Astronomy 150 Homework #1 – "The Scale of the Solar System"

(This lab was originally developed from a very old tradition in the department of starting off introductory classes with an outdoor demonstration of the solar system. It was formalized by John Collier and Paul Hodge.)

Introduction

The Solar System is big. But what does that statement really tell you? One of the goals of this course is to have each of you develop some sense for the size of the solar system and the objects in it. To do that requires more than just comparing numbers. It helps to actually design your own scale model of the solar system and demonstrate it to someone else.

There are other purposes of this exercise. One is to expose you to some numbers, like the kinds of numbers we will be using throughout the course to describe the Solar System. Astronomy deals mostly with concepts and ideas, but numbers play a useful role in expressing these ideas. We want you to know not only that the Solar System is big, but how big. Also, designing and building a scale model will give you a chance to brush up on your math skills if you haven't used them in a while. Nothing too hard, just some manipulations. This is as complicated as it will get in the class, and you can expect to run into some math from time to time when it will help with visualizing or understanding. The class will be filled with numbers, not for the sake of making you do algebra, but to help make comparisons and ideas clearer.

Scale Models

You are all familiar with scale models. Perhaps you have built models or played with toy cars or people when you were younger. Both of these are examples of scale models. In the case of model cars, they are usually 1/24th scale. That means every dimension in the model is 24 times smaller than the real car. If the car is 12 feet long, the model car will be 12/24 or 1/2 foot (six inches) long. The scale factor to convert dimensions from the real object to the model would be 1/24.

If we asked you to make a scale model of the University District, you might choose to make one city block equal to one step. Then the distance in your model from 40th street to 50th street would be ten steps and the model might fit inside a typical classroom. The scale factor in this case is 1 step/1 city block.

The solar system is very large compared to anything you have probably dealt with before (even though it is tiny compared to the size of our galaxy, the Milky Way, which is tiny compared to the size of the Universe!) so to fit the scale model within a realistic volume, like the UW campus, will require a tiny scale factor. Luckily, the planets all lie in roughly the same plane–the solar system is flat–so you don't have to worry about climbing buildings or renting balloons.

The Activity

Using the data included in the table and the added information that the sun is a sphere with a radius of about 700,000 km, choose an appropriate scale factor to describe a scale model of the solar system that you could demonstrate to your friends. You should first scale the distances between the Sun and the planets, then the sizes of the planets, using the distance from the Earth to the Sun <u>and</u> the size of the Sun for reference. For example, suppose the Sun were the size of Kane Hall or suppose the distance from the Earth to the Sun were 1 inch. What would the scale factor be in each case? Would these models make useful demonstrations?

It will probably take some trial and error to find a scale factor that will work for you. Once you've settled on a scale factor, make a table that describes your model. It should start with your scale factor and go from the Sun to Pluto, the most distant planet. The table should include both the distance to the planets and the size of the planets in whatever units you choose. The units for the distance and the size do not need to be the same. You might want to measure distances in one unit like yards, meters, steps or inches and the sizes in another unit like tennis balls, centimeters or gumbals. Think of something you could use to represent the Sun and the planets. Be creative!

By the end of the first class, you should have decided on your strategy for demonstrating the size of the Solar System, chosen a reasonable scale factor and started on the table. During the second class, we will discuss the models and ask a few of you to demonstrate the scale of the Solar System to the class. This may involve going out of the room.

What to turn in

There are two things to turn in at the end of the second class. First, a short explanation of how you chose your scale factor to best demonstrate the scale of the Solar System. This should be brief. One paragraph is plenty. Second, the table that describes your model.

What else to do

Demonstrate your model to someone else, your roommates, friends, parents or boss. Can you give them some sense of how spacious space is?

Planets: Basic Data

Name	Semi-Major Axis (10^6 km)	(AU)	Revolution Period	Diameter (km)	Rotation (Days)
Mercury	57.9	0.39	0.24 yr	4878	58.65
Venus	108	0.72	0.62 yr	12102	243.0 (R)
Earth	150	1.00	1.00 yr	12756	1.00
Mars	228	1.52	1.88 yr	6787	1.03
Jupiter	778	5.20	11.86 yr	142984	0.41
Saturn	1426	9.54	29.46 yr	120536	0.44
Uranus	2868	19.18	84.07 yr	51118	0.72 (R)
Neptune	4494	30.06	164.82 yr	49660	0.70
Pluto	5900	39.44	248.6 yr	2400	6.39 (R)

(R) denotes retrograde rotation.