Ages:
8th grade and up

Duration:
45 minutes

Materials:
Per group of 4 students
- 4 equatorial sky charts (found online at http://astro4.ast.vill.edu/labs/sc1h.jpg)
- A copy of the student data sheet
- Colored markers or large stickers/dots

Optional, for class: access to "Where is M13?" program (available for download at http://www.thinkastronomy.com/M13/index.html)

~ LPI Education/Public Outreach Science Activities ~

Mapping the Galaxy

adapted from http://astronomy.nmsu.edu/astro/Spr12labmanual.pdf

Overview —

The students determine the shape of the Milky Way and our location in it based on observations of the distribution of several different types of objects in the sky. The students create maps which show the distribution of different types of celestial objects in the sky. On the student data sheet, there are tables with lists of constellations within which bright objects can be observed using a small telescope. There are 4 lists, one for each type of object: globular clusters, open cluster, gaseous nebulae and galaxies.

Objective —

The students will:
- Map the locations of star clusters, galaxies, and nebulae on a constellation chart
- Compare the distribution of globular and open star clusters and nebulae in the sky
- Hypothesize about the cause of the differences seen between the maps

Before You Start: *The students should be familiar with the concepts of globular star clusters, open star clusters, nebulae, and galaxies.*
Preparation: if possible, download *Where is M13?* program and become familiar with it. Learn how to turn on and off the views of the globular clusters, open clusters, nebulae, and galaxies, and zoom in and out to see all of the Milky Way.

Activity —

Initiate a discussion of our galaxy—the Milky Way. What does it look like? Where are we inside of it? *(The Milky Way is a spiral galaxy; our Solar System is about halfway between the center and the outer edge of its disk)*.

Share that the class is about to do an activity that models the way astronomers first determined the location of our Solar System in the Milky Way.

1. Organize the students into groups of four students and give each group a copy of the Equatorial Sky Chart. Invite them to describe the chart and identify its coordinates. *(This is a map of the sky with line drawings of the constellations; "Declination" is similar to latitude and "Right Ascension" is similar to longitude. Let them know that the top and bottom (the poles) are missing from this map.)*
2. Tell the students to roll the map into a wide cylinder so that the left and right side of the paper meet, with the image on the inside. Ask them to imagine a little Earth in the middle of the cylinder, with people looking out at the map. Invite the students to describe what people on this mini-Earth would see as the night goes by. *(As the Earth rotates, people would be facing different parts of the map and see different constellations.)*
3. Ask the students to flatten their maps again. Let them know that each student in the groups will map the rough locations of a different object; one student will map the positions of galaxies in the sky, another will do nebulae, another will map globular star clusters, and the last will map open star clusters.
4. Invite the students to share their hypotheses as to how these objects will be arranged on the sky: Will they be scattered randomly, or grouped into some sort of pattern? Why?
5. Give each group a copy of the Student Data Sheet and either 4 different markers or large circle stickers to mark the location of each object on their chart with a dot for each count (for example, 4 galaxies in the constellation of Pegasus would receive 4 large dots or marks). The dots can be near the center of their corresponding constellation or scattered throughout it.

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6. Help students who are having difficulty finding specific constellations. Once the students are done, invite each group to report out their resulting distribution pattern to the classroom.

7. Invite the students to hypothesize why the objects are distributed in this manner. What can scientists tell about our Galaxy's shape based on the distribution of the objects? Does this tell us anything about our position in our Galaxy? What does it tell us about our Universe?

8. Finish by showing the students the "Where is M13?" program and point out the side and overhead views of our Milky Way. Turn on, in turn, the different objects (globular clusters, open clusters, nebulae, and galaxies) so that the students can view their positions within the Milky Way.

Background —

The band of light we call the Milky Way is actually the light from billions of faint distant stars and other objects. Of the four types of objects plotted, three belong to our Milky Way Galaxy: Open clusters, Gaseous nebulae, and Globular clusters. Other galaxies are "Milky Ways" in their own rite, and are located far beyond the boundaries of the Milky Way.

The Pleiades star cluster consists of about 250 stars that are about 100 million years old. All of the stars in the Milky Way form in clusters. Sometimes the gas cloud is small and produces a handful of stars, sometimes the gas cloud is large and produces thousands of stars. Eventually, however, such a cluster will slowly fall apart, and the stars will wander off and circle the galaxy with unique orbits. This is why astronomers call them "Open", they eventually fall apart.

In contrast, globular star clusters do not fall apart. Globular star clusters contain 100,000 stars or more, and the gravity from all of these stars keeps them "bound": Even as they pass by very massive objects, they cannot be pulled apart. Globular clusters are made up of some of the oldest stars found in our Galaxy.

"Gaseous nebulae" are closely related to Open clusters. When a cluster of stars first forms, much of the gas left over from the formation of stars is still present. The hotter stars in the cluster can "ionize" this gas and cause it to glow. We see this gas as glowing knots and wisps of material surrounding the stars.

Galaxies are large collections of objects mostly composed of stars, star clusters, gas, and dust. They are the hosts of Open clusters, Globular clusters and Gaseous nebulae (as well as molecular clouds, and some other objects we have not mentioned).

Ties to Standards —

NSES Content Standards

DESIGN AND CONDUCT A SCIENTIFIC INVESTIGATION. Students should develop general abilities, such as systematic observation… Students can learn to formulate questions, design investigations, execute investigations, interpret data, use evidence to generate explanations, propose alternative explanations, and critique explanations and procedures.

Student Data Sheet

Constellation Name	Pegasus	Aquarius	Capricornus	Sagittarius	Hercules	Ophiuchus	Bootes	Virgo	Centaurus	Hydra
Number of Globular Clusters	4	1	4	20	4	8	2	2	2	1

Constellation Name	Pegasus	Grus	Ursa Majoris	Virgo	Centaurus	Leo	Hydra	Eriadanus	Andromeda	Pisces	Cetus
Number of Galaxies	2	2	16	11	5	8	2	8	4	3	7

Constellation Name	Cygnus	Aquila	Sagittarius	Scorpius	Centaurus	Canis Major	Perseus	Taurus	Orion
Number of Open Clusters	7	3	2	6	1	6	4	3	3

Constellation Name	Cygnus	Aquila	Sagittarius	Centaurus	Canis Major	Perseus	Taurus	Orion
Number of Gaseous Nebulae	6	2	3	4	3	5	3	6