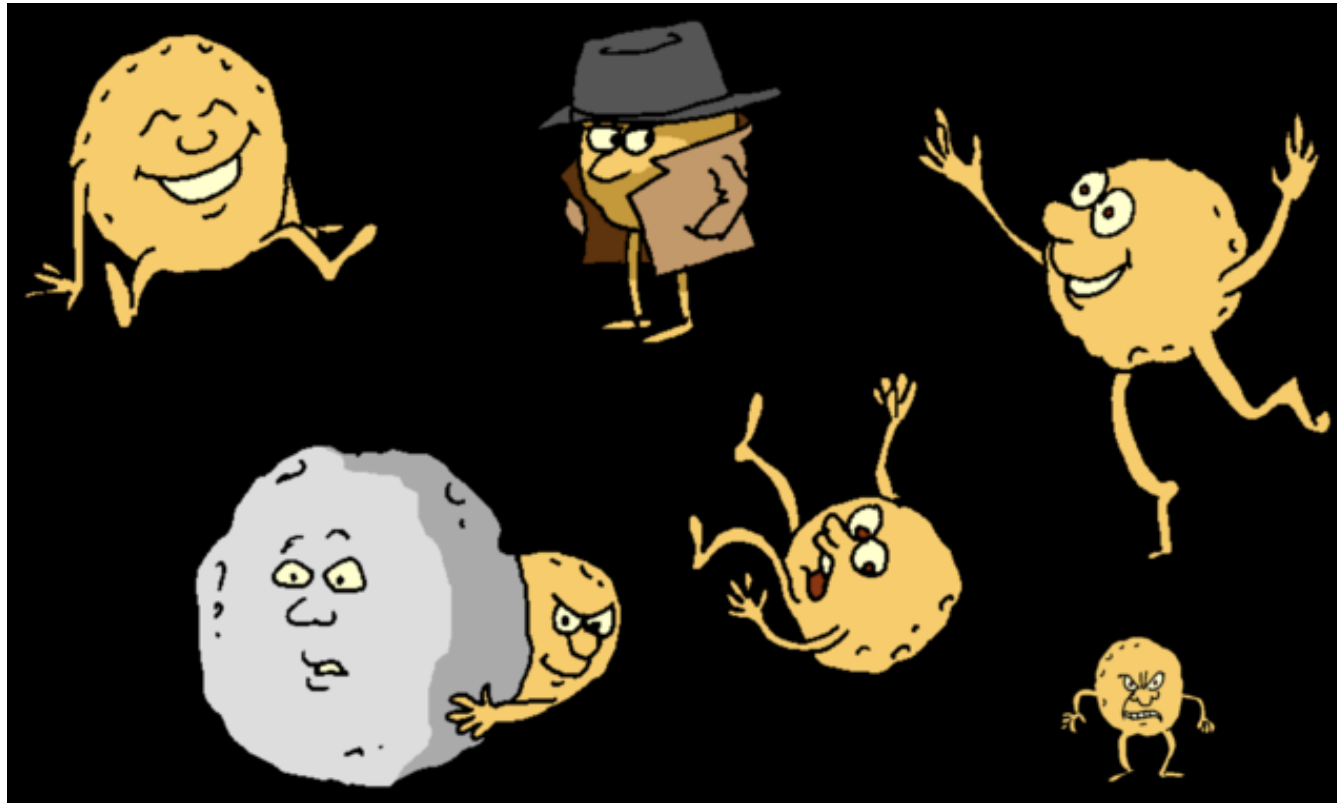


## Is Pluto a Planet?: Planet or Not a Planet?





## Summary

In this Activity, we will look at the actual debate about Pluto's status as a planet. In particular, we will learn about:

- the classification of objects in the [Solar](#) System;
- celebrating the new KBOs;
- the media getting it wrong; and
- resolving the issue about Pluto's status (or not. . .)



## Introduction

Everyone knows what a planet is, don't they? The Earth is the 3<sup>rd</sup> planet from the Sun and any decent textbook or astronomy website will tell you that there are 8 other planets in our Solar System. But what is a planet anyway? What is the *definition* of a planet? Surprisingly, there isn't one! Until recently not even the IAU<sup>1</sup> had an official definition of a planet.

In this final Activity, we will cover the debate about Pluto's status as a major planet. This has been a "real" debate among astronomers in that there were people "for" and "against", it has been revisited several times but a conclusion was officially made in August 2006.

<sup>1</sup> International Astronomical Union

## The new Solar System

Our knowledge of the Solar System and planets in general has changed dramatically over recent years. The field of [planetary](#) science is currently going through a revolution!

You might think of the Solar System as 4 terrestrial planets, 4 Jovians, Pluto, dozens of satellites, thousands of asteroids, and possibly millions of [comets](#). But lately things have been getting a bit confusing. For example, planetary scientists will tell you there are three clear groups of planets: the terrestrial, gas giants (Jupiter and Saturn), and ice giants (Uranus and Neptune) – though ice giants are a sub-class of gas giants.

Some asteroids have [comet](#)-like coma (like 2060 Chiron) and as we've seen hundreds of new objects are being found [orbiting](#) the Sun out past Neptune.



Added to this, over 350 extrasolar planets have been found, none of which look much at all like our Solar System. Many **stars** seem to host “hot Jupiters” – Jupiter **mass** planets on extremely short periods (ten times closer to their host **star** than **Mercury** is to the Sun), and most planets seem to be on **eccentric orbits**.

And if you thought all this wasn't bad enough, free floating “planets” have been found in the Orion star forming region – surely a planet has to *at least* **orbit** a star?

So with all this new information, there are strong arguments for defining exactly what a planet is. Let's have a look at the debate about defining planets in more detail.



Credit: G. Bacon (STScI), NASA

## What's in a name?

Let's turn back to 1801, when Italian astronomer Giuseppe Piazzi discovered an object between [Mars](#) and Jupiter. The object was thought to be the "missing planet" as predicted by the Titius Bode Law<sup>2</sup>, orbiting at 2.76 [AU](#). Piazzi called his new object *Ceres Ferdinandea*, the 8th planet.

However, the subsequent discovery of other "small planets" by German Heinrich Olbers immediately cast doubts about Piazzi's planet, which became known simply as Ceres. By 1849, 10 such objects were known, and the 100th *minor planet* or *asteroid* was announced in 1868. By 1923, 1000 asteroids were catalogued, and today the number exceeds 12,000.

<sup>2</sup> Is the Titius-Bode law really a "law"? To learn more about it, [follow this link](#).

With the discovery of the first four minor planets - Ceres, Pallas, Juno and Vesta - in the early 1800s, it was obvious that these objects formed a new class of objects in the Solar System. They all shared very similar orbits, were eccentric, had large inclinations and were all small.

As a group, we now call small objects orbiting between Mars and Jupiter *asteroids* or *minor planets*. We also know now that there are several different types (or groups) of asteroids:

- [Near Earth Asteroids](#) (of which there are 3 subclasses);
- Main Belt Asteroids;
- the Trojans; and
- the [Centaur](#)s.

And that's just their dynamical categories. Asteroids are also classified by their [albedo](#) and spectral characteristics.

For more info about the dynamical asteroid groupings, [follow this link](#).





So what's with all these names? Are we just going to classify objects and subdivide groups of objects ad infinitum? Having suitable names for the various classes of objects is useful for people working in the field so that they have a common language when discussing these different objects. It's also important in helping us understand their origin.

Clearly the Solar System is a complex object, and so if we can break it up into smaller parts and try to understand each individual component, we can then go back and try to build a more complete model of the Solar System. So we start by subdividing groups of objects and learning about each group, and then try to see how each group is related.

It often turns out that an individual object can fall into two classes, and this is where things start to get messy...



The current classification debate in planetary science is about the exact nature of the KBOs or TNOs<sup>3</sup>.

- Are these icy objects of the outer Solar System *asteroids*?
- Are they *comets*?
- Or are they a new class of objects all together?



They're listed by the IAU's Minor Planets Centre<sup>4</sup> as minor planets (so that means asteroids). They actually fall into two groups: the TNOs (1010 listed) and the Centaurs/[scattered disk objects](#) (173 listed). But this, remember, is a dynamical listing rather than a compositional categorisation.

<sup>3</sup> See how important names can be! For now, "KBO" and "TNO" are used interchangeably.

<sup>4</sup> To visit the Minor Planet Centre on the web, [follow this link](#).



It is difficult to tell the difference between Centaurs and scattered disk KBOs. For example, 1995 SN<sub>55</sub> is a **Centaur** and yet its eccentric orbit carries it past the orbit of Neptune. It could just as easily be classified as a scattered disk KBO.

Is it OK for one object to have two classifications? Taking this idea one step further, is it also OK for *Pluto* to have two classifications?

## Pluto's new family

As we saw in the previous Activity, the discovery of the KBOs has forced astronomers to think about Pluto's place in the Solar System, since it now seems to be more the "king of the Kuiper Belt" rather than the 9<sup>th</sup> planet in the Solar System.

This led to much debate, and then argument which reached fever pitch in early 1999, when friendships strained, internet headlines and editorials beefed up the story, and school children begged to have the little planet back.

Finally the IAU General Secretary had to issue a statement confirming that Pluto was indeed a planet (even though the term "planet" was not defined).

## The role of the media...

The story was quickly picked up by the media and incorrectly reported that the IAU was voting on whether to *demote* Pluto from its planet status.

A story in *BBC News Online* reported in early 1999:

“In just a few weeks time tiny Pluto will regain its crown as the most distant planet orbiting the Sun. Soon afterwards however it may lose its planetary status forever. . . Depending upon an email vote among astronomers our solar system may soon have eight instead of nine planets as all the textbooks say.”

USA Today ran an article stating:

*“The solar system is being downsized, and Pluto could get the pink slip.”*

Similar reports appeared in the *Boston Globe* and many other major American newspapers.

The internet was alive with debate (though rather one sided really), with many web pages showing their outrage over the proposed demotion of Pluto.

“Save Pluto” websites sprung up all around the globe, and school children sent pleading letters to astronomers and the IAU.

Planet



## Retraction...

In January 1999, the *Boston Globe* retracted its earlier article, noting that the idea was not a demotion after all, but that in celebration of Pluto's status it would be given dual citizenship. While Pluto would remain the smallest major planet in the Solar System, it would also be crowned the king of the [Kuiper Belt](#).

The *BBC News Online* also ran a story in late January 1999 under the heading:

*"Pluto will have 'dual citizenship'."*



## What happened in February 1999

On 2 February 1999, the Minor Planets Electronic Circular *MPEC 1999-C03*<sup>5</sup> carried an Editorial Notice by Brian Marsden about Pluto's status.

It argued that since the numbered minor planets was rapidly approaching 10000, something should be done to celebrate that fact. Traditionally each thousandth numbering was celebrated. For example, 1000 was named in honour of Piazzi (Ceres' discoverer), 2000 in honour of Herschel (Uranus' discoverer), 5000 honoured the IAU, and 6000 even honoured the United Nations.

<sup>5</sup> Actually issued on 4 February.

Marsden suggested that 10000 clearly called for a big celebration, and that the honour should go to Pluto - the first known and largest of the KBOs or TNOs.

Marsden stressed that this was in no way a “demotion” or “reclassification” of Pluto as a (major) planet. Further, the 10000 numbering would only be used in matters directly relating to Pluto’s status as a TNO.

He then invited readers of the Circular to email the [MPC](#) with a statement indicating that they either approved or didn’t approve of Pluto being made 10000. Marsden also asked that those who didn’t approve should try to suggest an alternative for 10000.



On 3 February 1999, the IAU General Secretary Joannes Anderson issued a Press Release clarifying the status of Pluto.

Anderson pointed out that many of the media reports had been false and that there were **no** plans to change Pluto's status as a planet.

He explained that there was a plan to number the TNOs and that the IAU's Planetary Science Division was having a technical debate about how best to do this. He also noted that the IAU was *considering* ways to classify planets by their physical characteristics.

Further, the Small Bodies Names Committee had decided **not** to assign any minor planet number to Pluto.



For the full IAU Press Release, [follow this link](#).



Then on 5 February, the Minor Planets Electronic Circular *MPEC 1999-C10* carried another Editorial Note in response to the IAU Press Release.

Marsden noted that the Small Bodies Naming Committee had not actually completed its job - to decide what to call the 10000th minor planet - but had only made a decision not to assign Pluto as number 10000.

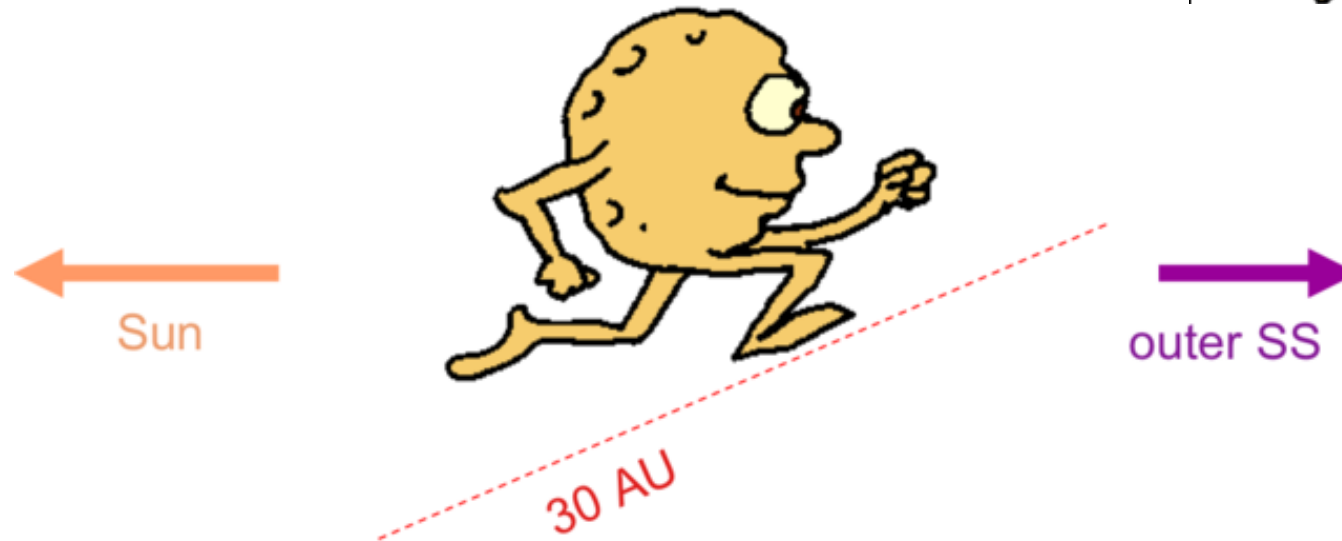
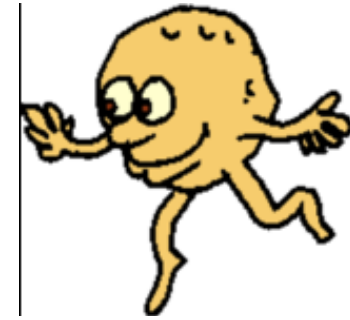
It was also reported that within 24 hours of *MPEC 1999-C03* being released, 63% of readers were in favour of using 10000 for Pluto, while 37% were against<sup>6</sup>, but that unfortunately few suggestions had been made for an alternative.

Marsden concluded by apologising to Anderson for the timing of the previous Circular, and to anyone whom he may have upset, and noted that the “Pluto issue” was clearly very emotional!

<sup>6</sup> however the number of voters was not given...

Meanwhile, totally ignorant of the debate raging on Earth, Pluto continued on its merry journey around the Sun in the outskirts of the Solar System.

After enjoying 20 years being the 8<sup>th</sup> planet from the Sun, on 11 February 1999 Pluto's elliptic orbit carried it past the orbit of Neptune and returned it to its rightful position as 9<sup>th</sup> planet from the Sun. It will remain the furthest planet in the Solar System for another 230 years.



## End of the debate?

So was there really a debate? Not really. A summary of events goes like this:

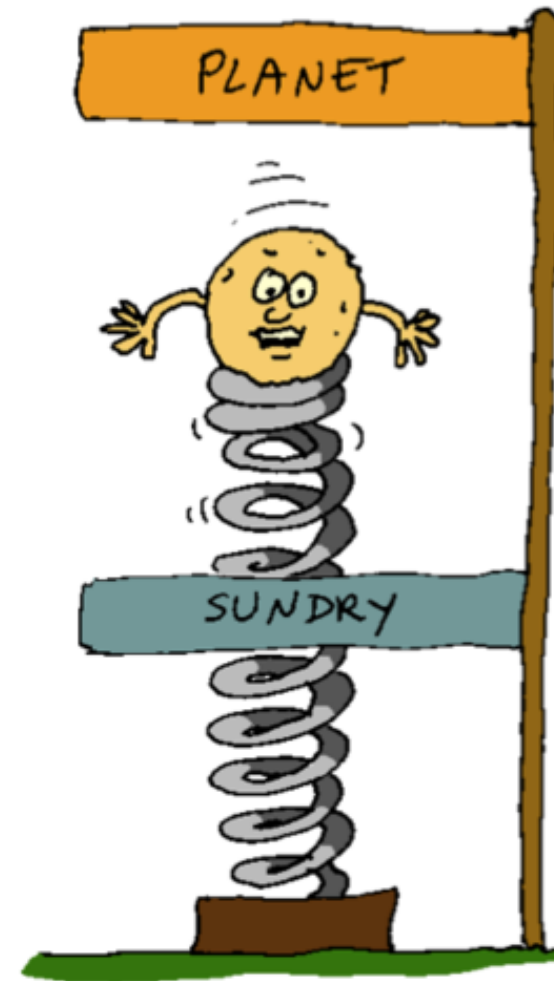
- Small icy objects were discovered past Neptune's orbit in the early 1990s that seemed to resemble Pluto.
- Astronomers started to question the relationship between Pluto and the KBOs, and some astronomers began to think that Pluto may not really be a planet after all.
- The media picked up on this story and announced that Pluto was being "demoted" as a planet.
- Confusion reigned, there was a public outcry and "Save Pluto" campaigns started up overnight.
- Astronomers tried to get the point across that Pluto was *not* being demoted, but that it would have a dual status.

- Finally the IAU announced that Pluto was not being demoted, nor was it going to be numbered as a minor planet.

So Pluto had bounced back and regained its status as a planet (which it had never lost) and everyone was happy.

Great - so the “debate” is over, right? Pluto *is* a planet, right?

What do **YOU** think??



## So then what happened?

On 2 March 1999, asteroid number 10000 was assigned to 1951 SY. However, that doesn't really stop the debate. Although Pluto didn't become asteroid 10000, one day in the future it might be assigned a number.

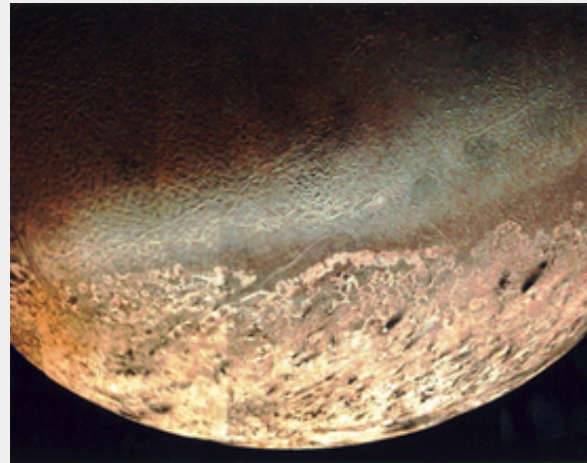
There are now many astronomers who are pretty comfortable with the idea that Pluto is really a KBO, but for historical reasons everyone is happy to continue with the dual title - there's no harm in calling Pluto the 9<sup>th</sup> major planet while we all know what it *really* is, right?

Old ideas can be slow to change and it seems that the asteroid 10000-Pluto debate occurred a little too early for people to feel comfortable with it.



And of course the KBOs keep being discovered. In 1999, the count was around 200, and seven years later it is greater than 1000. This means that we know quite a bit more about these objects (as discussed in the previous Activity), but also results in more questions - specifically about the origin of Pluto and the KBOs.

For example, what about Triton, Neptune's largest satellite? It has a similar size and **density** to Pluto, and is on a retrograde orbit, suggesting that it has been captured. It even has a transient atmosphere as does Pluto. These facts all suggest that it formed under similar conditions, in similar regions of the Solar System. . .

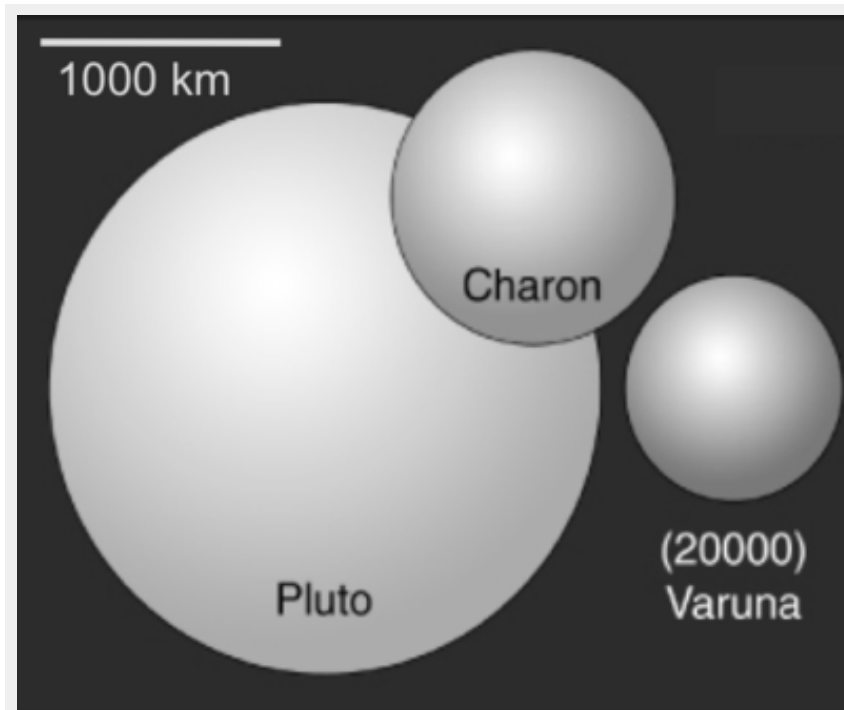


Credit: Courtesy NASA/JPL-Caltech

And what about Varuna, Quaoar and Sedna? With diameters larger than 900 km, these large KBOs are clearly closing the gap between the smaller ( 100 km) KBOs and Pluto & Charon (with diameters 2400 km and 1200 km respectively).

The recently discovered object Eris is substantially larger than Pluto. So, the discovery of more, larger objects must be considered.

Eris is approximately 3000 km in diameter (see the previous activities in this Module).



Credit: D. Jewitt, H. Aussen (IfA, Uni. of Hawaii) and A. Evans (Dept. Physics and Astronomy, State University of New York at Stony Brook)

The Pluto debate certainly highlighted the fact that we really need a definition of a planet.

Recently Alan Stern of the Southwest Research Institute, Boulder, and Hal Levison of SwRI-Boulder, have made some suggestions about how to define a planet in [light](#) of the recent debate.

- Based on easily observable characteristics (*such as mass and size, rather than poorly understood concepts like mode of origin*)
- Be context independent (*shouldn't depend on what other bodies are nearby*)
- Be robust to new discoveries (*shouldn't need to redefine every time a new class of objects is found*)
- Should classify uniquely (*so that no object is in multiple classes*)
- Should be quantitative (*based on numerical properties or parameters*)
- Involve as few criteria as possible!



Based on these guiding principles, Stern & Levison go on to suggest a simple criteria - the object's *mass*.

They need to set the upper and lower limit so that the object is not so large that it can sustain nuclear reactions, nor so small that it is held together by mechanical strength rather than *gravity*.

And to be a *planet* the object must orbit a single (or multiple) star. Thus massive satellites don't get classified as planets since they primarily orbit a larger planetary body. A *double planet* will have its centre of gravity associated with neither body.

This is just one idea (of both a classification scheme and what to classify by) and of course not everyone would agree with this system. So open the topic up for debate!

## The end?

Finally the matter was officially resolved at the August 2006 meeting in Prague. Ideas about definitions of planets, dwarf planets and double planets were extensively considered and debated. Early in the meeting the IAU proposed a draft definition based on recommendations of various sub-committees:

*“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.”*

This definition would have included at least Pluto, Ceres, Charon (as half of a *double-planet* with Pluto) and Eris.



## The end!

Unfortunately for Pluto astronomers were not in favour as it was unclear how many more “planets” fitting this definition would be discovered in the next few years. Estimates ranged from 50 upwards to over 200.

The final IAU [resolution](#) had a crucial extra clause added and was passed on August 24<sup>th</sup>.



Credit: IAU/Lars Holm Nielsen



## The final resolution

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

1. A 'planet'<sup>7</sup> 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 neighbourhood around its orbit.
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<sup>8</sup>, (c) has not cleared the neighbourhood around its orbit, and (d) is not a satellite.
3. All other objects<sup>9</sup> except satellites orbiting the Sun shall be referred to collectively as 'Small Solar System Bodies'.

<sup>7</sup> The eight planets are: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune.

<sup>8</sup> An IAU process will be established to assign borderline objects into either dwarf planet and other categories.

<sup>9</sup> These currently include most of the Solar System asteroids, most [Trans-Neptunian Objects](#) (TNOs), comets, and other small bodies.

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.”<sup>10</sup>



Credit: IAU/Lars Holm Nielsen



<sup>10</sup> An IAU process will be established to select a name for this category. (This reported in 2008, see later...)

## The need to debate...

At the end of a minor debate in 1997 between Marc Buie of Lowell Observatory and Daniel Green of the Smithsonian [Astrophysics Observatory](#)<sup>11</sup>, Buie says that *“the last batch of naysayers putting Pluto down are not acting with any authority and are really doing us a disservice in the process.”*

Some of Green’s responses to Buie’s comments are rather scathing, but he does say - quite correctly - that:

*“any attempt to silence reasonable discussion of Pluto... can be nothing other than science at its worst, and something very much against the principles behind the scientific revolution of the past few decades. Constructive dialogue is essential to the progress of astronomy, science and of mankind”.*

<sup>11</sup> The other SAO!



## Summary

In this Activity, we covered the recent debate about Pluto's status as a planet. We looked at the importance of defining various classes of objects and the importance of remaining open minded!

It seems that astronomers are now quite comfortable thinking about Pluto as a 'dwarf planet', KBO, or TNO, and most would agree that if Pluto was discovered now - rather than in 1930 - it would *not* be considered a major planet. However, due to the emotional nature of the debate and historical arguments, Pluto will most likely continue to remain the source of controversy.

It is clear from the debate that we needed a formal definition for the word "planet". It's also clear that we need to continue discussing Pluto and its position in the outer Solar System if we are to understand its origin and the origin of the various KBOs.

While this debate seems to have been a rather bitter one, a lot of good has come from it. The public has become much more aware of Pluto and will build support for NASA funding of missions to the far distant outer Solar System.

## Postscript 2008

And still it was not over. . .

In June 2008, the IAU meeting in Oslo decided to name the Transneptunian dwarf planets (currently Pluto and Eris) '*Plutoids*' starting another media storm.

To view the press release, [follow this link](#).

