23 - Asteroid Mapping and Sample Retrieval

The exploration of asteroids serves as a cornerstone in understanding the solar system's origins and evolution. These celestial early solar-system remnants allow for a deeper understanding of the primordial materials that shaped the formation of planets. Previous missions like NASA's OSIRIS-REx and Japan's Hayabusa series have successfully returned asteroid samples to Earth, providing valuable data on asteroid composition and physical properties. However, these missions were limited to collecting surface samples, which may not fully represent the asteroid's original material.

Mission Objective

Mission AESIR (Asteroid Exploration, Sampling, Investigation & Retrieval) aims to exceed the achievements of previous asteroid missions by extracting both surface and subsurface samples from an X-type asteroid Mimir. By drilling to a depth of 1 meter, AESIR will access pristine materials that have remained unaltered since the solar system's formation, offering deeper insights into cosmic conditions and processes. Named after Mimir, the wisest of Norse gods, this asteroid is notably rare, as asteroids of this type are not often found outside the asteroid belt, promising unique insights into lesser-studied celestial materials.

System Design

The AESIR spacecraft will be launched aboard the Falcon Heavy, embarking on a precise trajectory to the target asteroid Mimir, an X-type asteroid located between Earth and Mars. It utilizes gridded ion propulsion for efficient, electrostatically driven trajectory control, guiding it to a heliocentric orbit within 10 km of Mimir. AESIR is powered by solar panels, avoiding the use of Radioisotope Thermoelectric Generators. The spacecrafts structure is fortified with sandwich composites, providing robust, lightweight protection against the harsh conditions of space, including asteroid debris during sampling operations. The onboard Asteroid Research and Analysis Module, equipped with high-resolution and context cameras, captures detailed surface observations of Mimir. This module also includes a spectral analysis suite with spectrometers for analyzing optical spectra to determine the asteroid's composition. As AESIR orbits Mimir at 10 km, it conducts broad mapping followed by detailed gravity mapping via radio science to assess the asteroids internal mass and density. This comprehensive mapping process identifies optimal sampling sites at closer altitudes. A robotic arm, featuring a gas ablation system, then executes a touch-and-go maneuver to securely collect regolith into a contamination-free sample container. Communication with Earth is facilitated by a parabolic high-gain antenna, supported by two secondary low-gain horn antennas, all part of the Deep Space Network. This setup ensures reliable, long-distance communication across the vast expanse of space. Upon return, the spacecraft deploys the Sample Return Capsule, previously used in the Stardust and OSIRIS-REx missions, for a safe landing in a secluded desert area. Upon retrieval, scientists will conduct detailed studies, including chemical composition analysis, isotopic dating, and mineralogical examinations, to gain insights into the solar system's origins and evolutionary processes.