The Planets

otherwise titled, "It's a Pretty Big Place Out There..."

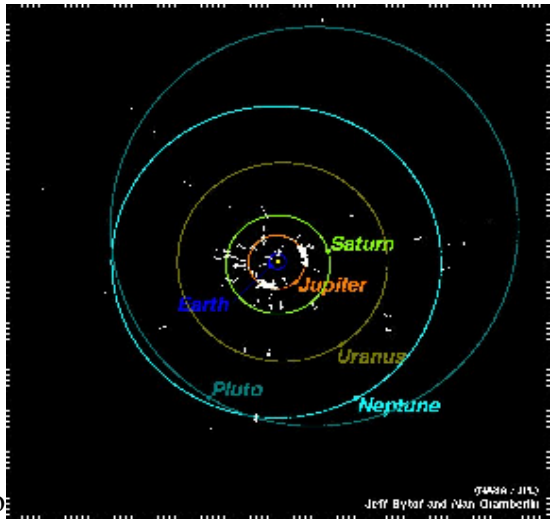
On August 24, 2006, the IAU (International Astronomical Union) voted to strip Pluto of it's "planet" status. Pluto was discovered way back in 1930 by the astronomer Clyde Tombaugh at the Lowell Observatory in Arizona, principally because he and other astronomers were looking for it, since some gravitational effects on Neptune couldn't be explained except by this mysterious *Planet X*. They did the math, they looked in that direction and they found it. Surprise. *NOT!*

It is now known that, at the time, a slightly incorrect value for the mass of Neptune was being used and this was causing the discrepancy in the "predicted" orbit of Neptune. Pluto was discovered quite by accident. (In fact, later searches on even older photographic plates showed that it was actually in these older plates dating back to 1915, if only someone had looked.)

Now, I'm not going to get into this "Pluto is a planet or not a planet" discussion, I think Dr. Phil Plait explained this in enough detail on Swoopy and Derek's "skepticality" episode of August 30, which you can find at http://media.libsyn.com/media/skepticality/032_Skepticality.mp3 .

What I will tell you is that my daughter, in a moment of confusion (they did study planets last year in school) thought that something was being lost here. After explaining the whole thing to her, I thought I would dive into a little exploring around the solar system, but specifically these 8 planets, Pluto, the Sun and their relative distances to each other.

You see, space is vast and above all else, it is *EMPTY*.



The average distance between the SUN and the Earth is a little more than 93 million miles. On average the distance out to the edge of the "solar system," defined by the average orbit of Pluto is a little more than 3.6 *b*illion miles. Pluto's orbit takes it inside Neptune's orbit some of the time, but as you can see, Pluto is quite far out when it is outside the orbit of Neptune. Pluto spends about 200 years being farthest out and about 20 being inside Neptune's orbit.

Wow, but you know, the average person really has no concept of what distances like this are. 3.6 billion miles vs. 93 million miles? Well, we could look up into the sky (carefully) and observe the SUN and then consider that Pluto is 39 times further away from the sun than we are (3.6 billion miles divided by 93 million miles).

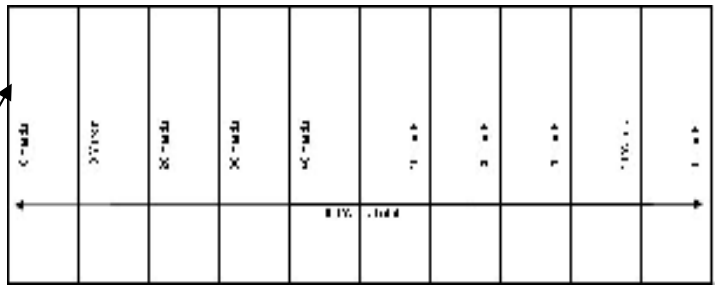
OK, but what is this 39 times and can I even really contrast this to the SUN in our own sky, after all I'm not supposed to look upon the SUN directly. I have looked at Mars and Jupiter in my little amateur telescope, and while they are tiny, I don't really get a sense of the distances involved either.

How about this… If we contrast the SUN's diameter of roughly 870 thousand miles (which you can compare to the Earth's diameter of just under 8,000 miles) means that about 110 Earths can fit, lined up edge to edge and strung across the diameter inside of the SUN. Even this is hard to understand, because

we humans often don't think of the Earth's diameter that much. Maybe the circumference, if we are a seasoned world traveler (think 14-16 hour airplane flights from the US to China). But then, most of us are not…

Perhaps we can put this in terms we might be a lot more familiar with.

Instead of 3.6 billion miles out to the orbit of Pluto, let's make things proportional, say to an American Football field, which is 100 yards, or 300 feet. Not the goal-post to goal-post distance, just the zero yard line, to midfield at 50 yards, and then on to the opposite zero yard line. I'll shrink the diameters of the planets down by the same proportion, so that we can get the correct perspective on these things as well.



So, our SUN, shrunk down so that Pluto fits into the 100 yard American football field, would have a diameter of 9.3 inches. This is about the size of the "bottom" of most large frying pans that you cook with in the typical American home. I looked at a number of frying pans here in the house and feel quite comfortable making this statement. Sure, some people will have larger and smaller, but let's not digress. This 9.3 inches is barely perceptible on this football field sized layout, but it is there, on the line, roughly larger than the line they "paint" on the field to represent the start of the end-zone.

Mercury is the first planet next to the SUN, it sits at about the 1 yard line, but it is so small that in our "proportional" solar system, it's only about 1/32nd of an inch in diameter. This is approximately the size of the ball of a ball point pen or the thickness of butter knife or thickness of 9 sheets of xerox paper (20# weight). That is pretty small and only 1 yard away from the sun.

Venus is 2nd, and just inside the 2 yard line, really at the 1.8 yard mark, from the sun. And her diameter is 2.5 times bigger, but in our proportional universe, this gets you to a little more than 1/16th of an inch at 2.05mm. This is about the size of a 12 gauge wire, which is a little more than the thickness of a single tine on a typical salad fork.

So we have the base of a frying pan on the goal line, a ball point pen sticking point up on the 1 yard line and a fork with a single tine at about the 1.8 yard mark.

The Earth weighs in at the around the 2.5 yard mark and is about the diameter of a small headset jack, you know the kind that fits into the smaller mobile telephones jacks. Not stereo jacks, those are little bigger. The literal diameter we are looking for is 2.16mm which is about the diameter of these smaller headphone jacks.

Mars is about ½ the Earth's diameter and his (he is a he, because he was named after the Roman god of War) location is at the 3.9 yard mark. Interesting, no? We are inside the asteroid belt and we are inside the 5 yard line!

Now we jump out to the 13.2 yard marker for Jupiter, and her diameter is a little larger that 15/16^{ths} of an inch. On most adult men, one inch is the distance between the tip of their thumb and the first knuckle. In my kitchen drawer, a little under one inch and you have the widest part of the salad fork, all 4 tines, and on my forks, the fork is a little wider further down from the tip of the 4 tines.

Saturn shows up at the 24.2 yard mark and is 13/16^{ths} of an inch wide, a little smaller than Jupiter. I found that this was width of the 4 tines of the salad fork.

We are now ¼ of the way down the football field and we've accounted for the inner planets and the gas giants. Only Uranus, Neptune, and of course, Pluto, left to go.

Uranus is just inside the 50 yard line at 48.6 yards, and is a little bit larger than 1/3 of an inch at 8.66mm. This is a little smaller than the diameter of a chocolate chip. So, put your chocolate chip a little more than 4 feet inside the 50 yard line.

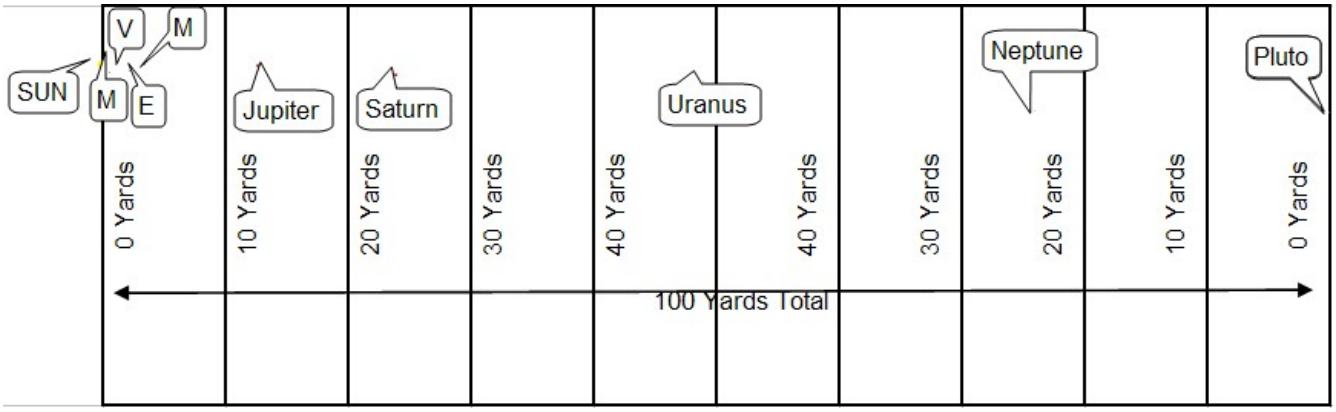
50 yards, and only Neptune and Pluto are left.

Neptune is at the 76.2 yard mark, and about the same size as Uranus, a little smaller, but not much. 8.39mm. Put another little chocolate chip out there, but imagine it a little smaller…

Pluto, as I started out, is at the 100 yard mark, and Pluto's diameter is about the thickness of 4 sheets of paper at 0.39mm. Smaller than our ball of the ball point pen that represents Mercury.

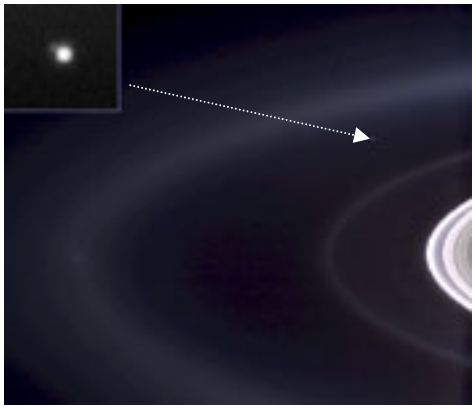
So, we have our

- frying pan (actually the base) at the 0 yard line (SUN)
- the ball of a ball point pen at the 1 yard line (Mercury)
- a 12 gauge wire or our fork tine sticking at 1.8 yards (Venus)
- a headset jack sticking at 2.5 yards (Earth)
- another smaller fork tine sticking at 3.9 yards (Mars)
- a whole salad fork is sticking up at 13.2 yards (Jupiter) – think the widest part
- another salad fork sticking up at 24.2 yards (Saturn) – think just the width of the tines
- A chocolate chip (even though this is too big) at 48.6 yards (Uranus)
- Another, think smaller, chocolate chip at 76.2 yards (Neptune)
- And finally, at the 100 yard mark, the other goal line, a really tiny object called Pluto. 4 sheets of paper, about ½ the size of the ball point pen ball that represented Mercury back at the 1 yard line.



So, the inner solar system, up to Mars, all exists inside the 5 yard line; inner planets and the 2 gas giants inside the 25 yard line. Imagine the distance involved…

I think I might be able to give you some help. The Cassini spacecraft has just gone past Saturn, and NASA took some pictures of Earth, looking back through the rings. The Earth looks so very, very small, the corner of the picture has a blow-up of the area of the picture that the Earth is in.



That story, and other links, is at

http://news.com.com/2061-11200_3-6117690.html?part=rss&tag=6117690&subj=news

These distances are really unbelievable, for in comparison to our "football field" we are at Saturn, looking back 21.7 yards line to the 2½ yard line where the Earth is, but we are looking at some really small objects, in this case remember, that the Earth is represented by a mobile phone headset jack.

Turning back "upfield", from there on, there are some larger and larger distances to contend with. After Saturn, then 24 more yards on our "football field" to Uranus, then 27.6 yards to Neptune and the final 23.8 yards to Pluto.

Imagine yourself standing on the goal line where Pluto is. Look down the football field until you see the other goal line and that base of the frying pan sitting there way down there. Now that is small, but more to the point, all of these small objects representing the planets on the football field between here and the SUN, 100 yards away, are really *really* small. You cannot even see (without assistance) some of these objects.

Now, the true vastness of space may just start to dawn upon you. Hopefully you can remember this the next time the 3rd graders bring the planetary models to school, not to correct them in as much as to really appreciate what is really "out there." Space is really vast.

Thomas Posz
September, 2006