NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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Near Earth Object Program

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Frequently Asked Questions

Also, see our FAQ on Impact Risk Assessment.

What Is A Near-Earth Object (NEO)?

Near-**E**arth **O**bjects (NEOs) are comets and asteroids that have been nudged by the gravitational attraction of nearby planets into orbits that allow them to enter the Earth's neighborhood. Composed mostly of water ice with embedded dust particles, comets originally formed in the cold outer planetary system while most of the rocky asteroids formed in the warmer inner solar system between the orbits of Mars and Jupiter.

What Is The Purpose Of The Near-Earth Object Program?

The purpose of the Near-Earth Object Program is to coordinate NASA-sponsored efforts to detect, track and characterize potentially hazardous asteroids and comets that could approach the Earth. The NEO Program will focus on the goal of locating at least 90 percent of the estimated 1,000 asteroids and comets that approach the Earth and are larger than 1 kilometer (about 2/3-mile) in diameter, by the end of the next decade. In addition to managing the detection and cataloging of Near-Earth objects, the NEO Program office will be responsible for facilitating communications between the astronomical community and the public should any potentially hazardous objects be discovered.

How Many Near-Earth Objects Have Been Discovered So Far?

As of February 12, 2013, 9697 Near-Earth objects have been discovered. Some 861 of these NEOs are asteroids with a diameter of approximately 1 kilometer or larger. Also, 1378 of these NEOs have been classified as Potentially Hazardous Asteroids (PHAs).

What Are Asteroids And Comets?

Asteroids and comets are believed to be ancient remnants of the earliest years of the formation of our solar system more than four billion years ago. From the beginning of life on Earth to the recent spectacular impact of Comet Shoemaker-Levy 9 with Jupiter, these so-called "small bodies" play a key role in many of the fundamental processes that have shaped the planetary neighborhood in which we live.

Comets are bodies of ice, rock, and organic compounds that can be several miles in diameter. Comets are thought to originate from a region beyond the orbits of the outermost planets. Scientists believe that gravitational perturbations periodically jar comets out of this population, setting these "dirty snowballs" on orbital courses that bring them closer to the Sun. Some, called long-period comets, are in elliptical orbits of the Sun that take them far out beyond the planets and back. Others, called short-period comets, travel in shorter orbits nearer the Sun.

When comets venture into the more intense sunlight of the inner solar system, the ices in the comet nucleus begin to vaporize and fall away. The evolved gas forms a tenuous atmosphere around the nucleus called a coma, while the dust previously in the nucleus forms a tail that can be thousands of miles long and sometimes can be seen from Earth. While striking the early Earth billions of years ago, comets are thought to have created major changes to Earth's early oceans, atmosphere, and climate, and may have delivered the first carbon-based molecules to our planet, triggering the process of the origins of life.

Most asteroids are made of rock, but some are composed of metal, mostly nickel and iron. They range in size from small boulders to objects that are hundreds of miles in diameter. A small portion of the asteroid population may be burned-out comets whose ices have evaporated away and been blown off into space. Almost all asteroids are part of the Main Asteroid Belt, with orbits in the vast region of space between Mars and Jupiter.

Some asteroids pass very close to Earth's orbit around the Sun. Scientists have found evidence that asteroids have hit our planet in the past. Usually, asteroids and smaller debris called meteoroids are too small to survive the passage through Earth's atmosphere. When these burn up on their descent, they leave a beautiful trail of light known as a meteor or "shooting star." Larger asteroids occasionally crash into Earth, however, and create craters, such as Arizona's mile-wide Meteor Crater near Flagstaff. Another impact site off the coast of the Yucatan Peninsula in Mexico, which is buried by ocean sediments today, is believed to be a record of the event that led to the extinction of the dinosaurs 65 million years ago. Fortunately for us, these big asteroid impacts are rare. A smaller rocky meteoroid or comet less than 100 yards in diameter is believed to have entered the atmosphere over the Tunguska region of Siberia in 1908. The resulting shockwave knocked down trees for hundreds of square miles.

What Are The Differences Between An Asteroid, Comet, Meteoroid, Meteor and Meteorite?

In space, a large rocky body in orbit about the Sun is referred to as an asteroid or minor planet whereas much smaller particles in orbit about the Sun are referred to as meteoroids. Once a meteoroid enters the Earth's atmosphere and vaporizes, it becomes a meteor (i.e., shooting star). If a small asteroid or large meteoroid survives its fiery passage through the Earth's atmosphere and lands upon the Earth's surface, it is then called a meteorite. Cometary debris is the source of most small meteoroid particles. Many comets generate meteoroid streams when their icy cometary nuclei pass near the Sun and release the dust particles that were once embedded in the cometary ices. These meteoroid particles then follow in the wake of the parent comet. Collisions between asteroids in space create smaller asteroidal fragments and these fragments are the sources of most meteorites that have struck the Earth's surface.

Because they are readily available for study, many meteorites have already been subjected to detailed chemical and physical analyses in laboratories. If particular asteroids can be identified as the sources for some of the well-studied meteorites, a detailed knowledge of the meteorite's composition and structure will provide important information on the chemical mixture and conditions from which the parent asteroid formed 4.6 billion years ago.

Summary Table

Asteroid	A relatively small, inactive, rocky body orbiting the Sun.
Comet	A relatively small, at times active, object whose ices can vaporize in sunlight forming an atmosphere (coma) of dust and gas and, sometimes, a tail of dust and/or gas.
Meteoroid	A small particle from a comet or asteroid orbiting the Sun.
Meteor	The light phenomena which results when a meteoroid enters the Earth's atmosphere and vaporizes; a shooting star.
Meteorite	A meteoroid that survives its passage through the Earth's atmosphere and lands upon the Earth's surface.

Why Study Asteroids?

The scientific interest in asteroids is due largely to their status as the remnant debris from the inner solar system formation process. Because some of these objects can collide with the Earth, asteroids are also important for having significantly modified the Earth's biosphere in the past. They will continue to do so in the future. In addition, asteroids offer a source of volatiles and an extraordinarily rich supply of minerals that can be exploited for the exploration and colonization of our solar system in the twenty-first century.

Asteroids represent the bits and pieces left over from the process that formed the inner planets, including Earth. Asteroids are also the sources of most meteorites that have struck the Earth's surface and many of these meteorites have already been subjected to detailed chemical and physical analyses. If certain asteroids can be identified as the sources for some of the well-studied meteorites, the detailed knowledge of the meteorite's composition and structure will provide important information on the chemical mixture, and conditions from which the Earth formed 4.6 billion years ago. During the early solar system, the carbon-based molecules and volatile materials that served as the building blocks of life may have been brought to the Earth via asteroid and comet impacts. Thus the study of asteroids is not only important for studying the primordial chemical mixture from which the Earth formed, these objects may hold the key as to how the building blocks of life were delivered to the early Earth.

Every day, the Earth is bombarded with more than 100 tons of dust and sand-size particles. Many of the incoming particles are so small that they are destroyed in the Earth's atmosphere before they reach the ground. These particles are often seen as meteors or shooting stars. The vast majority of all interplanetary material that reaches the Earth's surface originates as the collision fragments of asteroids that have run into one another some eons ago. With an average interval of about 100 years, rocky or iron asteroids larger than about 50 meters would be expected to reach the Earth's surface and cause local disasters or produce the tidal waves that can inundate low lying coastal areas. On an average of every few hundred thousand years or so, asteroids larger than a mile could cause global disasters. In this case, the impact debris would spread throughout the Earth's atmosphere so that plant life would suffer from acid rain, partial blocking of sunlight, and from the firestorms resulting from heated impact debris raining back down upon the Earth's surface. The probability of an asteroid striking the Earth and causing serious damage is very remote but the devastating consequences of such an impact suggests we should closely study different types of asteroids to understand their compositions, structures, sizes, and future trajectories.

The asteroids that are potentially the most hazardous because they can closely approach the Earth are also the objects that could be most easily exploited for raw materials. These raw materials could be used in developing the space structures and in generating the rocket fuel that will be required to explore and colonize our solar system in the twenty-first century. By closely investigating the compositions of asteroids, intelligent choices can be made as to which ones offer the richest supplies of raw materials. It has been estimated that the mineral wealth resident in the belt of asteroids between the orbits of Mars and Jupiter would be equivalent to about 100 billion dollars for every person on Earth today.

Why Study Comets?

Life on Earth began at the end of a period called the late heavy bombardment, some 3.8 billion years ago. Before this time, the influx of interplanetary debris that formed the Earth was so strong that the proto-Earth was far too hot for life to have formed. Under this heavy bombardment of asteroids and comets, the early Earth's oceans vaporized and the fragile carbon-based molecules, upon which life is based, could not have survived. The earliest known fossils on Earth date from 3.5 billion years ago and there is evidence that biological activity took place even earlier - just at the end of the period of late heavy bombardment. So the window when life began was very short. As soon as life could have formed on our planet, it did. But if life formed so quickly on Earth and there was little in the way of water and carbon-based molecules on the Earth's surface, then how were these building blocks of life delivered to the Earth's surface so quickly? The answer may involve the collision of comets with the Earth, since comets contain abundant supplies of both water and carbon-based molecules.

As the primitive, leftover building blocks of the outer solar system formation process, comets offer clues to the chemical mixture from which the giant planets formed some 4.6 billion years ago. If we wish to know the composition of the primordial mixture from which the major planets formed, then we must determine the chemical constituents of the leftover debris from this formation process - the comets. Comets are composed of significant fractions of water ice, dust, and carbon-based compounds. Since their orbital paths often cross that of the Earth, cometary collisions with the Earth have occurred in the past and additional collisions are forthcoming. It is not a question of whether a comet will strike the Earth, it is a question of when the next one will hit. It now seems likely that a comet or asteroid struck near the Yucatan peninsula in Mexico some 65 million years ago and caused a massive extinction of more than 75% of the Earth's living organisms, including the dinosaurs.

Comets have this strange duality whereby they first brought the building blocks of life to Earth some 3.8 billion years ago and subsequent cometary collisions may have wiped out many of the developing life forms, allowing only the most adaptable species to evolve further. Indeed, we may owe our preeminence at the top of Earth's food chain to cometary collisions. A catastrophic cometary collision with the Earth is only likely to happen at several million year intervals on average, so we need not be overly concerned with a threat of this type. However, it is prudent to mount efforts to discover and study these objects, to characterize their sizes, compositions and structures and to keep an eye upon their future trajectories.

As with asteroids, comets are both a potential threat and a potential resource for the colonization of the solar system in the twenty first century. Whereas asteroids are rich in the mineral raw materials required to build structures in space, the comets are rich resources for the water and carbon-based molecules necessary to sustain life. In addition, an abundant supply of cometary water ice can provide copious quantities of liquid hydrogen and oxygen, the two primary ingredients in rocket fuel. One day soon, comets may serve as fueling stations for interplanetary spacecraft.

What Are Atens, Apollos and Amors?

Atens, Apollos and Amors are subgroups of Near-Earth asteroids, and are categorized by their orbits. In terms of orbital elements, NEOs are asteroids and comets with perihelion distance q less than 1.3 AU. The vast majority of NEOs are asteroids, referred to as Near-Earth Asteroids (NEAs). NEAs are further divided into the following groups according to their perihelion distance (q), aphelion distance (Q) and their semi-major axes (a):

Group	Description	Definition
NEAs	**N**ear-**E**arth **A**steroids	q<1.3 AU
Atens	Earth-crossing NEAs with semi-major axes smaller than Earth's (named after asteroid 2062 Aten).	a<1.0 AU, Q>0.983 AU
Apollos	Earth-crossing NEAs with semi-major axes larger than Earth's (named after asteroid 1862 Apollo).	a>1.0 AU, q<1.017 AU
Amors	Earth-approaching NEAs with orbits exterior to Earth's but interior to Mars' (named after asteroid 1221 Amor).	a>1.0 AU, 1.017<q<1.3 AU

What Is A Potentially Hazardous Asteroid (PHA)?

Potentially **H**azardous **A**steroids (PHAs) are currently defined based on parameters that measure the asteroid's potential to make threatening close approaches to the Earth. Specifically, all asteroids with a minimum orbit intersection distance (MOID) of 0.05 AU or less and an absolute magnitude (H) of 22.0 or less are considered PHAs. In other words, asteroids that *can't* get any closer to the Earth (*i.e.* MOID) than 0.05 AU (roughly 7,480,000 km or 4,650,000 mi) or are smaller than about 150 m (500 ft) in diameter (*i.e.* H = 22.0 with assumed albedo of 13%) are *not* considered PHAs.

This ``potential'' to make close Earth approaches does ***not*** mean a PHA ***will*** impact the Earth. It only means there is a possibility for such a threat. By monitoring these PHAs and updating their orbits as new observations become available, we can better predict the close-approach statistics and thus their Earth-impact threat.

What Spacecraft Are We Sending To Asteroids & Comets?

Comet And Asteroid Mission Summary Table

NEAR	
Launch	February 17, 1996
Asteroid Mathilde Flyby	June 27, 1997
Asteroid Eros Initial Flyby	December 23, 1998

Asteroid Eros Rendezvous	February 14, 2000
The NEAR mission flew within 1200 km of asteroid Mathilde and spent nearly one year in orbit about asteroid Eros in 2001-2001.	
DEEP SPACE 1	
Launch	October 24, 1998
Asteroid 9969 Braille Flyby	July 28, 1999
Comet Borrelly Flyby	September 22, 2001
The primary Deep Space 1 mission objectives are test space technologies. The spacecraft flew within 2000 km of Comet Borrelly on September 22, 2001.	
STARDUST	
Launch	February 7, 1999
Comet Wild-2 Flyby	January 2, 2004
Earth Sample Return	January 15, 2006
Comet Tempel 1 Flyby	February 14, 2011
The STARDUST spacecraft imaged the nucleus of Comet Wild-2, collected dust from both the comet's coma and from interplanetary space and brought these dust samples back to Earth for study. After its primary mission was completed, the mission was extended to encounter another comet, and renamed to Stardust-NEXT.	
HAYABUSA	
Launch	December 2002
Asteroid 25143 Itokawa Rendezvous	September 2005
Earth Sample Return	June 2010
A cooperative mission between Japan and the U.S., the Hayabusa spacecraft orbited a near-Earth asteroid and will return asteroid surface samples to Earth for analysis.	
ROSETTA	
Launch	March 2, 2004
Comet Churyumov-Gerasimenko Rendezvous	May 2014
After three Earth gravity assists and a Mars gravity assit, the Rosetta spacecraft will rendezvous with, land upon, the surface of a comet in an effort to study its composition and structure.	
DEEP IMPACT/EPOXI	
Launch	December 30, 2004
Comet Tempel 1 Impact/Flyby	July 4, 2005
Comet Hartley 2	November 4, 2010
Deep Impact mission impacted the surface of Comet Tempel 1. The spacecraft studied the crater formation process and examine the subsurface structure of one of the solar system's most primitive objects, a remnant from the outer solar system formation process. After its encounter with Comet Tempel 1, the mission was renamed to EPOXI, and will flyby Comet Hartely 2 in late 2010	

DAWN	
Launch	September 27, 2007
Asteroid Vesta Rendezvous	July 2011
Asteroid Ceres Rendezvous	February 2015

The Dawn mission will orbit two asteroids on a single voyage. Ceres and Vesta evolved under radically different circumstances in different parts of the solar system nearly 4.6 billion years ago. By observing both protoplanets with the same set of instruments, Dawn will provide new insight into the formation and evolution of our solar system.