



Pluto Isn't a Planet

Lecture 5¹: The State of our Universe

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On the afternoon of 24th August 2006 – nearly twenty years ago now – a vote taken by astronomers waving pieces of yellow card in the air in a lecture theatre in Prague set down, for the first time, a formal, international agreement on the definition of the word 'planet'. This resolution, made by the individual members of the International Astronomical Union, a UN-affiliated body, had the effect of demoting Pluto from its status as the ninth planet in the Solar System¹, to a new status of...something else.

To the surprise of many of the participants themselves, this decisive vote came after more than a week of strident and often emotional debate, which had attracted world-wide attention: I remember watching from home live on BBC News. Many expressed sentiments similar to those expressed by Richard Binzel from MIT, a member of the much maligned and battle-weary 'Planet Definition Committee' that guided the initial stages of the process, when he said with some relief: 'It's over. It's done'.

Yet Pluto's status is still, in 2026, a topic of debate, not only amongst astronomers and planetary scientists, but in the media and beyond. Just last month President Trump's Nasa administrator, Jared Isaacman, speaking to a congressional committee, said he was "very much in the camp of 'make Pluto a planet again'" and that Nasa was taking (unspecified) steps to make this happen. At least one friend attending tonight's lecture has threatened (or promised) to show up in a 'Justice for Pluto' t-shirt. And another friend's young son, Hawthorne, insists that she's wrong about the number of planets having just seen a pre-demotion episode of 'Magic School Bus' which involved a class trip to Pluto. For many: Pluto is still a planet in their hearts, and its demotion inexplicable at best and unjust at worst.

How did we get here? The story starts when Pluto was discovered in 1930 by Clyde Tombaugh at the Lowell Observatory, in Flagstaff, Arizona. Established to look for Martians, Lowell was then, as now, a cutting-edge research institute. Just as peculiarities in the orbit of then newly-discovered Uranus had led nineteenth century astronomers to find Neptune, so Neptune's orbit seemed to suggest the gravitational influence of a large body, further out in the Solar System, and so a search for the perturbing body was launched.

Tombaugh, a recent recruit thanks to the quality of his astronomical sketches, took photographs of the relevant part of the night sky through the observatory's telescopes, comparing those taken on successive nights to look for objects which appeared to be changing position.

¹ Ruining mnemonics carefully learnt in school for many of us: my Devonian version was 'Many Vampires Eat Many Jam Sandwiches Up Near Plymouth' for Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune...and Pluto.

In February 1930, working through a backlog, he compared images taken on the 23rd and 29th January – and spotted something moving against the background stars. Follow-up observations confirmed the discovery, and on March 13 1930, 149 years to the day after William Herschel announced the discovery of Uranus, a press release was issued.

The New York Times ran with the story, explaining in suitably grandiose terms ‘In the little cluster of orbs which scampers across the sidereal abyss under the name of the solar system there are, be it known, nine instead of a mere eight, worlds’. In the same story, we are told the planet might be the size of Jupiter – a guess, given that Pluto had only been seen as a point of light, based on conjecture and its apparent influence on Neptune. There seems to have been little if any contemporary objection to this classification; this was clearly the ninth planet, and so it stayed for more than seventy years.

The number of Solar System planets acknowledged by astronomers had changed before. The six planets of classical astronomy² were joined by Uranus, then, by 1807, Ceres, Vesta, Juno and Pallas, all before Neptune made it twelve planets on its discovery in 1846. But when 15 more bodies were discovered before the end of 1851, all orbiting between Mars and Jupiter, William Herschel’s suggestion of a category of minor planets he called ‘asteroids’³ which included these lesser worlds was adopted, and the Solar System’s list of planets contracted to eight, where it remained into the 20th century.

It should not, perhaps, surprise us that following Pluto’s discovery there was immediate speculation that there might be more Pluto-like objects still to find, partly driven by excitement about the ability of photography to contribute to a true census of the Solar System. This idea was placed on a more systematic basis by Irish astronomer Kenneth Edgeworth, who argued that the disk of material from which the Sun’s planetary family formed was likely too sparse in its outer regions to produce large planets, and thus we should expect to find on the edge of the Solar System a belt of smaller bodies, of which Pluto was likely the first example. In 1951, these arguments were made again by American Gerard Kuiper⁴, who added that such a belt would provide a useful source for the short-period comets which from time to time infest the inner Solar System.

Neither Edgeworth or Kuiper could prove the existence of their postulated outer asteroid belt, which today is known as the Kuiper Belt⁵. Kuiper at least thought that Pluto was something special, suggesting that its gravitational effect (assuming it was at least as massive as Earth) would have cleared out and scattered comets in neighbouring orbits, producing the population we observe from our perch in the inner Solar System.

While Kuiper and colleagues thought about the outer Solar System as a whole, others were staring at Pluto, attempting to learn what they could about this distant, presumably frozen, world. The first big breakthrough came in 1978, when James Christy of the US Naval Observatory spotted a ‘bump’ on highly magnified images of Pluto. Going back through the archive, he found that it was not only real, but it orbited with the same period of 6.4 days that Pluto itself rotates with – a useful feature that suggested what Christy had discovered was a real moon, which he named Charon.

² If you want to go further back, one can find records in Greek astronomy where the Moon and Sun are considered members of the club along with the five naked-eye planets, excluding the Earth.

³ His Greek coinage was intended to mean ‘star-shaped’ or ‘star-like’, reflecting the fact that these small worlds, in contrast to the ‘major’ planets, did not show a distinct disk but were point-like even in the largest telescopes.

⁴ Who either ignored or was ignorant of Edgeworth’s work, which had been published in relatively minor British publications

⁵ Or, in Ireland in particular (as a friend lecturing there recently learnt to their cost), as the Edgeworth-Kuiper Belt

The presence of Charon was interesting in its own right, and it also allowed for the first time a clear measurement of Pluto's mass. The vaunted ninth planet is, in fact, puny – smaller than our own Moon, and only a sixth of the mass of our familiar neighbour.

Unlike the Moon, Pluto does have an atmosphere. This was discovered in the 1980s by astronomers observing its occultation of a distant star, which faded as its light was refracted by the atmosphere rather than cutting off sharply as it would if hidden by an airless body. Spectral observations show that this tenuous atmosphere is comprised of nitrogen with a sprinkling of methane, and that the surface it blankets is mostly nitrogen ice. An apparently changing atmospheric pressure led to speculation that the atmosphere might be dynamic; present during the years around perihelion in 1989 where Pluto was closest to the Sun, but freezing onto the surface when it returns to the outer parts of its elliptical orbit around the Sun⁶. Meanwhile, by the mid-1990s the Hubble Space Telescope – just – had the resolution to show the presence of darker and brighter patches on Pluto's surface, the first glimpse of otherwise hidden structures and a hint that geological – or perhaps cryogenic – processes were at work. It may not have been as massive as first thought – the deviations it was supposed to induce in the orbit of Neptune were shown by *Voyager 2* to be nothing more than an error in the assumed mass of Pluto's giant neighbour – but the ninth planet was clearly a fascinating and dynamic world.

It had company in the outer Solar System, though. Astronomers had realised that the reservoir of comets first postulated by Kuiper was much needed. Though longer period comets, then and now, were thought to come from a spherical zone surrounding the Sun at great distances, known as the Oort Cloud, shorter period comets tended to stick close to the plane of the Solar System. In the early 1980s, Uruguayan astronomer Julio Fernández, who would later play a crucial role in the IAU decision on the definition of a planet, suggested that a trans-Neptunian belt of comets at about 50 au⁷ were needed. When further models using supercomputers confirmed this prediction, observers David Jewett and Jane Luu went looking for members of the putative population.

Jewett and Luu used modern cameras, including CCD chips instead of film, but the process they followed was essentially the same as Tombaugh's sixty years before, comparing pairs of images to look for anything that might be moving. After five years of effort, on 30th August 1992 they announced the discovery of 1992 QB1⁸: to them, the first member of the proposed Kuiper belt, and to at least some of the press, the Solar System's tenth planet. Five more were found the following year, twelve in 1994, and more than a thousand in the decade following this first discovery. To many astronomers, it seemed obvious another asteroid-like reclassification was needed, lest the Solar System be flooded with new planets.

It was less obvious that this need make any difference to Pluto. The original denizen of the Kuiper Belt was much larger and more massive than 1992 QB1; could it be in a different category altogether? As the new discoveries mounted up, Pluto still seemed distinct.

The discovery of Eris, which we now know to be more massive and only slightly smaller than Pluto, in 2005 suggested it was not. Found by a team consisting of Mike Brown (who happily styles himself 'Plutokiller' on social media), Chad Trujillo and David Rabinowitz, Eris was large enough for at least some of the press to once again roll out the 'tenth planet' moniker

⁶ Pluto's orbit is surprisingly elliptical compared to the other large bodies of the Solar System; it actually comes closer to the Sun than Neptune for 20 years of its 248 year long orbit.

⁷ The au, or astronomical unit, is the average distance of the Earth from the Sun, roughly 150 million kilometers.

⁸ In 2018, it was named 'Albion', a homage to William Blake and his singular mythology. Most astronomers still know it affectionately as QB1, and similar objects found more recently as 'cubewanos'.

they'd originally used for 1992 QB1. Eris itself is a fascinating world, complete with moon (Dysnomia) on an orbit that suggests it was scattered following a close encounter with Neptune. Even at the time of discovery, it joined a set of large Kuiper Belt Objects that were filling in the gap between the properties of 1992 QB1 and its ilk, and the larger Pluto.

Are these new discoveries all planets? To answer this, the International Astronomical Union, itself born in 1930 and by long convention and international agreement the keeper of astronomical nomenclature, creaked into action. A first committee, asked to investigate, came up with a neat classification of possible definitions. Planethood, they decided, could be conveyed by criteria based on dynamics (what orbit you are in), structural (what you are made of, or what shape you are), or cultural (planets are what we say they are). Perhaps a lot of argument would have been saved if the IAU had prompted for the latter, but, chasing scientific consensus, its leadership pressed on.

By the time the Union's members gathered for their triannual assembly in Prague, there was a proposal, from a committee comprised of an astronomical historian in the chair, along with five planetary scientists and science writer Dara Sobel. They said:

'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.'

The roundness criterion is essentially a cut on mass, and the simplest possible dynamical criteria – you must orbit a star – is added to it. Pluto and Eris, along with Ceres in the asteroid belt, qualify for planethood, as does Charon, Pluto's moon, making this a double planet system. Twelve planets for now, but as exploration of the Kuiper belt continued more would surely be added – contemporary estimates suggested fifty, or perhaps hundreds of bodies which were planets by the definition, were out there waiting to be discovered.

There were criticisms. Amongst the more baroque were the fact that, as our Moon slowly recedes from the Earth due to the effects of the tides, there will come a time when it will suddenly qualify as half of a double planet system⁹. Planets ejected from the Solar System via close encounters – and such rogue planets were already known to be out there, drifting amongst the stars of the Milky Way – would, because of their failure to orbit a star, upon ejection suddenly cease to be planets. But really the problem for many people was that the strong belief that there must surely be many more such objects in the outer Solar System, awaiting discovery. Whatever 'planet' meant, there was a sense that they should be rare.

At this point, there was something of an air of chaos, with new proposals flying about conference halls. A proposal to call bodies too small to be full-sized planets 'plutons' offended geologists, for whom the word has a volcanic meaning. Astronomers using telescopes wanted to include details of orbits in any definition, while planetary scientists, used to studying landscapes, wanted the properties of the worlds they were considering to matter most. Others liked the neatness of distinguishing by formation mechanism, though this seemed like a license for more arguments. Amongst the kerfuffle, the need for a definition that could be applied to systems beyond our own was quickly forgotten, and the need to agree on a name for things smaller than planets postponed.

The final proposal, adopted at the crucial vote at the general assembly, says that planets have to meet three criteria. They must orbit the Sun, be round and 'have cleared the neighbourhood' around their orbit. This latter criterion, a dynamical one, was not otherwise

⁹ The Earth and Moon orbit their barycentre, or centre of mass. This is currently inside the Earth, but as the Moon moves away from us this will eventually not be true.

defined, and created much debate – does having a large satellite like the Moon stop you from being a planet? What about Neptune, which has failed, it might be argued, to expel Pluto? To remove ambiguity, if not stop the argument, the IAU resolution which passed defined the eight planets which were deemed to have met the criteria. Pluto, and all other bodies which met the first two but not the latter of the three criteria, were relegated to minor planet status, and Pluto recognised as belonging to a new category of ‘Trans-Neptunian Object’ or TNOs¹⁰.

As noted in the introduction, this decision did not satisfy everyone. There were protests with placards. The New Mexico legislature, for example, seeking to protect the interests of then long-term resident Clyde Tombaugh, passed a law declaring Pluto a planet whenever it ‘passes overhead’¹¹. And though Nasa announced it would follow the new nomenclature, one particular group of people working with the agency did not feel the same way.

Just a few months before the IAU decision, in January 2006, the *New Horizons* space probe had been launched en route to Pluto. The team’s leader, Alan Stern, had explicitly lobbied for the mission by claiming it would ‘complete the exploration of the major planets of the Solar System’. The mission logo was nine-sided (and the time would soon develop a nine figured salute, given awkwardly or enthusiastically at press conferences), and it carried a stamp issued as part of a 1991 set which included each of the planets – including Pluto, which is described as ‘Not yet explored’. For most of the nearly decade long journey of more than three billion miles his mission undertook, Stern continued to argue for Pluto’s planethood.

New Horizons finally flew past Pluto on July 14th, 2015, passing just 12,500 km above its surface, and sending back detailed colour images of both Pluto and its moons, especially Charon¹². This brief encounter, conducted at a speed of more than 30,000 miles per hour, captured an amazing suite of images and scientific data which the tiny craft sent back to Earth over the next few months. Even the initial images were a revelation, showing a surprisingly varied surface marked by mountain ranges made of frozen water ice, a flat (and wrenchingly heart-shaped) bright region later named Sputnik Planitia, which contrasted nicely with a darker whale-shaped region on the opposite hemisphere, and even dunes made of methane blown by winds in Pluto’s tenuous atmosphere. The surface appears fresh, likely less than ten million years old, and may indicate cryovolcanism or even the presence of a subsurface ocean – liquid water, out at the frozen edge of the Solar System.

This is clearly a fascinating, dynamic, complex world. A decade on, scientists are still poring over the *New Horizons* data, and the mission stimulated dreams of how we might one day get a spacecraft in orbit around Pluto, to better understand it. The mission also raised once more the issue of Pluto’s planetary status: for many, the complexity of what was seen suggested that it must, indeed, be worth the name ‘planet’.

Yet I remain convinced that, if an alien astronomer visited, they would decide that eight of the Solar System’s bodies were different from the others. A paper released in Jean-Luc Margot in 2024 avoids the complexity of the IAU definition, and just plots the mass of each body against its distance from the Sun. There are two clusters of four bodies each which lie near the top of such a graph – the inner planets (Mercury, Venus, Earth and Mars) and the outer ones (Jupiter, Saturn, Uranus and Neptune), while the trans-Neptunian objects of the Kuiper belt, and the asteroids, lie near the bottom.

¹⁰ The IAU was supposed to come up with a better name, but never did.

¹¹ If they mean the zenith, then this never happens. If they mean ‘in the night sky’, that’s approximately half the time.

¹² Pluto is known to have five moons: Charon, plus the much smaller Nix, Hydra, Styx and Kerberos, which orbit the two larger bodies.

While such a division may seem artificial, it appears to be a feature of the process by which our Solar System assembled – and will, I suspect, end up being replicated in other star systems that we might one day explore in detail. This, to me, is convincing. Pluto is not a planet.

It is, instead, something else. The most famous and well known, and largest (if not the most massive) of the trans-Neptunian objects. But that doesn't mean that it's not fascinating. Pluto was not demoted because it was boring, and whatever label we give it it will continue to orbit the Sun, same as has for billions of years. If one is studying how solar systems form, it may indeed be useful to note the division revealed in the Margot graph, but any such division does not – cannot – tell us what is important, or which sort of questions we can ask to lead to progress in understanding.

Some of the most memorable *New Horizons* images were taken as the probe was leaving the Pluto system, looking back towards the inner Solar System. Here, we see Pluto and Charon amongst the stars, a reminder of the odd worlds of the outer solar system, which wait for our next mission of exploration. Pluto, for me, is a reminder that there is, out there, more: more worlds to discover, more that we do not understand, and more kinds of thing than at any time we're prepared to open our minds to.

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References and Further Reading

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Pluto's atmosphere was the subject of much debate in the 1980s, but a good early study is Elliot et al. 1989, Icarus, 77, 148
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