SORTING THE SOLAR SYSTEM

WHAT IS THIS ACTIVITY ABOUT?

Objects in our Solar System do not have giant labels identifying them as a planet, asteroid or comet. This classification was invented by scientists as they were studying the diversity of objects in our Solar System and finding similarities among some of them. This activity allows students to analyze the various objects in the Solar System as well as develop their own classification system.

INFORMATION

Age group : 8 and up

Time required : 20 minutes to one hour

Preparation: For the first time, print out and cut the cards. If possible print in colours and laminate the cards. Subsequent uses of this activity will require no preparation.

Topics covered:

- objects in the Solar System
- planets
- asteroids
- comets
- natural satellites
- planet vs. dwarf planet

MATERIALS

- 28 cards with objects in the Solar System (print and cut before running the activity for the first time) – one set of cards for each team of 2 to 4 students
- pencils and paper to record classification system created by each team

BACKGROUND INFORMATION REGARDING THE CARDS

- Distances to the Sun are given in astronomical units (AU). An astronomical unit is the distance between the Sun and the Earth, which is equivalent to approximately 150 million kilometres. As distances in the Solar System are very large numbers, it is often easier to use astronomical units to measure them. By definition, the Earth is 1 AU from the Sun. An object 5 AU from the Sun is 5 times more distant to the Sun than the Earth.

- Some images are low quality (pixel, blurry, very small object…). Even with the best telescopes today, it is difficult to observe small objects located very far in the Solar System.

WHAT STUDENTS NEED TO DO

Using the cards, students study different Solar System objects and create their own categories to classify them. They then discuss the reasons why they chose this classification system. They can also discuss the categories currently used by scientists.

Important: The most challenging part of this activity is **to keep an open mind about new categories** and **not to be influenced by previous knowledge or officially recognized classifications**. Students might ask if an object is an asteroid, for example, in order to have the «right answer". The goal is to think beyond these categories and do what scientists had to do when they first discovered these objects: analyze the diversity of objects in order to group them by common attributes or features. **It is important to mention that there are no right or wrong answers!**

To create their own categories, students can use the pictures as well as any information provided on the cards: appearance, distance to Sun, composition, size, orbit … They can even use multiple criteria simultaneously. What matters is that all objects be classified within sufficiently well-defined categories which would allow the inclusion of any other objects added to the list or discovered in the future. For example, even if they know Mars is a planet, challenge them to explain what criteria define this category. Mention that scientists do not have the «right answers» in a book and that they need to define the categories themselves. Sometimes, they are even required to modify established categories as was the case in 2006 with the reclassification of Pluto as a dwarf planet.

- Are there any objects which are difficult to classify?
- Are there categories which have only one object? Is this normal?

INFORMATION ABOUT THE OBJECTS

Here are the main categories used by scientists today, as recognized by the International Astronomical Union (organization formed by astronomers from around the world). Objects on the cards are listed below in their official category. Note that there are thousands of other objects in the Solar System. **The lists are far from complete** and there are also other categories which are more specialized and for less known objects.

STAR

A star is a huge ball of gas that emits a lot of energy (light) through nuclear fusion occurring in its core. The Sun is the only star in our Solar System, but it is one of 200 billion stars in our galaxy, the Milky Way.

- **Sun**

PLANET

A planet is an object orbiting a star, in this case our Sun. In addition, this object must be large (massive) enough to have a spherical shape and it cannot share its orbit with several other objects.

- **Mercury**
- **Earth**
- **Mars**
- **Jupiter**
- **Saturn**
- **Neptune**

DWARF PLANET

A dwarf planet is an object orbiting the Sun. Like a planet, this object must be large enough to be spherical. However, it can share its orbit with several other objects. This last criterion is why Pluto is now considered a dwarf planet instead of a planet.

- **Pluto :** We now know Pluto is part of a second asteroid belt, much larger and located far into the Solar System. It is called the Kuiper Belt. Pluto is one of the largest Kuiper Belt objects, but the fact that many other objects can be found close to its orbit now puts it in the dwarf planet category.

- **Eris:** The discovery of this object, larger than Pluto, is what led to the new classification from 2006. Would Eris be called the tenth planet? Instead of changing the number of planets with each new discovery of Pluto-sized object, it was decided to amend the definition of a planet and to change the status of Pluto to dwarf planet.

- **Ceres :** This object is still considered the largest asteroid (it is located in the asteroid belt), although the new definition also puts it in the category of dwarf planet. When it was discovered in 1801 and for several years thereafter, Ceres was considered a planet, proof that the definition has changed several times!

- Also, **Sedna** is a candidate to be considered a dwarf planet, though it does not officially have this title yet. It's considered a trans-Neptunian object (beyond the orbit of Neptune).

ASTEROID

An asteroid is a small object orbiting the Sun. Due to its small mass, it has a random shape instead of a spherical shape like planets and dwarf planets. We find the majority, but not all, of the asteroids in the asteroid belt between the orbits of Mars and Jupiter. Asteroids are made of rock and metal.

- **Annefrank**
- **Eros**
- **Ida**
- **Itokawa**

COMET

A comet is a small object orbiting the Sun. Many comets have highly elliptical orbits, so their distance from the Sun varies greatly (get close to the Sun and then go back very far in the Solar System). Comets are characterized by their composition. Ice found within them creates long tails when they approach the Sun.

- **Hale-Bopp**
- **Halley**
- **Hartley 2**
- **Tempel 1**

MOON OR NATURAL SATELLITE

A natural satellite is an object in orbit around another object (planet, dwarf planet, asteroid) itself in orbit around the Sun. Note that some moons are bigger than planets and some even have an atmosphere.

- **Moon**

- **Ariel**
- **Callisto**
- **Dactyl**
- **Deimos**
- **Enceladus**
- **Europa**
- **Mimas**
- **Titan**

These definitions are those used today but they may be modified again in the future due to new discoveries. Moreover, now that research extends to other planetary systems around other stars, we may discover objects that do not fit any known category.

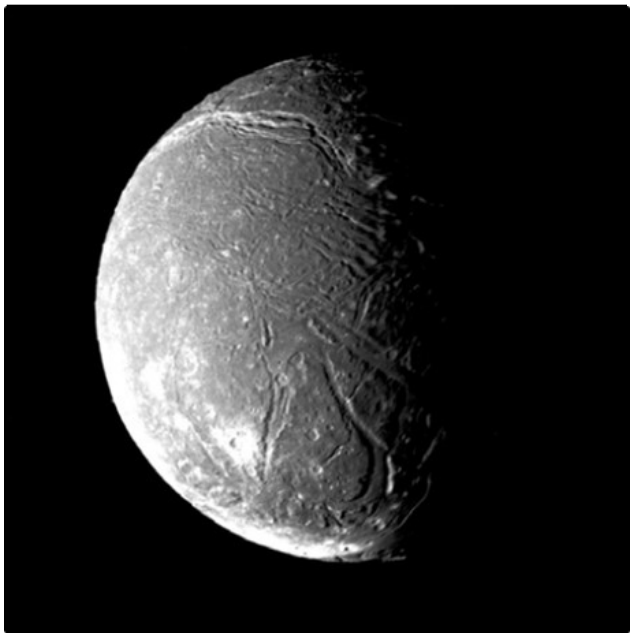
What could be changed in these definitions?
Could they be made more precise (for example, separating the gas giant planets from the terrestrial planets)?
Can you think of new possibilities?

ANNEFRANK

Size : 5 km (tiny)
Distance to Sun : 2.2 a.u.
Made of : Rocks
In orbit around : Sun

Image: Stardust, NASA/JPL

ARIEL



Size : 1 160 km (small)
Distance to Sun : 19 a.u.
Made of : Rocks, Ice
In orbit around : Uranus

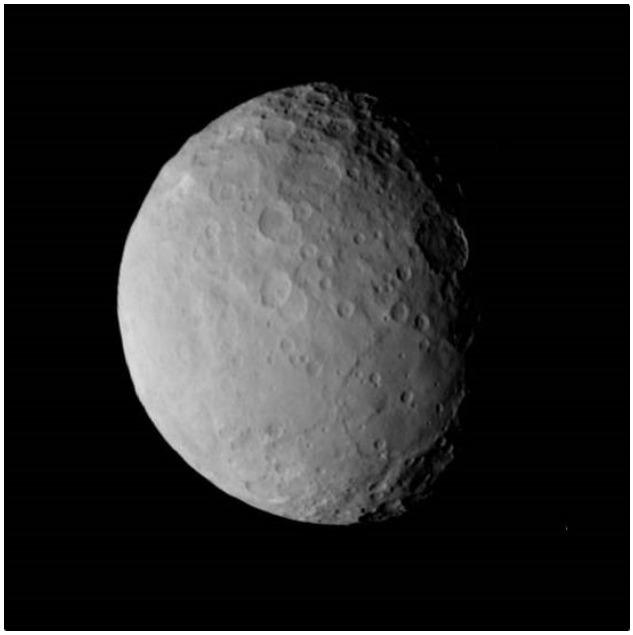
Image: Voyager 2, NASA, JPL

CALLISTO

Size : 4 800 km (medium)
Distance to Sun : 5.2 a.u.
Made of : Rocks, Ice
In orbit around : Jupiter

Image: Galileo, NASA/DLR

CERES



Size : 950 km (small)
Distance to Sun : 3.0 a.u.
Made of : Rocks, Ice
In orbit around : Sun

Image: Dawn, NASA, JPL-Caltech

DACTYL

Size : 1,5 km (tiny)
Distance to Sun : 2.9 a.u.
Made of : Rocks, Ice (?)
In orbit around : Ida

Image: Galileo, NASA/USGS

DEIMOS

Size : 12 km (tiny)
Distance to Sun : 1.5 a.u.
Made of : Rocks
In orbit around : Mars

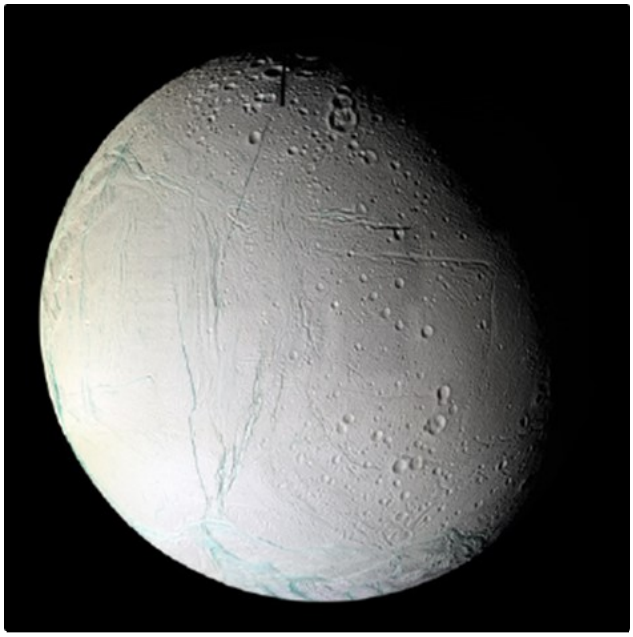
Image: Mars Reconnaissance Orbiter, NASA

EARTH

Size : 12 760 km (medium)
Distance to Sun : 1 a.u.
Made of : Rocks, Metal
In orbit around : Sun

Image: Apollo 17, NASA

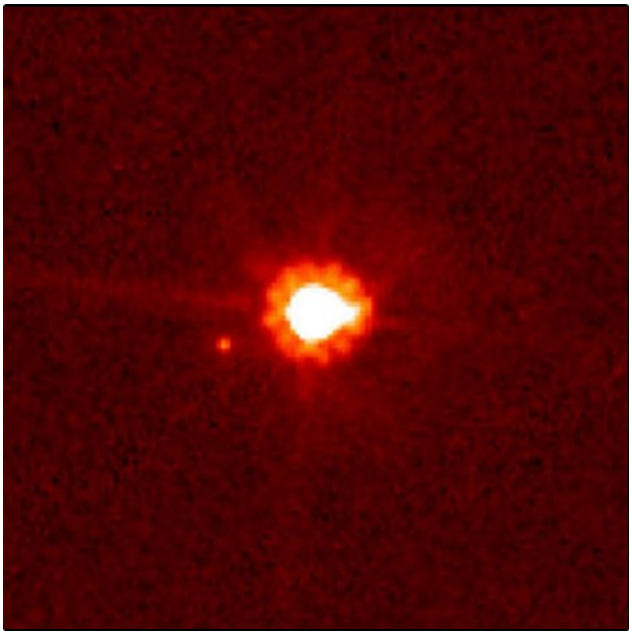
ENCELADUS



Size : 252 km (small)
Distance to Sun : 9.6 a.u.
Made of : Ice, Metal, Rocks
In orbit around : Saturn

Image: Cassini-Huygens, NASA

ERIS



Size : 2 400 km (medium)
Distance to Sun : 38 a.u. to 97 u.a.
Made of : Rocks, Ice
In orbit around : Sun

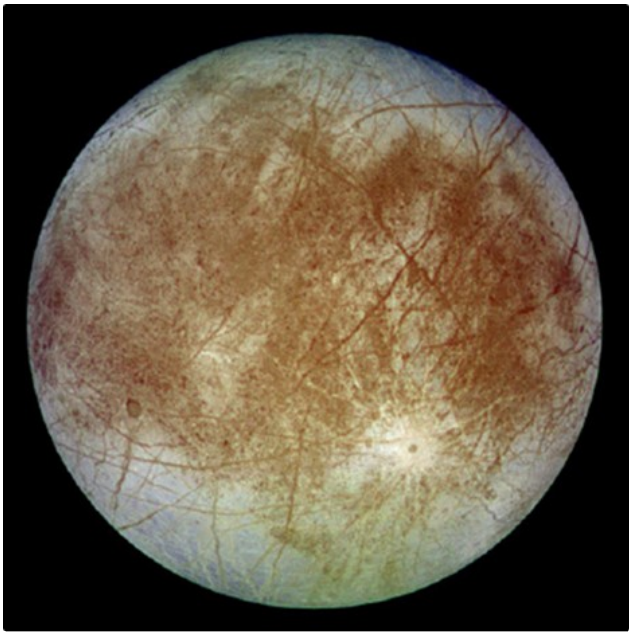
Image: Hubble, NASA/ESA/M.Brown

EROS

Size : 34 km (tiny)
Distance to Sun : 1.2 a.u.
Made of : Rocks
In orbit around : Sun

Image: NEAR, NASA/Johns Hopkins

EUROPA



Size : 3 140 km (medium)
Distance to Sun : 5.2 a.u.
Made of : Rocks, Ice
In orbit around : Jupiter

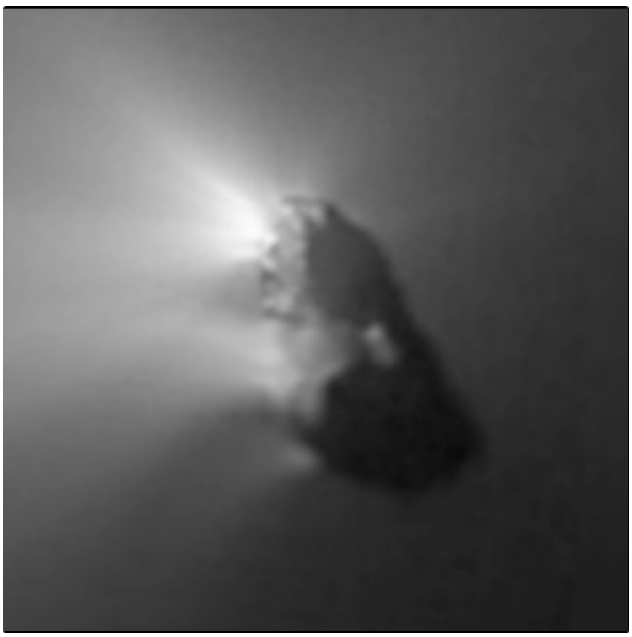
Image: Galileo, NASA/DLR

HALE-BOPP

Size : 60 km (tiny)
Distance to Sun : 0.9 a.u. to 371 a.u.
Made of : Ice, Rocks
In orbit around : Sun

Image: GSFC– Kevin Hartnett

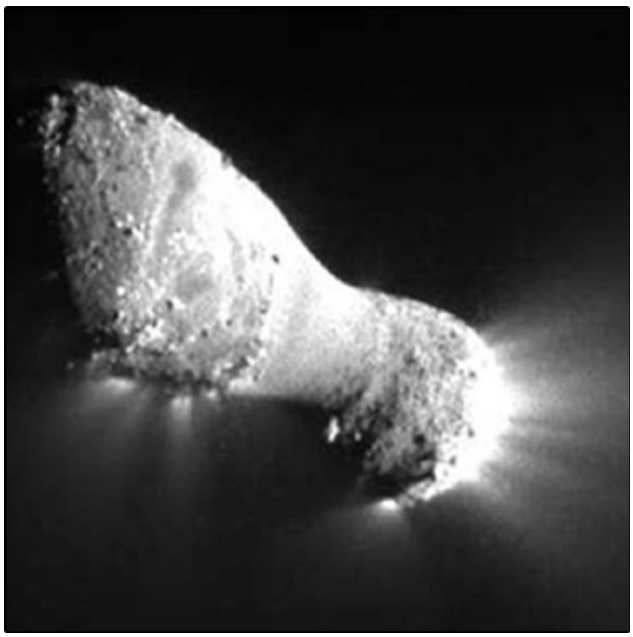
HALLEY



Size : 11 km (tiny)
Distance to Sun : 0.6 a.u. to 35 a.u.
Made of : Ice, Rocks
In orbit around : Sun

Image: Giotto, MPAE/ESA

HARTLEY 2



Size : 2 km (tiny)
Distance to Sun : 1.1 a.u. to 5.9 a.u.
Made of : Ice, Rocks
In orbit around : Sun

Image: EPOXI, NASA/JPL

IDA

Size : 53 km (tiny)
Distance to Sun : 2.9 a.u.
Made of : Rocks
In orbit around : Sun

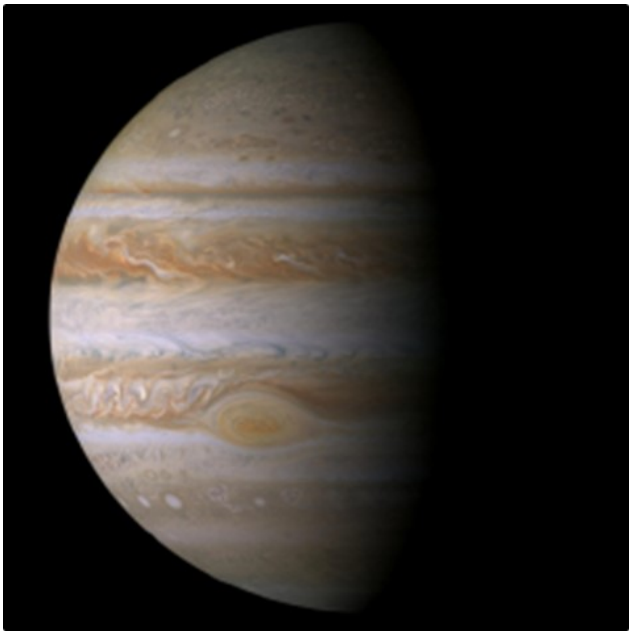
Image: Galileo, NASA/USGS

ITOKAWA

Size : 0,53 km (tiny)
Distance to Sun : 1.0 a.u. to 1.6 a.u.
Made of : Rocks
In orbit around : Sun

Image: ISAS, JAXA

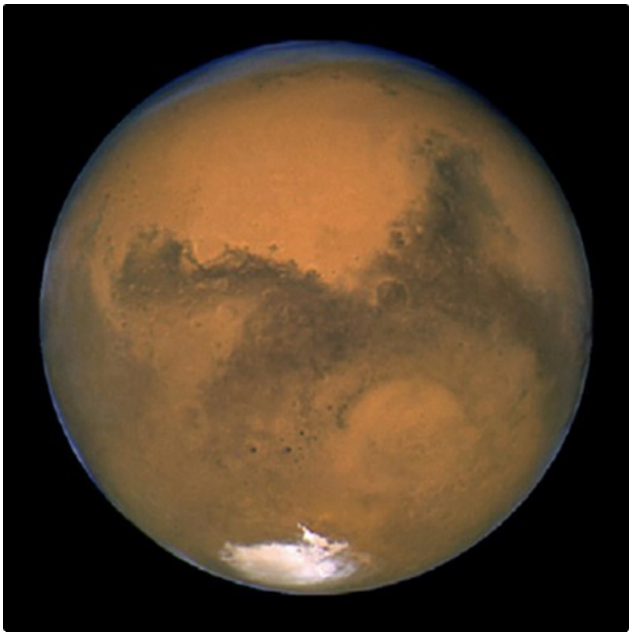
JUPITER



Size : 143 000 km (large)
Distance to Sun : 5.2 a.u.
Made of : Gas, Liguid Hydrogen
In orbit around : Sun

Image: Cassini, NASA/CICLOPS

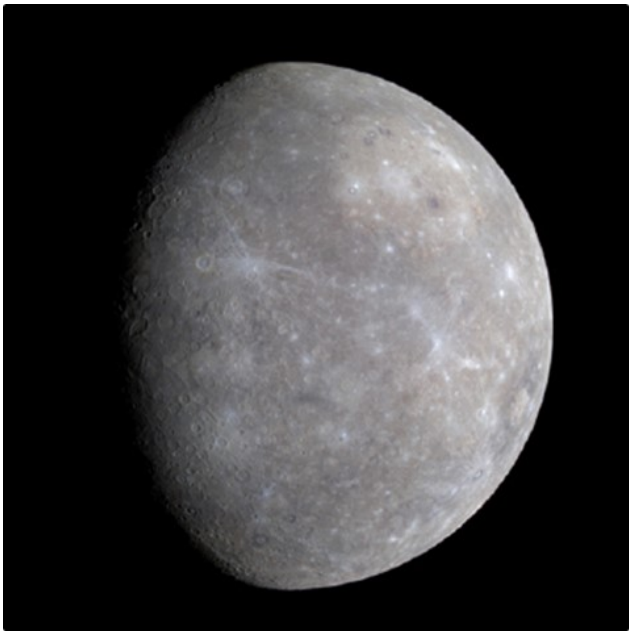
MARS



Size : 6 794 km (medium)
Distance to Sun : 1.5 a.u.
Made of : Rocks, Metal
In orbit around : Sun

Image: Hubble, NASA

MERCURY



Size : 4 880 km (medium)
Distance to Sun : 0.39 a.u.
Made of : Rocks, Metal
In orbit around : Sun

Image: MESSENGER, NASA/Johns Hopkins

MIMAS

Size : 392 km (small)
Distance to Sun : 9.6 a.u.
Made of : Rocks
In orbit around : Saturn

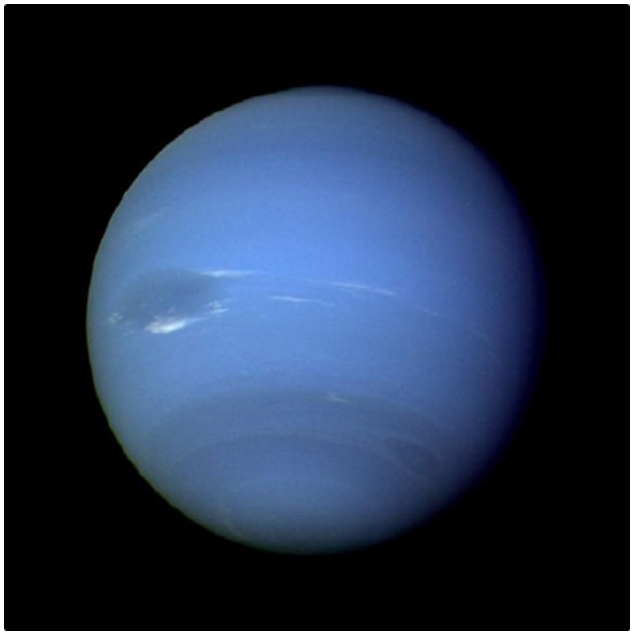
Image: Cassini, NASA/Cassini

MOON

Size : 3 475 km (medium)
Distance to Sun : 1 a.u.
Made of : Rocks, Metal
In orbit around : Earth

Image: NASA, GSFC, SVS

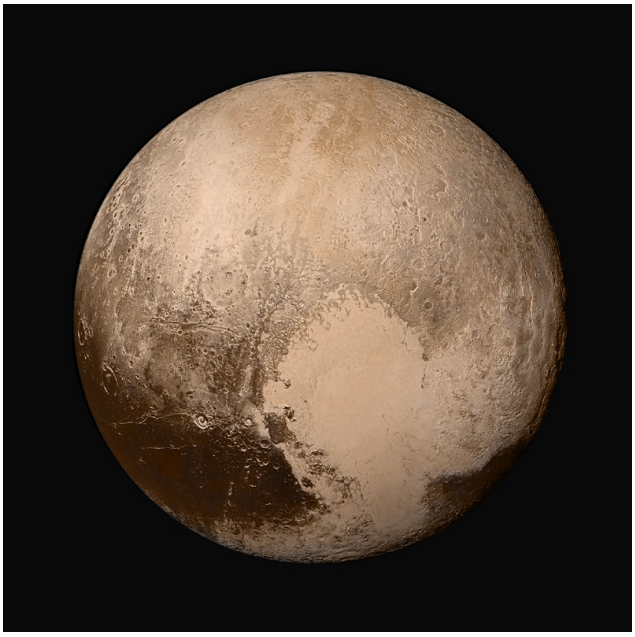
NEPTUNE



Size : 49 530 km (large)
Distance to Sun : 30 a.u.
Made of : Gas, « Liquid Ice »
In orbit around : Sun

Image: Voyager, NASA/JPL

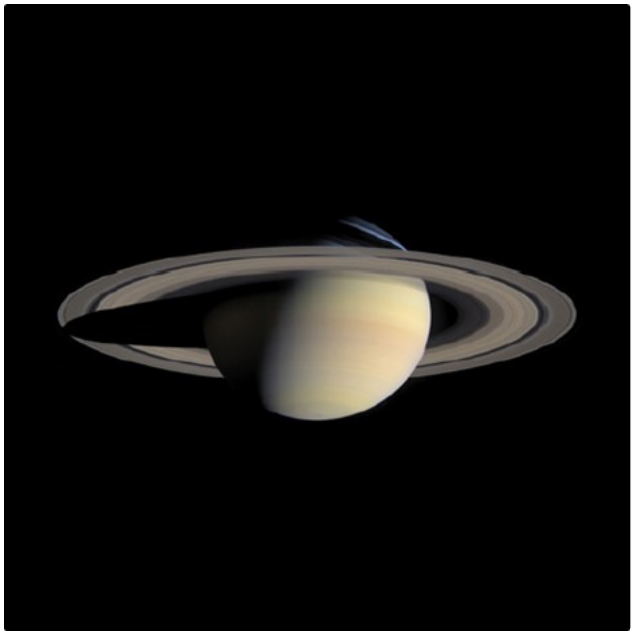
PLUTO



Size : 2 372 km (medium)
Distance to Sun : 40 a.u.
Made of : Ice, rocks
In orbit around : Sun

Image: New Horizons, NASA, JHUAPL

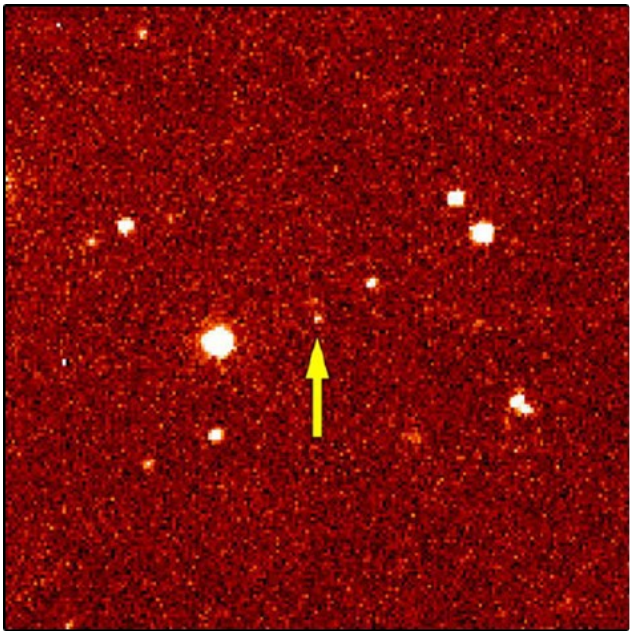
SATURN



Size : 120 500 km (large)
Distance to Sun : 9.6 a.u.
Made of : Gas, Liquid Hydrogen
In orbit around : Sun

Image: Cassini, NASA/CICLOPS/ISSI

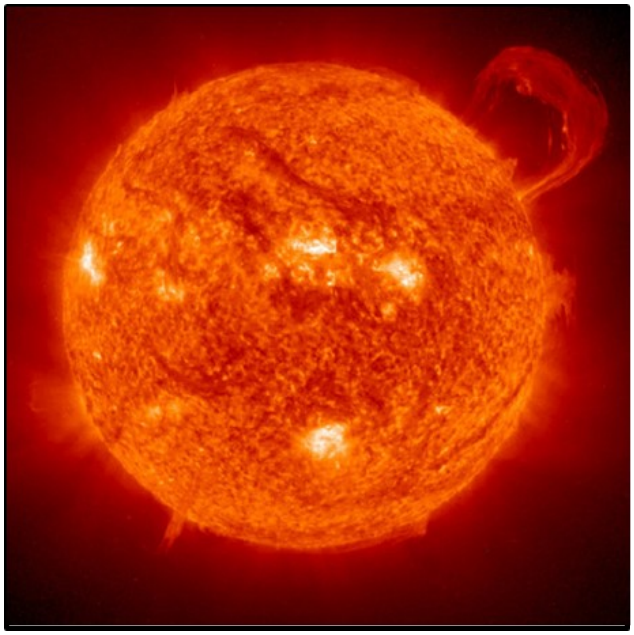
SEDNA



Size : 1 600 km (medium)
Distance to Sun : 76 a.u. to 929 a.u.
Made of : Rocks, Ice
In orbit around : Sun

Image: NASA/Caltech

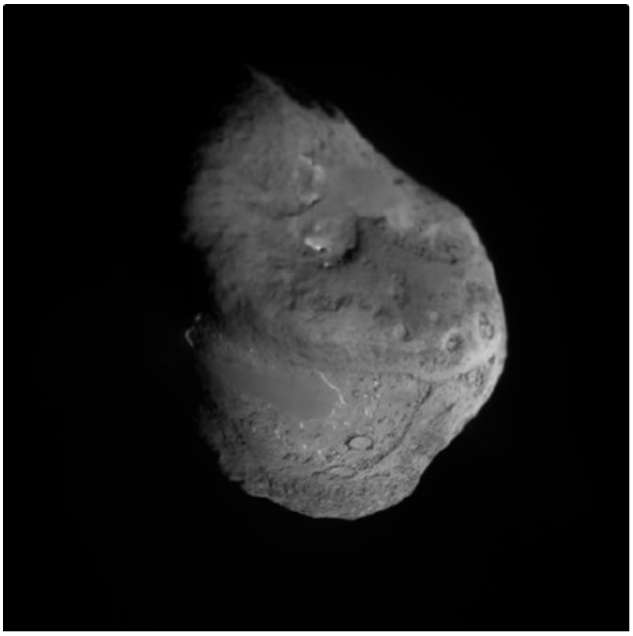
SUN



Size : 1 390 000 km (huge)
Distance to Sun : - - -
Made of : Gas/Plasma
In orbit around : Centre of the Galaxy

Image: SOHO, NASA/ESA

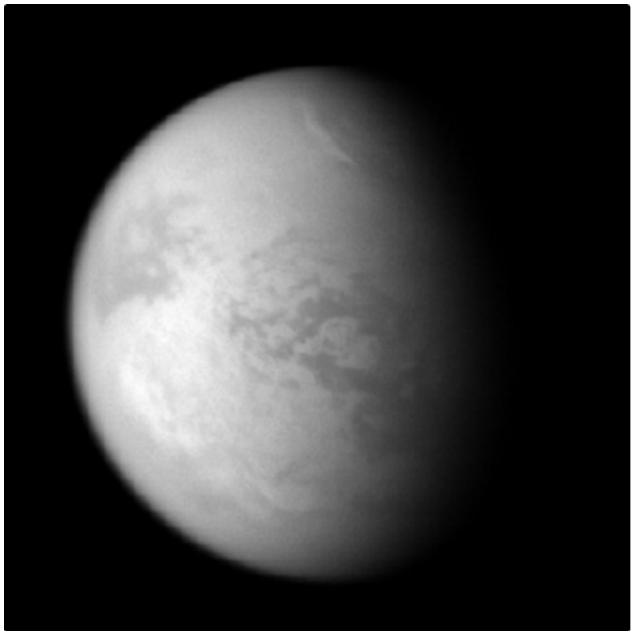
TEMPEL 1



Size : 6 km (tiny)
Distance to Sun : 1.5 a.u. to 5.3 a.u.
Made of : Ice, Rocks
In orbit around : Sun

Image: Deep Impact, NASA/U.of Maryland

TITAN



Size : 5 150 km (medium)
Distance to Sun : 9.6 a.u.
Made of : Rocks, Ice
In orbit around : Saturn

Image: Cassini, NASA/Cassini