THE ASTEROID IMPACT AND DEFLECTION ASSESSMENT MISSION AND ITS POTENTIAL CONTRIBUTIONS TO HUMAN EXPLORATION OF ASTEROIDS. 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: The joint ESA and NASA Asteroid Impact and Deflection Assessment (AIDA) mission 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. AIDA's primary objective is to demonstrate a kinetic impact deflection and characterize the binary NEA Didymos. The science and technical data obtained from AIDA will aid in the planning of future human exploration missions to NEAs and other small bodies.

The dual robotic missions of AIDA, ESA's Asteroid Impact Monitor (AIM) and NASA's Double Asteroid Redirection Test (DART), will provide a great deal of technical and engineering data on spacecraft operations for future human space exploration while conducting in-depth scientific examinations of the binary target Didymos [1, 2] both prior to and after the kinetic impact demonstration. The knowledge gained from this mission will help identify asteroidal physical properties in order to maximize operational efficiency and reduce mission risk for future small body missions. The AIDA data will help fill crucial strategic knowledge gaps 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 strategic knowledge gaps (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 [3]. 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.

Potential AIDA Contributions: The AIDA mission should be able to address specific aspects related to SKG themes 2 and 3, and possibly some aspects related to themes 1 and 4. Theme 1 deals with the identification of human mission targets within the NEA population. The current guideline indicates that human missions to binary asteroids may be too risky to conduct successfully from an operational perspective. However, no spacecraft mission has been to a binary NEA before. Hence the information that AIDA will gather on the Didymos system could be used to reassess the current restriction concerning binary asteroids as potential human destinations.

SKGs from themes 2 and 3 are undoubtedly where the data from the AIDA mission will return the most value. 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. The AIM spacecraft has a suite of remote sensing instruments (e.g., visible and thermal imagers, radar transmitter, radio science receiver, etc.) that can characterize the surface of Didymos to a high degree. These instruments can also be used to infer some of the interior properties of the binary asteroid system. In addition, AIM has two payload packages that are planned for deployment for *in situ* characterization of the surface. These element packages will be able to gather vital information on the geotechnical and compositional properties of Didymos. The combination of the remote sensing instrument suite and the *in situ* payloads with their local perspective, will provide AIDA with good insight into the asteroid's surface and subsurface properties. This knowledge will be useful in planning and designing the systems required for astronauts to explore and work on the surface of an NEA.

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. Both the DART and AIM spacecraft contribute to the SKGs related to this particular theme. AIM will be able to image the Didymos system and constrain the size of any particulates that may be present prior to the arrival of DART. AIM will also be able to image the impact of DART and monitor the response of the binary system to the kinetic impact. The information gained on the crater formation processes, the amount of ejecta released during the impact, and the ejecta's response over time will help address issues related to particle longevity, internal structure, and the near-surface mechanical stability of the asteroid. Understanding or constraining these physical characteristics are also important for future human mission planning.

Although Didymos has not been identified as an organic or volatile-rich asteroid [4], the AIDA mission data may be used to constrain whether or not potential resources could exist on similar targets on the surface or at depth. This would address the SKG theme 4 and help identify the protocols necessary for understanding the resource potential of small bodies.

Conclusions: The AIDA mission comprised of ESA's AIM spacecraft and NASA's DART impactor can provide a wealth of information relevant to the science and planetary defense of NEAs. However, this mission to investigate the binary asteroid Didymos 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] P. Pravec et al. (2006) *Icarus*, 181, 63 – 93. [2] L. A. M. Benner et al. (2010) 42nd DPS, abstract #13.17. [3] 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 [4] J. de Leon et al. (2010) *Astronomy and Astrophysics*, 517, A23, 1 – 25.