CLASSIFYING OBJECTS IN THE SOLAR SYSTEM

The objects that make up our solar system can be classified into three main groups: planets, dwarf planets and small solar system bodies.

1. **Planets** are spherical, orbit around the Sun and have cleared the neighbourhood around their orbits of other smaller bodies.
2. **Dwarf planets** are *mostly* spherical, orbit around the Sun and have *not* cleared the neighbourhood around their orbits.
3. **Small Solar System Bodies (SSSBs)** include any other objects that orbit around our Sun, but do not fit into either of the first two categories. This group includes asteroids and comets.

Asteroids

The **Main Asteroid Belt** is the region of our Solar System located roughly between the orbits of the planets **Mars** and **Jupiter**. It is occupied by numerous irregularly-shaped bodies called **asteroids**. Asteroids are left-over material from the early Solar System that never came together to form a planet. There are three main types of asteroids:

1. Most asteroids (around 75%) are rich in carbon. These dark-coloured bodies are part of the **C-group** of asteroids.
2. About 15% of asteroids are stony. These moderately bright bodies are part of the **S-group** of asteroids.
3. The remaining asteroids tend to be made of metals (**the X-group**).

Main belt asteroids have orbits around the Sun that are not easily altered. The largest asteroid, **Ceres**, has now been classified as a dwarf planet due to its mostly spherical shape. Ceres is the only dwarf planet in the inner Solar System.

Asteroids can sometimes 'escape' the Main Asteroid Belt and come close enough to Earth to cross the Earth's orbital path. These asteroids are termed **Near-Earth Asteroids (NEAs)**. NEAs come within 0.3 **AU** (**astronomical units**) of the Earth's orbit (an astronomical unit is the distance from the Earth to the Sun - 1.495979×10^8 km). Near-Earth asteroids are divided into four groups:

1. members of the **Amor** group pass close to the Earth's orbit, but never cross it;
2. members of the **Apollo** group cross Earth's orbit, but spend most of their time *outside* the orbit of the Earth;
3. members of the **Aten** group also cross the Earth's orbit, but spend most of their time *inside* the orbit of the Earth; and
4. members of the '**interior-to-Earth's orbit' asteroids (IEOs)** spend all of their time inside the orbit of the Earth (they do not cross Earth's orbit).

Figure 1: *Near-Earth asteroid Eros.*
Image source: Wikimedia Commons.

The near-Earth asteroids that cross the Earth's orbit (Apollos and Atens) pose the greatest threat to our planet. Near-Earth asteroids are also of particular interest because they can be reached by spacecraft. A mission to a near-Earth asteroid is much more energy-efficient than a trip to the Main Asteroid Belt. To date, three near-Earth asteroids, including the asteroid **Eros**, have been visited by spacecraft (see Figure 1).

Some asteroids have been found to orbit planets (or in the same orbital path as a planet). These asteroids are called **Trojan Asteroids** (or Trojans). Trojans do not collide with the planets they orbit, as they are located in 'stability' zones called **Lagrangian Points** and so are always ahead of or behind the planet as it orbits around the Sun. It is believed that Trojans have been 'locked' in their orbits since early in the formation of the Solar System. To date, astronomers have found over 5 000 Trojans in Jupiter's orbit, and only one in Earth's orbit (**2010 TK_7**).

Beyond the Main Asteroid Belt, there are objects that have a greater average distance from the Sun than the planet **Neptune**. These are called **Trans-Neptunian Objects (TNOs)**. Unlike objects in the Main Asteroid Belt, which are composed primarily of rock and metal, TNOs are icy and composed mainly of frozen methane, ammonia and water. There are three main regions of trans-Neptunian space - the Kuiper Belt, the Scattered Disk and the Oort Cloud.

The **Kuiper Belt** is similar to the Main Asteroid Belt, although it is far larger (20 times as wide) and contains much more material (20 to 200 times as much). It is mainly composed of small bodies which are left over from the Solar System's formation. It is home to at least three dwarf planets – **Pluto**, **Makemake** and **Haumea** (see Figure 2).

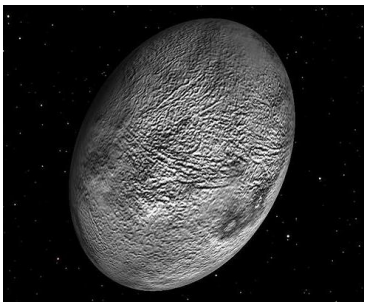

Figure 2: *Computer photograph of Haumea. Image source: Wikimedia Commons.*

Objects in the Kuiper Belt have stable orbits (meaning that they are not easily disturbed and will remain in their orbits over very long periods of time). However, objects in the **Scattered Disc** have unstable orbits which are easily disturbed by the gravity of Neptune. Objects in this region frequently get 'scattered' around in the outer solar system and sometimes cross into the inner solar system. **Eris**, the largest of the dwarf planets, is a Scattered Disc object.

Comets

Figure 3: *Comet Hale-Bopp. Image source: Wikimedia Commons.*

Beyond the Kuiper Belt and Scattered Disk is a region called the **Oort Cloud**. The Oort Cloud contains hundreds of billions of icy bodies which we call **comets**. Unlike asteroids, comets appear to have a 'tail.' The tail occurs because the Sun melts part of the ice of the comet when the comet reaches the inners Solar System. The bright tail of melted ice and dust always points away from the Sun.

Comets that come from the Oort Cloud are known as **long-period comets**, as they take over 200 years to orbit the Sun! There are also short-period comets, such as **Halley's Comet** that orbits the Sun every 76 years, which are thought to come from the Scattered Disc. We are still discovering new comets, such as **Comet Hale-Bopp**, which was first seen by two astronomers (Hale and Bopp) in 1995 (see Figure 3).

References

Near Earth Object Program (NASA) http://neo.jpl.nasa.gov/index.html (Accessed Sept. 2, 2014)

Information about Trojans (International Astronomical Union) http://www.minorplanetcenter.org/iau/lists/Trojans.html (Accessed Sept. 2, 2014)

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