

LEARN - How Do We Explore Asteroids?

Learning Objective:

To learn about the techniques we use to explore asteroids

Overview:

From the first telescopic observations to the present day's sample return missions, astronomers and planetary scientists have developed a number of increasingly advanced techniques to help them explore asteroids.

Specifics:

Remote Observation

This was the state of the art during the 19th century, and for most of the 20th. From the first asteroid discovered in 1801, up to the launch of NASA's Jupiter-bound Galileo spacecraft in 1989, remote observation using telescopes was the only way to study asteroids.

Asteroids could be distinguished from background stars because they moved from night to night. But apart from that, no surface details could be resolved, even with the largest telescopes of the age. Indeed, this is how asteroids got their name, which means star-like.

By the latter 19th century, the technique of spectroscopy was allowing astronomers to split the light from asteroids into a spectrum to investigate the space rocks' compositions. In the latter 20th century, radar techniques, most notably from the Arecibo Radio Telescope, were used to reveal the irregular shape of some asteroids.



Flybys

On 29 October 1991, Galileo flew past asteroid Gaspra and returned the first ever close-up pictures. This began a trend that continues to this day of spacecraft that are crossing the asteroid belt being targeted to flyby an asteroid or two on the way. Galileo flew past asteroid Ida on 28 August 1983, discovering that the asteroid was orbited by a tiny rocky moon, since named Dactyl.

NASA's Cassini made a distant fly-by of asteroid Masursky in January 2000. ESA's Rosetta flew past asteroid Steins in 5 September 2008 and Lutetia on 10 July 2010.

Rendezvous and Orbit

The next step for exploration was for spacecraft to rendezvous and orbit their target asteroids, rather than simply fly past. The [NEAR-Shoemaker spacecraft](#) was the first to do this, arriving in orbit at asteroid Eros on 14 February 2000, having flown past asteroid Mathilde on 27 June 1997.

Launched on 27 September 2007, NASA's Dawn mission rendezvoused and orbited asteroid Vesta and, subsequently, asteroid Ceres.

Orbits allow a spacecraft to fully map an asteroid as well as perform other 'remote sensing' observations such as using spectrometers to analyse the surface composition of different regions of the asteroid. The spacecraft's trajectory around the asteroid give information about the asteroid's mass and density.

Landings

The concept of landing on an asteroid was pioneered by the NEAR-Shoemaker mission team. At the end of their mission in February 2001, they manoeuvred their spacecraft to a touch down on the surface of Eros. This demonstrated how to do such a delicate manoeuvre and paved the way for newer spacecraft to be specifically designed for the task.

The first mission designed specifically to land on an asteroid was JAXA's Minerva mini-lander. Part of the Hayabusa mission to asteroid Itokawa, it unfortunately never made it to the surface. The subsequent Hayabusa 2 mission carried four landers that all successfully made it to the surface of asteroid Ryugu. They carried cameras and analysis equipment.

Sample Return

Closely allied to the asteroid landings are the sample return missions. There have been three so far: JAXA's Hayabusa and Hayabusa2, and NASA's OSIRIS-REx mission. Each one must land briefly in order to scoop up its sample for return to Earth. Launched on the 9 May 2003, Hayabusa proved the concept but only managed to capture around 1500 dust grains from asteroid Itokawa.

The subsequent Hayabusa2 mission was an unqualified success. It returned samples of asteroid Ryugu to Earth on 6 December 2020. OSIRIS-REx is on course to deliver its samples of asteroid Bennu in September 2023. Once on Earth, the samples can be analysed in laboratories much more thoroughly than a spacecraft's instruments could manage.

All exploration techniques now play a role in our quest to understand and characterise the asteroids.

Learn more about this subject by visiting these websites:

[NASA - Asteroid Exploration](#)

[Smithsonian NASM - Exploration of Asteroids](#)

[ESA Space for kids - Exploring asteroids](#)

[Intrepid Sea, Air and Space Museum - Exploring Asteroids in our Solar System](#)