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THE PLUTO QUESTION:

What is a Planet?

by **Bill Warren**

***Introduction.** If you were born before 1990, you probably remember how upset people were when **Pluto** was removed from the solar system's family of planets in 1996. One day it was a proud planet (albeit the runt of the litter); the next day it was something else entirely – a lowly “dwarf planet,” literally on the outside looking in at what a day earlier had been its siblings.*

How it happened is an intriguing tale. Many astronomers considered the change to be a long-overdue step in advancing astronomy as a science -- and as many others regarded it as a deception perpetrated by the International Astronomical Union (IAU).

Curiously, both sides were right.

*I've written about it before, but this Special Edition of the **Observer** is broader in scope. Written 22 yrs. after the event, it tells both sides of the story in far greater depth than previously.*

(Incidentally, this project began as a brief “This ‘n That” newsletter item about an article that appeared in Astronomy Magazine but quickly grew into something much larger. You'll see what I was writing about on p. 6.)

-Bill

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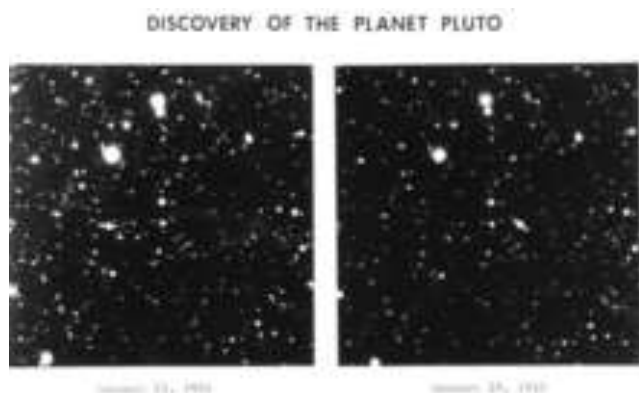
Beginnings. The discovery of **Neptune** by **William Lassell** in 1846 brought the solar system's planet total to eight. However, wobbles in the orbital paths of **Uranus** and **Neptune** led the American astronomer, founder and director of Lowell Observatory, **Percival Lowell**, to conclude that a ninth planet -- he called it **Planet X** -- lay somewhere beyond Neptune and was tugging gravitationally on that planet and Uranus. Lowell died in 1916, but in 1929 **Vesto Slipher**, his successor, assigned a young employee -- **Clyde Tombaugh** -- the task of searching for Planet X.

It was an exceedingly difficult task, given the enormous distance involved, the size of the night sky and the difficulty of finding a particular faint point of light amid countless thousands of stars

surrounding it. But Lowell had thought he knew roughly where Planet X should be located in order for it to affect the orbits of Uranus and Neptune, so that's where Tombaugh started his search. (Lowell was wrong because Pluto could not possibly affect those planets' orbits, but no one knew that at the time.)

As things turned out, though, it didn't matter: Planet X eventually was found just 6° from one of the two places where Lowell thought it might be. Tombaugh was lucky, and sometimes luck trumps what you think you know. Regardless, he must have felt like he was searching for a celestial needle in a celestial haystack.

To find Planet X, Tombaugh used a device called a *blink comparator* to examine and compare thousands of photos of the same general region of sky taken two weeks apart. He studied the photos two at a time, switching back and forth rapidly between them, looking for a single, faint white dot that had moved amid the starry background.



(Note the arrows in the two discovery photos. That's how far Pluto had moved in two weeks. Now imagine studying thousands of photos like these, looking for the one dot that moved.)

After months of painstaking and fruitless efforts, on Feb. 18, 1930 Tombaugh burst unannounced into the director's office and said, "Dr. Slipher, I've found your Planet X!" It was named **Pluto** in order to continue the tradition of naming planets for Roman gods (Pluto was the god of the underworld), and to honor Percival Lowell – the "PL" in Pluto – for his contributions to astronomy and the search for a ninth planet.

For the next 66 yrs., schoolchildren worldwide were taught that there are nine planets in the solar system, and the smallest and most distant one was

Pluto. But everything changed in 1996, when Pluto was voted out of the family of planets.

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Pluto's Problems. From the very start, Pluto's planetary status was challenged by the international community, especially in Europe.

For starters, until the 20th century astronomy was dominated by Europeans. From **Copernicus** until the early 1900s, virtually all of the important advances in astronomy were made by Europeans. But with the advent of huge telescopes in the U. S.; **Einstein's** theories of relativity; and **Edwin Hubble's** discoveries that galaxies are composed of stars rather than clouds of gas, and that the universe is expanding -- as a result of those things and others, leadership in astronomy was rapidly moving to the U. S. Tombaugh's discovery of a ninth planet was yet another nail in the coffin of European influence in astronomy.

Then there was the fact that Pluto didn't look like any of the other eight planets. While all of the original planets were seen as disks of various sizes, Pluto looked like a mag. 14 star – a faint point of light not unlike all of the faint stars around it, no matter how large the telescope was or the magnification applied to it.

Third, the discovery of Pluto's largest moon, **Charon**, in 1978 permitted astronomers to measure the planet's size and mass with a degree of accuracy for the first time. What they found was decidedly unplanetary.



(Comparing the dia. of Earth, the Moon and Pluto)

They already knew that Pluto is nearly twice as far from the **Sun** as Neptune is – at nearly 4 billion mi. away sunlight takes 5-1/2 hrs. to reach it. They knew, too, that Pluto resides in a distant area known as the **Kuiper Belt** that was thought to contain millions of other similar bodies. What they hadn't known until 1978 is that, at about 1,480 mi. in dia., Pluto is *tiny* – so small, in fact, that our **Moon**, **Saturn's** moon **Titan** and three of **Jupiter's** moons are larger than Pluto. But none of those things were known in 1930. Virtually all that astronomers knew for sure about the newly discovered ninth planet was that it lay somewhere far beyond Neptune. For a long time after Pluto's discovery, many astronomers thought that it might be as large as **Mars**.

*As severe as those problems might appear, though, they pale in comparison to a third bone of contention that arose in the early 1990s. The problem was so obvious that it's remarkable that no one had ever noticed it before.

The problem: *Throughout astronomy's long history, no one had ever agreed on a scientific definition of the word planet. There was no consensus among astronomers, other scientists, teachers, textbook writers or anyone else as to what a planet (or anything else in the solar system except the Sun, for that matter) really is.* Definitions were expressed in terms of common usage, i.e., what you think of when you hear the word planet. (The term planet comes from the ancient Greek word planos, which meant "wanderer." There were five naked-eye "wanderers" that, like the Sun and Moon, moved across the sky faster than everything else.)

That's where things stood when the International Astronomical Union entered the picture in 1996. They entered the fray because, in the early 1990s, astronomers began finding Pluto-sized bodies in the Kuiper Belt. Since that area contains countless icy bodies of all sizes, the chances were great that many of them would have to be added to the present nine planets. That fact led many astronomers to conclude that Pluto never should have been called a planet in the first place. It was very different from all of the other planets – but at the time of Pluto's discovery there was nothing else to call it.

The IAU's stated goal was to define and categorize the many kinds of nonstellar objects in the solar system, especially planets.

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The International Astronomical Union (IAU). The IAU is the closest equivalent to a governing body in astronomy. Begun in 1919, its headquarters are in Paris, and it serves as the internationally recognized authority for naming celestial bodies (stars, planets, comets, asteroids, etc., and any surface features on them). In 1996, there were about 9,000 members in the IAU, most of them professional astronomers.

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The Conference. In August, 1996 the IAU announced to its members that a special planetary conference of the General Assembly would convene that month. However, although the conference was slated to run from Aug. 16-24, the announcement was sent out just three days prior to the event. As a result, the vast majority of Americans – who comprised a sizable majority of the IAU's membership – were unable to drop what they were doing at the last minute, rearrange their schedules and make the financial, travel and other necessary arrangements in order to attend the nine-day convention in Prague, Czech Republic.

To make things worse, the IAU's executive committee decreed that only members present could participate in the discussions of the various draft proposals or vote on whether to accept or reject them. There would be no conference call discussions or electronic absentee votes. (Some IAU members wanted voting to be further limited to those astronomers who specialized in planetary studies, but the executive committee disagreed.)

A lot of members regarded those measures as an effort to demote Pluto to minor, non-planetary status without the interference of Americans, many of whom were proud of Pluto's present planetary status and might have voted to keep it that way. Why else, they asked, would the IAU have taken such drastic measures regarding what should have been an open discussion and vote involving all of its members? After all, Pluto had been a planet for more than half a century; it's not as if the issue had

to be decided with just three days' advance notice. They could have scheduled the conference a year ahead of time if they had wanted to.

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A Planet Defined. After rejecting three early proposals, the resolution committee came up with the following definition of a planet: a body that orbits the Sun without being some other object's satellite; is large enough to be rounded by its own gravity (but not so big that it begins to undergo nuclear fusion like a star); and has "cleared its neighborhood" of other orbiting bodies and debris, whether by absorbing them or pushing them out of the way.

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The Discussion and Vote. When the conference began, no one knew how long it would take for the resolution committee to arrive at an acceptable final draft, or if it could be completed before the conference ended. As it turned out, the first eight days were spent forging four drafts, three of which were rejected for various reasons. (The first draft suggested keeping Pluto as a planet.) The fourth and ultimately final draft -- although no one knew it at the time -- was completed on the final morning of the conference. Formal discussion was limited to three hours, after which the members adjourned for lunch and then reassembled to vote.

The resolution passed easily, with only 424 of the 2,400 members who attended the conference voting. (Most of the attendees, pressed for time and thinking that a final vote would not be taken, had already packed their bags and gone home.) Pluto was demoted to dwarf planet status and everyone went home -- some members to savor their victory and others to lick their wounds.

The 424 votes represented just 5% of the IAU's total membership.

In the aftermath of the IAU's historic vote, astronomers on both sides of the issue vented their pleasure or displeasure with the decision. Here are some of the points, pro and con, that I didn't mention earlier.

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Those Favoring the Changes

*Early on, it was pointed out that retaining Pluto's planetary status would require adding at least three or four more Kuiper Belt objects to the planetary list, with no end in sight. They were right, too: the Kuiper Belt probably contains at least 200 bodies as large or massive as Pluto. Those who favored reducing the planetary list to eight asked, *Which is easier, teaching children the names of eight planets, or hundreds of them?* (Like some of the objections raised by the opposing side, this question was an overly simplistic, emotionally charged reaction to opposition that blurred the complexity of the problem.)

*There was precedence for changing a planet's status. When **Ceres** was discovered in 1801, no one knew what an asteroid was, or that an asteroid belt orbits the Sun between Mars and Jupiter. Astronomers thought that the irregularities in those planets' orbits was due to the presence of an as-yet undiscovered planet orbiting somewhere between them. So for the next 50 years Ceres was thought to be that missing planet. (Ceres is the largest asteroid in the asteroid belt.) But gradually other large bodies were discovered at that distance; when the total reached 15 in 1851, astronomers realized that they were not planets. They called these new discoveries asteroids, which basically means "a star-like body."

*The conference wasn't just about re-defining Pluto's planetary status. It involved defining and categorizing *all* of the nonstellar objects in the solar system. Doing that cleared up many vexing questions such as *What is the difference between a planet, a moon, a minor planet, an asteroid and a comet?*

To answer that question, the resolution committee first changed certain terms (i.e., moons became "natural satellites" and minor planets became "dwarf planets." Then, over the next week or more, they came up with three categories of solar system objects:

Planets- Nonstellar solar system objects that orbit the Sun, are nearly round due to their own gravity and have cleared the neighborhood around their orbits of large objects and debris;

Dwarf Planets- Asteroids and trans-Neptunian objects (TNOs) in the Kuiper Belt that are round but have not cleared their neighborhoods and are not natural satellites orbiting a planet; and

Small Solar System Objects- All other objects that orbit the Sun. (Natural satellites were still natural satellites, but they were classified as small solar system objects, along with comets and most asteroids and Kuiper Belt objects.)

Perhaps the most important feature of this classification system was that it took an object's minimum size or mass out of the planetary definition. Pluto is round like the eight remaining planets, but the IAU classification defined all present and future TNO discoveries as dwarf planets. Even if an object larger or more massive than Saturn or Jupiter were to be discovered in the Kuiper Belt, it would be classified as a dwarf planet because it resides among millions of other Kuiper Belt objects.

Under those simplified guidelines, presently there are eight planets; five dwarf planets (including Pluto, Ceres and three TNOs); thousands of small solar system objects; and an ever-increasing number of natural satellites (moons).

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Those Opposed to the Changes

The following objections to the IAU's reclassification were expressed before, during or after the voting:

*Eliminating Pluto as a planet would require that all existing textbooks involving the planets -- including those just published -- would need to be updated at great expense to the publishers; the result would be a dramatic increase in the cost of general science and astronomy books. (Opponents argued that science is constantly changing with the addition of new knowledge; textbooks are constantly being updated to reflect those changes; and changes in science should be dictated by need, not by their economic impact on society.)

*Extrasolar planets -- exoplanets -- were excluded from the IAU reclassification, which was limited to planets in our solar system. (Opponents'

response: *So what? We can deal with that problem later.*)

*Keeping the number of planets down to a manageable level is unscientific; it does not reflect reality, and should not be a consideration in these discussions.

The strongest objections, however, concerned the requirement that planets must have cleared their orbital areas of large objects and debris:

*Earth, Mars, Jupiter and Neptune all have asteroids in their neighborhoods. For example, Earth presently is known to have 8,000 near-Earth asteroids orbiting our planet, and Jupiter has 100,000 trojan asteroids. And if Neptune had cleared its orbit of large objects, Pluto wouldn't be there. (Opponents' response: *Yes, but all of them are controlled by those planets' orbits.* The counter-argument: *So what? They haven't been cleared.*)

*The "clearing their neighborhood" requirement sets a new standard for planethood based on objects' distance from the Sun: The farther away a planet is, the larger it must be in order to clear its larger orbit. One astronomer pointed out that, if Earth were located where Pluto is, under the IAU requirements Earth would not be considered a planet. (Opponents' response: *New standards aren't wrong just because they are new; they're wrong only if they aren't needed, and that's not the case here.*)

*The final argument was that objects should be defined by their own characteristics, not by the presence of other objects near them. As one supporter put it, "A river is a river, no matter if there are other bodies of water nearby."

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The End Result. Whether compelling or frivolous, the arguments for and against the IAU decision are moot. The die was cast, Pluto lost its planetary status, and 22 years later there is absolutely no indication that it will ever regain it. Still...

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Rekindling an Old Flame. In an article, “An Organically Grown Planet Definition,” in the May, 2018 issue of *Astronomy* (pp. 28-29), **Kirby D. Runyan & S. Alan Stern** offer a rather compelling argument for regarding dwarf planets as planets. First, though, they have a bone to pick with the IAU.

Rather than criticizing the way the IAU handled Pluto’s demotion, the authors ask a more fundamental question: “*Should we really define a word by voting?*” They contend that words like planet should be defined in terms of their professional and common usage, not by the majority vote of a committee of astronomers deciding arbitrarily how everyone else (including other branches of science) has to define it.

For example, they point out that planetary scientists, geologists and others accept the “round” requirement but consider the “clearing their neighborhood” part unnecessary. In other words, if it’s rounded by its own gravity, it’s a planet, regardless of what kind of planet it is. (See below.)

Runyan and Stern accept the IAU definition and categorization of small solar system objects. However, they would prefer to see the other two categories combined, as originally envisioned by the IAU before that proposal was voted down.

Personally, I like the idea – and not just because Pluto was discovered by an American, either.

1. If dwarf planets are not planets, why is the word planet used to classify them as dwarf objects of some kind? (Answer: It was done to placate Pluto’s supporters by suggesting that, while no longer a planet, Pluto is very much like one in most respects. (And that in turn explains why in 2008 the IAU voted to replace the term trans-Neptunian objects with plutoids, although most astronomers prefer TNOs or Kuiper Belt objects.)

2. If the IAU were to make *dwarf planets* a sub-category of planets, they could add the other obvious sub-categories – *gas giants* (Jupiter & Saturn); *ice giants* (Uranus & Pluto); and *rocky planets* (Mars, Earth, **Venus & Mercury**). Those terms already exist and are used universally, but not as sub-categories of planets.

Such an approach, the authors say, would simplify how children learn about the solar system. Rather than learning about eight planets, they would learn about the four kinds of planets – how they are different, and how they are arranged in the solar system – using the original eight planets, Pluto and Ceres as examples of each type.

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Conclusion. The Pluto question is, and will continue to be, an emotionally charged issue. Like the religion vs. science debate, it instantly divided astronomy into two diametrically opposed camps in which everyone has strong opinions one way or the other.

If the IAU had voted to retain Pluto’s planetary status, they could have avoided the public ill will that still endures two decades later. But they didn’t do that, and no one expects that the situation will change in the future.

That’s especially true in light of the fact that Pluto’s most outspoken defender before, during and after the 1996 Pluto debacle was **Alan Stern**. Not only was Dr. Stern the principal investigator on NASA’s 2015 New Horizon mission to Pluto, but oh!, by the way: in case you missed the connection he is also one of the co-authors of the *Astronomy* article that criticizes the IAU for turning Pluto into a dwarf planet.

For the IAU to change its mind at this late date and decide that Pluto *is* a planet, after all, would mean admitting that Dr. Stern was right and they were wrong. And that, folks, just ain’t going to happen!

For better or worse, Pluto will always be a dwarf planet.



New Horizons photo of Pluto

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