

# **Small Body Science Issues**

**Joe Nuth, lead**

**SBAG**

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# Organization of Outline

- We have a broad range of objects that fall under our purview. However, to some extent, (more for some objects, much less for others) studies of any of these objects can contribute to the same set of basic scientific objectives.
- What follows is a list of solar system objects and broad scientific issues that can be addressed by the study of small bodies.
- Please feel free to add to either list – or to send text to be included in the initial report.

# **Initial List of Small Bodies Included**

- Meteorites, IDPs and Returned Samples
- Short and Long-Period Comets
- Near Earth Objects (Apollos, Atens & Amors)
- Main Belt Asteroids (and comets)
- Phobos and Demos
- Large, Icy Satellites of the Giant Planets
- Irregular Satellites of the Giant Planets
- Trojan Asteroids
- Centaurs and Trans Neptunian Objects
- Pluto and Kuiper-Belt Objects
- Small Bodies in the Oort Cloud

# Contributors to Various Sections:

- Meteorites, IDPs and Returned Samples – **We may add a section on the Zodiacal Dust Population if the promised contribution is ever delivered by Bill Reach (SOFIA Assoc. Dir. For Science).**
  - *Josep M. Trigo i Rodríguez, Institute of Space Sciences (CSIC-IEEC)*
  - Marc Fries Planetary Science Institute, Tucson, AZ
- Short and Long-Period Comets – **Meat-Axe Modification**
  - H. A. Weaver, Johns Hopkins University Applied Physics Laboratory, Laurel, MD
  - K. J. Meech University of Hawaii, Institute for Astronomy, Manoa, HI
  - Joseph Nuth, NASA's Goddard Space Flight Center, Greenbelt MD
- Near Earth Objects (Apollos, Atens & Amors) – **Shotgun Wedding**
  - Michael Nolan, Cornell University, Arecibo Observatory, Puerto Rico.
  - Dante S. Lauretta, Lunar and Planetary Laboratory, University of Arizona
  - Carl W. Hergenrother, Lunar and Planetary Laboratory, University of Arizona
  - Joseph Nuth, NASA's Goddard Space Flight Center, Greenbelt MD
- Phobos and Demos
  - Marc Fries Planetary Science Institute, Tucson, AZ
  - Andy Rivkin Johns Hopkins University Applied Physics Laboratory, Laurel, MD
  - Scott Murchie Johns Hopkins University Applied Physics Laboratory, Laurel, MD
  - Nancy Chabot Johns Hopkins University Applied Physics Laboratory, Laurel, MD
- Main Belt Asteroids (and comets)
  - Andy Rivkin, Johns Hopkins University Applied Physics Laboratory, Laurel, MD
  - Julie C. Castillo-Rogez, Jet Propulsion Laboratory, Pasadena, CA
  - Olivier S. Barnouin, Hopkins University Applied Physics Laboratory, Laurel, MD
  - Dante S. Lauretta, Lunar and Planetary Laboratory, University of Arizona
  - Carl W. Hergenrother, Lunar and Planetary Laboratory, University of Arizona
  - Joseph Nuth, NASA's Goddard Space Flight Center, Greenbelt MD
- Satellites of the Giant Planets
  - Julie C. Castillo-Rogez, Jet Propulsion Laboratory, Pasadena, CA
  - Akos Kereszturi, Collegium Budapest, Budapest, Hungary
- Trojan Asteroids
  - Andy Rivkin, Johns Hopkins University Applied Physics Laboratory, Laurel, MD
  - Yan Fernandez, University of Central Florida, Department of Physics, Orlando, FL
- Centaurs and Trans Neptunian Objects
  - **No one has yet contributed to this section**
- Pluto and Kuiper-Belt Objects
  - Julie C. Castillo-Rogez, Jet Propulsion Laboratory, Pasadena, CA
- Small Bodies in the Oort Cloud
  - **No one has yet contributed to this section**

# Modified List of Small Bodies

- Meteorites, IDPs and Returned Samples
- **Short and Long-Period Comets**
- **Near Earth Objects (Apollos, Atens & Amors)**
- **Main Belt Asteroids (and comets)**
- Phobos and Demos
- Satellites of the Giant Planets
- Trojan Asteroids
- **Centaur and Trans Neptunian Objects**
- Pluto and Kuiper-Belt Objects
- ~~Small Bodies in the Oort Cloud~~

**Needs Editing**

**Needs an Author**

# Original Scientific Issues of Interest

- **Solar System Origins**: understanding the original composition of the nebula; the timing of events such as planet formation, differentiation and core formation and the chemical and isotopic evolution of the system with time.
- **Solar System Dynamics** : understanding nebular collapse and transport; planetesimal accretion, migration and mutual interactions; evolution of the solar system through time and the cratering history of the solar system.

# Original Scientific Issues of Interest

- Current State of the Solar System : What is the size distribution and chemical composition of small bodies in the Solar System? How does this compare to extra-solar systems?
- ISRU : What resources might be available to support human and robotic exploration of and human expansion into the solar system?
- Hazards : What is the internal structure and chemical composition of objects that might become an impact hazard to life on Earth?

# Additional Scientific Issue of Interest

- **Astrobiology**
- **Julie Castillo-Rogez** (who has authored or co-authored much of this report!) suggested adding a section on the astrobiological relevance of each object class to the Roadmap – and I concurred.
- **Do we have objections or suggestions for change?**



# **Backup - Organization**

**From the original presentation to SBAG**

# The Matrix Approach & Redundancy

- It is my intention to organize the report by the class of small body. This will make it easy to search, track changes and reference in proposals.
- For each object class we can address each broad set of scientific objectives that are applicable: Origins, Dynamics, Current State, ISRU & Hazards.
- This will, of necessity, introduce redundancy into the document (e.g., meteorites and asteroids; comets, KBOs and bodies in the Oort Cloud) but this is preferable to an incomplete document.

# The Matrix Approach & Redundancy

- The intent is for anyone to be able to search on, e.g., comets and to find their relevance to each of the major Science Issues (or they may find a statement that comets are not relevant to this particular Issue).
- Similarly, searching each Object Class for e.g., Origins, will list why the study of each object is or is not relevant to this topic.
- I am certainly open to a different organization. Send suggestions to [joseph.a.nuth@NASA.gov](mailto:joseph.a.nuth@NASA.gov)