

# Solar System Taxonomy

## Introduction

There's recently been quite a bit of publicity about the definition of a planet, and in particular, how to categorize Pluto and its companion Charon. In this lab you will come up with your own categories for solar system objects, and in the process learn a little about what kinds of objects are out there.

Remember to record what you do in your lab notebooks. To remind you, I've put things that are particularly important to write down in **bold**.

## 1 Creating a classification scheme

### Materials

table of solar system object properties, graph paper

### Instructions

The debate about revising the definition of a planet has actually gotten quite heated at times. To aid your detachment from the emotional side of the argument, you've been given a table of solar system objects without their names. You will find, however, some properties that might be relevant in classifying them.

Work with your group to come up with your own classification scheme for the objects listed in the table. The steps listed below will walk you through some things that might help you develop your scheme.

You will make several graphs in this exercise. Don't think about drawing a straight line through the points, but look, rather, for natural groups of objects.

### Composition and distance from the sun

The "Composition" column indicates in which form most of the mass in the body is found. **Find the average distance from the Sun for objects of each composition (i.e. "rock", "ice", etc.). Are there any bodies who do not seem to fit in with the others of the same composition? If so, list them, then recalculate the average distance for that class again without this/these member(s). Does the composition of an object seem to correlate with its distance from the Sun?**

### Orbital eccentricity

Orbital eccentricity tells us how the orbit is shaped. Very eccentric orbits ( $e \approx 1$ ) are much longer in one direction than they are in the other. Orbits that are almost circular have low eccentricities ( $e \approx 0$ ). Identify the bodies that have the most eccentric orbits — you can set your own "cutoff" value. Look at the other properties of the eccentric bodies. Is there anything they have in common?

### Mass and distance from the sun

**Make a scatter plot of object mass  $m$  versus distance from the Sun  $r$ .** The x-axis will be  $\log_{10}(r)$  in units of AU and the y-axis will be  $\log_{10}(m)$  in units of Earth masses ( $M_E$ ). **Do massive bodies tend to be farther or closer? What about low-mass bodies? What exceptions are there to this?**

### Density versus distance from the sun

**Make a scatter plot of object density versus orbital radius.** The x-axis will again be  $\log_{10}(r)$  and the y-axis will be density. **Does there seem to be any relationship between density and distance from the Sun?**

### Number of moons versus mass

**Make a scatter plot of number of moons versus mass  $m$  of the object.** Let your x-axis be  $\log_{10}(m)$  in units of Earth masses ( $M_E$ ) and your y-axis will be the number of moons. **How do these two quantities tend to relate to each other?**

### Orbital zone clearing

The  $\mu$  (Greek letter “mu”) column tells us how much the body has “cleared out” its orbital zone — that is, collected stuff along its path around the Sun and accumulated it. More precisely,  $\mu$  is the ratio of the mass of the body to the total mass of all objects in the orbital zone. Identify the objects with the lowest  $\mu$  (define your own reasonable cutoff value). Look at the other properties of these low- $\mu$  objects. **Is there anything that these objects share in common?**

### Make your groups

Now you should come up with your own classification scheme. You can use or ignore any of the plots or numbers in the table. Ideally each object would belong uniquely and unambiguously to one category. Of course, this isn't always possible in the real world, and opinions can differ (especially among experts) about what properties are most important and should therefore form the basis of a classification system. As long as you can explain your reasoning, I'll be happy with anything you come up with.

**Record your scheme in your lab notebooks, along with what objects fall into what categories, and a few sentences explaining the reasoning behind your groupings. Are there bodies that don't seem to fit into any of your groups? Which of these groups do you think should be deemed “planets” (it can be more than one), and why?**

### Discussion

Once everyone has completed their classification each group will present their scheme to the class and we'll discuss any differences among your systems and if there is even any point in having these categories. Then I will reveal the identities of the mystery objects, and we can see if that changes how you feel about your schemes.

## 2 Evaluating other proposals

### Materials

Copies of the IAU draft and final versions of the IAU resolutions on the definition of a planet.

### Instructions

The International Astronomical Union recently tackled the question of how to define a “planet”. Several proposals were put forward before a definition was finally agreed upon. It should be noted that, while Astronomers overwhelmingly defer to the IAU in the area of nomenclature of solar system objects, there are

still many in the astronomical community who are unsatisfied by the final definition. I have given you the first draft resolution proposed at this years IAU meeting, and the resolutions that were finally adopted.

Read both resolutions and discuss them with your group. How do they differ from your scheme? **Think of some advantages and disadvantages of each resolution and record them in your lab notebook.**