

FINDINGS FROM SBAG 17

1. Participating Scientist Programs:

SBAG applauds the effort put forth by representatives from each of the AGs to study the demographics and the value of mission Participating Scientist Programs. With over 200 respondents, including many in the small bodies community and mission leadership, SBAG finds the responses informative. Participating Scientist Programs were found to have a clear and overall positive impact on the science and career advancement of individuals but lacked uniformity in their implementation. SBAG supports the full report as presented in the white paper entitled “The Value of Participating Scientist Programs to NASA’s Planetary Science Division” and endorses all of the recommendations that report lays out, especially that a Participating Scientist Program should be included on every planetary prime and extended mission as early in the schedule as feasible and that the expectations and scope for all involved be explicitly identified in the earliest stage.

PSD Response: PSD thanks the AGs and the report authors for their efforts to engage the community in the discussion of Participating Scientist Programs (PSPs) and to inform PSD of the results and their recommendations. PSD agrees that PSPs have shown themselves to be successful and highly effective ways to enhance the science return from planetary missions. PSD fully intends to continue to support PSPs on future missions when scientifically appropriate and when resources allow, and will consider issues such as timelines and duration of PSP funding, as discussed in the recommendations, in its plans for future PSPs.

2. Thematic organization for Decadal Survey

SBAG recommends that, in preparation for the next Planetary Science Decadal Survey, consideration should be given to organizing the Decadal Survey by science objective, rather than solar system destination. In the previous Decadal Survey, a number of crosscutting scientific themes were identified. Subsequently, the Planetary Science Division’s Research and Analysis program was restructured, with several of the newly-defined programs aligning strongly with the themes identified in the Decadal Survey. As the community’s research is now more frequently couched in terms of broad scientific objectives, rather than investigations of a specific body, we recommend consideration of organizing the Decadal Survey in this manner as well. For example, rather than addressing “What are the highest priority science objectives at Small Bodies for the next decade?” it may be advantageous for the Decadal Survey to address “What are the highest priority investigations to improve understanding of the formation of the solar system in the next decade?”

PSD Response: The suggestion to organize the Decadal Survey by science objective rather than by Solar System object(s) is worthy of consideration. It should be understood, however, that the sponsoring agencies (NASA and NSF) generally do not specify the organization of the Decadal

Survey study to this level and do not plan, at this time, to significantly change the way the next Decadal Survey is tasked. For the previous “Vision and Voyages” study, for instance, the Statement of Task only specified an “inventory of the top-level scientific questions that should guide NASA flight mission investigations and supporting research programs and NSF’s programs that support planetary science research” [Vision and Voyages, p. 319]. It further stated that “NASA and NSF anticipate that the [Decadal Survey] Committee will utilize specialized panels, with allocation of the domain of study among them to be determined by the Committee and the [Space Studies] Board” [V&V p. 321]. SBAG members are encouraged to express their opinions by participating in the Decadal process itself, e.g., as authors of white papers or as members of the Survey Committee.

3. Arecibo

SBAG reiterates its appreciation of NASA’s expressed willingness to continue support of Arecibo’s planetary radar capabilities at the present level in partnership with NSF and of the continued support for the Arecibo Observatory by NASA’s Planetary Science Division (PSD).

As detailed in previous findings, SBAG continues to identify Arecibo as a critical national asset that provides a highly valuable resource for scientific investigations as well as a key capability for planetary defense. Any disinvestment in Arecibo facilities and maintenance could have major negative scientific and security implications, which must be fully considered in any discussion of the future of the Arecibo facility.

PSD Response: NSF issued its Record of Decision (ROD) for Arecibo Observatory (AO) on Nov 15, 2017 (https://www.nsf.gov/mps/ast/env_impact_reviews/arecibo/arecibo_rod.jsp). The ROD formalized NSF’s preferred path forward - to collaborate with interested parties to maintain science-focused operations at the Observatory while reducing NSF funding. NASA served as a Cooperating Agency throughout NSF’s NEPA/environmental impact analysis process that informed this decision, and, in that role, confirmed its willingness to continue to support planetary radar observations at approximately the current level. NSF is presently reviewing proposals for the management of AO, which were solicited earlier in 2017. PSD will continue to provide further information as requested to NSF during its selection process.

4. Funding Sources for Future Space-Based Planetary Defense Missions

The small bodies community recognizes the necessity of space-based missions for detection and mitigation of near-earth object threats, i.e missions specific to planetary defense, and encourages the establishment of a mechanism for the funding of these efforts. The George E. Brown, Jr. Near-Earth Object Survey Act provides a mandate to NASA to detect 90% of all objects above the size of 140 meters, and dedicated surveys that utilized space-based platforms have consistently been identified as the best means of achieving this mandate. While detection

is the first step in any progress towards planetary defense, the value is minimal without a viable strategy to mitigate impacts. Effective strategies towards the goal of planetary defense require both missions that survey and characterize asteroids, and missions that test asteroid redirection techniques under realistic analog circumstances. Yet no direct funding mechanism exists for such space-based programs, and current programs will not be adequate in their present form to accommodate comprehensive space-based survey and mitigation missions. Therefore, SBAG encourages a dedicated and specific means of funding these space-based planetary defense missions.

PSD Response: The Science Mission Directorate, as informed by the recent report of the Near Earth Object Science Definition Team, also recognizes the value of space-based systems to address the needs for planetary defense capabilities, and is investigating the potential for funding levels of effort that would allow the acquisition of such capabilities.

5. The Future of NEO Survey Capabilities

SBAG reiterates its previous findings in support of space-based NEO survey capabilities.

Improved NEO survey capabilities will simultaneously benefit robotic and human exploration, planetary defense, resource utilization, and science, and a space-based NEO survey telescope would be a foundational asset to most efficiently achieve the goals of NASA's Asteroid Initiative and the objectives of the George E. Brown, Jr. Near-Earth Object Survey Act. The SBAG looks forward to the formal report document from NASA's NEO Science Definition Team (SDT) following the recent completion of their study efforts. The SBAG concurs with the NEO SDT findings presented at this SBAG meeting, given the assumptions used in the study. Of particular note are the NEO SDT findings that the 2003 SDT goal of discovering >90% of NEOs >140 m to retire >90% of the NEO impact hazard uncertainty remains unchanged after the new analysis.

PSD Response: The Science Mission Directorate has received the recent formal report of the Near Earth Object Science Definition Team and understands its findings, and also recognizes the value a more comprehensive survey of NEOs will bring to areas of endeavor beyond just planetary defense. NASA is investigating the potential for funding levels of effort that would allow the acquisition of NEO capabilities similar to those described in the findings of the SDT report.

6. Asteroid Redirect Mission

SBAG commends the Asteroid Redirect Mission (ARM) management for their efforts to engage the planetary science community during mission formulation. The dialogue between the ARM project and the science community was highly productive, and the mission evolved considerably from the original concept, resulting in a marked increase in the mission's science potential. Despite its recent cancelation, many of the goals of ARM remain relevant to the

planetary science community, including gaining a better understanding of asteroid properties, possible *in situ* resources, interacting with small bodies, and testing techniques for planetary defense. Asteroids and their potential resources are key to future HEOMD and SMD exploration and science goals, and SBAG encourages future HEOMD mission management teams to engage with the small bodies science community early and follow the precedent set by ARM. SBAG supports and encourages open communication and collaboration between SMD and HEOMD, such as that undertaken by the ARM team, to achieve mission goals and enhance value for future projects.

NASA Response: NASA greatly appreciates the efforts of the planetary science community during mission formulation for the Asteroid Redirect Mission. Feedback from SBAG over the early years of the mission lifecycle, including analyses by a Special Action Team, was critical to formulating a viable mission concept which was responsive to a number of mission objectives. Robust participation on the Formulation Assessment and Support Team also provided critical information for mission requirements and technical trades during formulation. NASA values the open communication and collaboration that developed between SMD and HEOMD during the Asteroid Redirect Mission. Continued collaboration across Mission Directorates is advocated at the highest levels of NASA and will be pursued across the organization.

7. Commercial Space Resources Industry

SBAG welcomes the growth of a dynamic commercial space resources industry and considers it an integral part of the SBAG community. This industry holds the promise for creating a range of new opportunities for the discovery, exploration, analysis, and understanding of small bodies. Commercial resource activities can create new venues for hosted access to space and the delivery of science instrumentation, as well as the need for focused prospecting and applied asteroid science. SBAG urges NASA to seek ways of utilizing these developing commercial resources, such as potentially including funding hosted instruments and Missions of Opportunity in partnership with the space resources industry.

PSD Response: PSD encourages the planetary science community to continue to explore the opportunities that partnership with commercial space ventures may offer. As always, PSD is open to pursuing viable partnership opportunities with commercial and private space ventures when they may offer avenues to economically accomplish planetary science objectives.

8. Diversity of Planetary Science Teams

SBAG urges the small bodies community to take steps to increase the diversity in our community, particularly on planetary mission science teams. Recent studies¹ have shown that the planetary science community still lags behind when it comes to engaging minorities and taking advantage of the variety of backgrounds offered by our diverse community. This is

reflected in particular in the make-up of planetary mission science teams² that starkly contrasts with the United States demographics.

The text of the recent New Frontiers 4 call for proposal set an example by emphasizing the importance of developing diverse and inclusive planetary mission science teams, though the efficacy of this text in leading to increased diversity in the proposed mission teams remains to be seen. Science leads should actively evaluate the science team when forming their proposals and avoid detrimental situations such as tokenism³. A minimum of 30% non-majority population members should be considered a target to realize the true advantage of diversity. Science leaders should explore a variety of networks in order to form diverse teams.

While diverse and inclusive science teams should be considered from the start of a mission proposal, participating scientist programs⁴ offer an avenue for further diversifying science teams. Furthermore, leaders in professional societies, conference chairs, organizing committees, and study groups should also lead by example and ensure unbiased representation and merit-based visibility for all members of our community. Finally, extra attention to cognitive-cultural bias should be exerted in the context of proposal reviews for Research and Analysis funding and access to telescopes and other large facilities.

[1] <http://www.lpi.usra.edu/sbag/meetings/jun2017/presentations/Vertesi.pdf>

[2] Rathbun, J. (2017) *Nature Astronomy* 1, Article number: 0148, doi:10.1038/s41550-017-0148

[3] Kanter, R. M. (1993). *Men and Women of the Corporation*. New York: Basic Books. ISBN 978-0-465-04454-2.

[4] <http://www.lpi.usra.edu/sbag/meetings/jun2017/presentations/Feaga.pdf>

PSD Response: PSD will continue to strongly encourage more diversity be attained on both existing and proposed future flight mission and science teams and will promote activities and programs that help increase the diversity on our teams and within our scientific community.