What is a Planet?

11 October 2006

On Wednesday, August 16, 2006, the International Astronomical Union (IAU) announced a proposed definition of a planet. A significantly revised version of this definition was passed by the membership at its general meeting on August 24, 2006. The IAU is an international organization of over 8,000 astronomers representing over 80 countries and held its meeting this year in Prague. The proposal for defining “what is a planet” and the fate of Pluto has been making front-page news for several weeks. In the draft resolution, three “planets” (asteroid Ceres, distant object 2003 UB313, and Pluto's satellite Charon) were added to the existing nine planets. However, there was concern by many astronomers that, if this definition of a planet passed, there was the likelihood that dozens of other planets would be added in the near future.

A summary [1] of what went on in Prague, the process that led to the final vote on August 24, the concerns that have since been raised by some astronomers, and the process that will lead to an eventual formulation for the definition of a planet was sent by Dr. Richard French, DPS Chair, to the entire DPS membership.

What brought about this proposal? In 1930, when Pluto was discovered by Clyde Tombaugh, it was thought to be as large as Earth. With more study, we now know that it is only a little more than 2200 km in diameter, smaller than our Moon! For this reason, during the 1990s, a few astronomers began questioning whether or not Pluto should be considered a planet. This question became more important beginning in 1992 with the discovery of objects in orbits similar to Pluto's orbit, some of which were almost as large as Pluto. Should these also be called planets? Is Pluto only one of many Kuiper Belt Objects (a subset of the Tran-Neptunian Objects that have orbits between 30 and 50 Astronomical Units from the Sun)? Then in 2003, an object was found that is larger than Pluto (2003 UB313, “Xena”). Should this object also be a planet?

An IAU committee of 19 planetary scientists tried, unsuccessfully, to come up with a definition of a planet in 2005. They failed to reach a consensus. In the spring of 2006, the IAU formed another committee to try to resolve this issue. The committee was made up of seven astronomers, journalists, and historians. They created a Draft Resolution defining a planet as an object orbiting a star which is large enough so that its gravity would pull it into an approximate sphere. By this definition, our solar system would have 12 planets. The committee presented this Draft Resolution at the IAU meeting and for a week, there were heated discussions and negotiations that led to the revised resolutions. These final resolutions were passed by the membership present for the final vote on August 24.

However, many planetary astronomers are unhappy with the process that led to the adopted resolutions, arguing that there was no time for a full and through debate by the larger planetary science community, most of whom were not in Prague. There will likely be further discuss about this issue.

Why is this important to scientists, and why is it important to you as a teacher or parent of a child who wants to know how many planets there are?

Importance to scientists

Scientists in any field use classification as a way to study things. Many times, the more we know, the more difficult it is to classify things. Some things may not fit into our “usual” classification scheme. This is true for planets, asteroids, comets, and satellites. Our original classifications have been challenged...
with the discovery of objects that orbit the Sun beyond the orbit of Neptune as well as planets around other stars.

**Importance to you**

You should not throw out your old textbooks. However, if the subject comes up, children will want to know the exact answer. The answer is that the IAU has voted on and approved a definition for “planet” that retains only the eight classical planets (Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune). Pluto becomes the prototype object for a new class of objects, “dwarf planets,” that at the moment includes Ceres and 2003 UB313 as well as Pluto.

As you are probably aware, the discussion is still going on. While the original resolution was based on several years of ongoing discussion, the resolutions that were passed were written in only a few days and so some points need to be clarified. **What is most important at the moment is that by seeing the process that scientists are going through to make their decisions of what constitutes a planet, you are seeing science at work.** New discoveries have made scientists rethink how they have defined a planet (a big object in orbit around the Sun). It shows that science is dynamic and not static. It shows that, many times, there is no clearly “correct” answer. Are the definitions perfect? No. Do all planetary scientists agree with the recommendations? Definitely no. While many astronomers are happy with the definitions, others are protesting the manner in which the resolutions were formulated and how the vote was carried out. While Pluto is now called a “dwarf planet,” it is still orbiting the Sun. It will still be visited by the New Horizons spacecraft in 2015, and scientists will still study it with ground-based and space-based telescopes. You, as a teacher, should take advantage of the on-going debate about Pluto and the definition of a planet as a way to teach about how science is done and how, as scientists learn more about the world around us, our view of the solar system and the rest of the universe is ever-changing—so must our definitions and theories be subject to change.

**Resolutions passed by the IAU General Assembly on 24 August 2006.**

Resolution 5A is the principal definition for the IAU usage of “planet” and related terms. Resolution 6A creates for IAU usage a new class of objects, for which Pluto is the prototype. The IAU will set up a process to name these objects.

[2] - and links to articles written by several scientists and science educators.

**IAU Resolution 5A: Definition of a Planet in the Solar System**

Contemporary observations are changing our understanding of planetary systems, and it is important that our nomenclature for objects reflect our current understanding. This applies, in particular, to the designation “planets.” The word “planet” originally described “wanderers” that were known only as moving lights in the sky. Recent discoveries led us to create a new definition, which we can make using currently available scientific information.

The IAU therefore resolves that “planets” and other bodies in our Solar System, except satellites, be defined into three distinct categories in the following way:

1. A “planet”\(^1\) is a celestial body that (a) is in orbit around the Sun, (b) has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape, and (c) has cleared the neighborhood around its orbit.

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\(^1\) A “planet” is a celestial body that meets the following criteria: (a) is in orbit around the Sun, (b) has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a nearly round shape, and (c) has cleared the neighborhood around its orbit.
While planets have to be nearly spherical, they usually bulge at the equator, thanks to the fact that planets rotate. The Earth’s diameter at the equator is about 12,760 km (7,925 miles), while from pole to pole it is about 12,720 km (7,900 miles). Scientists estimate that for a rocky body, hydrostatic equilibrium will happen for an object that is about 800 km (500 miles) and has a mass about 1/12,000 that of the Earth (Ceres is about 950 km and has a mass about 1/7000 that of Earth).

Part “a” eliminates satellites of the planets as potential planets even if they are “round.” Part “c” is the major difference between the original draft resolution and the one that passed. This eliminated the Main Belt asteroid Ceres (only one of many asteroids) and Pluto and 2003 UB313 (two of many Trans-Neptunian Objects) and eliminated the possibility of there being dozens of other planets in the near future.

2. A “dwarf planet” is a celestial body that (a) is in orbit around the Sun, (b) has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape\(^2\), (c) has not cleared the neighborhood around its orbit, and (d) is not a satellite.

In the original resolution, “dwarf planet” was not an official IAU term. The terms “terrestrial” and “gas giant” (or jovian) are not official IAU terms. This resolution then creates a new class of objects that includes Ceres (and possibly a few other Main Belt asteroids), as well as Pluto and other large Tran-Neptunian Objects.

3. All other objects\(^3\) except satellites orbiting the Sun shall be referred to collectively as “Small Solar-System Bodies”.

The term “minor planet” will no longer be used. Small Solar System Bodies include asteroids and comets. While most known asteroids have orbits between Mars and Jupiter in the Asteroid Belt, there are groups of objects that orbit in other parts of the solar system: Near-Earth Asteroids (NEOs), many of whose orbits cross the orbit of the Earth; Trojan Asteroids that share the orbits of several of the planets (Mars, Jupiter, and Neptune); Centaurs, whose highly elliptical orbits cross the orbits of the outer planets; Kuiper Belt Objects, objects in orbits beyond Neptune's orbit and that orbit in a relatively flat disk between 30 and 50 AU (30 to 50 times Earth’s distance from the Sun); and Trans-Neptunian Objects (TNOs), objects that have orbits beyond the orbit of Neptune (KBOs are a subset of the TNOs).

\(^1\)The eight “planets” are: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune.
\(^2\)An IAU process will be established to assign borderline objects into either dwarf planet and other categories.
\(^3\)These currently include most of the Solar System asteroids, most Trans-Neptunian Objects (TNOs), comets, and other small bodies.

**IAU Resolution 6A: Pluto**

The IAU further resolves:
Pluto is a “dwarf planet” by the above definition and is recognized as the prototype of a new category of trans-Neptunian objects.

One issue that has been raised is: Are “dwarf planets” planets or not? In a statement by Iwan Williams, the outgoing IAU President said: “To the question is Pluto a planet, you can now give two answers. No, it is a dwarf planet; and yes, it is a dwarf planet!” While there is a general feeling that this was not the intent of the people who voted on this, it is not explicitly ruled out in the resolution and probably will be one of the many aspects that will be discussed over the next few years as debate on this issue continues.
Further Reading

Below are several articles that will help in teaching about the ongoing issues of what is a planet and is Pluto a planet.

Support for IAU Resolutions, Dr. Michael Brown [3]
This Web page at CalTech discusses why Dr. Brown supports the IAU resolutions. Brown has a serious interest in the subject: he discovered the large Kuiper Belt Object Quaoar which reopened the question as to the status of Pluto as a planet, and then 2003 UB313 (“Xena”), an object that has been shown to be larger than Pluto. He is concerned that Pluto and “Xena” are both much smaller than the eight classical planets and that the new definition avoids the potential of having dozens of new, small, icy planets in our solar system.

Editorial article about the issue illustrates that the scientific process is dynamic, Dr. Nadine Barlow [4]
This was an editorial in Flagstaff's Arizona Daily Sun newspaper by Dr. Nadine Barlow of Northern Arizona University. Although she is a planetary scientist focusing on impact cratering, she is very interested in education and public outreach and is now teaching about this issue to her college students (in the city where Pluto was discovered). She addresses her concerns about the vote from the perspective of growing up with Pluto as a planet, as an educator, and as a planetary scientist. She was happy with the original resolution in that it was based on the physical nature of the objects and was a relatively simple definition. What is important for her as an educator is that this whole issue points out that science is not static.

Bulldoze Pluto? I Don't Think So, Dr. Jeffrey Bennett [5]
Dr. Jeffrey Bennett is a scientist, educator, and textbook and children's book writer at the University of Colorado. His view is somewhere between the previous two articles. As a scientist, he is happy to see that the issue has been resolved, but as an educator, he does have some reservations. He gives a good history of the discovery of Pluto and the discoveries leading up to the IAU vote.

The debate as a teachable moment, William Schmitt [6]
Finally, there is a message that was posted by William Schmitt. He is a science educator at the Science Center of Inquiry and is the former Director of the Pacific Science Center. To him, it is not important whether or not we call Pluto a planet, but that the process that is unfolding creates a teachable moment. He notes that nature does not classify things, but people and scientists do. We look at the properties of objects and categorize them so that they make sense to us. That is what really happened at the IAU meeting and this is what we should be teaching our children.

In summary, what is important is the process that went into the final vote. Even the people who support the new definition of planet are willing to admit that the definitions are still a little “fuzzy.”

If you have any further questions, please feel free to contact the DPS Education and Public Outreach Officer at dpsed@aas.org [7]