LEARN – Why Aren't Asteroids Round?

Learning Objective:
Learn what's behind the diversity of asteroid shapes.

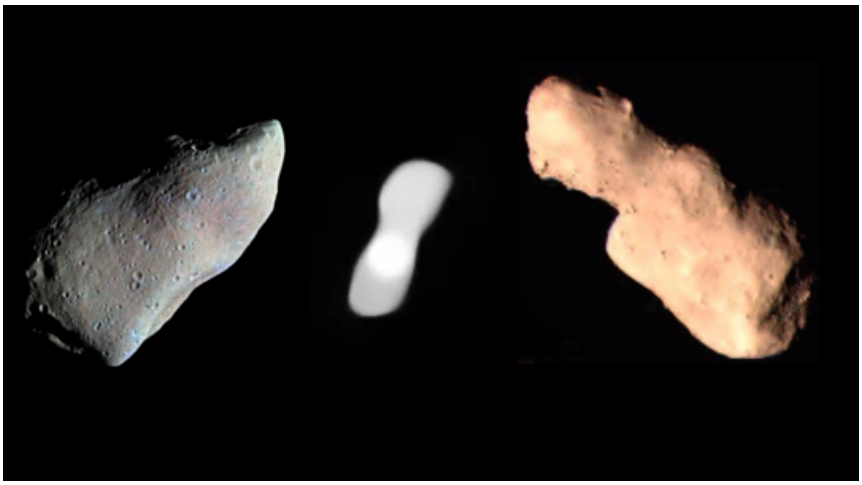
Overview:
Unlike planets, asteroids are irregularly shaped. This is true because smaller asteroids have inadequate gravity to crush their materials and form a more ball-like shape, however, it is important to add that there are of course other reasons besides gravity, why asteroids have different shapes.

Specifics:
Looking at images of the most well-known objects in the solar system, we can notice something in common. Their shapes, just like Earth's, are approximately spherical.

The force responsible for this is what prevents us from floating, causes objects to fall to the ground, keeps the oceans trapped in the crust, and also prevents gases in the atmosphere from escaping into space: gravity.

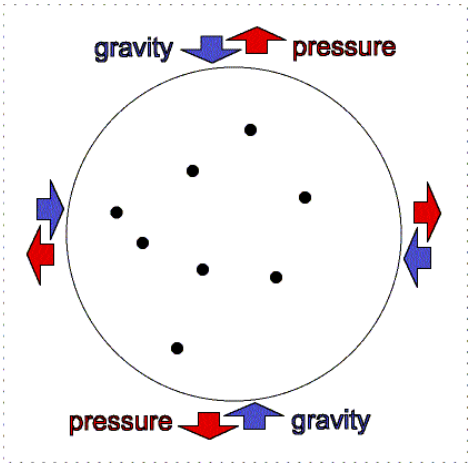
As a celestial body forms, it grows by adding matter and consequently increasing its mass. Mass is directly related to gravity. The greater the mass, the greater the gravity exerted. In a body, gravity acts uniformly in all directions. If it is the dominant force, the object will be moulded into a shape close to a sphere.

Asteroid images, however, show a diversity of shapes. Since there is not enough gravitational force to shape them, we can see asteroids that resemble potatoes, bones and other objects.

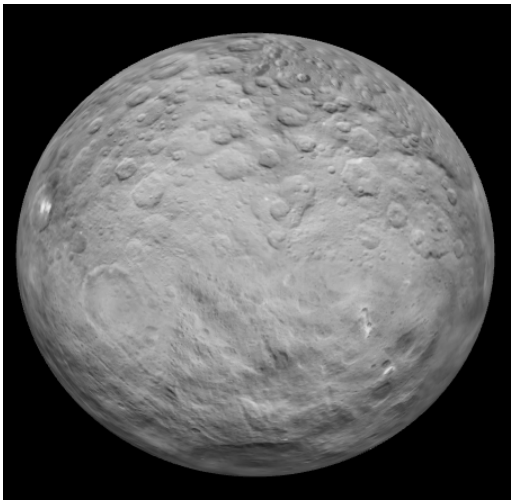


If the force of gravity depends on the mass of an object and not its size, this implies that objects made out of higher density materials can become spherical despite their smaller diameter.

The promoted asteroids - In astronomy, when a celestial body is rounded, we say that it has reached “hydrostatic equilibrium”. This balance is the result of an intense struggle between natural forces during their formation and explains more technically the sphericity identified in stars, planets and the largest asteroids or 'dwarf planets' like Ceres.



In 2006, the International Astronomical Union created a new category of celestial bodies having this hydrostatic balance as one of the criteria: dwarf planets. Thus, Ceres, considered to be a planet in the first years after its discovery and later an asteroid after the identification of other relatively close objects, was reclassified as a dwarf planet based on its shape other criteria.

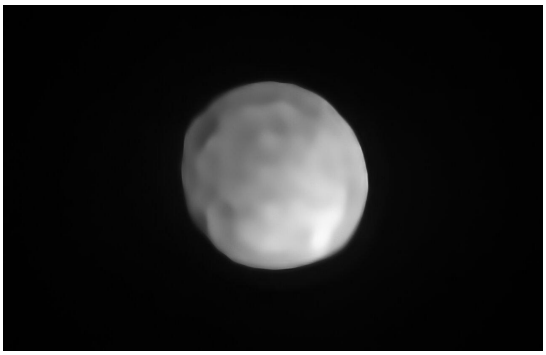


At 940 km in diameter, Ceres is very small and much less massive compared to stars and planets. Still, its formation added enough matter to generate a gravitational force capable of moulding it into a sphere.

According to the hydrostatic equilibrium criterion, it is possible that other objects originally considered to be asteroids may in the future be classified as dwarf planets.

Possible candidate - Discovered in 1849, Hygiea is located in the main asteroid belt between Mars and Jupiter. In 2019, a study based on observations made by the European Space Agency's SPHERE instrument using the Very Large Telescope (VLT) suggested that Hygiea has also reached hydrostatic equilibrium.

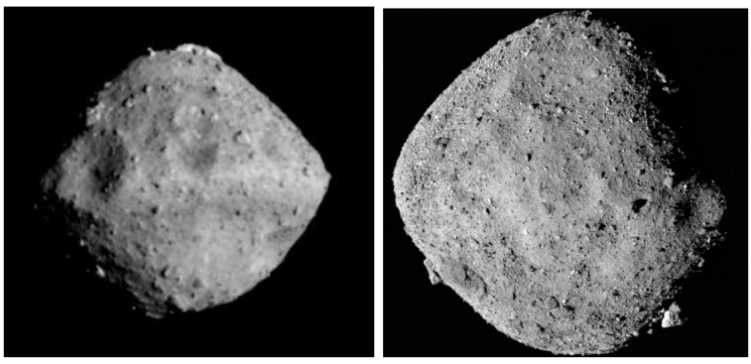
Less than half the size of Ceres and a smaller mass, Hygiea achieved a sphericity while other larger and more massive asteroids like Vesta and Pallas represent a transition between asteroids and dwarf planets. This indicates that particularities that arise during the asteroid formation process can also influence shape. It is possible that in the case of Hygiea, a major collision occurred during its formation and its debris coalesced again, generating the current shape of this asteroid.



Spinning-top asteroids - Analysing images of the Ryugu and Bennu asteroids taken by the Hayabusa2 and OSIRIS-REx missions respectively, scientists noticed an interesting similarity: both have a shape that resembles a spinning-top and it is not just a coincidence.

While some asteroids are composed of a single solid object as the end result of their formation process, others are piles of rubble – pieces of ancient collisions that fell back together and are held together by the same force of gravity that we find acting on other celestial bodies.

The peculiarity of these asteroids is that their deviations from a spherical shape are caused by the speed of rotation. Rotation is one of the known movements of celestial bodies and is also responsible for not finding perfectly spherical bodies in the solar system and universe.



Learn more about this subject by visiting these websites:
LEARN – What are the different types of Asteroids?
LEARN – Asteroids and the Formation of the Solar System
Asteroids Size Comparison (VIDEO)
Asteroid have weird shapes (ESA - short video)