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# Why Pluto Is Not a Planet Anymore or How Astronomical Objects Get Named

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## Abstract

Everywhere I go people ask me why Pluto was kicked out of the Solar System. Poor Pluto, 76 years a planet and then summarily dismissed. The answer is not too complicated. It starts with the question how are astronomical objects named or classified; asks who is responsible for this; and ends with international treaties. Ultimately we learn that it makes sense to demote Pluto.

## Catalogs and Names

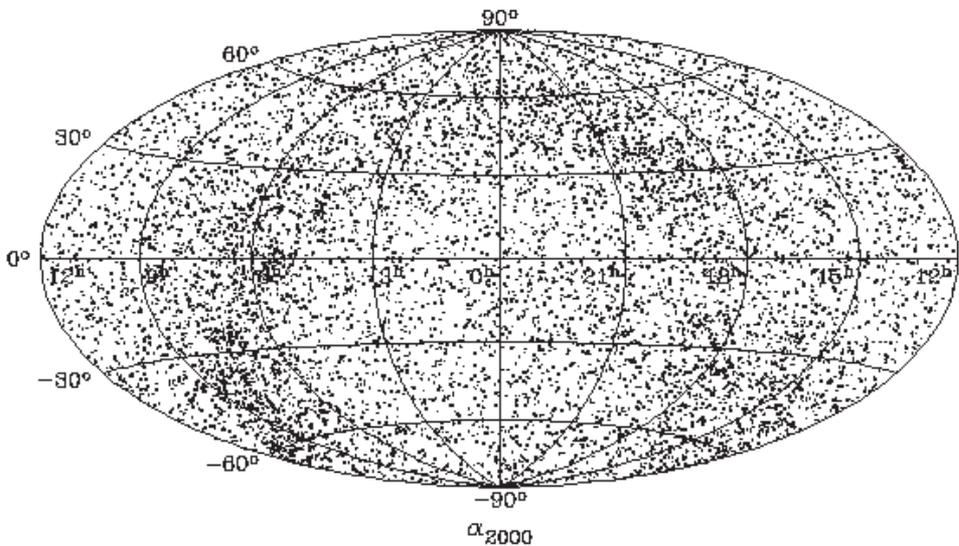
**WHO IS RESPONSIBLE** for naming and classifying astronomical objects? The answer varies slightly with the object, and history plays an important part.

Let us start with the stars. Most of the bright stars visible to the naked eye were named centuries ago. They generally have kept their old-fashioned names. Betelgeuse is just such an example. It is the eighth brightest star in the northern sky. The star's name is thought to be derived from the Arabic يد الجوزاء *Yad al-Jauzā'* meaning "*the Hand of al-Jauzā'*", *i.e.*, Orion, with mistransliteration into Medieval Latin leading to the first character *y* being misread as a *b*. Betelgeuse is its historical name. The star is also known by its Bayer designation –  $\alpha$  Orionis. A Bayer<sup>1</sup> designation is a stellar designation in which a specific star is identified by a Greek letter followed by the genitive form of its parent constellation's Latin name. The original list of Bayer designations contained 1,564 stars. The Bayer designation typically assigns the letter alpha to the brightest star in the constellation and moves through the Greek alphabet, with each letter representing the next fainter star. However, there are only 24 letters in the Greek alphabet, so when a constellation has more than 24 stars, the list continues using lower case Latin letters and then upper case Latin letters where the convention stops at the letter Q. So Betelgeuse is the brightest star in the constellation Orion.

Since most constellations have many thousands of stars this type of designation quickly loses its value. Astronomers need a better way to identify stars. What worked for the pre-telescope days does not work now.

We need a system that can handle millions of stars. The answer is a catalog (a listing) that uses numbers instead of letters or names.

A star can appear in any number of catalogs that uniquely identify it. In most stellar catalogs a star is named (numbered) by its position across the sky, generally right ascension.<sup>ii</sup> For example, The Bright Star Catalog (BSC) numbers 9110 stars (down to 6.5 magnitude<sup>iii</sup>) in order from west to east for the year 1950. Each entry gives the identifying number and then the coordinates. Figure 1 shows a map of the sky according to the Bright Star Catalog. The bright star Vega ( $\infty$  Lyrae) is BSC 7001 in that catalog. There are several catalogs in active use by astronomers. Two important ones are the Hipparcos Catalogue (HIC) and Hubble Space Telescope Guide Star Catalogue. The HIC lists over 100,000 stars. The star Vega is HIC 91262 in that catalogue. The HST Guide Star Catalog lists 19 million unique stars between 6<sup>th</sup> and 16<sup>th</sup> magnitude. Vega is brighter than 6<sup>th</sup> magnitude so it is omitted from this particular catalog.<sup>iv</sup> Such numbering sequences, although boring to read, make it easy to find a star again and again.



**Figure 1.** Stars in the Bright Star Catalog distributed by right ascension left to right and declination top to bottom.

There are many specialized stellar catalogs each useful for its class of stars. But there are other celestial objects that need identification. Galaxies have their own set of catalogs. And then there are the Solar System objects: planets, comets, and minor planets.

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Once we have these catalogs, who or what makes them official? Anyone can number the stars, but it is the International Astronomical Union (IAU) that authorizes that number. The IAU is the internationally recognized authority (by treaty) for naming celestial bodies and surface features on them. Names are never sold, but assigned according to internationally accepted rules. Thus, like many wonderful things in human life, the beauty of the night sky is not for sale, but is free for all to enjoy.

### **The International Astronomical Union**

Founded in 1919, the IAU's mission is to promote and safeguard the science of astronomy in all its aspects through international cooperation. Its individual members – structured in Divisions, Commissions, Working Groups, and Program Groups – are professional astronomers, at the Ph.D. level and beyond, and active in professional research and education in astronomy. In addition, the IAU collaborates with various organizations worldwide. The IAU has 10,894 Individual Members in 93 countries worldwide. The United States has signed the treaty related to the IAU; the appropriate reference in the US Code is Title 22 United States Code Section 274.

The IAU has been the arbiter of planetary and satellite nomenclature since its inception in 1919. At its inaugural meeting in 1922 in Rome, the IAU standardized the constellation names and abbreviations. More recently, IAU Committees or Working Groups have certified the names (numbers) of even more astronomical objects and features.

So we started with the historical naming of stars and have arrived at the treaty authorizing the naming and classification of all celestial objects. The IAU holds a general meeting every three years to process and vote on Resolutions. The last general meeting was held in Beijing in 2012. In between the general meetings are IAU special purpose symposia; however, Resolutions are processed only at the general meeting.

### **Our Solar System and its Minor Planets**

In pre-telescope days, humans knew of six so-called 'planets': Mercury, Venus, Moon, Mars, Jupiter, and Saturn. It is seven, if one counts the Sun in this group. Hence, we have our historical seven day week with the responsibility for each day assigned to one of these seven objects. Today, of course, we know the Sun and Moon are not planets.

Once we had telescopes we learned of Uranus, Neptune, Pluto, and several minor planets. Textbooks could now identify nine planets in the Solar System.

The previous paragraph mentions the term *minor planet*. What defines a minor planet? The IAU has rules and definitions for this too. A minor planet is an astronomical object in direct orbit around the Sun that is neither a dominant planet nor originally classified as a comet. The term minor planet has been used since the 19th century to describe these objects. Historically, the terms *asteroid*, *minor planet*, and *planetoid* have been more or less synonymous. The dominant planets are Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune. Pluto I will discuss a bit later.

The first minor planet discovered was Ceres in 1801 (although from the time of its discovery until 1851 it was considered to be a planet). To date the orbits of more than 570,000 objects have been archived at the Minor Planet Center.<sup>v</sup> In the early days of discovery most minor planets were found to orbit between Mars and Jupiter. These were the asteroids and the Trojans (asteroids sharing Jupiter's orbit and gravitationally locked to it).

The issue became complicated by the modern discovery of numerous minor planets beyond the orbit of Jupiter and especially Neptune that are not universally considered asteroids. Therefore, minor planets can be dwarf planets, asteroids, Trojans, centaurs (bodies in the outer Solar System between Jupiter and Neptune), Kuiper belt objects (objects inside an apparent population drop-off approximately 55 astronomical units<sup>vi</sup> from the Sun), and other trans-Neptunian objects.

Not only are there a lot of them, but also some are quite large (like Eris), approaching Pluto in size and mass.

At its 2006 meeting, the IAU reclassified minor planets and comets into *dwarf planets* and *small Solar System bodies*. Objects are called "dwarf planets" if their self-gravity is sufficient to achieve hydrostatic equilibrium, that is, an ellipsoidal shape, with all other minor planets and comets called "small Solar System bodies." However, for purposes of numbering and naming, the traditional distinction between minor planet and comet is still followed.

The discoverer of a comet or minor planet has the privilege of suggesting a name to a special Committee of the IAU that judges its suitability. Contrary to some media reports, it is not possible to buy a

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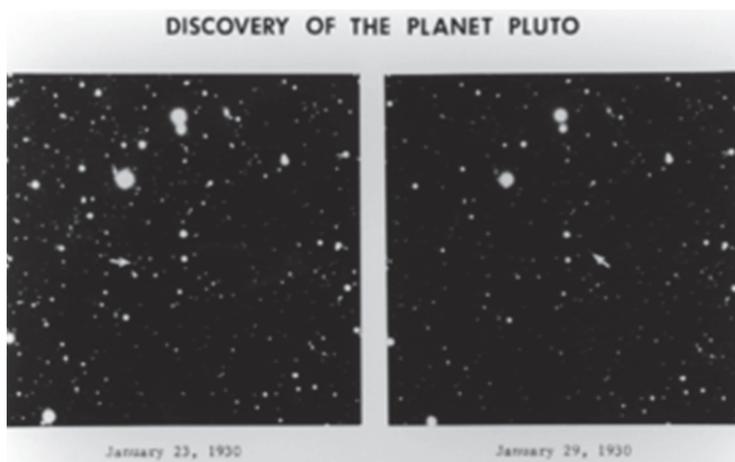
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minor planet. If you have a name you would like to apply to a minor planet, the best advice is “Go out and discover one!”

As the number of asteroids began to run into the hundreds, and eventually the thousands, discoverers occasionally gave them increasingly frivolous names. The first hints of this were 482 Petrina and 483 Seppina, named after the discoverer’s pet dogs. However, there was little controversy about this until 1971, upon the naming of 2309 Mr. Spock (the name of the discoverer’s cat). Although the IAU subsequently banned pet names as sources, eccentric asteroid names are still being proposed and accepted, such as 4321 Zero, 6042 Cheshirecat, 9007 JamesBond, 13579 Allodd and 24680 Alleven, and 26858 Misterrogers. A well-established rule is that, unlike comets, minor planets may not be named after their discoverer(s).

### Pluto

And then there is Pluto. Clyde Tombaugh discovered Pluto in 1930 at Lowell Observatory<sup>vii</sup> in Flagstaff, Arizona. Figure 2 shows the discovery photographic plates for Pluto. This became an international sensation – a new planet in the Solar System.



**Figure 2.** Two photographic plates showing the discovery of Pluto (marked with the small arrow). It moves with respect to the background stars between the two photographs.

The discovery made headlines across the globe. The Lowell Observatory, which had the right to name the new object, received more than 1,000 suggestions from all over the world, ranging from Atlas to Zymal. Constance Lowell proposed *Zeus*, then *Percival*, and finally *Constance*. These suggestions were disregarded.

The name *Pluto* was proposed by Venetia Burney (1918–2009), an eleven-year-old schoolgirl in Oxford, England. She was interested in classical mythology as well as astronomy, and considered the name, a name for the god of the underworld, appropriate for such a presumably dark and cold world. She suggested it in a conversation with her grandfather Falconer Madan, a former librarian at the University of Oxford’s Bodleian Library. Madan passed the name to Professor Herbert Hall Turner, who then cabled it to colleagues in the United States.

The object was officially named on March 24, 1930. Each member of the Lowell Observatory was allowed to vote on a short-list of three: *Minerva* (which was already the name for an asteroid), *Cronus* (which lost supporters through being proposed by the colorful but unpopular astronomer Thomas Jefferson Jackson See<sup>viii</sup>), and *Pluto*. Pluto received every vote. The name was announced on May 1, 1930. Upon the announcement, Madan gave Venetia five pounds (£5) as a reward.

The name was soon embraced by the wider culture. In 1930, Walt Disney introduced a canine companion, named Pluto, for Mickey Mouse apparently in the object’s honor, although this is not confirmed. In 1941, Glenn T. Seaborg named the newly created element plutonium after Pluto, in keeping with the tradition of naming elements after newly discovered planets, following uranium, which was named after Uranus, and neptunium, which was named after Neptune.

Now firmly in place as a Solar System planet, Pluto needed to be visited. NASA decided to send a space probe to it. In August 1992, the Jet Propulsion Laboratory scientist Robert Staehle called Tombaugh, requesting permission to visit his planet. “I told him he was welcome to it,” Tombaugh later remembered, “though he’s got to go one long, cold trip.” The call eventually led to the launch in 2006 of the New Horizons space probe to Pluto. It will fly past Pluto in 2015.

Tombaugh died on January 17, 1997 in Las Cruces, New Mexico, at the age of 90. Approximately one ounce of his ashes is being carried on the New Horizons space probe. The container includes the inscription: “Interred herein are remains of American Clyde W. Tombaugh, discoverer of Pluto and the Solar System’s ‘third zone’.” I was extremely privileged to meet him at his 85<sup>th</sup> birthday party.

Following its discovery until 2006, Pluto was classified as a planet. Pluto has five known moons, the largest being Charon discovered in 1978, along with Nix and Hydra, discovered in 2005, and the provisionally

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named S/2011 (134340) 1, discovered in 2011. Another discovery was announced July 11, 2012, provisionally designated S/2012 (134340) 1, bringing the total number of identified satellites orbiting Pluto to five. Pluto and Charon are sometimes described as a binary system because the barycenter of their orbits does not lie within either body. However, the IAU has yet to formalize a definition for binary dwarf planets and, as such, Charon is officially classified as a moon of Pluto.

### **Too Many Plutos?**

Evidence began to accumulate that Pluto was not unique. In the late 1970s, following the discovery of minor planet 2060 Chiron in the outer Solar System and the recognition of Pluto's relatively low mass, its status as a dominant planet began to be questioned. In the late 20<sup>th</sup> and early 21<sup>st</sup> centuries, many objects similar to Pluto were discovered in the outer Solar System, notably the object Eris in 2005, which is 27% more massive than Pluto. Eris has one moon. Subsequent observations show that it is currently uncertain which is the larger, Eris or Pluto.

The time was ripe, therefore, for a new classification system. The IAU had a choice: keep Pluto as a planet, and include all similar objects as planets too; or, demote Pluto. They chose the second option.

The IAU had never officially defined a "planet;" there had been no need until there were too many Plutos. It rectified this at its 2006 general meeting. On August 24, 2006, at the XXVI<sup>th</sup> General Meeting, the IAU voted to define what it means to be a "planet" within the Solar System (see Resolution B5 and Resolution B6 in the appendix). This definition excluded Pluto as a planet and added it as a member of the new category "dwarf planet" along with Eris and Ceres. After the reclassification, Pluto was added to the list of minor planets and given the number 134340.

A number of astronomers hold that Pluto should continue to be classified as a planet (especially since it has a cluster of moons), and that other dwarf planets should be added to the roster of planets along with Pluto.

### **A Detailed Description of How Minor Planets are Named**

The assignment of a particular name to a particular minor planet is the end of a long process that can take many decades. It begins with the discovery of a minor planet that cannot be identified with any already-known object. Such minor planets are given a provisional designation. The provisional designations are based on the date of discovery and are

assigned by the Minor Planet Center according to a well-defined formula that involves the year of discovery, two letters and, if need be, further digits (for example, 1989 AC, or 2002 LM60).

When the orbit of a minor planet becomes well enough determined that the position can be reliably predicted far into the future (typically this means after the minor planet has been observed at four or more oppositions<sup>ix</sup>), the minor planet receives a permanent designation. This is a number issued sequentially by the Minor Planet Center, for example (433), (4179) or (50000).

When a minor planet receives a permanent number, the discoverer of the minor planet is invited to suggest a name for it. The discoverer has this privilege for a period of ten years following the numbering of the object.

The discoverer writes a short citation explaining the reasons for assigning the name according to the guidelines of the IAU. Proposed names should be:

- 16 characters or less in length
- preferably one word
- pronounceable (in some language)
- non-offensive
- not too similar to an existing name of a minor planet or natural planetary satellite.

The names of individuals or events principally known for political or military activities are unsuitable until 100 years after the death of the individual or the occurrence of the event.

All proposed names are judged by the fifteen-person Working Group for Small Body Nomenclature (WGSBN) of the IAU, comprised of professional astronomers with research interests connected with minor planets and/or comets from around the world. As an example, the asteroid 29085 Sethanne (1979 SD) has the citation:

“Sethanne Howard (b. 1944) is an American astronomer who has held positions with U.S. national observatories, NASA, the National Science Foundation, and the U.S. Navy; Chief of the U.S. Nautical Almanac Office, 2000-2003. Her research specialty is galactic dynamics. She has also been active in science education, especially concentrating on the history of women in science.”

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The asteroid was discovered by Brian Marsden who graciously named it for his colleague.

Comets follow a similar naming procedure, except the name can be that of the discoverer. Usually two or three new comets are discovered each year. Most are too faint to be of general interest.

### **Naming Planetary Features**

That IAU also has responsibility for naming planetary surface features (*e.g.*, craters). The IAU has a system of uniquely identifying features on the surface of planets or natural satellites so that the features can be easily located, described, and discussed. Names must follow various rules and conventions established and amended through the years by the IAU. These include:

1. The first consideration should be to make the name simple, clear, and unambiguous.
2. Features whose longest dimension is less than 100 meters are not assigned official names unless they have exceptional scientific interest.
3. The number of names chosen for each body should be kept to a minimum, and their placement governed by the requirements of the scientific community.
4. Duplication of the same name on two or more bodies is to be avoided.
5. Individual names chosen for each body should be expressed in the language of origin. Transliteration for various alphabets should be given, but there will be no translation from one language to another.
6. Where possible, the themes established in early Solar System nomenclature should be used and expanded on.
7. Solar System nomenclature should be international in its choice of names. Recommendations submitted to the IAU national committees will be considered, but final selection of the names is the responsibility of the IAU. The WGPSN<sup>x</sup> strongly supports equitable selection of names from ethnic groups/countries on each map; however, a higher percentage of names from the country planning a landing is allowed on landing site maps.

8. No names having political, military, or religious significance may be used, except for names of political figures prior to the 19th century and gods and goddesses of ancient religions.
9. Commemoration of persons on planetary bodies should be reserved for persons of high and enduring international standing. Persons being so honored must have been deceased for at least three years.
10. When more than one spelling of a name is extant, the spelling preferred by the person, or used in an authoritative reference, should be used. Diacritical marks are a necessary part of a name and will be used.
11. Ring and ring-gap nomenclature and names for newly discovered satellites are developed in joint deliberation between WGPSN and IAU Commission 20. Names will not be assigned to satellites until their orbital elements are reasonably well known or definite features have been identified on them.

For example, craters on Mercury are named for famous deceased artists, musicians, painters, and authors. Features on Venus are named for ancient goddesses or deceased famous women. Small craters on Mars are named for villages of the world with a population of less than 100,000.

### **Conclusion**

It is clear that Pluto was a victim of the discoveries of a multitude of Solar System objects quite similar to Pluto. Pluto is no longer unique. So many such objects have been found that it became necessary to redefine what makes a planet. The IAU took action, demoted Pluto, and set it amongst the objects similar to it in size. It does mean that textbooks must now define a Solar System planet to be one of eight planets instead of nine. This is sad for those of us old enough to remember learning our nine planet Solar System, but it settles the issue for the future.

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## Appendix

The IAU approved the following two resolutions at its XXVI<sup>th</sup> General Meeting, August 24, 2006:

### *Resolution B5*

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, except satellites, in our Solar System be defined into three distinct categories in the following way:

- (1) A planet<sup>1</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>2</sup>,
  - (c) has not cleared the neighbourhood around its orbit, and
  - (d) is not a satellite.
- (3) All other objects<sup>3</sup>, except satellites, orbiting the Sun shall be referred to collectively as “Small Solar System Bodies”.

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<sup>1</sup> The eight planets are: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune.

<sup>2</sup> An IAU process will be established to assign borderline objects to the dwarf planet or to another category.

<sup>3</sup> These currently include most of the Solar System asteroids, most Trans-Neptunian Objects (TNOs), comets, and other small bodies.

### ***Resolution B6***

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>1</sup>.

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<sup>1</sup> An IAU process will be established to select a name for this category.

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<sup>i</sup> The 17th century German astronomer Johann Bayer.

<sup>ii</sup> Angle to the east of the Vernal equinox.

<sup>iii</sup> A magnitude is a measure of brightness.

<sup>iv</sup> HST cannot look at bright stars.

<sup>v</sup> Under the auspices of the IAU, the Minor Planet Center is the official organization in charge of collecting observational data for minor planets (asteroids) and comets, calculating their orbits and publishing this information.

<sup>vi</sup> The distance from the Earth to the Sun.

<sup>vii</sup> Lowell Observatory was established in 1894.

<sup>viii</sup> Thomas Jefferson Jackson (T. J. J.) See (February 19, 1866 – July 4, 1962) was an American astronomer who was infamous for a career dogged by plagiarism, being fired from two observatories, being ‘exiled’ to an isolated outpost, and his vitriolic attacks on relativity.

<sup>ix</sup> *i.e.*, the orbit is well determined.

<sup>x</sup> Working Group on Planetary Surface Nomenclature.

### **Bio**

Sethanne Howard is an astronomer who has held positions with U.S National Observatories, NASA, the National Science Foundation, and the U.S. Navy. She was Chief of the U.S. Nautical Almanac Office, 2000-2003. Her research specialty is galactic dynamics. She has also been active in science education, especially concentrating on the history of women in science.