

# Pluto and definition of planet

Vedran Vrhovac\*

## 1. Introduction

Until recently, Pluto was designated as planet but new discoveries were cause for changing his designation to dwarf planet. His name comes from Greek mythology, where Pluto was god of the Underworld. For very long time, Pluto was last known object in Solar System. After discoveries of similar bodies in outer Solar System, Pluto's status has become problematic for astronomy community. Just like accepting heliocentric model of Solar System five centuries ago was pivotal point in history maybe last years conference in Prague and accepting new definition of planet will be significant moment in history of planetology.

## 2. Discovery

Astronomer-amateur Clyde Tombaugh, employed in Flagstaff Observa-

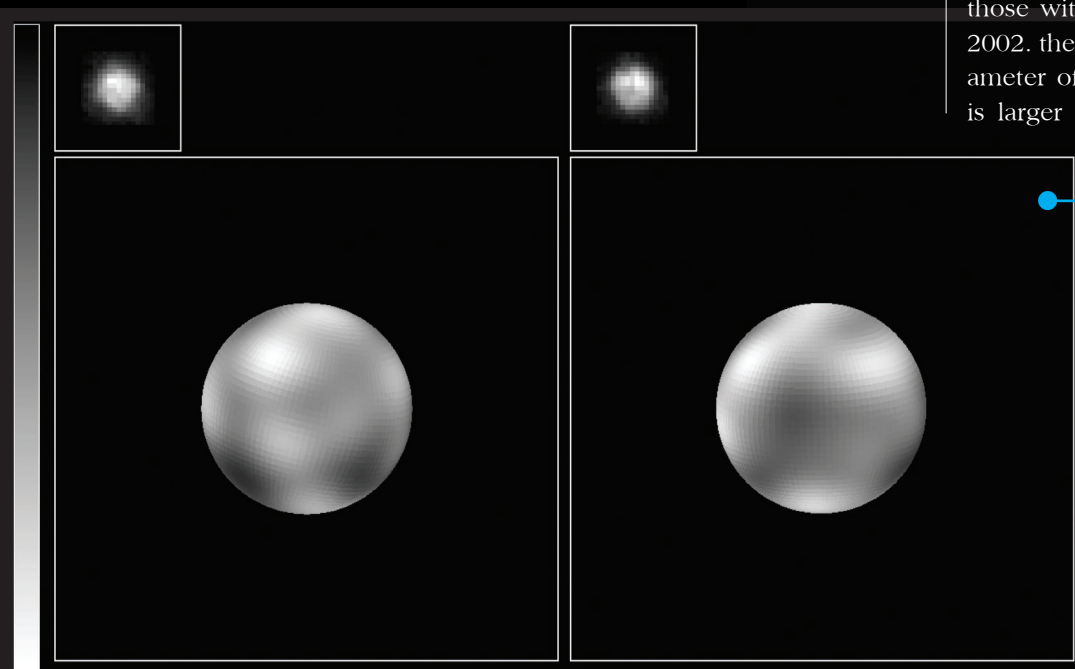
tory, was surveying the photos of sky taken through telescope. On February 18th 1930, he was comparing two photos of same part of sky, taken at different nights. He noticed that one little dot has changed her relative position between stars. It soon turned out that the small dot was 9th planet – Pluto.

Average distance between Sun and Pluto is almost 6 billion miles and for one orbit around Sun, he needs 248 years. Diameter of Pluto is 2390km, one third less than diameter of our Moon. Almost 50 years after discovery of Pluto, his largest satellite, Charon, was discovered. Charon is just half the size of Pluto.

Pluto's orbit is significantly different than orbit of other planets. His orbit is inclined for  $17^\circ$  and very elliptical. Pluto's orbiting around Sun is in orbital resonance with Neptune's. Orbital resonance is phenomenon ca-

used by gravitational forces and result of those forces is locking of orbital periods. While Neptune makes three orbits, Pluto makes just two.

All these non typical attributes were cause for suspicion about his planetary status. Until early 90's that suspicions were not argued. There were not such large body like Pluto with similar properties in that part of Solar System so he was unique. Development of advanced technologies, such as computers and CCD cameras enabled discoveries of new small objects in outer Solar System. First object discovered was 1992QB1. After Charon, 1992QB1 was first object discovered at those distances. This discovery proved that space beyond Neptune is not empty and it also gave new enthusiasm for search of undiscovered objects beyond Neptune. Until 2002, almost 400 new objects were discovered but none of those with significant dimensions. In 2002, the Quaoar was discovered. Diameter of Quaoar is 1260 km, so he is larger than Charon. After Quaoar even larger objects were discovered: 2005FY9, 2003EL61 and 90482 Orcus. Discovery of Eris, with dimension 5-35% larger than Pluto caused additional turbulences



**Figure 1.**  
Pluton imaged by Hubble Space Telescope.  
Source: NASA

**Figure 2.**

Compared dimensions of Pluto, Sedna, Quaoar, Earth and Moon.  
Source: NASA

in astronomy community. Some astronomers considered Eris as 10th planet but other group felt that Pluto and Eris didn't qualify to be planets. The revision of definition of planet was needed and regular conference of IAU<sup>1</sup> in Prague was opportunity to solve this problem.



### 3. Conference in Prague

Last year (14th to 26th August 2006.) conference of IAU was held in Prague. Definition of planets and criteria to divide them from other bodies in Solar System were one of the things that were debated on conference. First draft proposal of definition was announced on August 16th. According to the draft proposal, to existing nine planets would be added Ceres, Charon and Eris. Later, the number of planets would grow since there were already known bodies that fulfilled criteria.

Main criteria of this proposed definition were:

1. Planet is body that circles around star and it can not be star itself
2. Planet must have enough strong force of the gravity to be shaped approximately like sphere.

All bodies larger than 800 km and with mass greater than  $5 \times 10^{20}$  kg fulfill this criteria. Draft proposal also included a new class of objects in Solar System – Plutinos. Objects with orbital period greater than 200 years, large inclinations and great eccentricities of orbits would carry that name. Draft definition didn't pass voting and one week later (August 24th) new and final definition has been announced. New definition demoted Pluto's status and introduced new class of objects –

dwarf planets. According to these definition, objects in Solar System were divided in three groups:

1. Planet is a celestial body that
  - is in orbit around the Sun
  - has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape
  - has cleared the neighbourhood around its orbit.
2. Dwarf planet is a celestial body that
  - is in orbit around the Sun
  - has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape
  - has not cleared the neighbourhood around its orbit, and
  - is not a satellite.
3. All other objects, except satellites, orbiting the Sun shall be referred to collectively as "Small Solar System Bodies". These currently include most of the Solar System asteroids, most Trans-Neptunian Objects (TNOs), comets, and other small bodies.

### 4. Physical properties of Pluto

Pluto is mainly composed from rocks and ice. His composition is the reason why surface of Pluto is very reflective which caused many wrong estimates of his size in past. Today, we certain-

ly know that his diameter is 2390 km and mass 400 times less than Earth's. Pluto's orbit is very elliptical and inclined. When he is closest to the Sun, Pluto is 39.5 AU (one AU has 149.6 million km) from Sun and when farthest he is 49.3 AU from Sun. Consequences of this are large variation of average temperature on surface, from  $-240^{\circ}\text{C}$  to  $-218^{\circ}\text{C}$ . When going away from Sun, Pluto's atmosphere, composed from nitrogen, gets frozen. Pluto's period of rotation is 6 days and 9 hours and his axial tilt is  $119.6^{\circ}$ . Consequences of this are that some regions experience long periods of exposure to Sun radiation and heat. Pluto has three satellites. Largest satellite is Charon, with diameter of 1212 km and orbits close to the Pluto (on distance of 19570 km). Effect of such orbits is synchronized orbiting of Charon with Pluto's rotation. Due to this phenomenon, observer on Pluto would see Charon standing still on sky. From other parts of Pluto, Charon isn't visible. Charon's composition is similar to Pluto's, it's composed of rocks and ice but his surface is reddish. Other two satellites have minor dimensions, around 150km. They were discovered just recently, in 2005. using Hubble Space Telescope. They bear names Nix and Hydra. Pluto's surface is probably very similar to Triton, Neptun's largest satellite. Triton is bigger and more massive but

[1] IAU stands for International Astronomical Union



equally cold. Geysers that eject nitrogen in rare atmosphere are interesting phenomenon on Triton. Surface of Triton is very reflective cause of the geysers. Its believed thah Triton, just like Pluto, was circling around Sun until it was captured by Neptune.

## 5. Kuiper Belt

Kuiper Belt is space beyond Neptune occupied by numerous small bodies and dwarf planets, including Pluto. Existence of Kuiper Belt was predicted by Gerard Kuiper as source of short period comets. Objects in Kuiper Belt are remains from most early days of Solar System, when planetary genesis was still lasted. By exploring those planets we will find out more about conditions in early Solar System.

Today, more than 800 objects where discovered in Kuiper Belt. Most of those objects occupy space on distances between 39 AU and 50 AU from Sun. Neptune, as most massive body on those distance, has significant influence on their orbits. Because of that, bodies in Kuiper Belt are divided by orbital resonance with Neptune. Bodies with resonance of 1:1 are Neptune's Trojans, 2:3 are Plutinos and 1:2 are

Twotinos. Orbits of these objects can be inclined to  $50^\circ$  which explains why they where not earlier discovered. Eris is not Kuiper Belt object since she is too far. On distances of 50 AU there is sudden drop in number of Kuiper Belt objects. This drop is known as Kuiper Cliff. There are theories that object with mass between Earth and Mars is orbiting on those distances. His gravitational influence would clear those space from other objects.

## 6. Exploration of Kuiper Belt

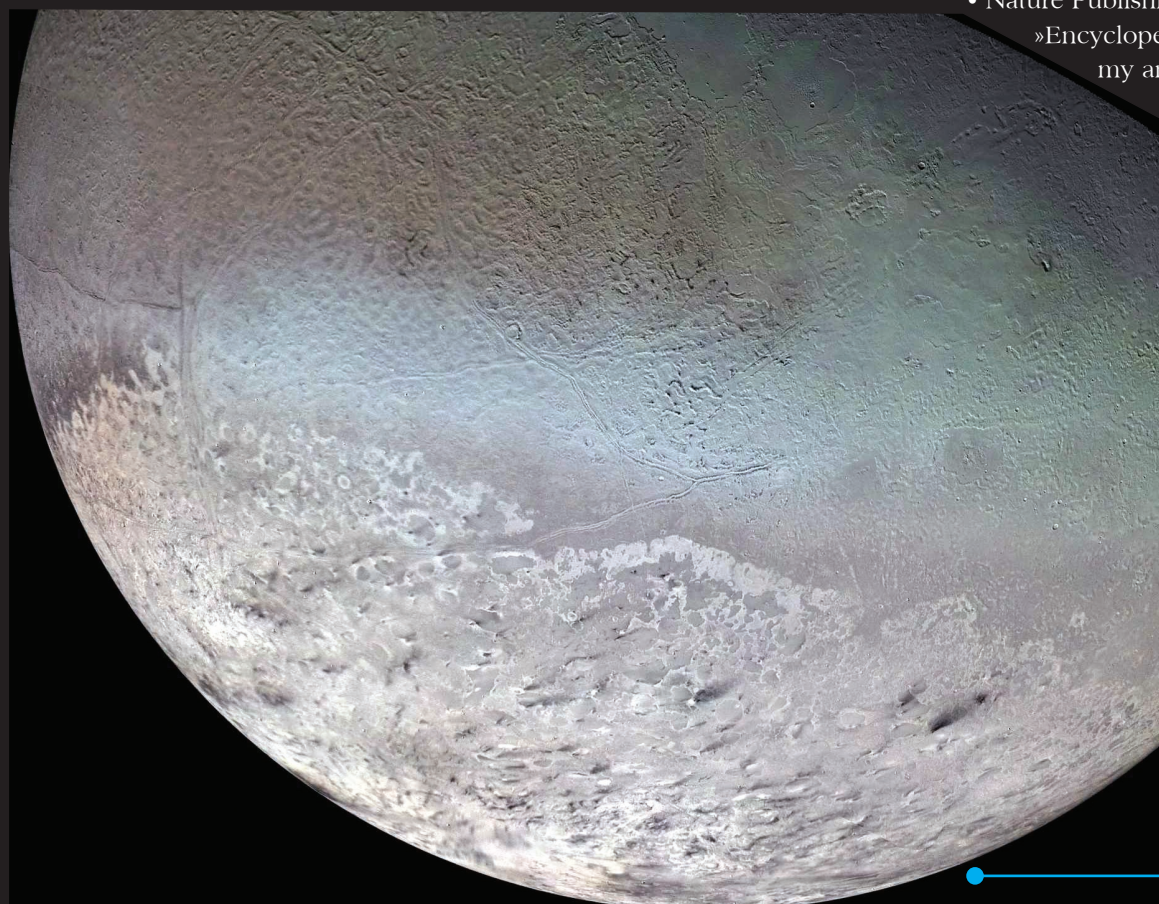
Exploring and deterring properties of such distant and small objects is very challenging task, even for most powerfull Earth based and orbiting telescopes. Most detailed informations of Pluto gathered Hubble Space Telescope in conjunction with moder telescopes on Earth's surface. Images of surfaces of those distant object we will have to wait until new generation of telescope becomes functional with larger objectives and better technologies. For now astronomers determine properties of those objects using IR part of spectrum. From IR data they can estimate size and composition.

No spacecraft has ever visited Plu-

to or other Kuiper Belt objects in spite of that that for spacecrafts have already traveled through Kuiper Belt. In January 2006. NASA has launched New Horizon spacecraft. New Horizon will fly by Pluto in July 2015. and continue his journey to interstellar space. There are possibilities that new bodies will be discovered so that spacecraft can explore than after she completes her task at Pluto. In mean time we can expect discoveries of new objects which slowly circle in those distant cold regions of Solar System. Exploration of those distant, cold worlds we will find out more about genesis of Solar System and once again convince ourself in hospitability and preciousness of planet Earth.

## References

- <http://en.wikipedia.org/wiki/Pluto> - slobodna enciklopedija, ožujak 2007.
- [http://en.wikipedia.org/wiki/Kuiper\\_belt](http://en.wikipedia.org/wiki/Kuiper_belt) - slobodna enciklopedija, ožujak 2007.
- <http://www.iau.org/iau0602.423.0.html> - web stranice IAU, izjava za tisak, kolovoz 2006.
- <http://www.iau.org/iau0601.424.0.html> - web stranice IAU, izjava za tisak, kolovoz 2006.
- Nature Publishing Group, 2001, »Encyclopedia of Astronomy and Astrophysics«, Hampshire, UK  
Cambridge University Press, 2002, »The Story of the Solar System«, Cambridge, UK ◆



**Figure 3.**  
Triton, Neptune's  
larger satellite.  
Sourcer: NASA