

Bonnie Buratti, SBAG Steering Committee Chair

March 10, 2020 NASA Headquarters

www.lpi.usra.edu/sbag/

Who are we?

Steering Committee

Dan Adamo (independent consultant),
Human Exploration Lead

Elena Adams (APL), Technology Lead

Maitrayee Bose (Arizona State Univ.)

Bonnie Buratti (NASA JPL), Chair

Terik Daly (APL), Early Career Secretary

Mike DiSanti (NASA Goddard)

Jesse Dotson (NASA Ames), Planetary Defense Lead

Carolyn Ernst (APL)

David Gerdes (U. of Michigan)

Andy Rivkin (APL)

Jennifer Scully (JPL)

Hannah Susorney (U. of British Columbia),
Early Career Secretary

Tim Swindle (U. of Arizona), Past Chair

Patrick Taylor (LPI)

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

What does SBAG do?

- Seeks broad planetary science community input on small bodies and missions to small bodies.
- SBAG TOR (2011) lists asteroids, comets, interplanetary dust, small satellites, and Trans-Neptunian Objects; we also include Centaurs, meteorites, and planetary defense.
- Holds open meetings twice each year for community participation.
- Maintains a Goals Document.
- Makes findings: community-based concerns and issues that need to be addressed.

The SBAG goals document

- 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 was planned, but interest dwindled from community

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.

Small bodies missions

- Two asteroid sample return missions arrived at targets: OSIRIS-REx (NASA), Hayabusa2 (JAXA; sample collected).
- New Horizons: Series of *Science* papers over the past year; extended mission to study KBOs remotely.
- NEOWISE: sizes and albedos of NEOs.
- Psyche and Lucy (submitted to *Discovery* 2014): investigate different stages in Solar System development from study of a metallic asteroid (16 Psyche) and primitive planetesimals (Jupiter Trojans), respectively.
- NEO Surveillance Mission : directed mission to discover and characterize the orbits of 90% (goal) the potentially hazardous asteroids larger than 140 meters
- Other missions: DART (kinetic impactor planetary defense demo), Hera (ESA), Destiny+ dust mission (3200 Phaeton, parent of Geminid meteor shower) and MMX (Mars moons) (JAXA, planned launches 2022 and 2024), Comet Interceptor (ESA; 2028 Launch),
- Overlap: Trident Discovery Mission downselect February 2020 to explore Triton, capture a flyby of a Centaur on the way, and accomplish an extended mission into the Kuiper Belt.

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



Psyche
future
NASA

OSIRIS-REx
current
NASA

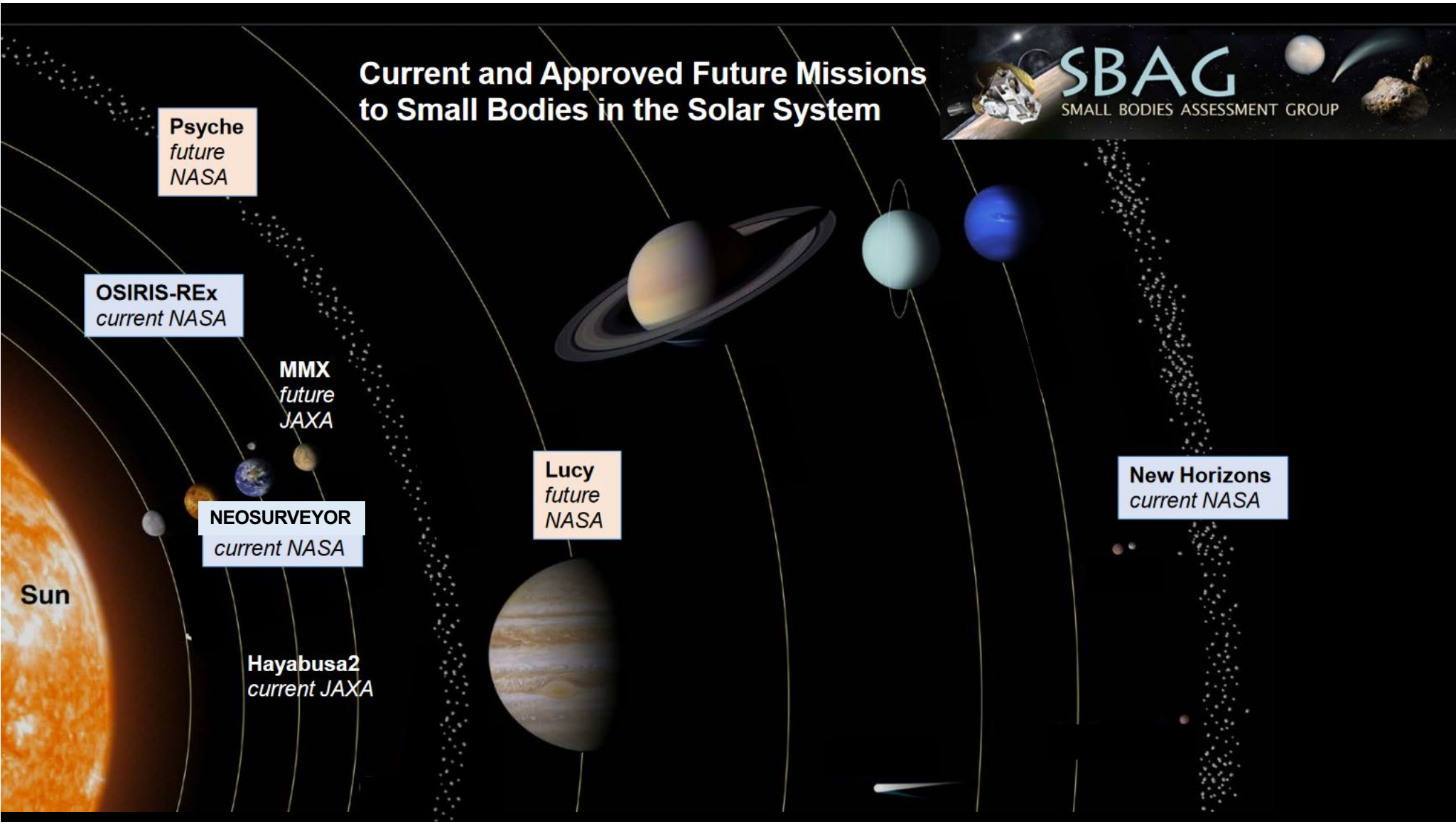
MMX
future
JAXA

NEOSURVEYOR
current
NASA

Hayabusa2
current
JAXA

Lucy
future
NASA

New Horizons
current
NASA



Meeting January 14-16, 2020 Pasadena

Tuesday January 14, 2020

- 8:30 Welcome
- 8:40 Planetary Science Division Overview – Lori Glaze
- 9:30 Responses to SBAG 21 findings – Tom Statler
- 10:00 *Break*
- 10:15 OSIRIS-REX update and report on Asteroid Science in the Age of Hayabusa2 and OSIRIS-REX workshop – Dante Lauro (by telecon)
- 10:35 New Horizons Extended Mission – Alan Stern (by telecon)
- 10:45 LSST update – Meg Schwamb (by telecon)
- 10:55 Early-career talk
- 11:10 Early-career lightning talks
- 11:30 Open mic and questions from community
- 11:55 Announcement of ACM 2020 (Flagstaff June 14-19, 2020) – Andy Rivkin
- 12:00 *Lunch*
- 1:30 Planetary Defense Coordination Office – Lindley Johnson
- 2:00 NEO Program – Kelly Fast
- 2:15 NEOWISE – Emily Kramer
- 2:25 NEO Surveillance Mission update – Amy Mainzer
- 2:45 DART – Elena Adams
- 3:00 NHATS update – Paul Chodas
- 3:15 *Break*
- 3:30 Janus – Lance Benner
- 3:40 The Parker Solar Probe and Sun-Grazing Comets – Karl Battams (by telecon)
- 3:50 Minor Planet Center: Comet Subnode of the Planetary Data System – Gerbs Bauer
- 4:05 Issues from PDS Management Council – Louise Prockter
- 4:15 FAIR practices and DOI citations in datasets – Anne C. Rough
- 4:25 Open mic
- 5:00 Close of Business

Wednesday January 15, 2020

- 8:30 Hera update – Ian Carnelli, Patrick Michel (by telecon)
- 8:45 NEA Scout Program Update – Julie Castillo
- 8:55 Psyche update – Carol Polansky
- 9:05 Comet Borisov science (review) – Matthew Knight
- Planetary Mission Concept Studies:**
- 9:20 Assessing Dwarf Planet Ceres Past and Present Habitability Potential – Julie Castillo
- 9:35 Pluto Orbiter and Kuiper Belt Exploration Mission – Stuart Robbins (by telecon)
- 9:50 Arecibo/Goldstone update – Noemi Pinilla-Alonso, Lance Benner, Flaviane C. F. Venditti
- 10:05 *Break*
- 10:30 HEOMD update – Paul Niles (by telecon)
- 10:45 Goals Overview – Tim Swindle/Bonnie Buratti
- 11:00 Goals: Diversity – Carolyn Ernst
- 11:10 Goals: ISRU – Dan Britt
- 11:20 Open mic
- 11:50 *Lunch*
- 12:30 Decadal Kick Off: Timing; preliminary list of White Papers and possible authors; strategy; coordination with other groups on overlapping areas (martian moons, Triton; outer irregular moons) etc. Include open mic during this time or after break
- 2:00 *Break*
- 3:15 MMX – Takahiro Nakamura (by telecon)
- 03:30 Hayabusa2 update – Yuichi Tsuda (by telecon)
- 03:45 Open mic and findings from community
- 04:15 Steering Committee Executive Session

Thursday January 16, 2020

- 9:00 Near-Earth Object Characterization Priorities for Planetary Defense – Brent Barbee (by telecon).
- 9:20 Lucy update – Hal Levinson (by telecon)
- 9:40 CAPS Report – Bonnie Buratti
- 9:50 PAC Report – Michael DiSanti
- 10:00 JWST and small bodies/upcoming proposal opportunity – Bryan Holler (by telecon)
- 10:15 *Break*
- 10:30 Hermes – Kristen John (probably by telecon)
- 10:45 Preliminary list of findings
- 11:30 Next meeting date (Eastern half of US)

Overview of January 2020 findings (key ones that keep coming up)

- SBAG encourages NASA to work with relevant stakeholders to ensure that future budgets support the Near-Earth Object Surveillance Mission (NEOSM) at a level sufficient to achieve the mission's planetary defense goals as currently scheduled
- SBAG urges NASA to continue its efforts to broaden participation in the field and to develop a workforce that supports and understands the benefits of a diverse community.
- SBAG expresses concern over insufficient investment by NASA on facilities and personnel essential to achieve the full benefit of analysis of samples returned by planetary missions.
- SBAG would like clarification of what targets will be permitted for the New Frontiers 5 call, particularly whether a comet nucleus sample return and a Trojan tour and rendezvous mission will remain options.

Overview of January 2020 findings, cont'd

- SBAG remains troubled by the overall funding profile of Arecibo Observatory and is increasingly concerned about the availability of klystron transmitters for Goldstone and Arecibo.
- SBAG supports the effort by NASA to adopt a policy enabling federal workers to attend international meetings.
- SBAG strongly supports NASA-funded Participating Scientist and Guest Investigator programs for US and non-US science and planetary defense missions to small bodies.
- SBAG encourages NASA and NSF to support preparatory work dedicated to maximizing small-body science from both ground-based and space-based telescopes including analysis tools and specialized workshops, and to identify the programs in which such efforts will be supported.

Incoming decadal thoughts and issues

- SBAG planned to produce a small number (less than a dozen) broadly supported white papers to assist the Decadal Survey Committee. Ideally, the entire steering committee would sign these papers
- SBAG supports the idea of science-based criteria driving the Decadal Survey.
- Overlap exists between the exploration goals of SBAG and the other AGS. Examples are moons of the gas and ice giants, as well as Phobos and Deimos. We therefore propose joint white papers among AGs.
- Specific mission white papers or technology white papers would not be “curated” by SBAG
- SBAG would sign on to a Diversity, Inclusivity, Equity paper.

Big questions for the decadal report (based on goals document)

- 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?

Discipline-specific issues for the decadal report

SBAG emphasizes the importance of including planetary defense priorities in the upcoming Decadal Survey. As recently highlighted in the National Academies ... report *Finding Hazardous Asteroids Using Infrared and Visible Wavelength Telescopes*, planetary defense missions are currently proposed in response to planetary science competed mission solicitations. However, since planetary defense priorities were not included in the last Decadal Survey, there are no criteria available to evaluate these missions' ability to achieve important, non-science, planetary defense objectives. The National Academies report recommends “missions meeting high-priority planetary defense objectives should not be required to compete against missions meeting high-priority science objectives.” As there is no current alternative mechanism for the evaluation of proposed planetary defense missions, SBAG encourages the inclusion of planetary defense priorities in the upcoming Decadal Survey, so that these missions, which draw strongly on expertise and technologies used and advanced by the planetary science community, may be evaluated on relevant criteria. (June 2019 finding)

Summary of SBAG “blessed” white papers (green)

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

A	B	C	D	E	F
Main White Papers Based on Scientific Goals	Relevant Targets	Lead Author	Contact email	Main Co-Authors	Notes
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)	Bjorn.Davidsson@jpl.nasa.gov		
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)	bottke@boulder.swri.edu		
Do sustainable habitable environments exist on any of the small bodies?	Ceres; large KBOs	Julie Castillo-Rogez (JPL)	Julie.C.Castillo@jpl.nasa.gov		
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)	Carol.A.Raymond@jpl.nasa.gov		
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)	amainzer@lpl.arizona.edu	Perhaps the same white paper as the Planetary Defense paper (see below)	
White Papers Based on Targets	Heritage/Shared With	Lead Author	Contact email	Main Co-Authors	Notes
Large KBOs (Including Pluto?)	OPAG	Stuart Robbins	robbins@boulder.swri.edu	Rivkin/Pinilla-Alonso/Leiva	There is a white paper led by Robbins entitled "A White Paper on Pluto Follow On Missions: Background, Rationale, and New Mission Recommendations" on the OPAG spreadsheet - I think this is the same one
Small KBOs	OPAG	Jason Hofgartner/Pinilla-Alonso	Jason.D.Hofgartner@jpl.nasa.gov Npinilla@ucf.edu	Leiva	There is a white paper led by Omurhan and Mandt entitled "Exploration of Dwarf Planets, KBOs and Centaurs" on the OPAG spreadsheet - this is probably a different white paper than the one listed here
Main-Belt Asteroids		McAdam/Rivkin	Andy.Rivkin@jhuapl.edu	Susorney, Rivkin, Hartzell/Pinilla-Alonso, De Pra, Masiero, Harris	
Comets		Knight/DiSanti	michael.a.disanti@nasa.gov	Springmann?	
Ceres	LPI	Castillo-Rogez	Julie.C.Castillo@jpl.nasa.gov	Rivkin/Hughson/Raymond/Scully/Villarreal	
Pluto	Joint with OPAG				There is a white paper led by Robbins entitled "A White Paper on Pluto Follow On Missions: Background, Rationale, and New Mission Recommendations" on the OPAG spreadsheet - is this the same one? Will large KBOs and Pluto be the same white paper?
NEOs		Mike Nolan	michaelcnolan.1@gmail.com	Hartzell, Harris, Dotson	

White papers, cont'd

Planetary Defense		Mainzer	amainzer@lpl.arizona.edu	Masiero, Daly, Harris, Binzel, Marcks, Do	Perhaps the same white paper as the scientific goals paper (see above)
Centaurs	OPAG	Pinilla-Alonso	Npinilla@ucf.edu	Leiva	There is a white paper led by Omurhan and Mandt entitled "Exploration of Dwarf Planets, KBOs and Centaurs" - this is probably a different white paper than the one listed here
Small Satellites - Outer Planets	OPAG	Holt/Buratti	Bonnie.Buratti@jpl.nasa.gov		There is a white paper led by Holt entitled "Exploration of Dwarf Planets, KBOs and Centaurs" on the OPAG spreadsheet - is this is the same one? If not, there should be a paper on small moons covering the same objects as the last decadal SBAG white paper.
Interplanetary and interstellar dust as windows into solar system origins and evolution	LPI	Horanyi/Turner	horanyi@colorado.edu	Balint/Kempf/Sternovsky/Szalay/Poppe	
Interstellar objects	LPI	Meech	meech@ifa.hawaii.edu	Hainaut/Raymond/Fitzsimmons/Michel i/Farnocchia/Jedicke/Bailer- Jones/Yang/Weryk/Pinilla- Alonso/Dotson	
Small Body Sample Return (inc. Facilities)		Seth Jacobson		Lister, Bose, Soderblom	Replaced by below white paper?
Small body sample return and their laboratory analysis	LPI	Scott Sandford		Bose, Lister, Soderblom, Raymond, Jacob	Replaces above white paper?
Habitable Small Bodies		Raymond (suggestion: add to habitability "big question").		Bose	Replaced by below white paper?
Habitability of Small Bodies	LPI	Castillo-Rogez			Replaces above white paper?
Phobos/Deimos		Ernst			
Trojans		Pinilla-Alonso/De Pra			
Eris		Castillo-Rogez to lead or find a lead (Jason Hofgartner interested)			
Hildas/Cybeles		De Pra			
Enabling Reactive Missions for Fast, High-Value Targets	LPI	Castillo-Rogez		Meech/Moore/Courville/Mitchell	
Main Belt Comets as clues to the Distribution of Water in the Early Solar System	LPI	Meech		Raymond/Choukroun/Castillo- Rogez/Hainaut/Hsieh/Huss/Jewitt/Krot /Morbideilli/Prialnik	
Nearly Isotropic Comets and Manxes	LPI	Meech		Hainaut/Yang/Micheli/Bufanda/Keane/Kleyna	

Summary and future

- Next Meeting: June 1 and 2, 2020 at APL
- 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.
- Small bodies white papers for the Decadal will be focused on “big picture” questions with broad support.