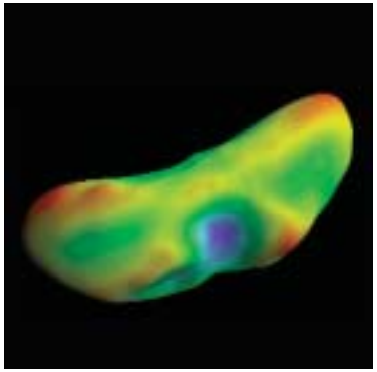
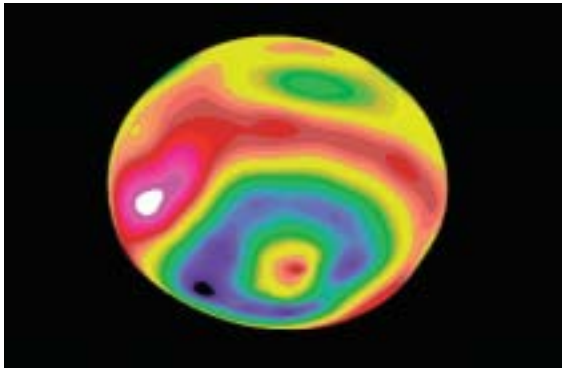
National Aeronautics and
Space Administration

Asteroids





National Aeronautics and Space Administration

Asteroids

ASTEROIDS are rocky fragments left over from the formation of the solar system about 4.6 billion years ago. Most of these fragments of ancient space rubble—sometimes referred to by scientists as minor planets—can be found orbiting the Sun in a belt between Mars and Jupiter. This region in our solar system, called the Asteroid Belt or Main Belt, probably contains millions of asteroids ranging widely in size from Ceres, which at 940 km in diameter is about one-quarter the diameter of our Moon, to bodies that are less than 1 km across. There are more than 20,000 numbered asteroids.

As asteroids revolve around the Sun in elliptical orbits, giant Jupiter's gravity and occasional close encounters with Mars or with another asteroid change the asteroids' orbits, knocking them out of the Main Belt and hurling them into space across the orbits of the planets. For example, Mars' moons Phobos and Deimos may be captured asteroids. Scientists believe that stray asteroids or fragments of asteroids have slammed into Earth in the past, playing a major role both in altering the geological history of our planet and in the evolution of life on it. The extinction of the dinosaurs 65 million years ago has been linked to a devastating impact near the Yucatan peninsula in Mexico.

Asteroids were first observed with telescopes in the early 1800s, and in 1802, the astronomer William Herschel first used the word "asteroid," which means "starlike" in Greek, to describe these celestial bodies. Most of what we have learned about asteroids in the past 200 years has been derived from telescopic observations. Ground-based telescopes are used to watch asteroids that orbit close to Earth, not only to detect new ones or keep track of them, but also to watch for any asteroids that might collide with Earth in the future. Scientists define near-Earth asteroids (NEAs) as those whose orbits never take them farther than about 195 million kilometers from the Sun.

In the last few decades, astronomers have used instruments called spectroscopes to determine the chemical and mineral composition of asteroids by analyzing the light reflected off their surfaces. Scientists also examine meteorites—the remains of comets or asteroids that can be found on Earth—for clues to the origin of these bodies. About three-quarters of asteroids are extremely dark and are similar to carbon-rich meteorites called carbonaceous chondrites (C-type). About one-sixth of asteroids are reddish, stony-iron bodies (S-type).

In 1997, instruments on the *Hubble Space Telescope* mapped Vesta, one of the largest asteroids, and found an enormous crater formed a billion years ago. Interestingly, Vesta is an uncommon asteroid type, yet meteorites having the same composition have been found on Earth. Could these be remnants from the collision that created Vesta's giant crater?

NASA's *Galileo* spacecraft was the first to observe an asteroid close-up, flying by main-belt asteroids Gaspra and Ida in 1991 and 1993, respectively. Gaspra and Ida proved to be irregularly shaped objects, rather like potatoes, riddled with craters and fractures, 19 km long and 52 km long respectively. Galileo also discovered that Ida has its own moon, Dactyl, a tiny body in orbit around the asteroid that may be a fragment from past collisions.

NASA's *Near-Earth Asteroid Rendezvous (NEAR)* mission was the first dedicated scientific mission to an asteroid. The *NEAR Shoemaker* spacecraft caught up with asteroid Eros in February 2000 and orbited the small body for a year, studying its surface, orbit, mass, composition, and magnetic field. In February 2001, mission controllers guided the spacecraft to the first-ever landing on an asteroid.

Fast Facts

(for some representative asteroids)

	Eros	Gaspra	Vesta	Ceres	Ida
Mean Distance from Sun (AU)	1.458	2.209	2.36	2.768	2.86
Orbital Period (yrs)	1.76	3.29	3.63	4.6	4.84
Orbital Eccentricity	0.26	0.17	0.09	0.08	0.05
Orbital Inclination to Ecliptic	10.8°	4.1°	7.1°	10.6°	1.1°
Rotational Period (hrs)	5.27	7.402	5.342	9.075	4.63
Dimensions	35 x 13 km	18 x 11 x 9 km	530 km diameter	933 km diameter	58 x 23 km
Asteroid Type	S	S	V	G	S

An Astronomical Unit (AU) is the average distance between the Sun and Earth, about 150,000,000 kilometers.

Some Asteroid Types:
S—Stony irons and ordinary chondrites; C—Carbonaceous chondrites; V—Like S, more pyroxene; G—Like C, brighter, very strong UV absorption.

Significant Dates

1801	First asteroid, Ceres, discovered by Piazzi.
1807	Vesta discovered by Olbers.
1884	Asteroid Ida discovered by Palisa.
1898	Asteroid Eros discovered by Witt.
1916	Asteroid Gaspra discovered by Neujmin.
1991	*Galileo* captures first close-up images of asteroid (Gaspra).
1994	*Galileo* discovers first satellite (Dactyl) of an asteroid (Ida).
1996	*NEAR Shoemaker* studies asteroid Mathilde.
1997	*Hubble Space Telescope* studies Vesta.
2000–01	*NEAR Shoemaker* orbits Eros for one year and then lands.

About the Images

(Upper left) Asteroid Eros is about 33 kilometers long (*NEAR Shoemaker*).
(Upper right) Surface of Eros is covered in rocks of all shapes and sizes (*NEAR Shoemaker*).
(Right center) Color-coded map shows uphill (red) and downhill (blue) areas on Eros (*NEAR Shoemaker*).
(Lower left) Mars' two moons Phobos (left) and Deimos (right) may be captured asteroids. Asteroid Gaspra (top) is shown at same scale.
(Lower center) Asteroid Ida and its moon Dactyl (*Galileo*).
(Lower right) Color-coded topography map of asteroid Vesta clearly shows a large crater with a central peak (blue is low, red is high) (*Hubble Space Telescope*).

References
1) *NEAR Shoemaker* mission to Eros: *http://near.jhuapl.edu*
2) Near Earth Object Program: *http://www.jpl.nasa.gov/neo*
3) Planetary Photojournal: *http://photojournal.jpl.nasa.gov*
4) National Space Science Data Center Asteroid information: *http://nssdc.gsfc.nasa.gov/planetary/planets/asteroidpage.html*

LG-2001-08-533-HQ