What about Pluto??!

The controversy over what is a planet.

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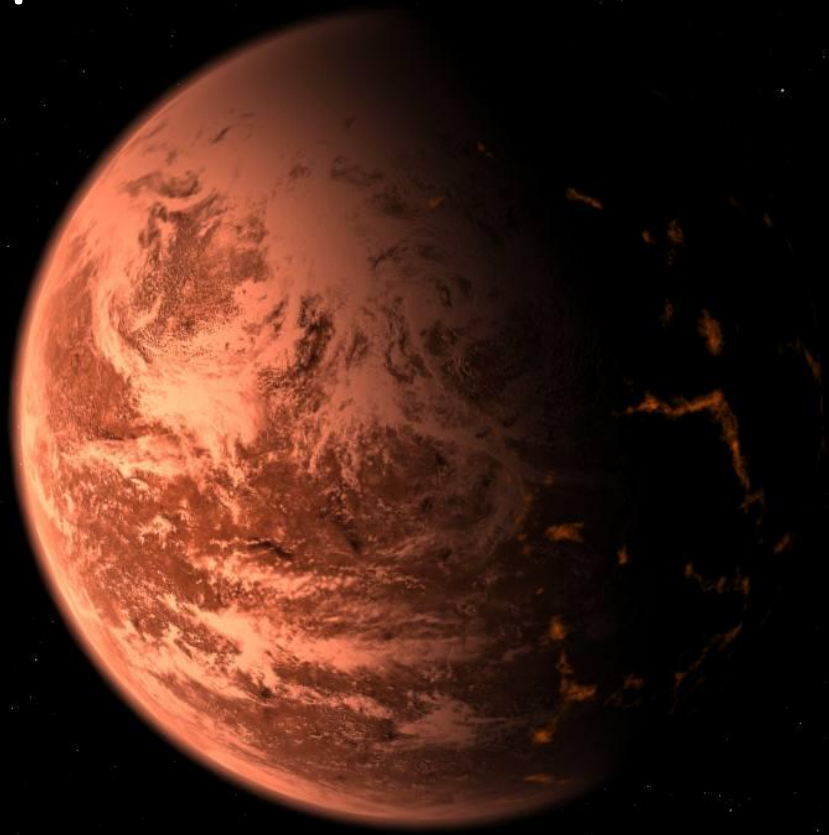
Commission on Planetary Certification

What *was* the definition of planet? (before 2006)

The definition of *planet* was very much like the definition of *obscenity*:

"I know it when I see it."



Unfortunately, this is not as straightforward as it at first seems.

What is a planet?

- It was smaller than a star.
- Bigger than an asteroid.
- Circled a star and not another planet.

Problem!

- As we find more planets beyond the solar system, what if they don't circle a star? A stray planet?
- What if it is a dead star?
- How big is big enough to not be an asteroid?
- What if it's a double planet?

This has happened before!

- 4 largest asteroids in the Asteroid Belt
  Ceres Pallas
  Juno Vesta
  were all considered planets when they were first discovered (1801-07).

- This nomenclature remained for several decades

Minor Planet vs. Asteroid vs. Planetoid

- Asteroid, minor planet & planetoid were all more or less synonymous.
- The term *minor planet* was official IAU terminology until 2006.
- Less well known is that this was also discarded and replaced with “small solar system bodies”.

Why now?

- Number of exoplanets (outside solar system) at >230 (early 2007), & continues to climb.
- Some of them defy what was conventionally believed to be the upper mass limit of a planet.
- Another large object was discovered in the Kuiper Belt beyond Neptune in 2003.
- True size of Pluto calculated in 1970's & status in question for some time already.

Pluto – a history

- Discovered in 1930, Pluto was found to have a moon, Charon, in 1978.
- Originally believed to be the mass of the Earth, now known to be smaller than Moon.
- 2 more moons, Nix & Hydra, discovered in 2005.

- Distance from Sun: 30 to 49 AU.
- Orbit highly elliptical and comes inside orbit of Neptune. Orbit tilted to plane of ecliptic.

Bombshell

- Originally designated 2003 UB 313, the object was nicknamed Xena. It was discovered to have a moon (nicknamed Gabrielle). These names were eventually changed to Eris (the goddess of discord, appropriately enough), and Dysnomia.

- Eris is larger than Pluto, and further away: 38 to 97 AU, and takes 560 years to orbit Sun.

New Definition of a Planet

- According to the IAU's 2006 ruling, the new definition of a planet:
  - Object orbits a star
  - Object in hydrostatic equilibrium (i.e. enough mass for differentiation of metals, rocks, ices)
  - Object has cleared its orbit of "debris"
- Original proposal with first two conditions only rejected.

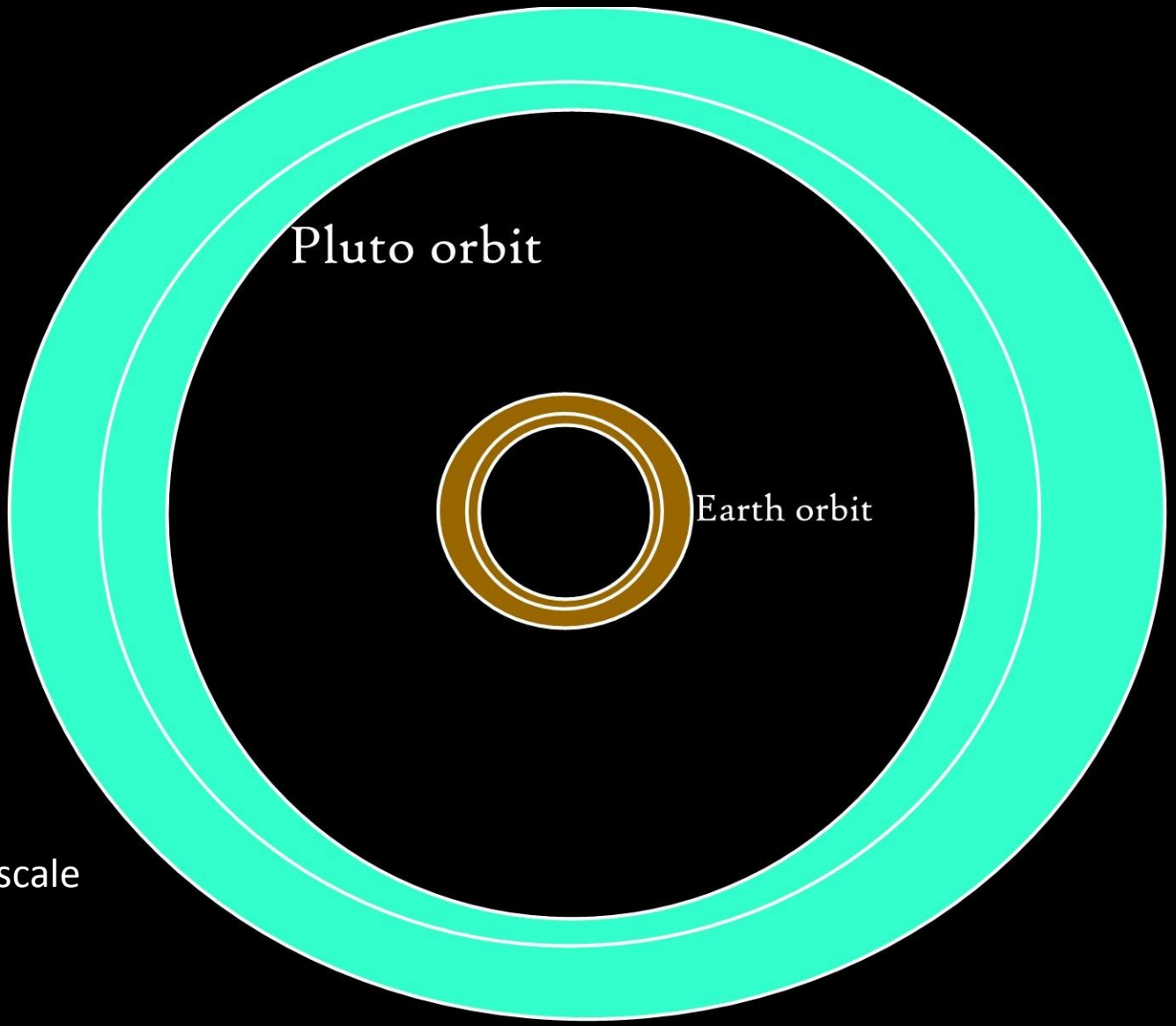
Controversy

- Public outcry over demoting Pluto
- Not all astronomers accept definition
- Vote took place in Prague on the last day of conference. Non-attendees & those leaving early could not vote.
- Original proposals had “clearing orbit of debris” condition as least popular
- “Dwarf planet” definition is nonsensical as it is neither a planet, nor does it depend on size.

Debris Requirement Problems

- Debris requirement essentially means that the further away from the Sun an object is, the larger the mass needs to be in order to be considered a planet.
- Some predictions of the Kuiper Belt suggest we could still find objects the size of Mars beyond the orbit of Pluto. This object would not be a planet.

Area of a ring



Not to scale

Area of a ring

- If we use the orbit of Earth as a model, halfway (average) to the orbit of Venus is 0.86AU, and halfway to the orbit of Mars is 1.26 AU. The area covered by that orbit (assuming it's circular) is 2.66 AU^2 or $2.3x10^{16}$ $miles^2$.
- A similar calculation for Pluto (using the same percentages relative to average orbit) yields 4262.5 AU^2 or $3.69x10^{19}$ $miles^2$.
- Taking eccentricity of orbit into account, you can get an even larger difference.

What does ‘cleared of debris’ mean?

- In general terms, it means that the would-be planet “dominates” all other objects in its orbit gravitationally.
- There are Earth-crossing asteroids, but they don’t threaten Earth’s planetary status.
- What relationship between size of orbit, size of object, and “debris” is not well-established. Like old definition of planet “I know it when I see it”.

Where does dwarf come in?

But then comes the definition of “dwarf planet”

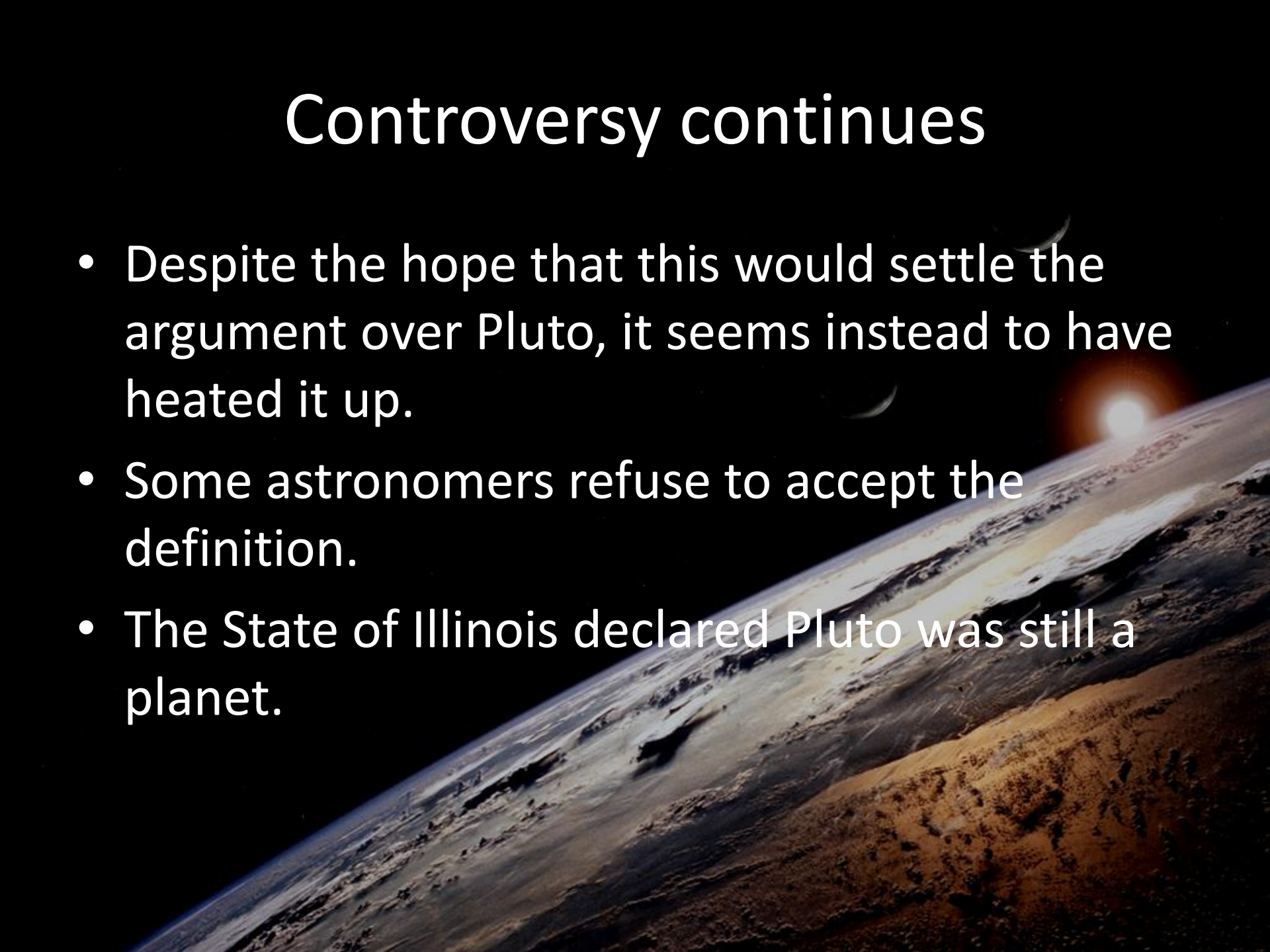
- What about the definition of a “dwarf planet” is “dwarf”.
  - Answer: Nothing!
- But the chief complaint, prior to the discovery of Eris, about Pluto being considered a planet was, in fact, its *size*.
- This leads one to conclude that orbital debris was an *excuse* to eliminate Pluto from class of planets.

What are the new “dwarf planets”?

- Three objects were designated “dwarf planets” according to the new nomenclature:
  - Ceres (the largest asteroid)
  - Pluto
  - Eris
- All would have been considered planets if the “orbital debris” criteria has been abandoned.

Controversy continues

- Despite the hope that this would settle the argument over Pluto, it seems instead to have heated it up.
- Some astronomers refuse to accept the definition.
- The State of Illinois declared Pluto was still a planet.



The End

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