

Name: \_\_\_\_\_  
Date: \_\_\_\_\_

## 15 Building a Comet

### 15.1 Introduction

Comets represent some of the earliest material left over from the formation of the solar system, and are therefore of great interest to planetary astronomers. They are also beautiful objects to observe in the night sky, unlike their darker and less spectacular cousins, asteroids, and therefore capture the attention of the public. The objective of this lab is to teach you more about these fascinating objects.

- *Goals:* to discuss the composition, components, and types of comets; to build a comet and test its strength and reaction to light
- *Materials:* ziplock bag, bucket, spoon, towel, mallet, light source, water, sand, ammonia, potting soil, dry ice, gloves

### 15.2 Composition and Components of a Comet

Comets are composed of ices (water ice and other kinds of ices), gases (water, carbon dioxide, carbon monoxide, hydrogen, hydroxyl, oxygen, carbon, silicon, and so on), and dust particles. The dust particles are smaller than the particles in cigarette smoke. In general, the model for a comet's composition is that of a "dirty snowball."

Comets have several components that vary greatly in composition, size, and brightness. These components are the following:

- *nucleus:* made of ice and rock, roughly 5-10 km across
- *coma:* the "head" of a comet, a large cloud of gas and dust, roughly 100,000 km in diameter
- *gas tail:* straight and wispy; gas in the coma becomes ionized by sunlight, and gets carried away by the solar wind to form a straight blueish tail. The shape of the gas tail is influenced by the magnetic field in the solar wind. Gas tails are pointed in the direction opposite the sun, and can extend  $10^8$  km.
- *dust tail:* dust is pushed outward by the pressure of sunlight and forms a long, curving tail that has a much more uniform appearance than the gas tail. The dust tail is pointed in the direction opposite the comet's direction of motion, and can also extend  $10^8$  km from the nucleus.

### 15.3 Types of Comets

Comets originate from two primary locations in the solar system. One class of comets, called the **long-period comets**, have long orbits around the sun with periods of  $> 200$  years. Their orbits are random in shape and inclination, with comets entering the inner solar system from all different directions. These comets are thought to originate in the **Oort cloud**, a spherical cloud of icy bodies that extends from  $\sim 20,000 - 150,000$  AU from the Sun. Some of these objects might experience only one close approach to the Sun and then leave the solar system (and the Sun's gravitational influence) completely.

In contrast, the **short-period comets** have periods less than 200 years, and their orbits are all roughly in the plane of the solar system. Comet Halley has a 76-year period, and therefore is considered a short-period comet. Comets with orbital periods  $< 100$  years do not get much beyond Pluto's orbit at their farthest distance from the Sun. Short-period comets cannot survive many orbits around the Sun before their ices are all melted away. It is thought that these comets originate in the **Kuiper Belt**, a belt of small icy bodies beyond the large gas giant planets and in the plane of the solar system. Kuiper Belt objects have only been definitely confirmed to exist in the last several years.

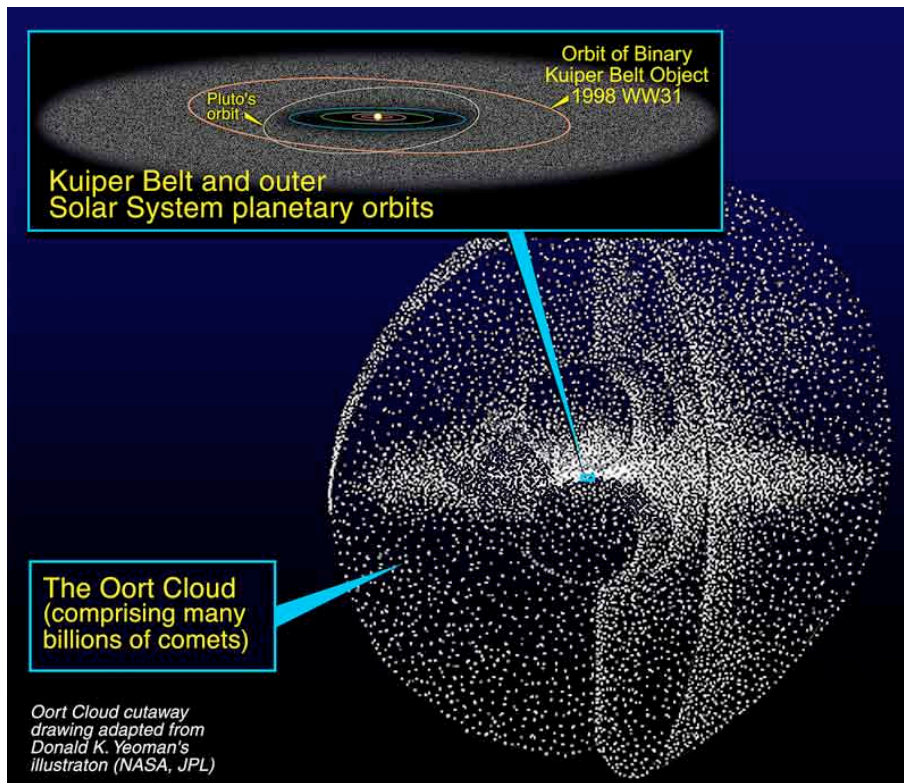


Figure 15.1: Different origins for long and short period comets. Image courtesy of NASA.

## 15.4 Exercises

### 15.4.1 Building a Comet

In this portion of the lab, you will actually build a comet out of household materials. These include water, ammonia, corn syrup, and dry ice (CO<sub>2</sub> ice). Be sure to distribute the work evenly among all members of your group. Follow these directions:

1. Put the ziplock bag in your bucket.
2. Place 1 cup of water in the bucket.
3. Add 2 spoonfuls of sand, mix well. (**NOTE:** Do not stir so hard that you rip the bag!!)
4. Add a dash of ammonia.
5. Add a dash of organic material (potting soil). Stir until well-mixed.
6. The TA will place a block or chunk of dry ice inside a towel and crush the block with the mallet.
7. Add 1 cup of crushed dry ice to the bucket, while stirring vigorously. (**NOTE:** Do not stir so hard that you rip the bag!!)
8. Continue stirring until mixture is almost frozen.
9. Lift the comet out of the bucket using the plastic liner and shape it for a few seconds as if you were building a snowball.
10. Add water slowly, and as needed, to get the mixture frozen into a ball.
11. Unwrap the comet once it is frozen enough to hold its shape.

### 15.4.2 Comets and Light

Observe the comet as it is sitting on a desk. Make note of some of its physical characteristics, for example: (**5 points**)

- shape:
- color:
- smell:

Now bring the comet over to the light source (overhead projector) and place it on top. Observe and record what happens to the comet. (**5 points**)







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## 15.6 Take-Home Summary

Summarize the important ideas covered in this lab. Questions you may want to consider are:

- Why are comets important to planetary astronomers, and what can they tell us about the solar system?
- What are some components of comets and how are they affected by the Sun?
- How are comets different from asteroids?

**Type this summary.** Use complete sentences, and proofread your summary before handing in the lab. **(30 points)**

## 15.7 Extra Credit

Use the internet to look up one (or more) of the following current or planned spacecraft missions to comets and briefly describe the mission, its scientific objectives, and the significance of these objectives. **DO NOT copy the information from the web sites; put it into your own words! (3 points each)**

- Stardust (<http://stardust.jpl.nasa.gov/>)
- Deep Impact (<http://deepimpact.umd.edu/home/index.html>)
- Rosetta (<http://sci.esa.int/science-e/www/area/index.cfm?fareaid=13>)
- CONTOUR (<http://discovery.nasa.gov/contour.html>)

