NASAfacts

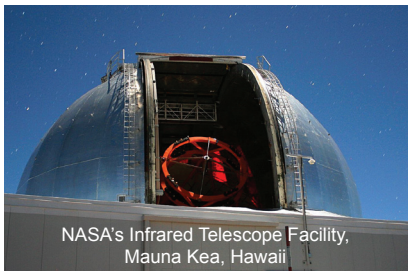
Asteroid Redirect Mission

NASA's proposed Asteroid Redirect Mission will robotically capture and then redirect a small asteroid into a stable lunar orbit, where astronauts can safely visit and study it. The asteroid could remain in place for several decades, allowing NASA and its partners to conduct important scientific investigations and develop capabilities for deep-space exploration and potentially for planetary defense of our home planet.

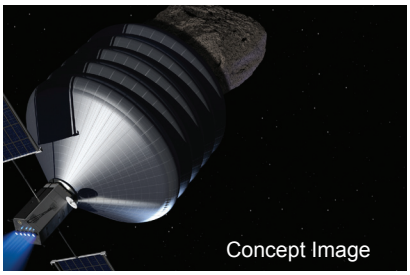
Leveraging the best of NASA's science, technology, and human exploration efforts, this mission aligns current agency investments into one integrated mission portfolio – including an increased asteroid observation campaign, development of an asteroid capture spacecraft powered by advanced solar electric propulsion, and a robust manifest for NASA's new Space Launch System (SLS) heavy-lift rocket and Orion crew vehicle. In addition, NASA will pursue innovative domestic and international partnerships and encourage citizen science to engage the global community in building experience and technical capabilities required for a human mission to Mars in the 2030s.

Advancing Science, Technology, and Exploration in Space

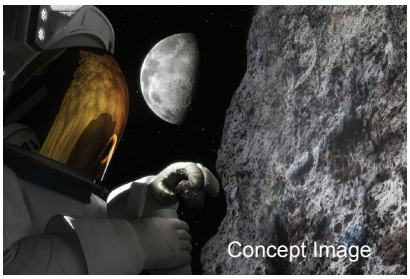
Experts have developed a range of criteria to select a suitable target asteroid for the redirect mission. These criteria are based on size, orbit, mass, shape, composition and spin rate of the asteroid. The ideal candidate will be in a natural orbit that brings it close to Earth in the 2020s and could be up to 10 meters in diameter, which would fit snugly onto a racquetball court. At that size, even if it survived entry into Earth's atmosphere, it would disintegrate before hitting the surface, so the mission poses no risk to our planet.



NASA's Infrared Telescope Facility, Mauna Kea, Hawaii



Concept Image



Concept Image

IDENTIFY:
Observe and Characterize
The United States has the most robust and productive survey and detection program for discovering near-Earth objects (NEOs). Through increased funding, NASA's Near Earth Object Observation (NEOO) Program is amplifying its coordinated efforts across the agency and global asteroid observation community to detect, track and characterize potentially hazardous asteroids. In its search for larger hazardous NEOs, the NEOO Program also finds a number of smaller asteroids that come very close to the Earth-moon system, which might be suitable for the Asteroid Redirect Mission. This enhanced observation effort will extend our catalog of hazardous asteroids and assist in developing techniques for impact mitigation – all while scouting for smaller asteroids for a bold human exploration mission.

REDIRECT:
Capture and Maneuver
Using solar electric propulsion (SEP) technology coupled with a robotic mechanism, NASA will build and launch a mission to capture the asteroid then redirect it to a stable lunar orbit. While options for the specific capture mechanism are in the early stages of engineering review, NASA has ongoing investments in SEP technologies. SEP uses power converted from sunlight to produce a continuous low thrust at very high efficiency levels, which substantially reduces the amount of propellant needed. In addition, the power of the SEP system can be adjusted during use and offers great flexibility to spacecraft and mission planners to modify the trajectory while the mission is in operation.

EXPLORE:
Rendezvous and Sample
The first humans to visit the captured asteroid will launch aboard NASA's Orion crew vehicle atop the SLS. This next class of astronauts will leverage knowledge from decades of operations in space, including the construction and use of the International Space Station in low-Earth orbit. Investigating an asteroid in deep space presents new levels of challenge and opportunity for human space exploration. At distances of up to 300,000 miles from Earth, the crew will be farther from our home planet than ever before, operating at the frontiers of human exploration. The astronauts will become increasingly self-sufficient, using systems and operational techniques to rendezvous, dock and interact with the asteroid in distant, complex orbits, many days away from Earth-based assistance.

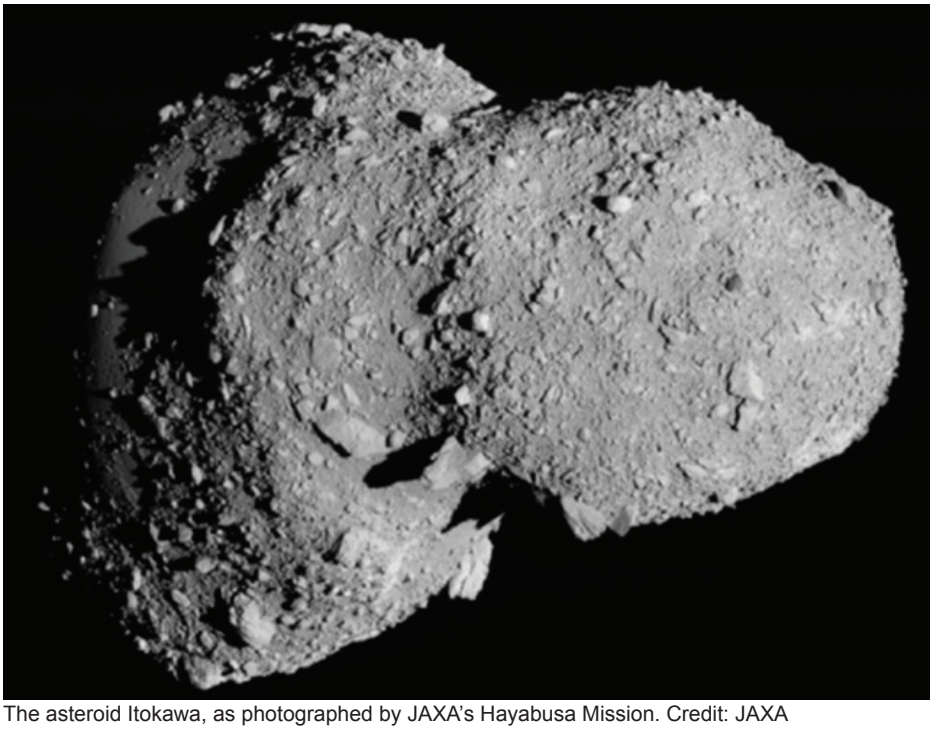
Asteroid Redirect Mission

Why Should Humans Explore Asteroids?

Robotic asteroid missions, such as NASA's Near Earth Asteroid Rendezvous (NEAR) and Dawn have revealed important findings about asteroids – unlocking clues to our solar system's early formation and increasing our knowledge about the NEO population. The upcoming OSIRIS-REx mission – which will orbit another asteroid for almost 26 months and return a sample to Earth – will provide information that is vital in preparing for the future human mission.

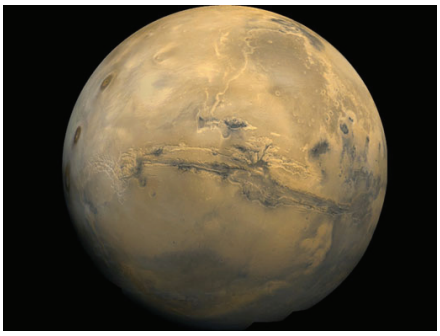
Mission planners will use information from these robotic achievements to assist in understanding the operational environment around asteroids – which reflect a very broad spectrum of physical properties – and therefore requires diverse exploration techniques for the astronauts. Direct human investigation is advantageous and allows for rapid responses to the possibly unforeseen engineering challenges to maximize scientific and exploration returns. Mission planners will still define mission and science objectives, but reliance on astronaut intuition, situational adaptation, and decision-making skills will ultimately provide the most effective way to achieve them. Autonomous crew decision-making, coupled with training, is another essential tool for success in exploring deep space on long-duration missions, much as they will during future missions to Mars.

Depending on the composition of the captured asteroid, it could show that asteroids can be mined for water, metals, and other compounds and volatiles that could support human life or be used to produce propellants. The ability to harvest resources from planetary surfaces – rather than relying on resupply missions from Earth – is a key capability required for long-term, deep-space exploration missions.



The asteroid Itokawa, as photographed by JAXA's Hayabusa Mission. Credit: JAXA

Asteroid Redirect Mission: A Stepping-Stone to Mars



The Asteroid Redirect Mission will mark a significant advancement in human exploration, building on the capabilities developed in low-Earth orbit and tested on space station, while pushing the envelope on state-of-the-art capabilities needed for the ultimate human destination: Mars. In addition to SLS and Orion performance validation, the mission will leverage new extravehicular suits and systems while evaluating sample-handling techniques and investigating opportunities to harvest resources from planetary surfaces.

Through advances in radiation protection and sustainable life support systems – including recycling of air and water without resupply from Earth – crews will be protected from the harsh space environment. The Orion crew vehicle will pioneer deep-space navigation for human spaceflight, using Earth and moon gravity assists in complex orbits to help prepare for maneuvers necessary for orbital operations in Martian environments.

The Asteroid Redirect Mission represents a challenging and inspiring next step for humans in space on the path to Mars, spurring the development and demonstration of advanced deep-space exploration capabilities, and fostering innovative partnerships here on Earth.

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