An Appendix of the Minutes of Division III

Friday afternoon open discussion on the status of Pluto as a planet.

Fernandez presented the following proposal:

The definition of a planet

Overview

There has been a long discussion about what a planet is. This problem appears at both ends: for the very massive bodies and for the smaller ones. At the large end, the limit seems to be clearer; it is now widely accepted that planets must not generate any energy from nuclear fusion, while brown dwarfs generate some nuclear energy from the fusion of deuterium. More problematic is the small end. We think that the definition should be kept as simple as possible and based on physical and cosmogonic reasons.

There is a wide consensus that planets formed by the accretion of small bodies – the planetesimals. The accretion process led to the formation of embryo planets that, as they grew in size and acquired more powerful gravitational fields, went to a process of runaway accretion in which the size of a few of them detached from the rest of the bodies of their neighboring zones. Given the powerful gravitational fields of these massive bodies - that we can call at this stage protoplanets - they were able to clean the population that had close encounters with them. The bodies interacting with the protoplanets were finally incorporated to the planets or scattered to other regions.

From a cosmogonic point of view, it therefore makes more sense to consider a planet as an object that acquired a mass large enough to clean a zone around its orbit. According to this definition, only eight planets, Mercury (perhaps marginally), Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune fulfill this condition. It is obvious that, at least for our solar system, this cosmogonic definition implicitly carries the condition of objects with a roundish shape determined by self-gravity.

From our definition, Pluto, Ceres and other large Trans-Neptunian objects in quasi-hydrostatic equilibrium [1] should be not considered as planets, since they never were the dominant bodies in their accretion zones. It is suggested that Pluto be kept unnumbered by historical reasons.

Is may be possible that in the near future cases of objects not foreseen at present could appear beyond our solar system, as for instance free-floating planets, stray planets, or double planets. We think that we should not advance definitions at this point for these exotic cases and leave their discussion when if they became a part of the observed world.

[1] From our present knowledge of the Solar System, we know that objects as small as Mimas (D~400km) are roundish. If this were the lower limit for an icy body to be in hydrostatic equilibrium, then we would already have several tens of bodies fulfilling this requirement.

Fernandez: We tried to put together two criteria, size and a cosmogenic criteria, the dominant bodies within a feeding zone... The planets that become a dominant body, accreted and then detached from the rest of the population by a factor of 100 or more. If we combine these two criteria we come up with the classical planets.

Akers: I remind you, we are aware of the upper end... there is a working group on extrasolar planets that has dealt with this. We purposefully did not ask the committee to address that issue. That's not the issue we discuss here. In setting up the committee we were sensitive to the difference between science and nomenclature. Part of the IAU job is to agree on things, so that everyone agrees on the same difference. It is not our job to tell you how to do your science.

What follows are comments from the floor (usually without identifying the speaker) after the introduction of the second proposed definition:

There are three necessary ingredients in defining a planet: first, its orbit cannot be chaotic, and should be close to circular; second, one must consider mutual perturbations by other planets (which is how others were discovered and this is how most planets are still discovered); and third, the dominance of that body in a feeding zone.

(Binzel): A proposal defining a planet this way, with emphasis on its orbital processes, was discussed within the original committee at great length and received little support there. When the second committee was trying resolve this impass, we looked at intrinsic vs. extrinsic definitions, and in our deliberations we decided we wanted to find a definition that was most consistent of astronomy, and looked at the analogy of how the term "star" is defined: it doesn't matter if the body in question has a million neighbors in a globular cluster, or if it is alone in a spiral arm, it is still a star. We thus favored an intrinsic definition. Also, the definition we proposed has already been criticized for being too complex; the public does not read Astro-PH. We wanted to find a definition was universally applicable.

These two definitions are not so far apart, and we should look at the similarities. With small modifications you can satisfy everybody. We could use the Tancredo definition for defining the difference between small vs. classical bodies; we can use that as the division between planets and non-planets, which remains as originally proposed.

Going back to first principles, it may be useful to ask ourselves, what is the problem we're trying to solve? All the questions we are getting from the public are, "is X a

planet?" Does this definition allow us to answer that question, does it solve the problem? No, it doesn't solve the problem, it merely changes the value of X. There are already twelve more candidates, and to decide if they qualify will require knowledge that is going to be very difficult to get. Consider that in 2010 we discover some very distant object that might be considered a candidate; all that will be known, originally, is its apparent brightness and orbit. How do we establish whether it is near hydrostatic equilibrium or not? We must choose between a scientifically "sensible" definition that will be very difficult to establish, or a non-scientifically palatable but very simple definition that would be the easiest to implement. For instance, we use a definition based solely on absolute magnitude. Obviously it has problems, but there is a nice appeal to the number zero; using an absolute magnitude of zero for our cut-off point gives us three icy planets. It doesn't revise history, it doesn't change the status of Pluto.

The definition that a planet is capable of clearing its dynamical zone is good. It might be better, however, to just admit that astronomy is full anachronisms and just say, "we have nine planets, we're grandfathering in Pluto, none of the others make the grade."

The issue of binary planets doesn't trouble me; we know more than 40 such objects in the Kuiper Belt already, so widely separated that their barycenters are clearly outside either member. I suggest we change "planetoid" to "dwarf planet" in the alternate proposal. The second proposal only differs from the official one in (the latter's) somewhat muddled description of "plutons".

Mercury has a significant eccentricity, after all; saying that classical planets are in nearly circular orbits is not correct. To eliminate Mercury and Pluto because of their orbits or small masses, would lose an important description of the current solar system.

Schoolchildren and the general public need a definition with a simplicity of language. "Small solar system bodies" does not meet that criterion; I would rather use planetoids and comets. (Iwan Williams responds, "We are not banning 'asteroid' or 'comet', we encourage the use of those terms except in official titles for IAU bodies that deal with moth types of objects.") And to me the term "classical" planets refers to those known to the Greeks and Romans, only Mercury to Saturn.

It's my opinion that the IAU proposed resolution is a good compromise. Only the low (800 km) diameter makes me nervous, and several people will raise their eyebrows at including as planets Ceres and Charon; I would have preferred a 1000 km radius limit.

Do not use "pluton", because many Latin languages already call "Pluto," "Pluton."

It was recognized in the early 19th century that having two "planets" whose orbits cross, like Ceres and Pallas, meant that they could conceivably have collisions, so the idea that planets have a stable orbit was broken. Thus I disagree that only one physical

criterion defines a planet, its shape; you must also consider another important factor, namely its orbit.

“Classical planet”? Is that term defined here? (Iwan Williams replies, “That was not the intention, to define a “classical” planet.”)

We sitting here in this room don’t need a definition of a planet; as scientists we understand what we are studying. So, who does needs this definition? The IAU, who needs to know which committee can name it, and those who are responsible for what is taught in schools, who are not professionals in this field. We in this room don’t need the definition, it is needed by the outsiders. We have to keep these outsiders in mind. Keep the definition physical, and come up with a definition that can be used by those who need it.

Why is “dwarf planet” only optional rather than a mandatory defined term? (Rick Binzel replies, “We only wanted to define two words, “planet” and “pluton,” to minimize the number of newly defined terms.”)

The purpose of having terms defined is to help provide a clarity in the communication of ideas. The public is very confused by this new proposed definition. People think from now on they are going to have to learn all the fifty objects that will eventually be found that fit this definition, that all of these fifty objects are going to have to be taught in the schools. To change this, without the confusion, we should emphasize the two classes of planets, the classical planets and dwarf planets.

In writing textbooks, astronomers should not be the ones setting the definition but the users of the textbooks. It is important to keep things simple, in terms that students will understand. The technicalities of dynamics or hydrostatic equilibrium will not be easily communicated or well understood, but “size” and “roundness” will.

(Andersen): I was the one who had to handle the first discussion about Pluto in 1999. Since I am not longer on the executive committee or had anything to do with this current version of the controversy, I no longer have to be diplomatic! I must say that this constituency was the most belligerent and self-centered group of people I ever had to deal with. The one thing I beg of you is, do not let this confused discussion spill over into a confused vote in the GA. We don’t want to make absolute fools of all astronomers in the eyes of the world.

Iwan Williams then conducted a straw poll of those present. The second resolution, which includes dynamic matters, is favored, “by a roughly 60-40 majority,” with Ceres and Pluto defined as dwarf planets. The major novelty between this proposal and the

original one is point “a” which uses “dominance in its orbit” as the way to distinguish between a “classical planet” and a “dwarf planet.”

Williams then conducts another straw poll: “Who here hates the name ‘pluton’?” The vote is almost unanimous, against “pluton.”

(Williams): At the end of the day, then, how do we reply to the question we are sure to be asked, “Is Pluto a planet?” There are two possible answers, given this definition: “The answer is no, it’s a dwarf planet” or, “The answer is yes, it’s a dwarf planet.”

A members of the audience commented, “That’s exactly the ambiguity we’re looking for.”