

**A NASA SMALL BODIES ASSESSMENT GROUP WHITE PAPER
DESCRIBING A
SMALL BODIES COMPONENT
OF A NASA EXPLORATION SCIENCE INSTITUTE**

February 8, 2012

On January 17, 2012, James Green, NASA Planetary Science Division Director, stated at the Sixth NASA Small Bodies Assessment Group Meeting that an Exploration Science Institute was being contemplated that would encompass the range of targets embodied in the “Flexible Path” scenario for human exploration. These include NEOs, the Moon and Phobos and Deimos. In this white paper, we contemplate the mission of such an institute in the context of the small body components of these targets (NEOs, Phobos and Diemos) and an approach to achieving mission goals through Research Teams (similar to those supported by NLSI and NAI) and what we refer to as “Cornerstone Programs” that would be unique to characterizing these objects. It is the opinion of the SBAG that by competing not only research, but management of this institute, administration costs can be kept to a minimum, efficiencies maximized, and that resources available to research and other institute goals can also be maximized.

Overview

Flexible path scenario targets include NEOs, Phobos and Deimos. The Martian satellites are widely held to be captured asteroids, while the NEO population contains members originating in the main asteroid belt, Jupiter family comets, and other populations out through the Kuiper Belt and possibly beyond. Small bodies have been the targets of thirteen missions and have been observed by thirteen other missions and space-based observatories. Three missions are at or en route to their small body targets (Dawn, Rosetta, New Horizons), and four missions are currently under development targeting these bodies or are being planned (OSIRIS Rex, Hayabusa 2, Don Quixote, Marco Polo). These missions coupled with decades of ground-based observations and laboratory studies of meteorites have revealed a very compositionally and physically diverse population of objects.

In addition to being Flexible Path targets, Congress has directed NASA to improve our knowledge of the NEO population, because of their potential hazard to life on Earth. At the same time, NEOs also represent resources, possibly including abundant extractable water and metals, which may be used to permanently expand the presence of humans beyond Earth. Many NEOs are energetically easier to get to and return from than the surface of the Moon. On April 15, 2010, President Barack Obama gave a speech at the Kennedy Space Center in which he identified the goal of sending a crewed mission to an asteroid by 2025.

Mission Statement

A small bodies component of an Exploration Science Institute should foster collaborations within and among competitively selected domestic teams, the broader small bodies community, and multiple international partners, as well as educational institutions and the amateur astronomer community in order to

- ❖ Provide scientific and technical data and perspectives to NASA in support of its relevant small bodies research programs and missions, its human exploration programs, and planetary protection and defense.
- ❖ Conduct collaborative, cross-disciplinary research in relevant areas of small bodies science and enhance communication among geographically disparate researchers.
- ❖ Engage the broader domestic and international small bodies science community through in-person conferences, virtual seminars, and community-driven focus groups.
- ❖ Attract the next generation of small bodies scientists and expand a scientifically literate public by giving them research experiences at the secondary and undergraduate level.
- ❖ Train the next generation of small bodies scientists with research experiences and leadership roles at the graduate and post-doctoral level, while supporting early and later career scientists by facilitating collaborative opportunities across generations for funding and by providing conferences focusing on their needs.
- ❖ Encourage Education and Public Outreach (EPO) and Science, Technology, Engineering, and Mathematics (STEM) interest through formal education content development, informal student programs and participatory public events.

Research Teams

A small bodies component of an Exploration Science Institute would bring together competitively selected research teams to focus on questions of fundamental importance in understanding the formation, past and future evolution, composition and potential of NEOs (and Phobos and Deimos). These questions are derived from the Roadmap for the Exploration of Small Bodies in the Solar System by the NASA Small Bodies Assessment Group (in preparation), which in turn feed into fundamental science questions that guide NASA's solar system exploration program (2010 Science Plan for NASA's Science Mission Directorate). These questions are also informed by the Global Exploration Roadmap:

- (1) What is the inventory of NEOs and what processes are active in and among them?
- (2) How did NEOs originate and evolve, what are the characteristics of their source populations, and what are the processes by which the NEO population is lost and increased?
- (3) What is the role of NEOs and their source populations in solar system evolution and origin of life?
- (4) What are characteristics of small bodies that pose hazards and/or provide resources?

Thus, research increases our understanding of the NEO population (and Phobos and Deimos) by their direct study, theoretical studies, laboratory studies of meteorites, and indirectly by the study of their source populations.

Cornerstone Programs

In addition to Research Teams, which are major components of the NASA Lunar Science Institute and NASA Astrobiology Institute, a small bodies component of an Exploration Science Institute could also support and manage several Cornerstone Programs to systematically characterize populations of NEOs and potentially their source populations. They are highly diverse in their composition, physical properties, and evolutionary histories. Even when limited to NEOs alone, there are many thousands of targets that require individual characterization that are presently known today and many thousands of meteorites in the worlds' collections. This challenge mandates long-term collaborative efforts extending beyond the typical three to five year period of most research grants. Cornerstone projects contemplate a more novel model of collaborative activity in which guidelines and some level of overarching programmatic guidance are provided to coordinate interested educational and government institutions, private institutions and amateurs and assist them in the archiving of their data into the NASA Planetary Data System (resulting in referenceable peer-reviewed citations) or into meteorite databases. Characterization could include multi-wavelength imaging, spectroscopy, light-curves, phase-curves, serendipitous occultation observations, and other observations and fundamental compositional and other measurements of meteorites.

Exploration Science Institute Management

Like the NASA Astrobiology Institute (NAI) and NASA Lunar Science Institute, a small bodies component of a NASA Exploration Science Institute would be virtual, with the participation of teams from institutions scattered across the country. While novel more than 15 years ago with the establishment of NAI, with the evolution of the Internet efficient administration of geographically distributed organizations and projects is increasingly common by universities and private businesses.

NASA would maximize efficiency and the funds available for Institute science by openly competing Institute administration and management.

Small bodies science expertise should be required within NASA Exploration Science Institute management in order for it to effectively perform its duties.