ROBOTIC RECONNAISSANCE MISSIONS TO SMALL BODIES AND THEIR POTENTIAL CONTRIBUTIONS TO HUMAN EXPLORATION. P. A. Abell[1] and A. S. Rivkin[2], [1]Exploration Integration and Science Directorate, NASA Johnson Space Center, 2101 NASA Parkway, Houston, TX 77058, paul.a.abell@nasa.gov, [2]The Johns Hopkins University Applied Physics Laboratory, 11100 Johns Hopkins Road, Laurel, MD 20723, andy.rivkin@jhuapl.edu.

Introduction: Robotic reconnaissance missions to small bodies will directly address aspects of NASA's Asteroid Initiative and will contribute to future human exploration. The NASA Asteroid Initiative is comprised of two major components: the Grand Challenge and the Asteroid Mission. The first component, the Grand Challenge, focuses on protecting Earth's population from asteroid impacts by detecting potentially hazardous objects with enough warning time to either prevent them from impacting the planet, or to implement civil defense procedures. The Asteroid Mission involves sending astronauts to study and sample a near-Earth asteroid (NEA) prior to conducting exploration missions of the Martian system, which includes Phobos and Deimos.

The science and technical data obtained from robotic precursor missions that investigate the surface and interior physical characteristics of an object will help identify the pertinent physical properties that will maximize operational efficiency and reduce mission risk for both robotic assets and crew operating in close proximity to, or at the surface of, a small body. These data will help fill crucial strategic knowledge gaps (SKGs) concerning asteroid physical characteristics that are relevant for human exploration considerations at similar small body destinations.

Small Body Strategic Knowledge Gaps: For the past several years NASA has been interested in identifying the key SKGs related to future human destinations. These SKGs highlight the various unknowns and/or data gaps of targets that the science and engineering communities would like to have filled in prior to committing crews to explore the Solar System. An action team from the Small Bodies Assessment Group (SBAG) was formed specifically to identify the small body SKGs under the direction of the Human Exploration and Operations Missions Directorate (HEOMD), given NASA's recent interest in NEAs and the Martian moons as potential human destinations [1]. The action team organized the SKGs into four broad themes:

1) Identify human mission targets;
2) Understand how to work on and interact with the small body surface;
3) Understand the small body environment and its potential risk/benefit to crew, systems, and operational assets; and
4) Understand the small body resource potential.

Each of these themes were then further subdivided into categories to address specific SKG issues.

Robotic Precursor Contributions to SKGs: Robotic reconnaissance missions should be able to address specific aspects related to SKG themes 1 through 4. Theme 1 deals with the identification of human mission targets within the NEA population. The current guideline indicates that human missions to fast-spinning, tumbling, or binary asteroids may be too risky to conduct successfully from an operational perspective. However, no spacecraft mission has been to any of these types of NEAs before.

Theme 2 addresses the concerns about interacting on the small body surface under microgravity conditions, and how the surface and/or sub-surface properties affect or restrict the interaction for human exploration. The combination of remote sensing instruments and *in situ* payloads will provide good insight into the asteroid's surface and subsurface properties.

SKG theme 3 deals with the environment in and around the small body that may present a nuisance or hazard to any assets operating in close proximity. Impact and surface experiments will help address issues related to particle size, particle longevity, internal structure, and the near-surface mechanical stability of the asteroid. Understanding or constraining these physical characteristics are important for mission planning.

Theme 4 addresses the resource potential of the small body. This is a particularly important aspect of human exploration since the identification and utilization of resources is a key aspect for deep space mission architectures to the Martian system (i.e., Phobos and Deimos).

Conclusions: Robotic reconnaissance of small bodies can provide a wealth of information relevant to the science and planetary defense of NEAs. However, such missions to investigate NEAs can also provide key insights into small body strategic knowledge gaps and contribute to the overall success for human exploration missions to asteroids.

References: [1] A. S. Rivkin et al. (2013) Small Bodies Assessment Group Special Action Team report on small body strategic knowledge gaps. http://www.lpi.usra.edu/sbag/meetings/jan2013/presentations/sbag8_presentations/MON_1330_Sykes_SBAG_SKG_SAT_report.pdf