INSIDE LAB 9: Classification of Stars and Other Celestial Objects

OBJECTIVE: *To become familiar with the classification of stars by spectral type, and the classification of celestial objects such as galaxies.*

DISCUSSION:

One of the first steps to understanding any subject is organizing its elements into categories. In this lab you will apply this philosophy to both stars and other objects.

Stars are categorized on the basis of their *spectrum*, the pattern of colors that appear when the light is separated into its component colors by a diffraction grating or a prism. This spectrum contains typically a number of *absorption lines* corresponding to special frequencies of light that are absorbed by different gasses. The strength (darkness) of these lines can depend sensitively on the temperature of the star. Thus, by measuring the strengths of the lines we can determine the temperature of the surface of the star. This gives us one of the two parameters that we use when we plot stars on the H-R diagram.

EXERCISES:

EXERCISE 1:

Determine the spectral type of each of the stars whose spectra are provided by your instructor. Be sure to write the full classification, for example G2. Record your results in a table.

EXERCISE 2:

Using an H-R diagram provided by your instructor, estimate the surface temperature of each star and record it in your table.

Star	Spectral Type	Temperature

Since ancient times, primitive people as well as scientists have gazed into the heavens. At night, it is clear that there are a large number of point-like objects called stars. Whether viewed by the naked eye or through a telescope, these objects have no apparent size. Furthermore, though they appear to move across the sky over the course of the night, they move together, apparently fixed in place compared to each other.

It was recognized, however, that a small number of objects seem to move compared to the stars. These objects were called *planets*, which means wanderers. Ancient peoples recognized seven planets: Mercury, Venus, Mars, Jupiter, Saturn, and the Sun and Moon. In addition to these objects, occasional *comets* (meaning long-haired) appeared, which appeared fuzzy, and they also moved across the sky.

The discovery of the telescope in the early seventeenth century revolutionized astronomy. The Sun and Moon have obvious size, even to the naked eye, and even a modest telescope revealed that the planets (to which eventually were added Uranus and Neptune) also had size. All had distinct boundaries. Telescopes also allowed scientists to search for comets, and in the 18^{th} century, searching for new comets was a popular hobby among astronomers, both amateur and professional. The technique for finding comets generally involved scanning the skies for fuzzy objects using a telescope, then announcing the discovery. Then scientists had to make sure the discovery moved against the background stars, and the comet was confirmed.

One problem was that there were a variety of background fuzzy objects which were constantly being "discovered" by comet hunters, but were constantly being misidentified as comets. It was realized it would be useful to have a list of fuzzy background objects that were definitely *not* comets, and would allow the quick elimination of many false discoveries. In 1771 Charles Messier compiled a list of objects that were not comets. The list was expanded, and in 1784 he published his final list of Messier objects, numbered and now denoted M1 through M110.

Although there are many scientists that are still interested in comets, many more are fascinated by these far more distant objects first catalogued by Messier. In this lab you will look at some high-quality modern images of the Messier objects, and attempt to identify and classify them.

Your TA will distribute to you a set of images. Your job is to place them into categories, based on appearance. The Messier objects consist of the following types of objects: nebulae of various types, open star clusters and globular clusters, and galaxies. For the nebulae try to identify the type: Planetary, supernova (or nova) remnant, HII region, molecular cloud, reflection nebula.

EXERCISE 3: Take the set of images and classify each one. You should explain your thinking in each case. **Note that you should put the object with the lowest Messier number first in the table, the object with the next lowest number second, and so forth.**

For those which are clusters you should state whether they are globular clusters or open clusters.

For those which are nebulae you should state whether each is a planetary nebula, a supernova remnant, an HII region, a reflection nebula, or a molecular cloud.

For those that are galaxies further classify them according to the categories given below. For each elliptical galaxy you should measure it to determine what type of an elliptical galaxy it is. For all other objects including each spiral and irregular galaxy you should explain the reasoning behind your classification.

Galaxies are categorized on the basis of their shape. In Hubble's original classification there are three main categories: elliptical, spiral, and irregular.

Elliptical galaxies are then subcategorized in the range E0 (circular) to E7 (very flattened). The number is determined by the formula

$$n = 10(1 - b/a)$$

Here b is the shortest diameter and a is the longest one.

There are two types of spiral galaxies, barred and unbarred. They are classified by how tightly wound their arms are and by how large their central bulges are compared to the sizes of their spiral arms. Spirals range from Sa (very tightly wound arms and relatively large central bulges), to Sb, to Sc (very loosely wound spiral arms and relatively small central bulges). The various types of Barred Spirals are denoted by SBa, SBb, and SBc. Galaxies that have a disk and central bulge but no spiral arms are called S0 galaxies. They are in between spirals and elliptical galaxies.

There are two types of irregular galaxies. Irregular type I galaxies have an irregularly shaped disk and no central bulge. Irregular type II are any galaxies that do not fit into one of the above categories.

Messier Number	Classification	Explanation

EXERCISE 4:

Place all of your photos in a stack, numerically increasing from M1 to the largest value which is there. Return the stack to your TA.