

NASA Responses to SBAG #16 Findings

Discovery Missions

SBAG enthusiastically supports the recent selection of two new missions for the Discovery Program. The Discovery Program, with its open nature, objective peer review, and competitive selections, is vital to the exploration of the Solar System. The Decadal Survey recommended a cadence of five Discovery missions in a decade. By selecting two new Discovery-class missions, NASA has made significant progress toward achieving this Decadal Survey priority, a priority that is crucial to the planetary science community as a whole. The considerable efforts made by NASA to enable the selection of two missions are highly appreciated and position the Discovery Program for an active and healthy future.

Response: You're welcome. We look forward to the very exciting and productive science proposed by the Lucy and Psyche mission teams.

Space-based Asteroid Survey

SBAG supports NASA's decision to provide continued Phase A funding for the NEOCam mission proposal, but is concerned that no plan for fully funding NEOCam, or any other space-based NEO survey telescope, currently exists. In previous findings, SBAG has noted that NASA has asteroid-based activities across multiple directorates, serving as a cornerstone of future objectives for human exploration, planetary defense, resource utilization, and science, and that a space-based NEO survey telescope would be a foundational asset to most efficiently achieve the goals of NASA's Asteroid Initiative. Specifically, simulations indicate that currently operational ground-based facilities alone cannot achieve the Congressional mandate of discovering >90% of NEOs >140 m; a space-based facility with thermal imaging capability is ideally suited to accomplish this task. SBAG urges NASA to consider a means to conduct a space-based NEO survey mission given its cross-cutting foundational importance to the agency at large.

Response: PSD agrees with SBAG's assertion of the importance of a space-based IR survey for finding NEO's >140 m. NEOCam is only one possible way to implement a space-based IR system and PSD is looking into options that can be accommodated with the budget limitations, such as a re-scoped NEOCam mission.

Cubesats

SBAG supports NASA's plan to fly CubeSats on future large missions and to consider future science missions that could be accomplished with smallsats. The process to develop viable platforms under reasonable cost and risk assumptions and accommodate them on large missions is new and remains to be fully defined, and SBAG supports the programs recently introduced, Small Innovative Missions for Planetary Exploration (SIMPLEX) and Planetary Science Deep Space SmallSat Studies (PSDS3), to support this needed development. The SBAG community has a strong interest in using small, low-cost, and flexible platforms for a variety of applications, including: the reconnaissance of near Earth asteroids that may be suitable for human exploration and resource utilization; closing knowledge gaps on the physical properties of asteroids with the purpose of informing planetary defense strategies; characterization of targets of scientific interest to improve knowledge of their origin and evolution; and expanding the

sample of visited asteroids, comets and NEOs to support future in situ and sample return missions. In addition, CubeSats have the potential to increase the science return of large missions. However, implementation needs to be carefully considered to be effective.

Response: NASA intends to fly SmallSats, including CubeSats, on future large missions to conduct compelling science, and appreciates SBAG's support. The response to the Planetary Science Deep Space SmallSat Studies (PSDS3) solicitation has convinced us that credible missions to destinations throughout the solar system will be proposed to future SIMPLEx solicitations, and we are pleased to have awarded ten mission concept studies to more fully assess the potential costs and capabilities of these small missions. **NASA expects that future planetary science SmallSat missions will be managed as Class D, Category 3 or even 7120.8 (Research and Technology Program) missions. The Planetary Science Division is learning lessons from the Earth Science Division and the Human Operations and Exploration Mission Directorate (HEOMD), both of whom are effectively managing risks associated with flying secondary SmallSat payloads on primary missions.** NASA welcomes further suggestions from SBAG about opportunities for SmallSats to contribute substantially to the study, reconnaissance, and tracking of small bodies.

Arecibo

SBAG gratefully acknowledges the continued support for the Arecibo Observatory by NASA's Planetary Science Division (PSD) and appreciates NASA's expressed willingness to continue support of Arecibo's planetary radar capabilities at the present level, in partnership with NSF. As emphasized in previous findings, SBAG believes that Arecibo is 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. Additionally, SBAG emphasizes that, in the current discussions about the fate of the Arecibo facility, all evaluations of reduced-scale operations should accurately reflect the effect any proposed reductions would have on Arecibo's planetary radar capabilities.

Response: NASA is a participating agency in NSF's continuing process to prepare an Environmental Impact Statement (EIS) that will evaluate the potential effects of possible changes in the operation of the Arecibo Observatory (AO). Completion of the EIS is required by law before NSF can reach a final decision on AO's future. NSF solicited proposals for the management of AO earlier this year, and NASA provided an update to its statement on planetary radar which was referenced in the solicitation (<https://science.nasa.gov/researchers/sara/library-and-useful-links/psd-radar>). The window for proposal submission closed on April 25, and the proposals received are under review by NSF. NASA/PSD is participating with NSF in that review.

Planetary Science Data Analysis from Astrophysics Missions

SBAG encourages NASA to consider fortifying present research and analysis programs and/or creating new data analysis programs to realize the full science potential of future data streams from Astrophysics missions that are scheduled to provide an unprecedented amount of data about small bodies and other Solar System objects. The small bodies community recognizes the potential for the large yield of data

produced by astrophysics projects, including the Large Synoptic Survey Telescope, that will be highly relevant to planetary science research over the next decade and a half. Large surveys and targeted observations from ground-based and space-based platforms are likely to create unprecedented volumes of imaging photometry and spectra valuable for the characterization of the various small body populations. Yet there is a concern that the traditional data analysis programs will not be adequate in their present form to accommodate the thorough analysis and research required to fully utilize these data, or even to analyze them at first-pass levels. SBAG urges PSD to develop and share with the community a plan to support planetary science research of data from large Astrophysics missions.

Response: The Planetary Science Division appreciates being made aware of this potential boon of planetary science-relevant data from upcoming astrophysics missions and ground based observatories. We have not, at this point in time, formulated an approach to modifying our Research & Analysis program elements to handle an unexpectedly large influx of data from ground based observatories such as LSST or missions such as JWST. We recognize the importance of a more comprehensive sky survey and the volume of data that the LSST will produce. To date, time allocated to planetary science on existing astrophysics assets has been relatively small and the resultant data has been straightforwardly accommodated by the existing R&A program elements. However, given the elevated status of this finding, we will charge the new Planetary Science Advisory Committee or a subordinate group thereof, with assessing the potential impact to the R&A program and ask them to craft potential solutions and make recommendations to the PSD Director.

During the restructuring of the Planetary R&A program, it was recognized that there needed to be some flexibility to accommodate unexpected events such Comet ISON. The result was to establish an “Emerging Topics in Planetary Science (ETIPS),” program element to provide accommodation for time sensitive events. ETIPS is always available should an unexpected opportunity arise that warrants PSD spending time and resources on it.

Small Bodies Science and Astrophysics Missions

SBAG appreciates the astrophysics community’s efforts to include early involvement of the small bodies scientific community’s expertise in the design and scope of future Astrophysics space- and ground-based assets. The small bodies community requires unique augmentations and specific desired capabilities for such assets in order to facilitate and enhance cutting edge science, and these requirements should be considered from the start to achieve effective implementation. To further these ends in the future, SBAG plans to form a committee, preferably including the small body science representatives already involved with envisioned assets, to compile a uniform set of basic capabilities and needs to maximize the yield of Small Body and Solar System science with future Astrophysics missions while allowing those missions to achieve their Astrophysics priorities.

Response: NASA welcomes this effort and look forward to your committee results so that we can provide them to the Astrophysics Division.

In Situ Resource Utilization (ISRU)

SBAG recognizes that in situ resource utilization technologies being developed for human exploration and commercial asteroid mining are relevant to those being developed for the scientific exploration of small bodies and for planetary defense against impacts. SBAG appreciates the ISRU community sharing information, and notes the synergies between the communities involved, and encourages a strategic communication strategy that can ensure that successes in one area can be infused into the others.

Response: NASA encourages efforts to enhance the interface between these two communities.

Asteroid Redirect Mission

SBAG appreciates the continuing engagement of the Asteroid Redirect Mission (ARM) management with the planetary science community. The dialogue between the ARM project and the science community has been highly productive, and the mission has evolved considerably from the original concept, resulting in a marked increase in the mission's science potential. The possibility of additional science instruments (possibly provided as hosted payloads, as solicited in the ARM Broad Area Announcement (BAA)), could further enhance the science of the mission. In addition, many early technical concerns of the science community have been allayed. The small bodies community's interest in this mission as now formulated is demonstrated by the large number of proposals in response to the ARM BAA Investigation Team solicitation.

Response: NASA and then entire Asteroid Redirect Mission Team appreciates the many contributions of the planetary science community to the formulation of the mission. These contributions are exemplified by the excellent response and input resulting from dialogue and assessment through SBAG meetings and Special Action Team support, Formulation Assessment and Support Team participation, and proposals to the ARM BAA Investigation Team. Due to a lack of budget for this mission in the FY18 budget blueprint and subsequent budget request, NASA is in the process of an orderly close out of the Asteroid Redirect Mission. NASA will continue the solar electric propulsion efforts benefitting from those developments initiated by ARM in support of future in-space transportation initiatives. Asteroid encounter mission concepts remain of interest due to the broad array of benefits for the human and robotic exploration, science, planetary defense, and asteroid resources communities.

DART, AIM, and NASA Planetary Defense

SBAG expresses continued support for NASA's Double Asteroid Redirection Test (DART). Additionally, SBAG continues to support development of the Asteroid Impact Mission (AIM), the European portion of the joint NASA/ESA Asteroid Impact and Deflection Assessment (AIDA) mission (AIDA = AIM + DART). Although AIM was not funded during the recent European Ministerials, SBAG supports the AIM team's continued efforts to acquire funding for a reduced-scope version of AIM. While DART is capable of meeting its requirements as a standalone mission, the inclusion of the AIM observer spacecraft greatly enhances the overall investigation and provides a key international component to the mission, emphasizing the global scope of planetary defense.

While DART's progress toward flight is encouraging, there is not yet a specific funding program for planetary defense driven missions and research projects. AIM's current funding challenges further underscore this issue, which is the need for a mechanism by which missions driven by planetary defense research, rather than science, can be proposed, selected, funded, and, in the case of missions, flown. SBAG reiterates a previous finding that there is a need for planetary defense missions, including technology development research and demonstration missions. Prudent preparation activities would provide an array of proven and reliable tools for use when an Earth-impacting asteroid or comet warranting mitigation is discovered. Finally, it is important to note that, while planetary defense demonstration missions are not science-driven, they provide useful data about the small bodies with which they interact and are, therefore, synergistic with planetary science.

Response: We're looking into this. See earlier response above.