

FINDINGS FROM SBAG 19, June 13-14, 2018

SBAG supports the extensive community effort put into the recent studies for future small bodies missions and recommends assessing the feasibility of such missions prior to serious consideration and inclusion in the Decadal Survey. Studies and the resulting white papers of the Pluto Follow-on Orbiter, and the KBO and/or Centaur tour in conjunction with an ice giants mission, will be important in informing the next decadal process. These will also complement the study of a mission to the dwarf planet Ceres, which is already in progress.

SBAG is pleased that Planetary Defense has now been allocated a separate line in NASA's Planetary Science Division budget, which is evidence that NASA recognizes the importance of a direct funding mechanism for missions specific to planetary defense, and SBAG urges NASA to include adequate funding for a space-based infrared NEO survey mission in the near term. SBAG is also pleased that Planetary Defense would receive a significant increase in funding in the latest budget request. SBAG recognizes that much of this budget increase is intended to fund development of the DART mission, which SBAG supports as an important test of an asteroid redirection technique. However, the budget increase was not adequate to also fully support the development of NEOCam, a well-studied and favorably reviewed Discovery-class mission for surveying and characterizing the NEO population. For many years, SBAG has strongly supported a space-based infrared NEO survey mission, which 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. Such a mission would also benefit robotic and human exploration, resource utilization, and asteroid science. SBAG strongly encourages NASA to fully fund NEOCam as soon as possible, so that a space-based infrared NEO survey mission can finally come to fruition.

SBAG encourages NASA to open New Frontiers calls to all targets, or to establish a transparent procedure for determining what targets will be allowed. The Decadal Survey process can result in a well-considered list of choices for upcoming New Frontiers missions. However, the addition of ocean worlds to the New Frontiers 4 targets, demonstrated that scientific priorities can change dramatically over the course of a full decade. SBAG suggests that NASA clarify how the evolution of scientific priorities between Decadal Surveys will be addressed, either by accepting all proposals for high-priority New Frontiers-level science, or by having a mechanism established in advance to re-evaluate the list.

SBAG supports collaboration with other communities in the development of mission concepts in advance of the Decadal Survey. We welcome development of synergistic mission concepts, such as a combined ice giant and KBO mission, which would draw on the interests of both the outer planets and small bodies communities. Additionally, we see the possibility for collaboration on mission concepts including Phobos and Deimos, which are of interest to both the small bodies community and the Mars community, and sample return missions to small bodies, which are of interest to both the small bodies community and the sample science community.

SBAG, jointly chartered by SMD and HEOMD, is disappointed that current plans for the SSERVI CAN prioritizes lunar studies, presumably at the expense of small bodies studies, and urges NASA to remove this stated preference when the final CAN is released and when proposals are selected. Lunar-focused investigations were considered to be equally meritorious to small bodies-focused investigations during prior SSERVI calls, when official NASA human spaceflight policy first worked toward a visit to an NEO and then developed the Asteroid Redirect Robotic Mission and Asteroid Redirect Crewed Mission concepts. Similarly, we feel that SSERVI would be stronger if it included asteroidal studies at equal preference to lunar ones, especially given continued community interest in human visits to NEOs and the recent positive experiences between the science, exploration, and engineering communities as ARM development progressed. In addition, Phobos and Deimos, both covered in the SBAG charter, remain specific waypoints of interest as humankind reaches toward Mars.

SBAG cautions ISECG on the absence of small body themes from its Global Exploration Roadmap (GER). The importance of primitive near-Earth asteroids (NEAs) to planetary science and in-situ resource utilization (ISRU) associated with human space flight (HSF) is addressed in narrative from the ISECG's third GER published early in 2018. But the strategic importance of NEAs and martian moons to HSF is neglected. These small bodies serve as incremental HSF stepping-stones into interplanetary space and as cis-Mars logistics nodes doubling as observing platforms. Furthermore, graphic roadmap overviews appearing in the GER and in presentation slides from ISECG representatives completely ignore small bodies. These graphics give mistaken impressions that Mars is barely more distant from Earth than the Moon and that space between the Moon and Mars is empty. Such impressions convey false expectations among the general public and space exploration policy-makers worldwide that humans can easily reach the surface of Mars immediately after exploring the Moon. Mars' distance from Earth actually ranges from 150 to over 1000 times that of the Moon as the two planets independently orbit the Sun. Roundtrips to over 2400 NEAs are known to require less propellant than a roundtrip to orbit about Mars. Of these NEA destinations, over 2200 can be associated with at least one roundtrip whose duration is less than a year, while Mars roundtrips typically last 2.5 years. Because NEAs exert virtually no gravity, roundtrips to over 1000 of them are known to require less propulsion than a roundtrip to the lunar surface.

SBAG encourages NASA to delineate how planetary defense, in-situ resource utilization (ISRU), and human exploration should fit into the next planetary science decadal survey. Due to the funding of planetary-defense initiatives through the Planetary Science Division (PSD), SBAG suggests that planetary defense be included explicitly, but that only the scientific contributions of research funded through PSD to ISRU and human exploration, e.g., physical characterization of small bodies, should be included.

SBAG remains concerned regarding Arecibo Observatory's (AO's) continuing operations. The AO is one of only two planetary radar facilities regularly contributing to knowledge of physical characteristics and refined orbits for small bodies passing near Earth. In this capacity, AO data are of critical importance to planetary science and planetary defense. Management for AO transitioned to a team led by the University of Central Florida in April 2018, and SBAG appreciates this team's dedication to maintaining AO viability. Both management and staff face challenges from employee attrition, policy changes, ongoing observations, and continued recovery from Hurricane Maria damage, which may not be

completed before 2020. A transition constraint is the reduction of NSF funding from over \$7 million in FY'18/19 to \$2 million four years later. How this reduction will be backfilled is not yet certain, but SBAG is hopeful stakeholders can together address any future AO funding shortfall without curtailing high-quality radar operations.

SBAG is pleased to see the creation of the NASA common themes in planetary small bodies research document. SBAG supports the adoption of this document, which aligns well with SBAG's goals, and is grateful that NASA has incorporated suggestions and changes by the small body community throughout the creation of the document.

SBAG enthusiastically supports NASA's decision to include the use of radioisotope power systems for the 2019 Discovery mission opportunity, and appreciates the information provided by NASA on its plan to ramp up the production of plutonium-238. A ready supply of radioisotope material enables missions of interest to the small bodies community, such as those to Kuiper Belt Objects and Centaurs.