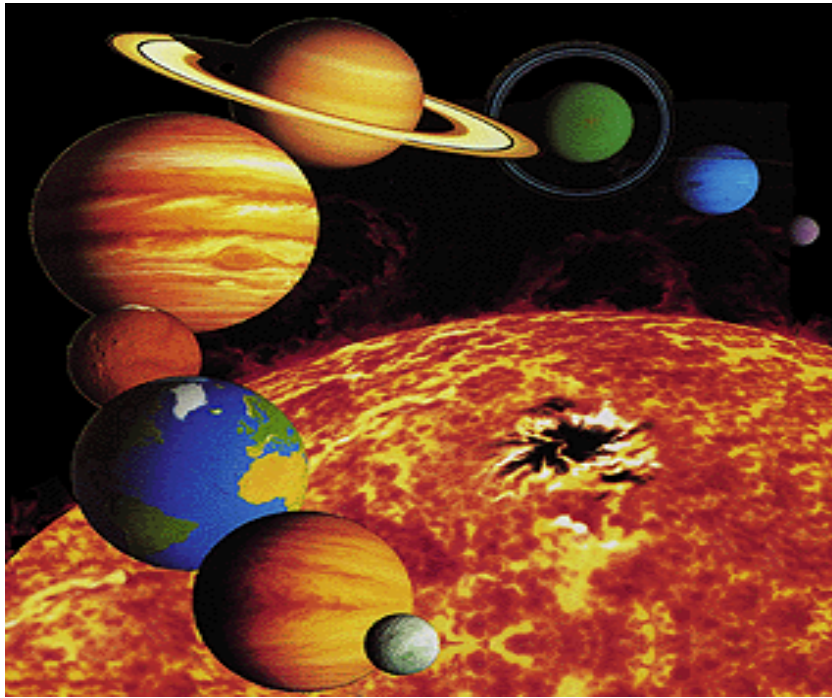


Artist's impression of the major Solar System bodies (including Pluto). Downloaded March, 2013 from NASA website, http://starchild.gsfc.nasa.gov/Images/StarChild/solar_system_level1/solar_system.gif



Our Evolving Solar System

FAASA, June 1st 2013
Vivien Lowe



Artist's impression of Sedna. Downloaded March, 2013 from NASA website, <http://www.spaceflightnow.com/news/n0404/14sedna/viewfromsedna.jpg>

Our Evolving Solar System

Contents

Current definition of a planet	3
Bodies currently identified as Dwarf Planets.....	4
Inner Planets	5
Asteroid Belt	5
Hilda Asteroid Family	6
Jupiter Trojans.....	6
Cis-Neptunian objects.....	7
Gas Giants	7
Ice Giants.....	7
Centaur's	8
Neptune Trojans	9
Trans-Neptunian objects (TNO)	9
Kuiper belt objects (KBO).....	10
Classical KBO	10
Resonant KBO	10
Scattered disk objects (SDO).....	10
Detached objects	11
Sedna.....	11
Oort cloud	11
Moons	12
Comets.....	12
Interplanetary dust	12
Using these bodies in Astrology.....	12
References	14

Following are the notes on which the FAASA June 2013 talk was based.

It is important to note that there are discoveries almost daily in this field and so these notes were out of date even while I was writing them! They are, however, a guide to the major regions of our Solar System.

Current definition of a planet

The word planet comes from the Greek language and means wanderer, so planets were originally visible bodies that moved against the background of the fixed stars.

It was the discovery of Eris, with the realisation that are many other bodies in the Solar System that are the size of Pluto or larger, that caused a reconsideration of the definition of planet. A Planet Definition Committee was established by the International Astronomical Union (IAU) and announced their consensus decision in July 2006. So, according to the current (February 2013) definitions:

- ✚ A planet is a celestial body that
 - a) has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape, **and**
 - b) is in orbit around a star, and is neither a star nor a satellite of a planet, **and**
 - c) has cleared the neighbourhood around its orbit.

- ✚ A "pluton" (not to be confused with a "Plutino" which is discussed later) is an object satisfying the technical definition of planet (see previously), but has an orbit around the Sun that takes longer than 200 years to complete (i.e. they orbit beyond Neptune).
 - Plutons typically have orbits that are highly tilted with respect to the classical planets (technically referred to as a large orbital inclination).
 - Plutons usually have orbits that are very elliptical (technically referred to as having a large orbital eccentricity).

- ✚ The term "small Solar System body" has replaced the term minor planet.

- ✚ A pair of objects, which each independently satisfy the definition of "planet" are considered a "double planet" if they orbit each other around a common point in space that is known as the "barycentre".
 - This "barycentre" point must not be located within the interior of either body.
 - If the barycentre point is within either of the bodies, then the other body is referred to a satellite.
 - For example:
 - Pluto and Charon orbit a point above the surface of Pluto and so are an example of a double planet.
 - The Moon and the Earth orbit around a point within the Earth and so the Moon is a satellite of the Earth.

- ✚ There are other descriptive terms that are in common use.
 - Classical planets are those planets known from pre-history to 1900 (8 planets: Mercury out to Neptune).
 - Dwarf planets are smaller than Mercury.
 - Terrestrial planets are Mercury, Venus, Earth and Mars.
 - Giant planets are Jupiter, Saturn, Uranus and Neptune.
 - Inferior planets orbit between the Sun and the Earth, while superior planets have orbits beyond Earth.

Bodies currently identified as Dwarf Planets

In order of distance from the Sun, the five "official" dwarf planets (February 2013) are:

Ceres

- discovered on January 1, 1801
- located in the asteroid belt
- considered a planet for half a century before reclassification as an asteroid
- accepted as a dwarf planet by the IAU on September 13, 2006
- orbital period of 4.6 years

Pluto

- discovered on February 18, 1930
- located in the Kuiper Belt (classified as a Resonant KBO and as a Plutino)
- classified as a planet for 76 years
- reclassified as a dwarf planet by the IAU on August 24, 2006
- orbital period of 248.09 years

Haumea

- discovered on December 28, 2004
- located in the Kuiper Belt (classified as a Resonant KBO, but *not* as a Plutino due to a different resonance with Neptune's orbit)
- accepted by the IAU as a dwarf planet on September 17, 2008
- orbital period of 283.28 years

Makemake

- discovered on March 31, 2005
- located in the Kuiper Belt (classified as a classical KBO or cubewano)
- accepted by the IAU as a dwarf planet on July 11, 2008
- orbital period of 309.9 years

Eris

- discovered on January 5, 2005 (initially referred to as Xena)
- scattered disc object
- called the "tenth planet" in media reports
- accepted by the IAU as a dwarf planet on September 13, 2006
- orbital period of 557 years

The other four "nearly certain" dwarf planets according to Mike Brown and others (February 2013) are:

Orcus

- discovered on February 17, 2004
- located in the Kuiper Belt (classified as a Resonant KBO and as a Plutino)
- orbital period of 245.18 years

- ✚ **Quaoar**
 - discovered on June 5, 2002
 - located in the Kuiper Belt (classified as a classical KBO or cubewano)
 - orbital period of 285.97 years
- ✚ **2007 OR10**
 - discovered on July 17, 2007
 - Scattered Disc Object
 - orbital period of 550.98 years
- ✚ **Sedna**
 - discovered on November 14, 2003
 - Detached Object
 - Orbital period between 10,500 and 12,050 years

Inner Planets

- ✚ Composed primarily of rock and metal.
- ✚ Few or no moons.
- ✚ No ring systems.
- ✚ All have atmosphere sufficient to generate weather except Mercury.
- ✚ All have impact craters and tectonic surface features such as rift valleys and volcanoes.

Includes: **Mercury, Venus, Earth, Mars**

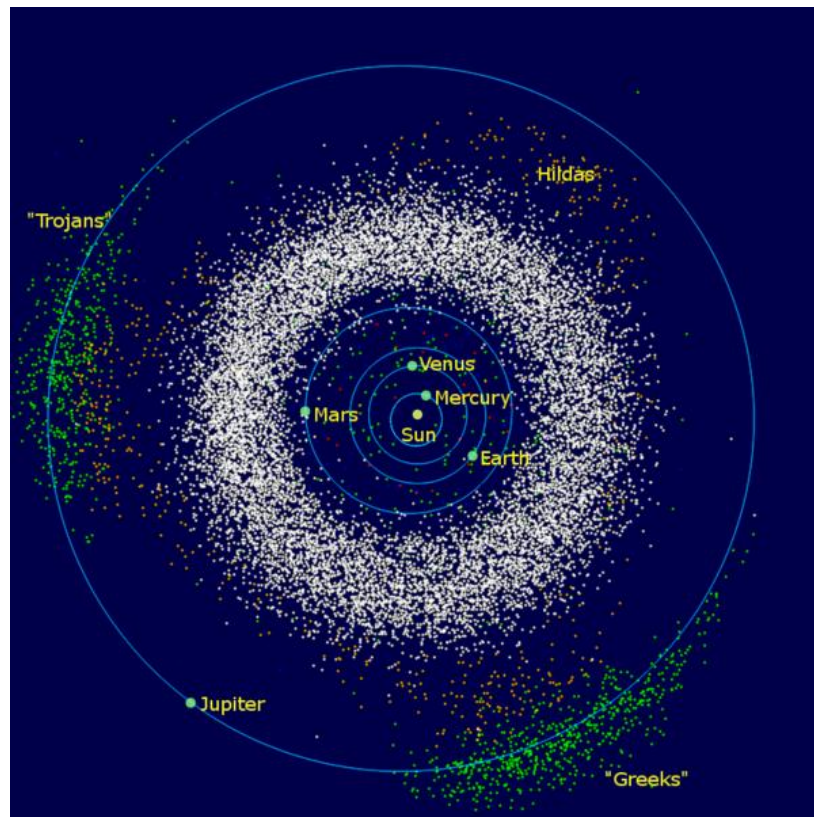
Asteroid Belt

- ✚ Occupies orbit between Mars and Jupiter.
- ✚ Similar composition to inner planets.
- ✚ Thought to be remnants from Solar System's formation that failed to coalesce because of the gravitational influence of Jupiter.
- ✚ The size of the asteroids ranges from microscopic to hundreds of kilometres across.
 - **Ceres** is a dwarf planet.
 - Others are classified as small Solar System bodies.
- ✚ Meteoroids are asteroids with a diameter of 0.1mm to 10m.
- ✚ The term rogue asteroids describes asteroid-like bodies that are found throughout the Solar System and often cross the orbits of the inner planets.

Ceres

- ✚ Also referred to as a protoplanet or a dwarf planet.
- ✚ Mass is large enough to pull it into a spherical shape.
- ✚ Was considered a planet when discovered in the 19th century.
 - Classified as a dwarf planet in 2006.

Includes: **Vesta, Juno, Pallas Athena**



The Asteroid belt, including the Jupiter Trojans, Greeks and Hilda family.
Downloaded from: <http://en.wikipedia.org/wiki/Asteroids>

Hilda Asteroid Family

The Hilda or Hildian asteroids are a group of asteroids in a 3:2 orbital resonance with Jupiter.

- ✚ Move in their elliptical orbits.
- ✚ Aphelia occur opposite or 60 degrees ahead of or behind Jupiter.
 - Over three successive orbits each Hilda asteroid passes through all of these three points in sequence.
 - Appear to be in 3:2 resonance with Jupiter.
 - Orbits twice for every 3 orbits of Jupiter.
- ✚ Inclination of less than 20° to the ecliptic.
- ✚ Are not a true asteroid family because they did not form from a common parent object.
- ✚ Named after 153 Hilda, discovered by Johann Palisa in 1875.
- ✚ More than 1,100 known Hilda asteroids known.
- ✚ Appear to be made of similar material to comet nuclei.

Jupiter Trojans

(Trojans are asteroids that share an orbit with a planet near the stable points in front of or behind the planet. Because they constantly lead or follow in the same orbit as the planet, they never collide with it. In our solar system, Trojans share orbits with Neptune, Mars and Jupiter. Two of Saturn's moons share orbits with Trojans. In 2010, the first Earth Trojan was discovered (2010 TK₇).)

- ✚ Jupiter Trojans are Solar System bodies that orbit the Sun:
 - Travel in same orbit as Jupiter.
 - Same orbital period of Jupiter.
 - By convention, named after heroes of the Trojan war.

- ✚ 5.253 identified by March 2012.
 - Some inclined at $> 40^\circ$ to the ecliptic.
- ✚ Includes:
 - **Achilles** (588 Achilles).
 - First Jupiter Trojan discovered (1906).
 - **Hektor** and **Patroclus** discovered in 1906-1907.
 - **Hektor** is the largest Trojan and may have a small moon.
- ✚ The term “Greek camp” describes the Trojans that orbit ahead of Jupiter.
 - The “Trojan camp” describes the Trojans that follow Jupiter.
 - Some asteroids were named before this convention was adopted and are in the “wrong” camp, eg **Patroclus**.

Cis-Neptunian objects

- ✚ Astronomical bodies found outside the orbit of Jupiter but within, or close to, the orbit of Neptune.
- ✚ Includes: **Centaur**s and **Neptune Trojan**s.

Gas Giants

- ✚ Jupiter and Saturn are composed mainly of hydrogen and helium.
- ✚ All 4 planets have ring systems.

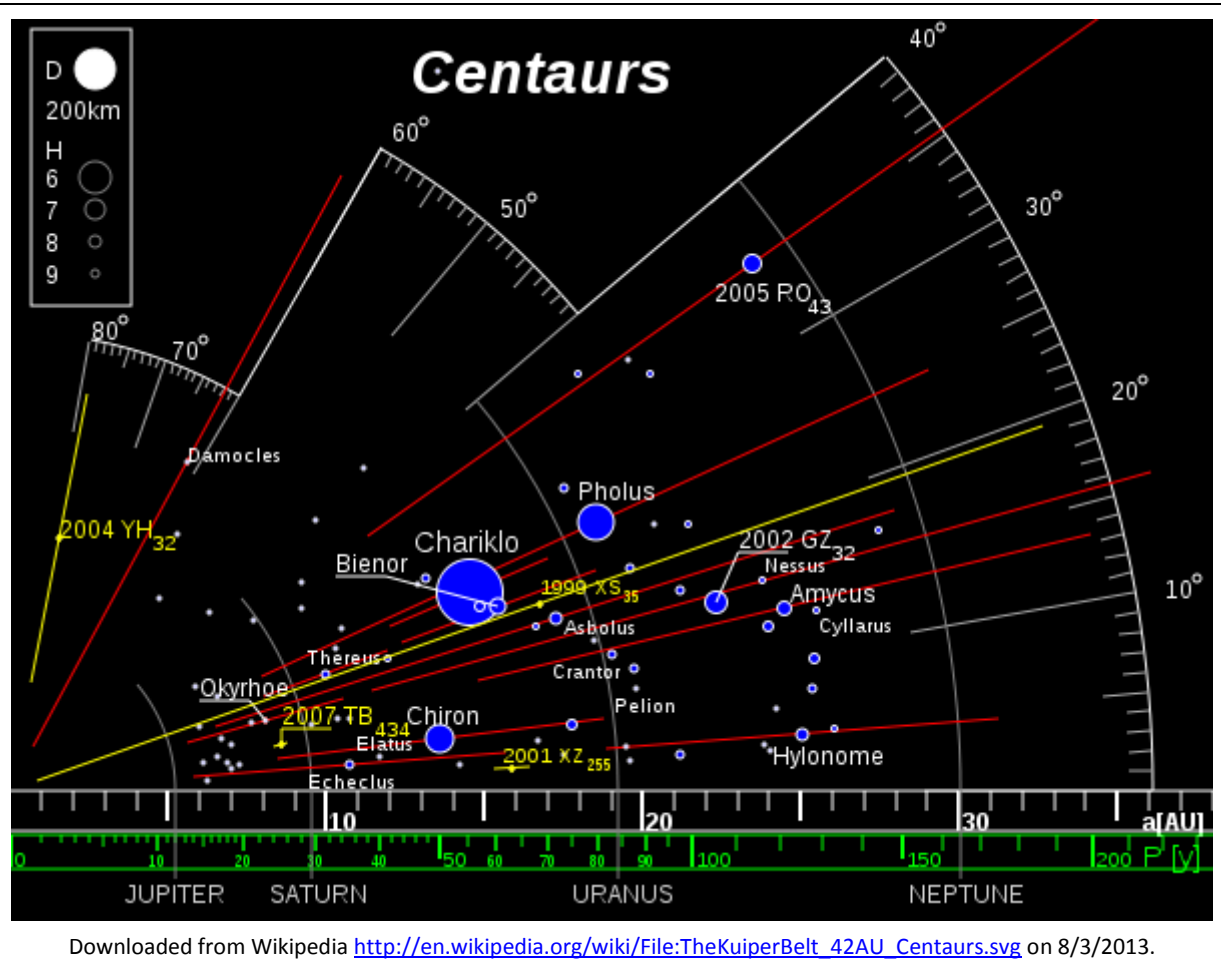
Includes: **Jupiter**, **Saturn**

Ice Giants

- ✚ Subset of the gas giants.
- ✚ Composed of substances with relatively high melting points, called *ices*, such as water, ammonia and methane.
 - Considered by many to be a sub category of the Gas Giants.

Includes: **Uranus**, **Neptune**

Centaurs



- ✚ Definition of a Centaur varies with different astronomical groups, so there is no clear consensus on how many centaurs there are.
- ✚ In astrology we tend to focus on the ones that have been given mythological names.
- ✚ Orbit the Sun between Jupiter and Neptune.
 - Often cross the orbits of the large gas giants.
- ✚ Icy, comet-like bodies.
 - May be similar to the SDOs (see later) but were scattered inwards from Neptune, rather than outwards.
- ✚ **Chariklo** is the largest known with a diameter of about 250km.
- ✚ **Chiron** was discovered in 1977 and led to the identification of the centaurs as a specific group.
 - Also classified as a comet as it develops a coma when it approaches the Sun.
- ✚ Saturn's moon Phoebe may be a captured centaur.

The following list is from Zane Stein's website (<http://www.zanestein.com/chiron.htm>). They are listed in order of discovery (current at February 2013), the centaurs are:

Hidalgo

- Discovered in 1920, but it was initially identified as an asteroid.

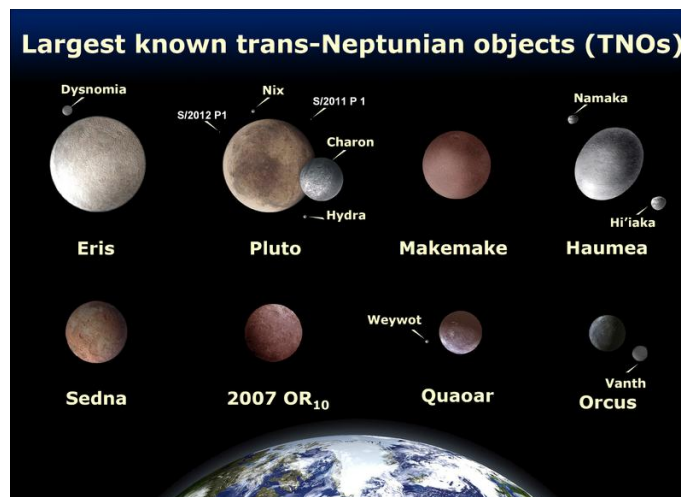
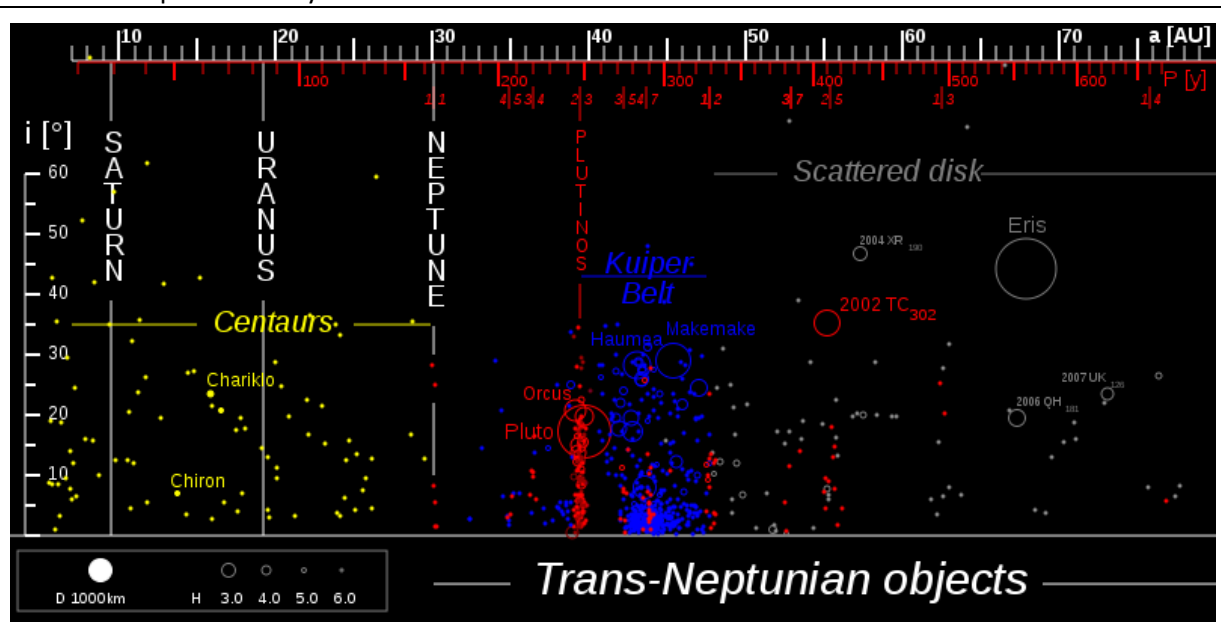
Chiron, Pholus, Nessus, Hylonome, Asbolus, Chariklo, Pelion, Okyrhoe, Cyllarus, Elatus, Echeclus, Bienor, Thereus, Amycus, Crantor, Orius

Neptune Trojans

- ✚ Solar System bodies that orbit the Sun:
 - Travel in same orbit as Neptune.
 - Same orbital period of Neptune.
- ✚ 9 currently identified (February 2013), all with stable orbits.
 - Some inclined at $> 25^\circ$ to the ecliptic.
 - Named "Trojans" following the Jupiter Trojans.
- ✚ None have yet (February 2013) been given names.

Trans-Neptunian objects (TNO)

- ✚ Composed mostly of ices.



Kuiper belt objects (KBO)

- ✚ “Great ring of debris” similar to the asteroid belt, but bodies are made of ice.
- ✚ Extends between 30 and 50AU¹ from the Sun.
- ✚ There may be dozens of dwarf planets yet to be discovered.
- ✚ Many KBO have multiple satellites.
- ✚ Many have highly eccentric orbits.

Classical KBO

- ✚ Orbits are not linked to Neptune’s orbit.
- ✚ Extends between 39.4 and 47.7 AU.
- ✚ Classified as cubewanos (named after the first example discovered, (15760)1992QB₁).
- ✚ **Makemake**
 - Largest known object in the classical Kuiper Belt.
 - Designated a dwarf planet in 2008.
 - Orbit inclined at 29°.

Resonant KBO

- ✚ Have orbits linked to Neptune
 - For example, a 3:2 resonance describes a body that orbits twice for every 3 orbits of Neptune.
- ✚ **Pluto** is an example of a dwarf planet with a 3:2 resonance.
 - Relatively eccentric orbit (inclined at 17°)
 - Largest Moon is Charon.
 - Other, much smaller moons include P5, Nix, P4 and Hydra.
 - Other KBOs with this resonance are called plutinos and include:
 - **Orcus**
 - **Ixion**
- ✚ **Haumea**
 - Orbit similar to Makemake except that is in a 7:12 orbital resonance with Neptune.
 - 2 moons.
 - Designated a dwarf planet in 2008.

Scattered disk objects (SDO)

- ✚ Overlaps the Kuiper Belt, extending outwards.
 - Most objects have perihelia within the Kuiper Belt and aphelia far beyond.
 - Orbits are highly inclined, some almost perpendicular.
- ✚ Source of some short-period comets.
- ✚ Some astronomers consider the Scattered Disk region to be an extension of the Kuiper Belt.
- ✚ Some astronomers consider the centaurs to be “inward scattered disk objects”.
- ✚ **Eris**
 - Largest and best known SDO.
 - 25% more mass than Pluto, with the same diameter.
 - Most massive of the dwarf planets.
 - One moon, Dysnomia.
 - Highly eccentric orbit, 44° from ecliptic.

¹ An Astronomical Unit (AU) is defined as 149,597,870,700 metres (92,955,807.273 miles), or roughly the mean Earth-Sun distance.

Detached objects

- ✚ Detached objects are a class of bodies in the outer Solar System beyond the orbit of Neptune.
- ✚ Have orbits whose perihelia are sufficiently distant from the gravitational influence of Neptune that they are essentially unaffected by Neptune and the other planets.
 - therefore they are considered “detached” from the Solar System.
 - differ substantially from the majority of the known trans-Neptunian objects (TNOs), which have been perturbed to varying degrees onto their current orbit by gravitational encounters with the gas giants, predominantly Neptune.
 - have more distant perihelia than the TNO populations.
- ✚ Have also been referred to in the scientific literature as:
 - extended scattered disc objects (E-SDO).
 - distant detached objects (DDO).
 - scattered–extended (classification by the Deep Ecliptic Survey).
- ✚ At least nine have been identified, of which the largest, most distant, and best known is [Sedna](#).

Sedna

- ✚ Large, reddish object.
- ✚ Highly elliptical orbit.
 - Orbital period quoted in various sources as:
 - 10,500 years (Hammaker-Zondag).
 - Approximately 11,400 years (Wikipedia, 10/2/13).
 - 12,050 years (Mike Brown).
 - Orbit inclined at 12° to the ecliptic.
- ✚ Thought by Mike Brown, the astronomer who also discovered Eris, to be the first example of a new category of bodies (see “Detached objects”).
 - Brown describes the area as the “inner Oort Cloud”.
 - Too close to the Sun to be in the true Oort Cloud.
 - Too distant to be a Kuiper Belt body, which have all been influenced by Neptune’s gravitational pull (even if not resonant with Neptune).
- ✚ Other astronomers consider it to be part of the Oort Cloud.
- ✚ Probably a dwarf planet, but the designation has not yet been made.

Oort cloud

- ✚ Source of long period comets.
- ✚ Located about one light year from the Sun (nearest star to the Sun is about 4 light years away).
 - Exists at a distance of roughly a thousand times further than the heliosphere.
 - Heliosphere is defined by the extent of the solar wind, which is a plasma flow from the Sun.
 - Heliopause is the point at which pressure from the solar wind is equal to the opposing pressure of the interstellar wind.

Moons

- ✚ Natural satellites of a solar system body.

Comets

- ✚ Small Solar System bodies usually a few kilometres across.
- ✚ Icy surface sublimates as it approaches the Sun causing the coma, a long tail of gas and dust.
 - Once all volatiles have burned off often categorised as asteroids.
- ✚ Usually have highly eccentric orbits with:
 - Perihelion within the inner planets.
 - Aphelion beyond Pluto.
- ✚ divided into:
 - Short period:
 - Orbit lasts less than 200 years.
 - Believed to originate in Kuiper Belt.
 - Long period:
 - Orbit lasts more than 200 years.
 - Believed to originate in the Oort Cloud.
- ✚ There are some family groups that form from the breakdown of a single parent, eg Kreutz Subgrazers.

Interplanetary dust

- ✚ Spread throughout the Solar System and travels between regions.

Using these bodies in Astrology

There is no consensus at this time as to how we can use these bodies in Astrology.

For people new to Astrology:

- ✚ The following texts would probably be described as beginner's texts.
- ✚ Sue Tompkins in *The Contemporary Astrologer's Handbook* and Frank C Clifford in *Getting to the Heart of Your Chart* both consider the planets and Pluto to be the "essentials".
- ✚ Sue Tompkins then lists "non-essential bodies" as
 - Moon's nodes
 - Chiron and the Centaurs
 - Asteroids

Steven Forrest in his article *The New Solar System* suggested that:

- ✚ Discoveries of Uranus, Neptune and Pluto were far enough apart that we were able to integrate one planet before the next one appeared.
- ✚ Certain bodies are considered important over others for no obvious reason, eg why is Chiron so well known but not the larger Pholus?
- ✚ For consulting astrologers the current number of named bodies is too many for a single consultation, so each astrologer must "edit" the solar system to suit their way of working.

- ✚ One way may be to consider planetary groups:
 - The “Rocky Worlds”
 - Moon, Mercury, Venus and Mars
 - Represent our more personal attributes/motivations
 - Gas giants
 - Jupiter, Saturn, Uranus, Neptune
 - Describe higher level mental functions and social interactions
 - Trans-Neptunians
 - The unconscious mind
 - Pluto represents the Guardian of the Gate by crossing Neptune’s orbit and linking our world to the next

Karen Hamaker-Zondag in her DVD from the CPA Master Class series suggests the following system for understanding the symbolism of our solar system:

- ✚ Classic/sacred planets
 - Known drives.
- ✚ Outer/collective planets
 - Powers and realities that are beyond our control.
 - Can understand and work with the energies, but NEVER control them.
 - Other realities, Shamanism, psychology.
- ✚ Centaurs
 - Highlight areas of conflict between classic and outer planet, and can help us integrate, eg Chiron as a bridge between Saturn and Uranus.
- ✚ Kuiper Belt and Oort Cloud
 - Background themes and issues that are part of the Zeitgeist and that we cannot easily influence.
 - Movements in the collective unconscious.
 - Superhuman issues of nature, cosmos and Earth.
 - Including the need to relate in more harmonious ways to Gaia and the Cosmos.
 - Kuiper Belt bodies tend to be named for underworld Gods and Goddesses.
 - Bodies beyond the Kuiper Belt tend to be named for creation myths.

Other issues that may be worth considering when deciding on which bodies to include in your charts:

- How quickly was a specific body named?
 - (15760)1992QB₁ still has not been named, even though its original designation has now given its name to the classical Kuiper Belt objects known as Cubewanos.
- How quickly, and how extensively, was a particular solar system body introduced into charts by Astrologers?
 - Can be an indication of how quickly the issues represented by the body became consciousness.
 - Jupiter Trojans Achilles, Hektor and Patroclus were discovered in the early 20th century, but have not been adopted by many Astrologers.
 - This may relate to the power of the myth associated with the name.
- Does a particular solar system body tie in with the personal planets or major points in the chart that you are looking at?
 - Possibly also look at links to Jupiter and Saturn.
 - May be more of an indicator of society’s pre-occupations at specific periods.

- Possibly useful in mundane charts.
- Some of the solar system bodies with long orbital periods may be more evolutionary than being harbingers of specific events:
 - Karen Hammaker Zondag has suggested this interpretation of Sedna transits in personal charts.

References

Brown, M (2007-2013). *Mike Brown's planets*. Blog available at:

<http://www.mikebrownsplanets.com/> .

Hamaker-Zondag, K. (2004). *Sedna*. CPA Masterclass Series. Available from:

http://www.esotech.com.au/products/study_shops.html .

International Astronomical Union.

http://www.iau.org/public_press/news/release/iau0601/q_answers/ downloaded 14/2/13.

NASA (2013). Various articles and images. Downloaded January to March 2013 from

<http://solarsystem.nasa.gov/index.cfm> .

Stein, Z (February 2013). *Chiron and friends*. <http://www.zanestein.com/chiron.htm> downloaded 9/2/13.

Wikipedia. (February 2013). *Solar System*. http://en.wikipedia.org/wiki/Solar_system#cite_note-87 downloaded 10/2/13.