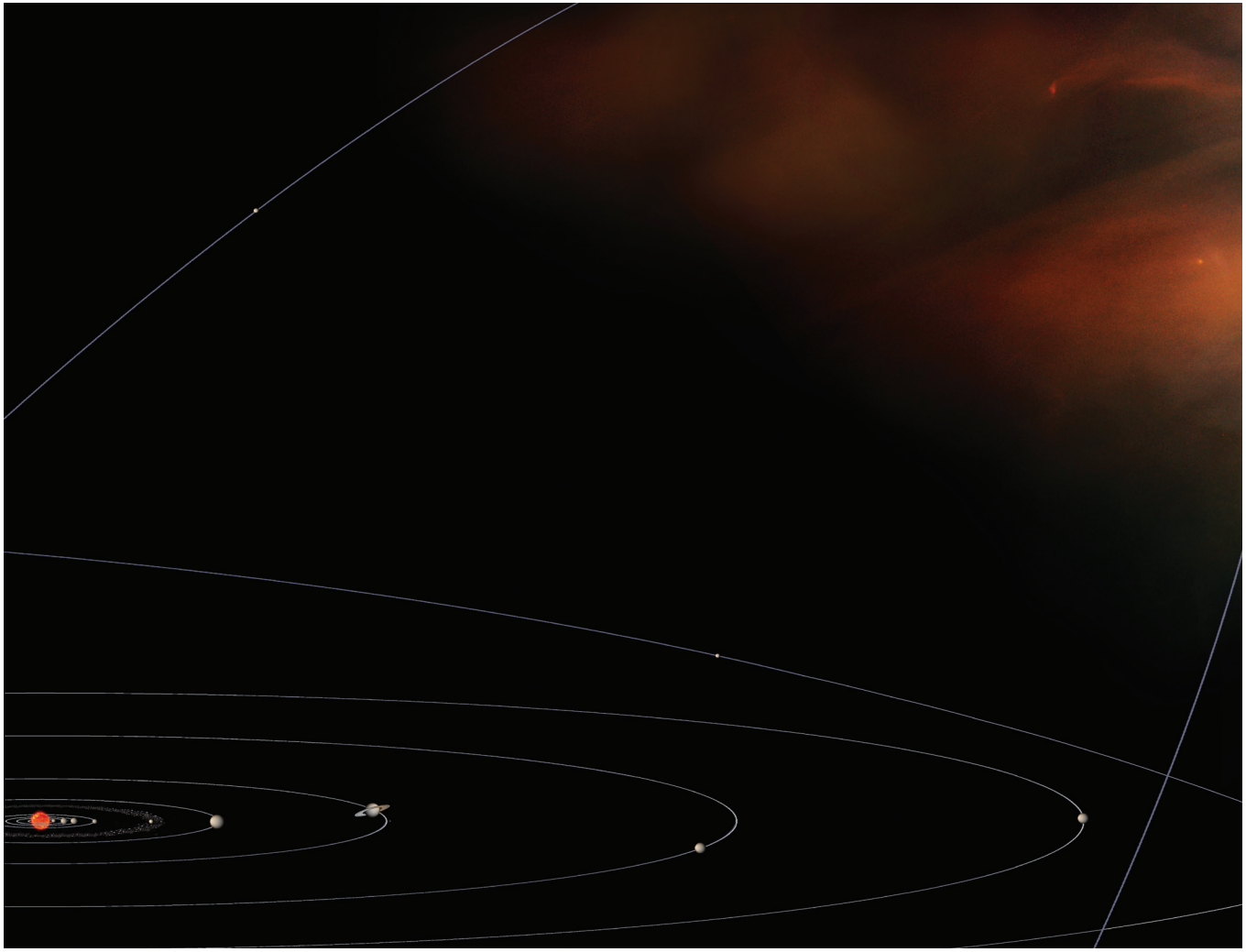

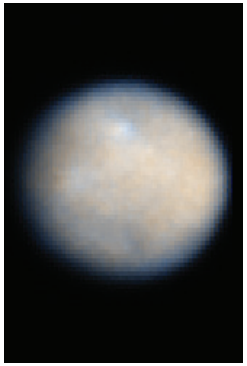

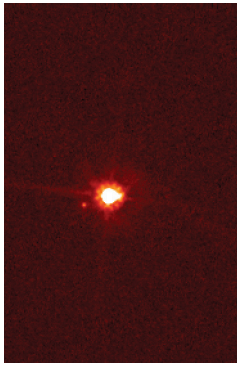

What Is a Planet?

Science is a dynamic process of questioning, hypothesizing, discovering, and changing previous ideas based on what is learned. Scientific ideas are developed through reasoning and tested against observations. Scientists assess and question each other's work in a critical process called peer review.

Our understanding about the universe and our place in it has changed over time. New information can cause us to rethink what we know and reevaluate how we classify objects in order to better understand them. New ideas and perspectives can come from questioning a theory or seeing where a classification breaks down.

Defining the term *planet* is important, because such definitions reflect our understanding of the origins, architecture, and evolution of our solar system. Over historical time, objects categorized as planets have changed. The ancient Greeks counted the Moon and Sun as planets along with Mercury, Venus, Mars, Jupiter, and Saturn. Earth was not considered a planet, but rather was thought to be the central object around which all the other celestial objects orbited. The first known model that placed the Sun at the center of the known universe with the Earth revolving around it was presented by Aristarchus of Samos in the third century BCE, but it was not generally accepted. It wasn't until the 16th century that the idea was revived by Nicolaus Copernicus. By the 17th century, astronomers (aided by the invention of the telescope) realized that the Sun was the celestial object around which all the planets — including Earth — orbit, and that the Moon is not a planet, but a satellite (moon) of Earth. Uranus was added as a planet in 1781 and Neptune was discovered in 1846.

Ceres was discovered between Mars and Jupiter in 1801 and originally classified as a planet. But as many more objects were subsequently found in the same region, it was realized that Ceres was the first of a class of similar objects that were eventually termed asteroids ("star-like") or minor planets.

Pluto, discovered in 1930, was identified as the ninth planet. But Pluto is much smaller than Mercury and is even smaller than some of the planetary moons. It is unlike the terrestrial planets (Mercury, Venus, Earth, Mars), or the gas giants (Jupiter, Saturn), or the ice giants (Uranus, Neptune). Charon, its huge satellite, is nearly half the size of Pluto and shares Pluto's orbit. Though Pluto kept its planetary status through the 1980s, things began to change in the 1990s with some new discoveries.

Technical advances in telescopes led to better observations and improved detection of very small, very distant objects. In the early 1990s, astronomers began finding numerous icy worlds orbiting the Sun in a doughnut-shaped region called the Kuiper Belt beyond the orbit of Neptune — out in Pluto's realm. With the discovery of the Kuiper Belt and its thousands of icy bodies (known as Kuiper Belt objects, or KBOs; also called transneptunians), it was proposed that it is more useful to think of Pluto as the biggest KBO instead of a planet. Then, in 2005, a team of astronomers announced that they had found a "tenth planet" — it was a KBO even larger than Pluto. People began to wonder what planethood really means. Just what *is* a planet, anyway? Suddenly the answer to that question didn't seem so self-evident, and, as it turns out, there are plenty of disagreements about it.

The International Astronomical Union (IAU), a worldwide organization of astronomers, took on the challenge of classifying the newly found KBO (later named Eris). In 2006, the IAU passed a resolution that defined *planet* and established a new category, *dwarf planet*. Eris, Ceres, Pluto, and two more recently discovered KBOs named Haumea and Makemake, are the dwarf planets recognized by the IAU (as of July 2013). Pluto, Eris, Haumea, and Makemake are also classified as KBOs, and Ceres retains its asteroid label. There may be another 100 dwarf planets in the solar system and hundreds more in and just outside the Kuiper Belt.

Astronomers and planetary scientists did not unanimously agree with these definitions. To some it appeared that the classification scheme was designed to limit the number of planets; to others it was incomplete and the terms unclear. Some astronomers argued that location (context) is important, especially in understanding the formation and evolution of the solar system.

One idea is to simply define a planet as a "natural object in space that is massive enough for gravity to make it approximately spherical." But some scientists objected that this simple definition does not take into account what degree of measurable roundness is needed for an object to be considered round. In fact, it is often difficult to accurately determine the shapes of some distant objects. Others argue that where an object is located or what it is made of do matter and there should not be a concern with dynamics; that is, whether or not an object sweeps up or scatters away its immediate neighbors, or holds them in stable orbits. The lively planethood debate continues.

As our knowledge deepens and expands, the more complex and intriguing the universe appears. Researchers have found hundreds of extrasolar planets, or exoplanets, that reside outside our solar system; there may be billions of exoplanets in the Milky Way Galaxy alone, and some may be habitable (have conditions favorable to life). Whether our definitions of "planet" can be applied to these newly found objects remains to be seen.

PLANET CHARACTERISTICS

What makes a planet, according to the definitions adopted by the International Astronomical Union —

	PLANET	DWARF PLANET
Is in orbit around the Sun	✓	✓
Has sufficient mass to assume a nearly round shape	✓	✓
Is not a satellite	✓	✓
Has cleared the neighborhood around its orbit	✓	
Has *not* cleared the neighborhood around its orbit		✓

ABOUT THE IMAGES

1 This illustration* of our solar system shows Eris in its highly tilted orbit beyond Pluto.

2 A Hubble Space Telescope image of Ceres. NASA's Dawn mission will visit Ceres in 2015 for a much closer look.

3 The Hubble Space Telescope took this image of Eris and its small moon, Dysnomia. Astronomers combined images from Hubble and the Keck Telescope to calculate Eris's mass and Dysnomia's orbit.

4 A size comparison of dwarf planets Eris, Pluto, and Ceres (artist's concepts); Pluto's moon Charon (artist's concept); Earth's Moon; and Earth.

FOR MORE INFORMATION

solarsystem.nasa.gov/dwarf

*In the illustration, the orbit of dwarf planet Eris, out beyond Pluto, is not to scale. Eris's mean distance from the Sun is 67.6 astronomical units (AU), compared to Pluto's mean distance of 39 AU. (One AU is the mean distance from Earth to the Sun.)

ACTIVITY: WHAT IS A PLANET?

In this activity, students (grades 9–12) compare the characteristics of planets, comets, asteroids, and transneptunian objects. Download the activity from this website — *pluto.jhuapl.edu/education/educators_eduGuide.php*

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