IDEA WG to coordinate the next survey as appropriate. Such a survey should be funded; if NASA cannot support this effort, perhaps the DPS can do so again. [See also the related PAC finding from June 2022.]

Statements of Support & Concern from November 2023 OPAG community meeting (4)

Concern about Ocean World technology. OPAG looks forward to coordinating with the Planetary Exploration Science Technology Office (PESTO), the Network for Ocean Worlds (NOW), and the Ocean Worlds Working Group (OWWG) to prioritize technologies of importance and timelines for development. OPAG stands ready to provide inputs on formulation and strategy to develop technologies highlighted by the OWL Decadal Survey for future missions. OPAG suggests that further conversations be planned between PESTO, NOW, and OWWG to coordinate and provide the best inputs.

A specific recommendation gathered so far from OPAG is that PESTO should consider more specificity within instrumentation for life detection/astrobiology for their drafted prioritization of technology gaps. OPAG would benefit from not only instrumentation development but also sample collection/handling/preparation technology developments, especially as applied to downstream chemical analyses of liquids/ices. Furthermore, the development of subsurface access technologies to 10m and beyond, including simulation/testing facilities, should start early, as these are closely linked with life detection/astrobiology measurements and are long-lead technology development efforts.

Lunar Exploration Analysis Group Updates and Action Requests

March 2024 Lightning Edition

Dr. Benjamin Greenhagen, LEAG Chair

Presented to NASA Planetary Advisory Committee

5 March 2024

Sample priority within the Architecture Definition Document (ADD) in collection, transport, and analysis *in situ* and on Earth

- **The Lunar community continues to express concern over sample mass, sample transit conditions, and curation. LEAG and ExMAG have responded to NASA's request for a Sample Specific Action Team (SAT) to examine curation and data infrastructure, but it may not address all needs.**
  - The LEAG ExMAG Joint SAT does not explicitly examine funding needs.
  - Technology development may be needed to enable curation and promote analyses described in the ADD. Will ESDMD include this as a necessary item in the ADD? Or does this fall to SMD working with STMD?
  - To fully address some goals/objectives, the community needs to do more than identify, collect, document, and return samples. Where does the analysis on Earth fit in to complete addressing these goals/objectives?
  - ADD guides architecting from the right, but sample mass allotted in Orion appears to contradict this, especially for transporting cold-conditioned samples, whose freezer is a significant mass. Is the allotted sample mass enough to address the goals?
  - LEAG supports a trade study to examine the use of uncrewed sample return vechicles to increase the mass of samples returned by the Artemis missions.
- **LEAG requests action to ensure SMD and ESDMD are coordinating to ensure support through to the completion of the goals and objectives.**

Dr. Ben Greenhagen, on behalf of the
Lunar Exploration Analysis Group

Given to the NASA Planetary Science Advisory Committee

March 5, 2024

LEAG Activities and Updates

- **Annual Meeting Findings (presented to PAC in November 2023) are online now**
- **LEAG thanks NASA for facilitating the development of rubrics for inclusion plans, which closes a finding from our 2023 Annual Meeting.**
- **Draft Implementation Plan for a NASA Integrated Lunar Science Strategy in the Artemis Era**
  - Detailed LEAG feedback provided in December 2023
- **LEAG Lunar Science Goals**
  - Activity is underway, all subcommittees are filled, meeting regularly, aiming for summer release
- **LSSW 22: Science Enabled by the Artemis Base Camp (April 3, 2024)**
  - LEAG is supporting the workshop and will organize community white papers
- **LEAG ExComm Community Meetings**
  - January 2024 – MEPAG Mars human science objectives
  - February 2024 – Lunar Exploration and Science Orbiter (LExSO)
- **LEAG values continued planetary science community support for the Decadal Survey science priorities, including (but not limited to) those attributed to LDEP**

Additional LEAG Slides for the PAC

- ***Updated LEAG Executive Committee***
- ***Supporting International Lunar Year***
- ***Coordination with other AGs: Joint LEAG-ExMAG SAT & Working with MEPAG on M2M***

Dr. Ben Greenhagen, on behalf of the
Lunar Exploration Analysis Group

Given to the NASA Planetary Science Advisory Committee

March 5, 2024

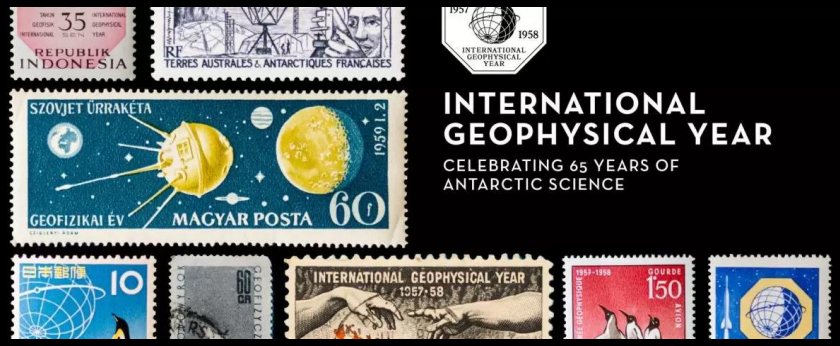
Updated LEAG Executive Committee (March 2024)

Chair	Benjamin Greenhagen, JHU APL
Emeritus Chair	Amy Fagan, Western Carolina Univ.
Science	Timothy Glotch, Stony Brook Univ.
Human Exploration	Jacob Richardson, NASA GSFC
Technology	Jose Hurtado, Univ. of Texas, El Paso
Astrophysics Liaison	Nivedita Mahesh, California Institute of Technology
Equity, Diversity, & Inclusion	Alexandra Matiella Novak, JHU APL
Operations	Lauren Jozwiak, JHU APL
Strategic Roadmap	**< vacant for FY24 >**
Workforce Development	Tabb Prissel, NASA JSC
At-Large Member	Kerri Donaldson Hanna, Univ. Central Florida
At-Large Member	Erica Jawin, Smithsonian Institute
At-Large Member	Sarah Valencia, NASA GSFC
Chair, CAB	Stephen Indyk, Honeybee Robotics

Ex Officio Members
Sarah Noble, NASA SMD
Jacob Bleacher, NASA ESDMD
< vacant >, NASA STMD
Gregory Schmidt, SSERVI

LEAG is Helping the Community Organize an International Lunar Year Towards the End of this Decade

- **LEAG has formed a community coordination group (30+ institutions) to help communicate and align activities**
  - Meeting at LPSC (March 23th, 5pm CT)
- **An ILY during the timeframe 2027-2030 could:**
  - Prompt new multilateral coordination relevant to enduring human and robotic presence at the Moon
  - Promote long-term safety and sustainability in exploration and utilization activities at the Moon
  - Foster coordination between scientific, educational, and commercial space communities
  - Promote communication and coordination between operators in Cislunar space
- **ILY requires a concerted, grassroots effort from the lunar science and exploration communities to get off the ground**



INTERNATIONAL GEOPHYSICAL YEAR
CELEBRATING 65 YEARS OF ANTARCTIC SCIENCE

Intent is to model after successful past Science Years, such as the IGY 1957-58

Community Sign-up Form

For more info contact either:
LEAG ILY Lead, Erica Jawin (JawinE@si.edu)
LEAG Chair, Ben Greenhagen (Benjamin.Greenhagen@jhuapl.edu)

LEAG is Coordinating with other AGs: Joint LEAG-ExMAG SAT & Working with MEPAG on M2M

- **Joint LEAG-ExMAG SAT will examine three main topics: (1) Volatile Samples and Cold Curation, (2) Nominal Samples, and (3) Sample Data Infrastructure**
  - Three LEAG ExComm Members are Supporting: Sarah Valencia (Nominal Samples, Vice Chair), Tim Glotch (Sample Data Infrastructure, Vice-Chair), Amy Fagan (Ex Officio)
  - Vice Chairs are supported in their topics by four members of the community and a graduate student executive summary
- **LEAG and MEPAG are investigating ways improve coordination given the alignment of our communities through the Moon to Mars Architecture**
  - MEPAG provided the LEAG ExComm with a briefing of their recent Mars science objectives for human exploration tiger team (January 2024)
  - Lessons-learned from the well-established Mars Science Goals process are feeding into a lunar science goals process to be kicked off in December 2023
  - MEPAG and LEAG both attended the M2M workshop and are exploring opportunities to coordinate feedback to the annual M2M ADD review cycle

Mapping and Planetary Spatial Infrastructure Team (MAPSIT)

Findings for the Planetary Advisory Committee (PAC), March 4–5, 2024 Meeting

MAPSIT Steering Committee

Brad Thomson (Univ. Tenn.), *Chair*

Julie Stopar (LPI), *Vice Chair*

Brent Archinal (USGS)

Ross Beyer (SETI/NASA Ames)

Robin Fergason (NASA Ames) *Ex Officio, Planetary Data Officer*

Sander Goossens (NASA Goddard)

Justin Hagerty (USGS), *Ex Officio*

Trent Hare (USGS)

Jay Laura (USGS)

Sam Lawrence (JSC), ESDMD rep, *Ex Officio*

Myriam Lemelin (Université de Sherbrooke, Canada)

Jeannette Luna (Tennessee Tech Univ.)

Becky McCauley Rench (NASA HQ), *Ex Officio*

Moses Milazzo (Other Orb), *Ex Officio*

Jani Radebaugh (Brigham Young Univ.), *past Chair*

David Williams (Arizona State Univ.)

MAPSIT Findings (1) – Geologic Mapping

Finding 1: MAPSIT strongly emphasizes the critical importance of planetary maps for research and exploration, including systematic Venus and Lunar geologic mapping. MAPSIT endorses and appreciates PSD's support of geologic maps and applauds the inclusion of the Lunar Mapping Program element in ROSES 2024 (NNH24ZDA001N-LMAP).

- This element enables participation in a "geologic mapping team in the planning and execution of campaign-style mapping of selected regions of the Moon." A central objective would be to produce "targeted, innovative, and content-diverse geologic maps that will aid in lunar exploration as context for scientific investigations, guidance for region and site down selection, and/or surface operations."
- This follows the recommendations of the Lunar Surface Science Workshop, *"Geological Mapping to Support Artemis Strategic Decisions"* Aug 16–17, 2023 (Virtual). Organizers: J. Skinner (USGS), A. Huff (ASU), J. Luna (TNTech), R. Watkins (NASA HQ)
- The MAPSIT Geologic Mapping (GEMS) subcommittee is regularly meeting to engage with the planetary mapping communities (researchers, MAPSIT, NASA, USGS) and helping to prioritize cross-body mapping goals. Contact GEMS chair Jeannette Luna for more information.

MAPSIT Findings (2) – Software for Planetary Data

Finding 2: MAPSIT sees a community-wide need to discuss and identify critical software gaps for planetary data analysis. MAPSIT urges a Specific Action Team (SAT) be formulated and requests direct involvement in this effort

- Some efforts (e.g., through STMD) seek to identify and fill technology gaps; however, MAPSIT sees a particular need for continued development of software relevant to planetary science and data analysis.
- MAPSIT views this assessment as essential for the long-term planning of infrastructure investments and analyses of planetary data, as well as for upcoming missions (one example, software to visualize data collected on the Moon's surface).
- This assessment need fits with the recommendations of the Lunar Critical Data Products SAT Report (2021) https://doi.org/10.5281/zenodo.7236426

Additional MAPSIT Findings

Finding 3: MAPSIT endorses NASA's ongoing efforts to support researchers and promote training and accessibility in the planetary data ecosystem.

- MAPSIT endorses the PSD support of planetary data workshops, and other opportunities and resources

Finding 4: MAPSIT encourages the continued NASA support of efforts producing analysis-ready data products in a platform-agnostic format.

- These products maximize accessibility and findability of PSD data in the planetary data ecosystem

Finding 5: MAPSIT encourages continued support for planetary spatial data infrastructures.

- SDIs engage the community and help formulate standards and maximize accessibility and findability of PSD data

Finding 6: MAPSIT urges extremely careful consideration and assessment prior to NASA's support of any major revisions to the planetary reference systems (e.g., for the Moon)

- Such revisions can have wide-sweeping effects for PSD data and should be assessed extensively before adoption

Upcoming community activities

- MAPSIT Town Hall at LPSC
  5:30 to 6:30 pm, March 11 (Tuesday), 2024

- Planetary Geology Mappers' Meeting
  August 14-16, 2024, adjacent to the Workshop on Terrestrial Analogs for Planetary Exploration, Flagstaff AZ. Hybrid format.
  - Organizers: Jim Skinner (USGS), Jeanette Luna (TN Tech) and Amber Gullikson (USGS)

- Planetary Data Training Workshops
  Organizers: David Williams et al.
  - 8 events over 5 dates planned for 2024 (see https://rgcps.asu.edu/gis-pdtw/)

PAC meeting
March 5, 2024

VEXAG

2023 Findings
Inter-AG findings doc
Upcoming Activities

Noam Izenberg	Applied Physics Laboratory, Chair
Debra Buczkowski	Applied Physics Laboratory, Dpty Chair
Siddharth Krishnamoorthy**	Jet Propulsion Laboratory, ECR
Sara Port**	Glenn Research Center, ECR
Chuanfei Dong	Boston University, ECR
Erika Kohler	Goddard Space Flight Center, ECR
Eric Grosfils	Pomona College
Daniel Nunes	Jet Propulsion Laboratory
Anna Gulcher	California Institute of Technology, ECR
Michael Way	Goddard Institute for Space Studies
Tracy Gregg	University of Buffalo
Alexander Akins	Jet Propulsion Laboratory, ECR
Kelsey Crane	Mississippi State University, ECR
Jacob Izraelevitz	Jet Propulsion Laboratory
Piero D'Incecco	National Institute for Astrophysics, Italy, ECR
Robbie Herrick	University of Alaska, Fairbanks

Ri Cao	Scribe
Nathan McGregor	Scribe
Darby Dyar	PSI, Mount Holyoke College, Emeritus
Nick Lang	NASA HQ, ex officio

**Term ends in July 2024

VEXAG FINDINGS 2023

Finalized January 2024,
Delivered to NASA and the Community

R&A Finding:

A "Precursor Science Investigations – Discovery" (PSI-D) R&A program, focused on ensuring success of and maximum scientific return from upcoming Discovery missions and the EnVision partnership, is in the interests of the planetary community. PSI-D could focus on any selected Discovery mission stages prior to primary Phase E science, and thus would currently specifically include VERITAS and DAVINCI, possibly EnVision, as well as Psyche and Lucy. Proposals could include laboratory studies, development, modeling, planetary mapping, precursor observations, etc. that could affect, augment, or improve late primary mission phases, and/or extended mission phases and/or enhance specific investigations or mission science goals following the model of Precursor Science Investigations for Europa (PSI-E). Proposals to PSI-D could target missions in phases B through D (or part-way through E until a mission's primary science phase begins).

VEXAG FINDINGS 2023

Finalized January 2024,
Delivered to NASA and the Community

In-Situ Technologies Finding:

VEXAG finds that a solar-system-wide push for in-situ exploration technology would enable critical follow-ons to the DAVINCI, VERITAS, and EnVision missions, as well as missions to other planetary environments. A next logical step in Venus exploration is for in-situ observations (in-atmosphere, and on-surface), and we need to continue to support technology that will do this. To this end, we encourage a final **HOTTech (HOTTech 3) program** to focus on maturing important technologies and integration into platforms and systems, and the initiation of a new **"CloudTech" program** for technologies and science instruments for the Venus clouds and other planets.

CROSS-AG FINDINGS

VEXAG

Document is intended as a reference for NASA Assessment Group [AG] leadership, HQ, and potentially other parties, so that latest findings can be accessed, referred to, and potentially commented upon and discussed with individual AGs and the Cross-AG leadership.

https://docs.google.com/document/d/1Vq6uMgao0FuOcS7bj_CnWICDmpu6McBBLG46VwHYmY8/edit?usp=sharing
(Also QR code to left)

As of 2/27/2024: VEXAG, XAG EDIA WG, and SBAG have findings/draft findings on doc

Upcoming VEXAG events, etc.

Townhall at LPSC

*Release of Exploration Strategy

Update of GOI, Roadmap, Tech Plan documents (Spring-Summer ‘24)

LPI Initiative meeting #4 (Summer ‘24?)

Exoplanets in our Backyard 3 (Nov. ‘24)

22nd VEXAG, November ‘24

MEPAG Update

Vicky Hamilton, MEPAG Chair

Planetary Science Advisory Committee Meeting

5 March 2024

hamilton@boulder.swri.edu

Mars Exploration Program Analysis Group (MEPAG)

- MEPAG has not held a meeting since the last PAC meeting; we are eagerly awaiting the report of the MSR IRB Response Team (MIRT) in late March and a public discussion of that report at our 24-26 April hybrid meeting in Washington, DC
- Workshop on the value of returned samples (with ExMAG) in April: https://www.lpi.usra.edu/mepag/meetings/mepag-exmag-workshop/
- Feedback from multiple stakeholders inside and outside of NASA indicates that they do not see the PSD science community uniting behind the scientific priorities outlined in our Decadal Survey (e.g., as compared to the Astrophysics community) and thus, the top line Science budget
  - Mixed messages about funding priorities poses a risk to support for all planetary science as well as the Decadal Survey process itself — we should not allow this process to be weakened, even as we strongly advocate for affordable and sustainable funding for all missions, not just MSR
- **MEPAG requests that the PAC reiterate planetary science community support for our Decadal Survey's scientific priorities and the top line NASA Science budget**

Cross-AG EDIA Working group

- Co-chairs
  - Julie Rathbun – she/hers – Cornell
  - Kas Knicely – she/hers – U. Alaska Fairbanks
- Everyone is welcome to join
  - email planetaryedi+subscribe@psi.edu
  - Meetings are every 4th Wednesday at 1 pm ET (next is March 6th)

- Recent Accomplishments:
  - Submitted TWSC to fund a 2-day AG style meeting this fall
  - Thanks to Andy Shaner we now have an updated website: https://www.lpi.usra.edu/idea/working-group/
  - Thanks to Laura Breitenfeld for sending updates to the PEN, etc.
  - Thanks to Serina Diniega, Cynthia Philips, and Sarah Valencia for creating a compilation of awards in planetary science.

Cross-AG EDIA Working group

- Continuing work
  - Community demographics questions collection. Thanks Kennda Lynch for leading early efforts.
  - Work with PAC, NAC, SMD on recommendation for an outward-facing position at NASA that focuses on EDIA issues.
- Co-sign SBAG rec:
  - To continue training programs that support early career researchers and improves EDIA within the community
- Reaction to concerns about budget modifications affecting Decadal science priorities
  - We emphasize that a diverse, equitable, and inclusive planetary science community requires a vibrant science program with consistent funding support to achieve the science priorities laid out by the community.

Ocean Worlds Working Group Update

Cynthia Philips and Mike Bland

- New cross-AG working group chartered by OPAG, SBAG, and NOW
- Co-Chairs: Cynthia Phillips (JPL) and Mike Bland (USGS)
- Subgroups:
  - Science Goals: Angela Marusiak (U. of Arizona), Misha Zolotov (ASU)
  - Technology Roadmap: Kate Craft (APL), Paula do Vale Pereira, Peter Willis

- **Goal: Create an actionable ocean worlds exploration strategy**
  - Specific, prioritized science goals
  - Identify needed technology development
  - Multi-decadal timescale
  - Fit within NASA's existing framework

Status Update

- Initial working session at OPAG on Nov. 29th
- Provided updates to NOW (Jan 8th) and SBAG (Jan 31st)
- Science Goals and Technology Roadmap subgroups met individually (Feb. 14th and Feb. 21st)
  - Crowd source the identification and synthesis of relevant, existing community documents
- LPSC discussion session on Wednesday March 13th (8am)
- Next meetings will begin to collate and organize documents
  - Technology Roadmap: April 3rd
  - Science Goals: April 10th