

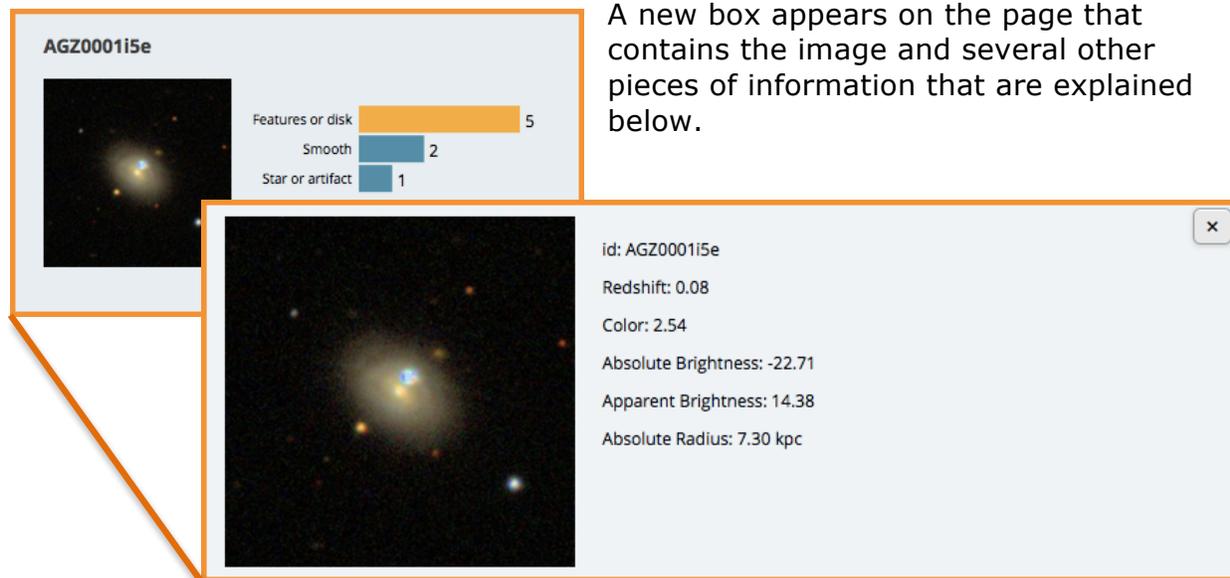
Student Guide to Navigator Graphing Tool

People analyze the shape of each galaxy in the Galaxy Zoo. This represents one layer of information about that galaxy. Computer programs have been written to take measurements of the light recorded in the image for each galaxy. The color of the light and size are two basic pieces of information that are recorded. These measurements are carefully organized into tables. All together this information is referred to as a database. Images in the Galaxy Zoo come from the Hubble Space Telescope (HST) and the Sloan Digital Sky Survey (SDSS) and are stored in separate databases.

The Navigator Graphing Tool has access to three different databases; Galaxy Zoo classifications, the SDSS database and the HST database. The Graphing Tool retrieves information from the appropriate source in response to your requests and creates a graph of that information.

What Kinds of Information Can We Choose?

If you explore the objects listed on the **My Galaxies** page, you will notice that each image is linked to additional information about that object.



The screenshot shows a user interface for a galaxy. On the left, there is a small thumbnail of a galaxy labeled 'AGZ0001i5e'. To its right is a horizontal bar chart with three categories: 'Features or disk' with a value of 5 (represented by a long orange bar), 'Smooth' with a value of 2 (represented by a medium blue bar), and 'Star or artifact' with a value of 1 (represented by a short blue bar). Below this is a larger, detailed view of the galaxy image. To the right of the image is a text box containing the following information: id: AGZ0001i5e, Redshift: 0.08, Color: 2.54, Absolute Brightness: -22.71, Apparent Brightness: 14.38, and Absolute Radius: 7.30 kpc. A close button (X) is visible in the top right corner of the text box.

A new box appears on the page that contains the image and several other pieces of information that are explained below.

id

Giving each object that you classify in the Galaxy Zoo a unique name allows the databases to assign your classification to the measurements already available for that object. Think of it as the bridge that links different tables of information. Generally, you do not need to be concerned with the ids.

Redshift

Redshift is a calculation based upon measurements of the spectrum of the object. Most of us are familiar with the rainbow spectrum. When the rainbow spectrum is plotted as a graph there are certain high points and low

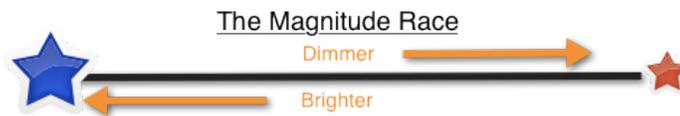
points that we expect to see. When objects are very far away from us these special points are shifted to the red end of the spectrum.

The amount of this displacement is called redshift. Astronomers have found that the greater an object's redshift, the further away it is from us. A redshift of zero means that the object is in our galactic neighborhood, which can be very far away indeed but small when we are discussing the entire universe. Very few objects have ever been imaged at redshifts higher than six.

Absolute Brightness and Apparent Brightness

We will return to color in a moment. In order to talk about color, we first must understand brightness and how it is measured.

Our measurement of brightness comes to us from ancient Greece. It has been adapted and modified over the centuries but remains essentially the same. The brightness of an object is referred to in terms of its magnitude. The magnitude number assigned to an object lies on a scale that runs backward of what you might first imagine. It is natural to think of greater brightness being assigned a larger number. Instead, you need to think of magnitude as a brightness race with the small numbers coming in ahead of the larger numbers.



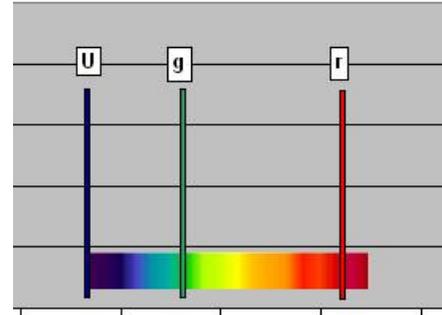
For example the star, Vega, which can be seen overhead in the summer from the northern hemisphere, is assigned a magnitude of zero. The dimmest star we can see from a very dark location has a magnitude of six while the full moon has a magnitude of approximately -12. Yes, there are negative numbers. When the magnitude scale was invented, it was only used to describe the stars visible with our eyes. Now we use magnitude to describe objects that can be seen through telescopes as well. We describe both how bright the object appears (**apparent brightness**) and how bright it would appear if they were at an equal distance from Earth (**absolute brightness**).

You will gain an understanding of how apparent brightness and absolute brightness relate to one another by paying attention to the information that is available on your *My Galaxies* page and by using the graphing tool.

Color

Color is a characteristic that we are not used to measuring. We are much more familiar with describing color with words. In order for color to be used scientifically to compare one object to another, we need a way to assign a number to a color. Numbers do not change their meaning from one person to another as long as the method for calculating it is agreed upon.

In very simplified terms, the method for assigning a number to the color of an object involves measuring how bright the object is at two different points in the spectrum and subtracting. We use magnitude as our measure for brightness. For every image in the SDSS database, filters attached to the telescope allow scientists to calculate the magnitudes at three points in the rainbow spectrum.



Observe the diagram of the SDSS filters in the image on the right. If we subtract the magnitude for the object as seen through the red (r) filter from the one taken for the same object using the ultraviolet (u) filter we get a measurement that can be used to compare one galaxy's color to another. Any two filters can be used to calculate a color but you have to be careful to communicate which ones you are using.

No matter what magnitude numbers you start out with in each filter, subtraction leaves us with a number we can compare. Note the example below.

u	r	u-r	Interpretation
20	16	4	red galaxy
16	12	4	exact same color as the previous galaxy

Absolute Radius

Some galaxies appear larger than others in an image. It is relatively easy to write a computer program that will record the greatest extent of the light from an object in an image. It is more useful to know how big the object is compared to other objects. Because objects appear smaller with increased distance, we need to consider how far away a galaxy is when talking about its size. Computer programs use the measured size from the image along with the calculations for redshift to estimate the absolute or real size of the galaxy.

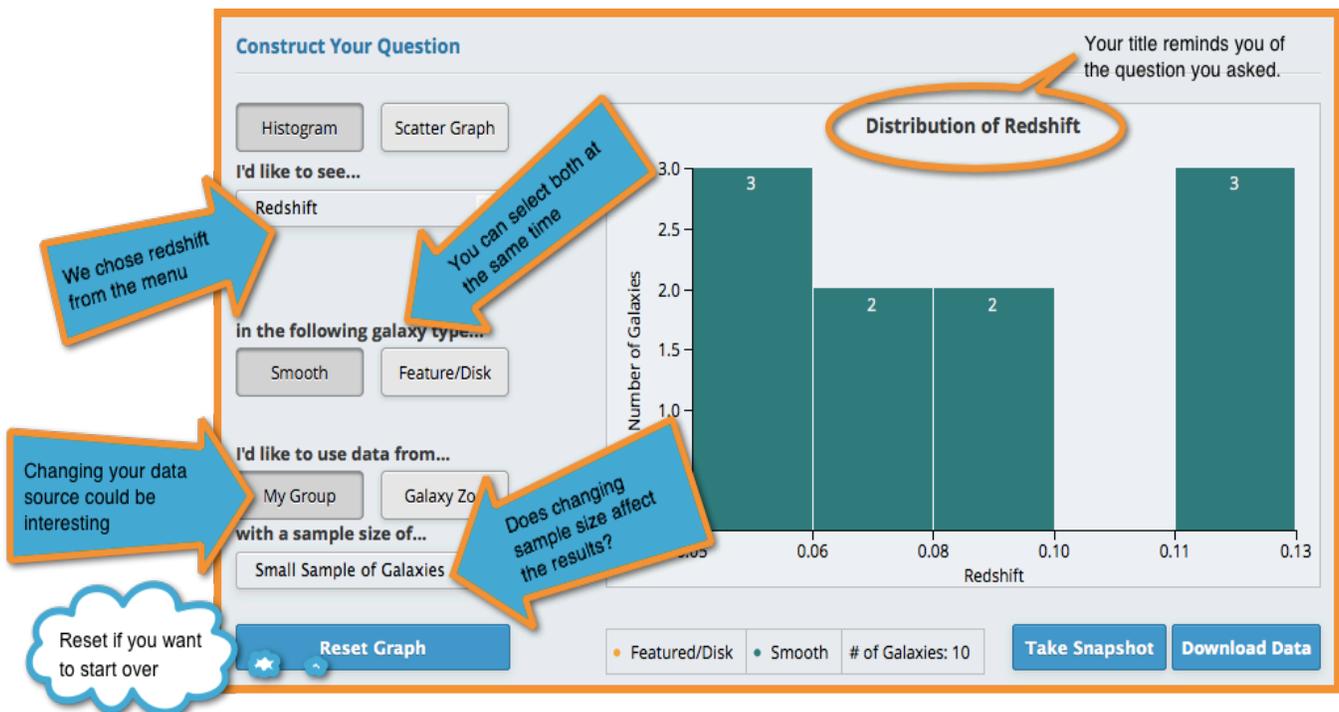
A parsec is a distance measurement used in astronomy. It is equal to 3.26 light years. The absolute radius of a galaxy in the Zoo is given in kiloparsecs (kpc). Kilo means 1000 so, a kpc is equal to a thousand parsecs or the distance light travels in 3,260 years. Our Milky Way galaxy is about 30 kpc across. Keep that in mind as you classify galaxies: The disc of our Milky Way appears to span the entire night sky while none of the galaxies you classify in the zoo are visible at all!

Graphs Answer Questions

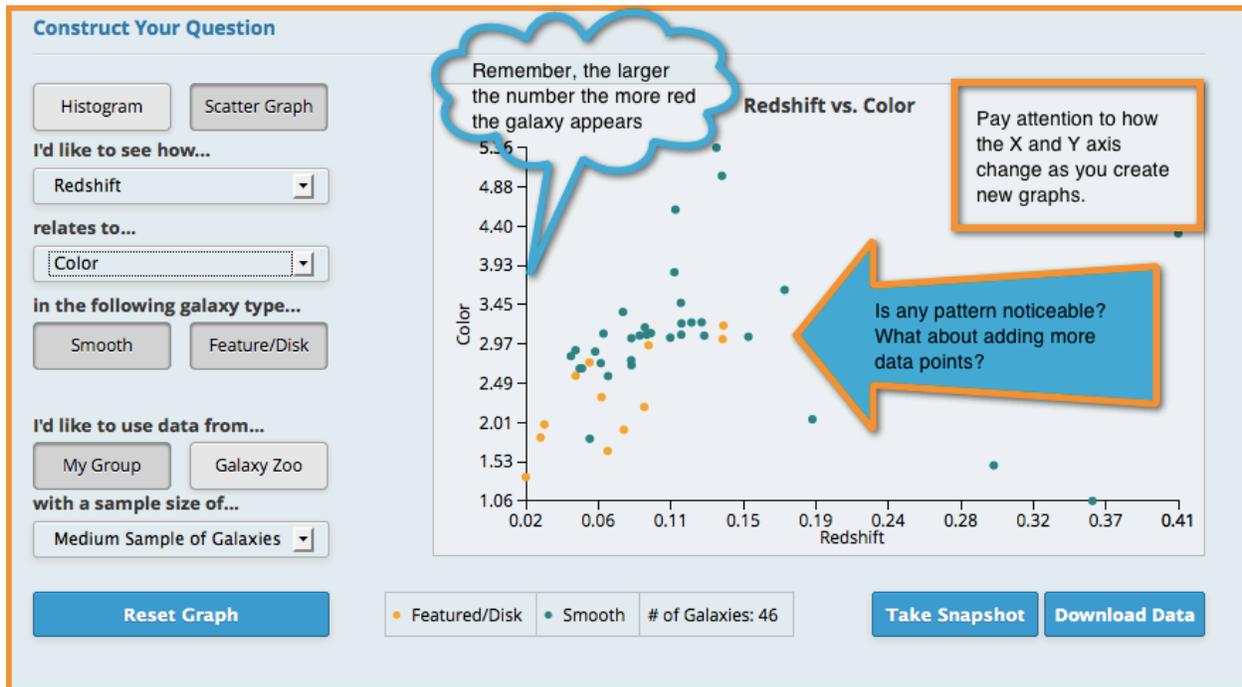
The **Graph Data** button brings you to the graphing tool. The title at the top of the page tells you to *construct your question*. A graph is created from a question in the investigator's mind. If you want to see how one thing relates to another, you make a graph. The prompts on this page not only allow you to choose what information will be retrieved from the databases but also, remind you what the resulting graph tells you. Keep this in mind when you are making graphs and you will not lose track of what you are doing and why you are doing it.

Histogram or Scatter Graph?

How would you like the data you ask about to be displayed? A **histogram** looks like a traditional bar graph. It will let you see the distribution of one of the characteristics described above over the range of possible values. This is a great way to get a feel for what the measurements are telling you about galaxies. It opens the door to a lot more questions. Example:



A **scatter graph** allows you to answer questions about the relationship of one characteristic to another. When you view a scatter graph, you look for a pattern to how the dots are distributed. You may see them clustered in a particular area, or arranged in along a line or curve. Your teacher can help you interpret the meaning of these different patterns. If the distribution appears completely random, that tells you something as well: There is no relationship between the two characteristics you plotted.



Take a Snapshot

This great little tool opens an image of your graph in a new tab. Right click on the image to save it to your computer.

Download Data

If you want to do more with the data in your graph, you can save it to your computer as a .csv (comma separated variables) file that can be opened in a spreadsheet program. NOTE: If you see .part appear at the end of the file name, remove it before clicking save. Once saved to your computer, you can now open the file from a spreadsheet program.