

NASA Responses to Findings from the 14th Small Bodies Assessment Group (SBAG) Meeting

SBAG celebrates the recent successes of spacecraft missions focused on small bodies across the Solar System, such as New Horizons' historic exploration of the Pluto system, Dawn's discoveries at Ceres, NEOWISE's characterization of thousands of Solar System objects, and Rosetta's investigation of comet 67P/Churyumov-Gerasimenko. These missions have proven to be not only scientifically successful but have also captured public attention in demonstrating how fascinating and diverse these worlds can be. At the same time, SBAG eagerly looks to the future, enthusiastically encouraged by a NASA budget for planetary science that enables scientific priorities in the exploration of our Solar System to be accomplished, through spacecraft missions and research and analysis programs. New discoveries by missions such as OSIRIS-REx's asteroid sample return, partnerships with Hayabusa2, and New Horizons' proposed 2019 Kuiper Belt Object encounter are highly anticipated, as are future small bodies missions currently under development and consideration. To support the realization of such a future, **SBAG encourages the small bodies community to make every effort to engage with the public and to share the excitement of our current and future exploration of the Solar System.**

RESPONSE: NASA shares in the excitement over all of these successes, and congratulates the academic, space center and industry project teams that made them happen. We enthusiastically agree with the recommendation that the small bodies community, and the entire planetary science community, should engage the public with the excitement of solar system exploration.

Planetary Defense Coordination Office

SBAG enthusiastically supports the formation of the Planetary Defense Coordination Office (PDCO), a top recommendation by the 2010 NASA Advisory Council Planetary Defense Task Force. This new office will allow greater ease in coordinating planetary defense activities across NASA, other U.S. federal agencies, foreign space agencies, and international partners. The formation of the PDCO is a significant advancement in recognizing the importance of planetary defense activities. Now that the PDCO is established, SBAG encourages the PDCO to investigate means to: 1) complete the NEO population survey to assess the impact threat to Earth, and 2) find ways to support flight validation missions of mitigation techniques.

RESPONSE: The PDCO's mission is to lead national and international efforts to detect any potential for significant impact of planet Earth by natural objects, appraise the range of potential effects by any possible impact, and develop strategies to mitigate impact effects on human welfare. NASA appreciates the many past and ongoing efforts of the small bodies' community to carry out this mission. The PDCO continues to support a range of activities and improvements in NEO discovery, tracking, and characterization. With regard to mitigation, the Double Asteroid Redirection Test (DART) was recently

approved to proceed through Formulation Phase A. As a component of the international Asteroid Impact Deflection Assessment (AIDA) mission, in concert with the European Space Agency's (ESA's) Asteroid Impact Monitor (AIM), DART is the first technology capabilities test of a kinetic impactor mitigation technique. A second mitigation technique, the enhanced gravity tractor, is to be demonstrated by the Asteroid Redirect Mission (ARM) which will meet for KDP-B in a few weeks. Other options, particularly for short-warning impact scenarios, also continue to be explored with FEMA and the Department of Energy.

Discovery Program

SBAG reiterates the importance of the Decadal Survey recommendation of a ≤ 24 month average launch cadence for Discovery missions as an essential guideline.

SBAG sees the open nature, objective peer review, and competitive selection of Discovery missions as crucial to enable the exploration of the Solar System and views an active and healthy Discovery Program as a key priority. Given the large number of compelling and mature concepts submitted to the Discovery 2014 AO, selecting two missions would be a means of addressing the Decadal Survey guidelines and regaining the recommended cadence, given that the previous Discovery AO was released in 2010. In addition, the selection of two missions from the 2014 AO would leverage the considerable investment of time and resources in development of the AO, preparation of proposals, and evaluation of the submissions.

RESPONSE: The NASA Planetary Sciences Division (PSD) is committed to achieving as fast a cadence for Discovery mission launches as possible given the resources made available for the Discovery Program. Currently we are striving to achieve a launch cadence for future missions of not longer than 36 months. We are eager to see the Discovery 2014 AO concept studies and final proposals so that the selection process can be completed. Because this competitive process is ongoing, we cannot commit to any specific number of selections.

New Frontiers Program

The New Frontiers program is a critical component of achieving NASA's Solar System exploration goals, and **SBAG strongly supports the release of a New Frontiers Announcement of Opportunity (AO) in January 2017, to meet the Decadal Survey recommended cadence of two New Frontiers class missions between 2013-2022.**

Extensive studies and thorough community-wide discussions formed the foundation for the strategy identified in the Decadal Survey to achieve a robust and balanced exploration of the Solar System, with specific priority missions identified for the upcoming New Frontiers 4 and 5 opportunities. **SBAG emphasizes that the New Frontiers 4 candidate missions should be those specifically identified as priorities for the New Frontiers 4 opportunity by the Decadal Survey process.** Alternatively, if additions or other changes to the candidate mission list for the New Frontiers program are necessary, SBAG supports an appropriate and transparent community-wide process by NASA to properly re-evaluate the overarching strategy and priorities, such as was done by the NOSSE (New

Opportunities in Solar System Exploration) report of 2008. Such an open and transparent approach would further support the credibility and balance of the entire Decadal Survey and increase confidence in the Decadal Survey process, thereby affirming a means through which the input of the entire planetary science community is freely solicited and carefully balanced.

RESPONSE: PSD plans to release the Draft AO for New Frontiers 4 (NF-4) in July 2016. The expanded scope for NF-4 was announced in January 2016 following the enhancement in opportunity provided by Congressional direction in the FY2016 appropriation regarding Ocean Worlds. These plans were described to the Planetary Science Subcommittee (PSS) in March and presented to the Committee on Astrobiology and Planetary Science (CAPS) on March 29, 2016. CAPS co-chair, Phil Christensen, briefed the Space Studies Boards on April 27, 2016 stating:

1. Proposed change does not alter the scientific priorities that are laid out in the current planetary decadal survey.
2. Enceladus and Titan are significant elements of the decadal survey and their inclusion consistent with the overall scientific priorities discussed in the survey report.
3. A sound management approach should allow the program manager the flexibility to add elements as the situation changes throughout the decade.

NASA issued the Science Objectives for all the targets to the planetary science community in an announcement issued on April 24, 2016.

Arecibo Observatory as a Critical National Asset

Arecibo Observatory provides a unique capability for a range of cutting-edge science that includes astrophysics, aerometry, and planetary science as well as planetary defense and human and robotic exploration missions. Arecibo is a critical national asset whose loss would not only affect science return but also increase the nation's risk exposure. SBAG is highly concerned about a potential disinvestment in Arecibo facilities and maintenance. **SBAG encourages NASA to continue its current support of Arecibo and urges NSF to find a funding formula for Arecibo that reflects the nation's science and security interests and provides for the stability and productivity of this critical national asset.**

RESPONSE: NASA considers the capabilities of the Arecibo Planetary Radar to be extremely important to the national research infrastructure, and has supported these capabilities since 1971. The Arecibo Observatory itself is a facility of the National Science Foundation (NSF), which funds basic operations and use of the 300-meter telescope for astronomy and atmospheric science. PSD does not have sufficient resources on its own to fully operate the observatory, but has communicated to NSF its willingness to continue support for Arecibo's planetary radar capabilities at the present level. Currently, NSF is conducting the studies that it is legally required to complete before any decision on the future of the facility can be made. That decision lies with the NSF Director. We remain in contact with our NSF colleagues, and we will continue to work

with them to determine a course of action that can meet budgetary constraints and preserve capabilities that both agencies deem essential.

Support for Dawn's Extended Mission

The Dawn mission's investigation of Ceres has revealed fascinating new discoveries about this previously unvisited world, providing new insights into the Solar System's formation and evolution. Given the compelling results achieved to date and the unique potential to further advance our knowledge of Ceres, **SBAG strongly supports the continued operations of the Dawn spacecraft through an extended mission** that lasts through the mission's full potential lifetime, estimated as extending to the end of January 2017. This would only extend Dawn operations by roughly seven months but is a unique opportunity to fully utilize NASA's investment in Dawn and maximize the mission's science return.

RESPONSE: The Dawn mission extension was part of this year's Senior Review. We are expecting to release the results of that review within the next several weeks.

Value of NEO Survey Capabilities to NASA's Agency-Wide Goals

SBAG is pleased to hear that NASA is conducting several coordinated studies in 2016 to develop the best-integrated solution for achieving the G. E. Brown Survey Act objectives (discovering >90% of NEOs >140 m by 2020 to assess the threat of the NEOs to Earth (Public Law 109-155 Sec.321)), and SBAG looks forward to hearing the results of those studies at the 16th SBAG meeting. However, as detailed in previous findings and the forthcoming SBAG Goals Document (planned for release in March 2016; <http://www.lpi.usra.edu/sbag/goals/>), SBAG continues to emphasize: (1) that enhanced NEO survey systems are a foundational asset to most efficiently achieve the goals of NASA's Asteroid Initiative and complete the congressionally recommended survey for NEOs in a timely manner, and (2) that NASA has asteroid-based activities across multiple directorates as a cornerstone of future objectives for human and robotic exploration, planetary defense, resource utilization, and science, reflected in the aforementioned forthcoming SBAG Goals Document. Therefore, **SBAG finds that enhanced NEO survey capabilities should be considered an agency-wide initiative**, with the pursuit of a new start, and should not rely solely on support from the resources available to the Planetary Science Division (PSD) of the Science Mission Directorate (SMD), the Near-Earth Object Observations (NEOO) program within PSD, or the newly created Planetary Defense Coordination Office (PDCO).

RESPONSE: The agency-wide mission-enabling value of NEO survey capabilities is understood. However, the agency programmatic structure does not spread out resourcing as explicitly agency-wide in nature. Typically, one mission directorate must be designated as lead to bring capabilities that benefit the entire agency, even the entire national space endeavor, to fruition. Launch vehicle development and space communications and navigation are examples of this model.

Asteroid Redirect Mission

SBAG continues to appreciate NASA's efforts to engage and communicate with the small bodies community on the topics of science, planetary defense, and resource utilization regarding the Asteroid Redirect Mission (ARM). The 100 applications for the Formulation Assessment and Support Team (FAST) show the high level of interest of the community in participating in the formulation of ARM. SBAG thanks the ARM team for creating the FAST and the community members that volunteered and were selected for the FAST, for the substantial work completed in a short timeframe. **SBAG encourages the continued engagement between the ARM team and the small bodies community as the mission moves forward and supports the plan for a competed opportunity this year to establish the Investigation Team membership.** Consistent with previous findings, for science-driven missions, SBAG continues to support the priorities identified in the Decadal Survey to guide use of Planetary Science Division (PSD) resources and funds.

RESPONSE: NASA greatly appreciates the contributions of the community and SBAG to the ongoing processes for the formulation of ARM. The FAST report was a key input to the Asteroid Redirect Robotic Mission (ARRM) Requirements Closure Technical Interchange Meeting (TIM) and ARM strategy discussion, and informed development of the strategy for hosted payloads and the investigation team. While ARM is not a science directed mission, we are pleased to continue a close working relationship with the small bodies' science community. We anticipate further excitement and support from the community as the solicitation for the Investigation Team is released later this year.

Planetary Science Division Research and Analysis Program

Research & Analysis (R&A) funds are foundational to NASA's Science Mission Directorate and the Planetary Science Division (PSD). NASA spends a significant fraction of its PSD funds supporting the development, implementation, and operation of robotic missions. Yet the investment in these missions is not fully realized until the science community has analyzed the data to extract new discoveries and to answer the questions that drove NASA to select and fund the mission development. As has been said before, science is not just "bits on the ground", but rather science gets done when the community at large has the resources to pose and answer questions about our Solar System. NASA's R&A programs provide this support. Ultimately it is the R&A funding that drives the discoveries of the planetary mission portfolio. The results of current missions form the basis of knowledge that both reduce the risk for future missions and raise new questions that drive subsequent exploration and future Decadal Survey priorities. Because of this, **it is essential that NASA fund a robust and reliable R&A program, and SBAG encourages PSD to explore potential means to increase funding to R&A programs to improve the selection rate of highly rated proposals.** Additionally, SBAG urges PSD to avoid delays in R&A programs that result in severe gaps in funding opportunities for members of the community and to explore solutions when such gaps occur, even if on a case-by-case basis. Decreases and/or gaps in funding have serious and negative repercussions across the community, and early-career

individuals can be especially vulnerable. SBAG urges PSD to engage early-career scientists to explore means to lessen any hardships, even on an individual basis.

RESPONSE: PSD is committed to maintaining a robust R&A program, and understands that stability of funding is extremely important to the research communities. PSD strove, and was able, to maintain nearly constant or steadily increasing R&A funding through a recent period when the overall PSD budget endured a 20% cut. But budgetary limits are only partially responsible for the steady decrease in proposal selection rates over the past decade; in that period, the number of proposals submitted annually to PSD R&A programs increased by roughly 30%. The competition for resources will continue to increase as long as the growth in the budget is outpaced by the growth in the size and aspirations of the community.

We understand that there is always concern in the community when a previously regular cycle of proposal opportunities is altered. The change in the proposal deadlines for the Solar System Workings (SSW) program has been implemented over two years to try to mitigate the perturbation. But this change was essential due to crowding of the annual calendar with other program deadlines and reviews in the Fall. By shifting SSW to a single Step-2 deadline in February, we can better assure the timeliness and quality of the review. This shift will be complete with the ROSES-2016 cycle.

We are also aware of a perception that the burden of a change in the proposal opportunity cadence may fall disproportionately on NASA Postdoctoral Program (NPP) Fellows, because of restrictions imposed by the program. We remind the community that NPP Fellows are fully permitted by the program to submit proposals to ROSES or other research opportunities in their second and third years, typically in the role of Science PI. They are “discouraged” from doing so in their first year, in order that they can focus effort on their NPP-supported research. The policies are explained in the NPP Policy and Procedures Handbook, at <https://npp.usra.edu/policies-procedures/index.shtml#proposals>, and in the NPP FAQ document, at <https://npp.usra.edu/about/faq/fellow/>.

Data Analysis Programs

Data Analysis Programs (DAPs) enhance the scientific value of NASA’s missions by opening up analysis of data sets to a broad segment of the scientific community, offering expertise and viewpoints beyond those of the flight teams. **SBAG encourages the speedy establishment of two new programs: A New Frontiers Data Analysis Program and a Rosetta Data Analysis Program.** The former will serve as a means to analyze New Horizons data and to establish a continuing DAP for forthcoming New Frontiers missions, while a Rosetta DAP will enable access to a unique set of observations of Comet 67P/Churyumov-Gerasimenko that complement the science return of NASA’s existing small body programs.

RESPONSE: PSD intends to solicit proposals for the New Frontiers Data Analysis program as part of ROSES-2016. When this Program Element is incorporated into ROSES-2016, an amendment with the text will be released at least 90 days prior to the

due date for Step-2 proposals. PSD's current plan is to work toward a Rosetta DAP opportunity in ROSES-2017. In the ROSES-2016 cycle, relevant Rosetta-related research may be proposed to Emerging Worlds or Solar System Workings.

Midterm Decadal Survey Assessment

SBAG supports a 2013-2022 Decadal Survey midterm assessment to evaluate and reinforce the decadal process. Such a process was proposed within the Decadal Survey also as a means of preparation for the next Decadal Survey. SBAG hopes that a midterm assessment does not merely confine its attention to the account of "any new discoveries", but rather in accounting for "other changes that have taken place", **SBAG encourages a midterm Decadal Survey assessment to address the broader issue of identifying the elements of a healthy scientific community capable of supporting NASA's needs, and what should be done to maintain that community.** SBAG particularly encourages the inclusion of early-career participation in the midterm assessment by reaching out to early-career individuals of the research community for membership in the assessment panels. Furthermore, SBAG hopes the midterm review may address key assets and facilities in planetary science studies, such as PI-led laboratories that are particularly vulnerable to funding fluctuations. The productivity of these assets and facilities are often disrupted as a result of the loss of key personnel during times of low grant award rates.

RESPONSE: PSD absolutely supports the Decadal Survey process, including the mid-decadal assessment. SMD expects to follow its standard procedures, in cooperation with the National Academies of Science's Committee on Astrobiology and Planetary Science, to draft the Statement of Task and initiate the review. A draft of the Decadal Midterm task is under development with the plan to provide this to the NAS this summer.