

Caltech



Bonnie J. Buratti, SBAG Steering Committee Chair

August 18, 2020 NASA Planetary Science Advisory Committee (PAC)

Virtual Meeting

The Steering Committee

Present Steering Committee

Elena Adams (APL), **Technology Lead**

Maitrayee Bose (Arizona State Univ.)

Bonnie Buratti (NASA JPL/Caltech), **Chair**

Michael Busch (SETI Inst.)

Terik Daly (APL), **Early Career Secretary**

Mike DiSanti (NASA Goddard)

Jessie Dotson (NASA Ames) **Planetary Defense Lead**

David Gerdes (U. of Michigan)

Mihaly Horanyi (UC Boulder)

Stefanie Milam (NASA GSFC)

William O'Hara (Sierra Nevada Corp.) **Human Exploration Lead**

Jennifer Scully (NASA JPL/Caltech)

Steering Committee selects Chair and Steering Committee members from among nominations, applications. General membership open.

SBAG Representatives

Thomas Statler NASA Headquarters Liaison

Jake Bleacher Human Exploration and Operations Mission Directorate (HEOMD) Liaison

Paul Abell (JSC) HEOMD Observer

What does SBAG do?

- Seeks broad planetary science community input on small bodies and missions to small bodies.
- SBAG TOR (updated this year) includes in SBAG's charter human and robotic exploration, fundamental research and analysis, resource utilization, and planetary defense; and lists all of the following as being in SBAG's bag: Main Belt Asteroids, Comets, Near-Earth Objects, Meteoroids, Interplanetary Dust and Meteors, Trojans (of all the planets), Centaurs, Trans-Neptunian Objects (TNOs), Dwarf Planets, small planetary satellites (including Phobos, Deimos, and the irregular satellites of the Giant Planets), and Meteorites and returned samples from any of these objects
- Holds open meetings twice each year for community participation; last one January 26-27, 2021; next one June 6-7, 2021
- Maintains a Goals Document.
- Makes findings: community-based concerns and issues and transmits them to NASA
- **Supports the Decadal Survey through white papers and presentations**



The SBAG goals document

<https://www.lpi.usra.edu/sbag/goals/>

- New goals document posted February 2020
- New document preserves the three goals listed on the right.
- Technology and human exploration sections are included
- ISRU section will be updated in the next goals document

Goal 1: Small Bodies, Big Science.

Investigate the Solar System's formation & evolution & advance our knowledge about the early Solar System conditions necessary for the origin of life through research & exploration uniquely enabled by small bodies.

Goal 2: Defend Planet Earth.

Understand the population of small bodies that may impact our planet & develop ways to defend the Earth against any potential hazards.

Goal 3: Enable Human Exploration.

Advance our knowledge of potential destinations for human exploration within the small body population & develop an understanding of the physical properties of these objects that would enable a sustainable human presence beyond the Earth-Moon system.

Current and Approved Future Missions to Small Bodies in the Solar System



Psyche
future
NASA

OSIRIS-REx
current
NASA

MMX
future
JAXA

NEOSURVEYOR
future

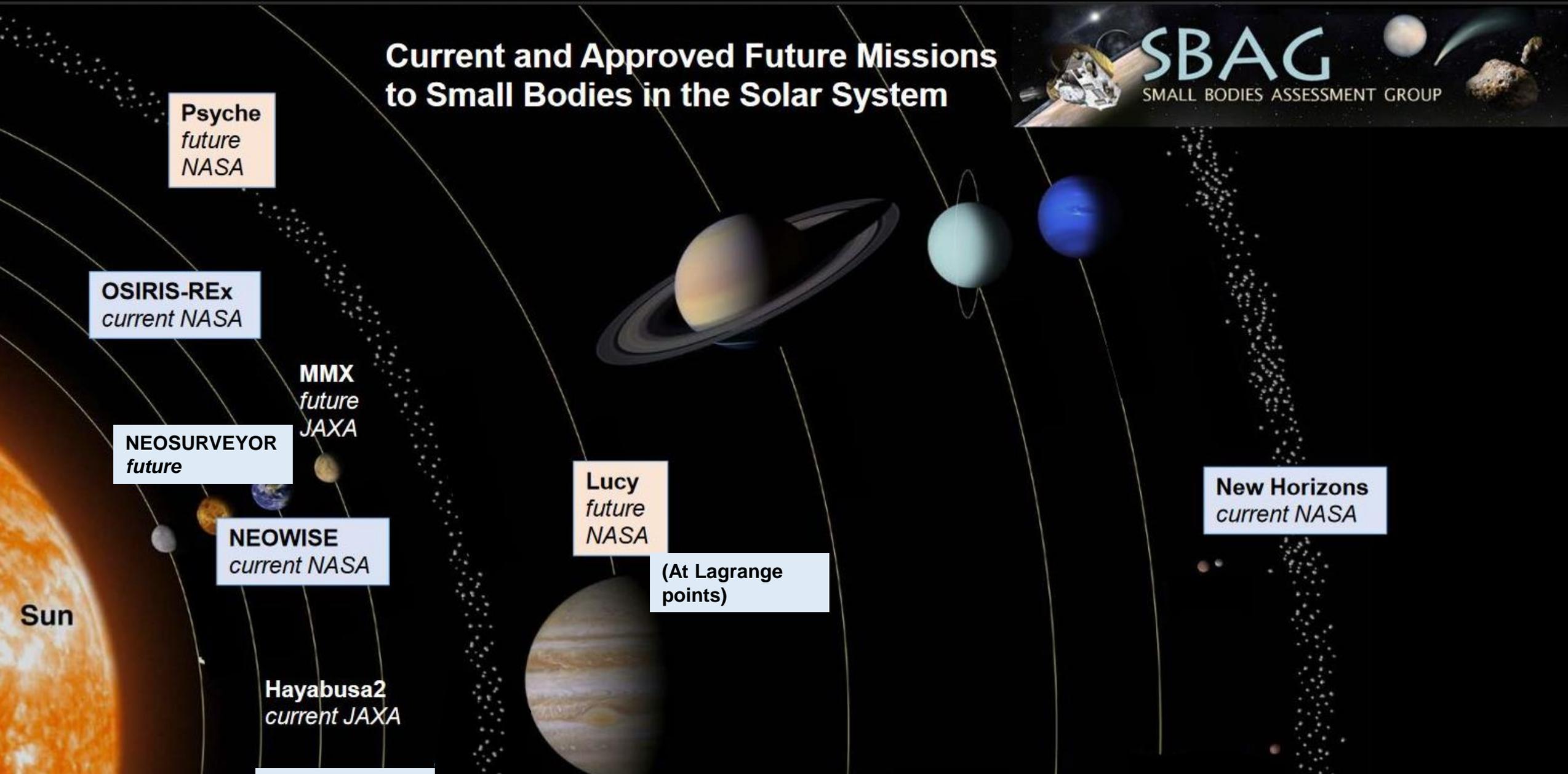
NEOWISE
current
NASA

Lucy
future
NASA

(At Lagrange points)

Hayabusa2
current
JAXA

New Horizons
current
NASA



Highlights of of January 2021 findings (key ones that keep coming up)

1. **SBAG reiterates its support for a space-based near-infrared asteroid survey mission and expresses concern over the delay to KDP-B for NEO Surveyor.**
2. **SBAG recommends that NASA support additional asteroid radar observations at other facilities in order to meet a portion of the scientific and planetary defense goals previously accomplished by the Arecibo Observatory.** These steps are outlined in a white paper (https://www.lpi.usra.edu/sbag/documents/SBAG_RadarRecovery_20210217.pdf)
3. **SBAG also recommends that NASA continue to consult with NSF and/or other relevant agencies about the Arecibo collapse and the process for deciding what happens next with the site, in order to ensure that the implications for NEO observations are adequately included.**
4. **SBAG applauds the transparent, full-community process conducted by NASA to confirm the targets that will be in scope for New Frontiers 5.**
5. **SBAG urges NASA to clarify in the PDART (or other relevant) solicitation that explicitly indicate that development of software tools to work with Solar System data from the Rubin Observatory are within the scope of the program or to add a solicitation specifically for Solar System science using Rubin data.**

(Full text at <https://www.lpi.usra.edu/sbag/findings/>)

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6. SBAG encourages NASA to use resources at its disposal to identify the key science that can be addressed from the 2029 Earth flyby of asteroid Apophis, and to also investigate spacecraft and ground-based opportunities to support this event.
7. SBAG encourages NASA to continue exploring potential opportunities for cooperation with other US government agencies (e.g. NSF, Space Force, DoD, etc.) in the development of technologies and the operation of facilities relevant for planetary science, planetary defense, and space situational awareness
8. SBAG appreciates the lengths to which NASA has gone to soften the impacts of the COVID-19 pandemic on the community. SBAG appreciates the lengths to which NASA has gone to soften the impacts of the COVID-19 pandemic on the community.

(Full text at <https://www.lpi.usra.edu/sbag/findings/>)

Table 1. SBAG's suggested improvements to current radar capabilities.

Facility	Description	Estimated additional cost to NASA	Comments
DSN: Goldstone	Increased radar observing time with GSSR and DSS-13	Operating costs	
Green Bank Phase 1 transmitter Phase 2 proposal	NEO observations Development of new transmitter	Operating costs \$30 million +	Collaborate with NSF
DSN: Canberra Receive with Parkes (Australia)	DSS-43 80 kW klystron New Parkes receiver	Operating costs ~\$300,000	Collaborate with CSIRO
Haystack	NEO observations with existing transmitters and receivers	Operating and startup costs	Operated by MIT, Lincoln Laboratory; requires proposal to NASA.
DSN: Madrid Receive with Sardinia (Italy)	DSS-63 or DSS-53 transmitters	Operating costs	Collaborate with INAF
EISCAT UHF EISCAT 3D (Scandinavia)	Available through 2025. Buildup of new system; available after 2022.		Encourage planetary radar observations by EISCAT consortium
TIRA (Germany)	NEO observations with existing transmitter and receivers.		Encourage planetary radar observations by Fraunhofer Institute, ESA.

Summary and future

- Next Meeting: June 6-7, 2021, virtual
- SBAG Findings are based on broad community input, represent the consensus of the community, and pinpoint persistent problems that need attention at the highest levels. Right now that is recovery of Arecibo NEO science
- SBAG Decadal White Paper work (detailed in backup slides)
 - Oversaw a collection of Decadal White Papers that represent broad science questions and community input.
 - Distributed and analyzed a questionnaire on research and mission priorities that was produced as a white paper.
 - “Supervised” (lightly) target papers, but not mission papers or technology
 - The Steering Committee endorsed some of the Decadal papers on Diversity, Inclusion, and Equity, and workforce and climate issues.
 - Prepared to assist the Decadal Committees in any way we are asked.



Small Bodies Assessment Group (SBAG)

Backup (Decadal work)

Decadal Survey, summary of SBAG actions

- SBAG curated five broadly supported white papers based on five “Big Questions” (next viewgraph, which in turn were based on our goals document).
- The January 2020 meeting included a workshop in which the community signed up for individual papers that covered the major small body targets.
- Specific mission white papers or technology white papers were not organized by SBAG
- SBAG sent out a questionnaire to the community on science and mission priorities that was turned into a white paper.
- SBAG intends to endorse a Diversity, Inclusivity, Equity paper, or other workforce or climate papers if asked. MAPSIT White Paper already endorsed

Big questions for the Decadal Survey (based on goals document) that formed the basis of five SBAG-initiated White Papers

- What do small bodies tell us about the formation of the Solar System and the conditions in the early solar nebula?
- What does the distribution, composition, and sizes of small bodies tell us about the evolution of the Solar System, including its dynamical history, cratering processes, and the influx of volatiles and organics into the inner Solar System?
- Do sustainable habitable environments exist on any of the small bodies?
- What are the main geological processes that determined the evolution and current state of the small bodies and are they similar to those on larger bodies?
- What threat do Near-Earth Objects pose to civilization and life on Earth, and how can we quantify and mitigate that threat?

Summary of white papers, cont.'d (see <https://www.lpi.usra.edu/decadal/sbag/>)

Main White Papers Based on Scientific Goals	Relevant Targets	Lead Author
What do small bodies tell us about the formation of the Solar System and the conditions in the early solar nebula?	KBOs; Small satellites; Comets; Asteroids; Interstellar bodies	Bjorn Davidsson (JPL)
The Evolution of Small Body Populations: from Planet Migration to Thermal Drift Forces What does the distribution, composition, and sizes of small bodies tell us about the evolution of the Solar System, including its dynamical history, cratering processes, and the influx of volatiles and organics into the inner Solar System?	All	Bill Bottke (SWRI), JJ Kavelaars (Dominion Astrophysical Observatory)
Do sustainable habitable environments exist on any of the small bodies?	Ceres; large KBOs	Julie Castillo-Rogez (JPL)
What are the main geological processes that determined the evolution and current state of the small bodies and are they similar to those on larger bodies?	All	Carol Raymond (JPL)
The Future of Planetary Defense in the Era of Advanced Surveys. What threat do Near-Earth Objects pose to civilization and life on Earth, and how can we quantify and mitigate that threat?	NEOs	Amy Mainzer (LPL)

Most of the other small body white papers, including ones on Main Belt asteroids, comets, dust, KBOs, interstellar objects, Centaurs, Pluto, and small moons, are also listed and linked at the above web site. Many were encouraged by SBAG during the January 2020 workshop. Copies of the submitted white papers are on the Academy website: <https://www.nationalacademies.org/our-work/planetary-science-and-astrobiology-decadal-survey-2023-2032>

The Questionnaire

Mark Sykes commissioned a SBAG-led questionnaire for the previous Survey. The questions covered missions and research priorities. The questions were updated by the current SBAG Steering Committee and distributed to the community. The results were submitted as a white paper.

Summary: SBAG surveyed the small bodies community for input to the Planetary Decadal Report. Seventeen questions on science and mission priorities were answered by 121 respondents. The highest priority scientific issues for small bodies were population identification and physical/compositional characterization; understanding the characteristics and evolution of individual objects; determination of the early conditions in the Solar System; and completion of the catalogue of PHAs. The highest priority flagship mission was a comet sample return followed by a Pluto orbiter/KBO mission. A comet sample return was also the highest priority New Frontiers mission, followed by a Ceres lander and a Main Belt multiple asteroid mission. Emphasis was also placed on the importance of ground-based and Earth orbiting telescopes (including radar), laboratory studies, and theory. The group also advocated preserving research funding over missions in the event of budget pressures.