Annals by David Jewitt & Jane X. Luu

Pluto, perception & planetary politics

Last summer, in Prague, members of the International Astronomical Union (IAU) voted to remove Pluto from the list of planets. It is not a major planet like our own Earth, or Mars, or Jupiter, they declared; it is instead a 'dwarf planet' along with several other diminutive but approximately round bodies in orbit about the sun. Apparently adding insult to injury, the IAU's Minor Planet Center promptly assigned Pluto a number, as they routinely do for run-of-the-mill asteroids. From now on, Pluto is 134340.

Pluto's loss of planetary status, while pleasing to the many astronomers who have long viewed Pluto as a planetary usurper, has enraged others. Dark rumors of a revolution at the IAU swirl on the Internet, and pro-Pluto political action groups have formed. Pluto's reclassification has also bemused science writers and the general public, many of whom believe planethood is Pluto's right, not to be cruelly snatched away by mean-spirited astronomers. The dusty world of the IAU has never been racked by so much controversy.

Astronomers will study Pluto just the same whatever it is called: a planet, an ex-planet, or a dwarf – it doesn't matter. In this sense, Pluto's removal from the list of planets is inconsequential. So what is behind the abnormally high level of interest and, in some quarters, the almost pathological passion aroused by Pluto's reclassification?

It turns out that the answer to this question is deep. The reaction to Pluto's demotion tells us little about Pluto, but a lot about the public perception of science, and about the role of politics and public relations in modern planetary astronomy.

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Astronomers have known since 1992 that Pluto is not alone. It orbits the sun along with a vast number of cohorts in the frozen realms beyond Neptune. This region, now widely known as the Kuiper Belt, contains bodies consisting mostly of ice and rock, like dirty snowballs trapped in the solar system's deep freeze. More than a thousand Kuiper Belt objects (KBOs) have been identified as a result of prodigious search efforts. Based on these discoveries, we can predict some seventy thousand KBOs larger than 100 kilometers in size, and tens, even hundreds, of millions of KBOs measured down to 1 kilometer in size. The new discoveries show that the Kuiper Belt is a ring-like assemblage of bodies extending roughly from Neptune's orbit at 30 astronomical units (AU; 1 AU is the average distance between the Earth and the sun) to at least 1000 AU.

The Kuiper Belt has immediately emerged as a new frontier in astronomy, scientifically important on several different levels. It turns out that the Belt is the source of many of the comets that intermittently grace Earth's skies. More significantly, it is a vast repository of icy bodies left over from the solar system's formation 4.5 billion years ago, and its study promises to tell us much about the way in which the solar system formed and evolved. With the discovery of the Kuiper Belt, it became clear that Pluto was more usefully viewed as a large KBO than as a planet. Most astronomers have recognized since 1992 that Pluto's earlier classification as a planet was a mistake, but the message has been poorly received by the wider public.

The first objects discovered in the Kuiper Belt were a few hundred kilometers in diameter, tiny compared to Pluto, which is 2300 kilometers in diameter. But it did not take long for larger bodies to be identified. By the turn of the century, objects fully 1000 kilometers in diameter were being discovered with regularity. Starting in 2000, press reports began to tout the applicability of the term 'planet' to these objects with 2000 WR106 (Varuna; some 600 to 900 kilometers in diameter); then 2001 KX76 (Ixion; 800 kilometers); then 2002 LM60 (Quaoar), 2004 DW, 2003 EL61, and 2005 FY9 (all 1000 to 1300 kilometers). The straw that broke the planetary camel's back was 2003 UB313 (Eris), a KBO whose diameter is the same as Pluto's within the uncertainties of measurement. The point of all these discoveries was clear: Pluto is not alone. The press release announcing Eris, however, advertised it as "the tenth planet," a label that many in the press and the public accepted uncritically. But describing Eris as the tenth planet presupposes that Pluto is the ninth planet – and this had already been a controversial assertion for many years.

The history of how Pluto came to be labeled the ninth planet is well known. Astronomers in the early twentieth century noted that Uranus's position deviated from its predicted ephemeris by a small but significant amount. Since these deviations could not be attributed to Neptune, astronomers supposed that they must be due to the tug of an unseen planet. Urbain LeVerrier and John Adams had successfully used a similar argument in the previous century to predict the existence and location of Neptune, which led to its discovery in 1846 by Johanne Galle. Percival Lowell named the unseen disturber of Uranus "Planet X." He calculated its position from the perturbations on Uranus, then instigated an observational search at his private observatory in Flagstaff, Arizona. In 1930, fourteen years after Lowell's death, Clyde Tombaugh indeed found Pluto near the predicted position and

announced Planet Pluto to an awestruck world.

But things began to unravel quickly. Physical measurements showed that Pluto was too small to perturb the other planets measurably: its mass is only one-fifth of 1 percent of Earth's mass, six times less than even Earth's moon. Pluto did happen to be near in the sky to Lowell's predicted location, but it had nothing to do with a Uranus-tugging "Planet X." Even worse for Percival Lowell (if not for Pluto), the deviations in the position of Uranus he used to infer the location of Pluto are now known to be observational errors, not real deviations due to an unseen planet. Thus, Pluto is not "Planet X" – not because it does not have enough mass to cause deviations in Uranus's orbit, but because those deviations are not even real!

We have to conclude that Tombaugh discovered Pluto not because of the quality of Lowell's predictions, but simply because he was looking when nobody else was. These facts, however, did not distract astronomers at Lowell Observatory from advancing Pluto as a planet; and, in the absence of much public discussion until the discovery of the Kuiper Belt, these facts made little impression on the public. For all the wrong reasons, the 'planet' label stuck.

It is interesting to speculate on what might have happened had Pluto been properly described as a large KBO upon its discovery in 1930. Most likely, our understanding of the solar system would have been advanced by many decades. The next-brightest KBOs after Pluto are fainter by a factor of fifteen or twenty. They would have been difficult for Tombaugh to locate, but astronomical sensitivity increases almost yearly and additional objects could have been identified within a decade or two. Indeed, some of the bright KBOs found in recent years were also recorded in photographic observations from the 1950s and 1960s, but they went undetected. One of the main reasons for this is psychological: humans are not very good at perceiving things they do not expect to see. With Pluto entrenched in our minds as the 'last planet,' nobody was able to see even the bright KBOs until this population had been firmly established in the 1990s. (This is an oft-repeated story in astronomy. Pluto was recorded photographically decades before Tombaugh discovered it, but went unnoticed because it was not sought. Amazingly, Neptune was recorded by none other than Galileo, but he paid no attention to it, delaying Neptune's discovery for two hundred years.)

If Pluto had been immediately recognized as the 'tip of the Kuiper Belt iceberg,' we would have known soon after World War II – and certainly before the space age – where comets come from and where to go in the solar system to find our most primitive materials. Our understanding of the dynamics and origin of the solar system would also have been much less biased by observations of the rocky planets and the inner solar system than it has been. The damage done by the mislabeling of Pluto as a planet, in this sense, has been considerable.

So what is behind the public fascination with Pluto as a planet? Nostalgia, mostly. Pluto was always a planet in the past, how could it not be a planet now? This is the essence of the so-called cultural defense of Pluto's planethood advanced by astronomer Mike Brown at Caltech. The argument is that the definition of a planet is determined by collective beliefs rather than by any scientific metric. We can draw an analogy with the continents. There is no serious, scientifically based definition of what

constitutes a continent, just a set of accepted continents that we, as children, more or less commit to memory. This analogy is good because, as with planethood, the definition of 'continent' we are familiar with plays no important role in understanding the geology, geophysics, geography, or even politics of the world. It is a socially accepted construct. But this doesn't mean that anything goes. For example, it would be unacceptable to most people to suddenly declare Long Island or Florida a continent: it doesn't help scientifically, and it clearly subverts the intent of the 'continent' label, which is to point to a substantial, coherent land mass. Likewise, labeling tiny Pluto as a planet implies that it is in the same league as Earth (which is 500 times more massive), Uranus (7,500 times), and even Jupiter (140,000 times). This doesn't make sense.

More deeply, we believe that the public attachment to Pluto-as-planet reflects a fundamental misunderstanding of the evolving, self-correcting nature of science. This misunderstanding stems from a confusion between memorization and comprehension that seems inherent to educational systems worldwide. Those of us who teach undergraduate classes often see students to whom the lectures are merely an exercise in memorization. Every detail of every lecture is written down and memorized, with the idea being that to 'pass the test' one needs only to remember everything and regurgitate it upon demand. While memory is an important part of learning, this is clearly taking it too far. If we teach children the names of the planets and do little or nothing to explain their fundamental significance, of course they will react negatively when membership in the planet club is revoked. Since they have little idea of what the solar system means in any broader context, their main impulse is to cling to the status quo, whatever that might be.

Astronomers have a different view (hopefully). The important and essentially uncontested fact is that modern research clearly reveals Pluto as a large but otherwise unremarkable KBO. Even the strongest advocates of Pluto's planethood cede this fact. Calling Pluto a planet adds nothing to our understanding of its nature, properties, or origin, and in fact obfuscates its position as one of a group of many bodies in the ring of debris in the outer solar system. Nevertheless, a vocal minority of scientists is expressing outrage, partly in sympathy with the public confusion but more obviously for reasons of self-interest.

There are two main groups in this latter category. First, those connected in some way to the discovery of Pluto and other large KBOs have a vested interest in asserting planetary status. We all know that planets are discovered by historical luminaries such as William Herschel and Urbain LeVerrier, whereas KBOs are already a dime a dozen. Discovering a 'planet' is perceived as better than discovering a big KBO because it garners more press attention. Second, those involved in NASA's 'Horizons' mission to 'the last planet' suddenly find their spacecraft on its way to a seemingly less important body. We see no intrinsic problem with this. The Horizons mission is no less impressive, and the loss of the planet label does not diminish scientific interest in Pluto. But there is undoubtedly a degree of unease in having to explain to hard-nosed NASA administrators why they have spent $700 million on a ten-year mission to an ex-planet. This is a matter of planetary politics.

Lastly, what was the motivation of the International Astronomical Union? This body had its heyday in the cold war, when it provided almost the only regular

opportunity for Western astronomers to meet their counterparts from the other side of the Iron Curtain. Since then, it has taken responsibility for apportioning names to asteroids and to geological features observed on solid bodies in the solar system, and for fighting light- and radio-frequency pollution of the skies on behalf of astronomers worldwide.

Unfortunately, in the 'what is a planet' debate, the IAU trapped itself between the irreconcilable positions of the public, which was overtly interested in having the IAU pronounce Pluto a planet, and of the astronomers, most of whom were more interested in clearing the air by reversing a seventy-six-year-old mistake. Worse, the IAU allowed its deliberations to drag on, mostly in secret, for years, so magnifying the impression that a weighty and complicated scientific issue was under study. They could have, and should have, declared that Pluto was first and foremost a big KBO, and that calling it a planet was an unhelpful and ultimately unjustifiable matter of public relations and planetary politics, not science. Instead, they waffled, struggling for years in a doomed quest to find a compromise that would keep all sides happy. While the IAU in the end reached the right decision (except for the unnecessary invention of the 'dwarf planet' class), the public perception of the process, and of astronomers and astronomy, has been soiled. Millions of people now think of astronomers as having too much time on their hands, and as unable to articulate the most basic definitions or clear positions in a coherent way. Even the nature of science was muddied: do scientists really make progress democratically, by voting, as they did on the status of Pluto? Should we vote on the value of the gravitational constant? None of this is good for astronomy.

On the brighter side, one cannot buy the level of public interest that has been triggered by the planethood debate. The IAU and astronomers everywhere have the potential to use this interest to focus the public toward more fundamental, more scientific issues, such as the origin of the solar system and even the nature and purpose of science. As a result, the public, especially children, might care more about how our solar system came to be, how collisions and aggregation of solids and gas led to the emergence of distinct types of planets: the Earth-like rocky planets in the inner solar system, and the gas- and ice-rich giant planets in the outer regions. And it might wonder how the process of planet accumulation produced the leftovers that litter the region beyond Neptune. Let's hope that what ultimately comes out of the planethood debate is a better understanding of what science is about, rather than hollow mourning for the Icy Body Formerly Known as a Planet.