

NAME: \_\_\_\_\_

**GALAXY MORPHOLOGY<sup>1</sup>****What will you learn in this Lab?**

In this lab, you will learn how to separate galaxies into the different morphological types of the Hubble Classification scheme.

**What do I need to bring to the Class with me to do this Lab?**

For this lab you will need:

- A copy of this lab script
- A pencil
- A personal computer, if not using lab computers

**I. Background**

A galaxy is a gravitationally bound grouping of stars, dust and gas that is isolated in space. Our solar system resides in a galaxy called the Milky Way, which is also sometimes referred to as “the Galaxy.” As we have observed many galaxies, we have discovered that the number of stars can vary from millions to billions and that the amount of gas and dust varies between different galaxies. As part of an endeavor to better understand galaxies, in the early twentieth century Edwin Hubble developed a classification scheme in which the galaxies were separated into different types based on shape. These classifications are called “morphological” types, because morphology is the study of form or structure.

In the simplest form of the Hubble classifications, there are three primary types of galaxies:

- **Ellipticals** – Elliptical galaxies appear as smooth distributions of stars with little evidence of substructure. The usual designation for an elliptical galaxy is “En”, where the number n is a function of the relative size of the major and minor axes of the observed ellipse. In this scheme, an elliptical galaxy that was perfectly spherical would be an “E0” (most spherical), whereas the most oblong elliptical would be an “E7” (most elliptical).
- **Spirals** – Spiral galaxies are characterized by a distinct spiral shape in the distribution of stars. Spirals also appear to have prominent dust lanes, which can be seen even if the galaxy is observed from a side view where the spiral structure is not evident. The subclasses of spirals are related to the size of the galactic nucleus and the tightness of the spiral arms. Also noted is whether or not the galaxy shows a bar; in a barred spiral, the spiral arms appear to trail from an elongated nucleus, as opposed to a spherical nucleus. Spirals are classified Sa, Sb, or Sc, whereas barred spirals are denoted SBa, SBb, or SBc. The nucleus of an Sc galaxy is smaller than in an Sa

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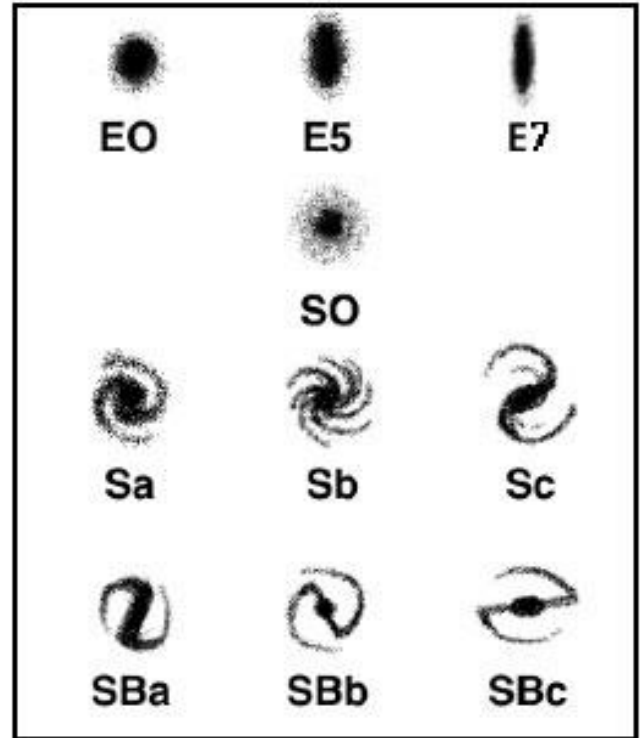
<sup>1</sup> Hubble Morphology Type graphic is from the University of Washington’s Hubble Galaxy Classification lab.

galaxy, and the arms of the Sc are wrapped more loosely.

- Irregulars – Irregular galaxies do not exhibit an obvious spiral or elliptical structure. Some astronomers hypothesize that irregulars may once have been spirals or ellipticals, but have lost those structures due to gravitational interaction with another galaxy(ies). Or that some irregulars are too small to have formed a disk of stars with spiral arms.

## II. Procedure

Now it is your turn to decide the Hubble Morphological type for several galaxies. In this figure are displayed the typical shapes of several morphological types. When deciding which classification to give to a galaxy, make certain to denote a **subtype**. Please use one of the **subclasses** given here. If you **cannot decide** between an Sa or Sb, make a choice and **explain why** you were having difficulty.



## Part I: Provided Images

- Use the classroom computers to view the provided images (at <http://windhorst114.asu.edu/galmorph.html>) of galaxies to determine their Hubble Classification type.
- Fill in the provided table with morphological type and your reasons for choosing the type.
- Make certain to include an estimate of subtype using the classes established above.

## Part I Table

Name	Hubble Type	Reason? Short answer justification.
<b>M51</b>		
<b>M99</b>		
<b>IC 2233</b>		
<b>NGC 1232</b>		
<b>NGC 1407</b>		

<b>NGC 1507</b>		
<b>NGC 1550</b>		
<b>NGC 1600</b>		
<b>NGC 1637</b>		
<b>NGC 1700</b>		
<b>NGC 1752</b>		
<b>NGC 1832</b>		
<b>NGC 1888</b>		
<b>NGC 1954</b>		
<b>NGC 2339</b>		
<b>NGC 2344</b>		
<b>NGC 2377</b>		
<b>NGC 2389</b>		
<b>NGC 2424</b>		
<b>NGC 2486</b>		
<b>NGC 2487</b>		
<b>NGC 2493</b>		
<b>NGC 4038</b>		

## Part II: AHaH Tool

You will now be conducting an investigation of your own into galaxy types using the tool Appreciating Hubble at Hyperspeed (AHaH). The lab computers should already have the tool ready to launch. If you are using your own computer and don't already have the tool installed, go to <http://ahah.asu.edu>, and navigate to the Download page to download the .zip file, and install the tool.

In brief, AHaH gives a relativistic, 3D simulation of the Hubble Ultra Deep Field, allowing us to “fly” through the galaxies shown in that image. Your goal is to pick a few galaxies in the tool and determine their Hubble Classification type. You can view a specific object by typing “j” and entering the object ID, or double-click a galaxy you see to zoom to it. If you are uncertain how to use the software, type “h” or “F1” to bring up the help screen.

Fill in the provided table with morphological type, overall color of the galaxy (reddish? bluish?), and whether or not dust is evident in the galaxy. Feel free to record any notes that might make answering the questions at the end of the lab easier. Make certain to include an estimate of subtype using the classes established above when determining the Hubble type.

**Part II Table**

<b>Object ID</b>	<b>Color?</b>	<b>Dust?</b>	<b>Hubble Type</b>	<b>Comments</b>

**Part III: Additional Questions**

- Q1.** Could any of the Hubble Classification types represent objects in other classes seen from different angles? If so, which? How could you tell them apart?
- Q2.** What type of galaxies (spirals or ellipticals) contain large regions of gas and dust?
- Q3.** If stars form out of large clouds of gas and dust, in which type of galaxy is there *least likely* to be ongoing star formation? (In other words, in which type (E,S,Irr) did not seem to contain much gas and/or dust?)

- Q4.** Recalling earlier work on spectral types of stars and the color magnitude diagram, what is the typical color of a young group of stars? What is the typical color of an older group of stars?
- Q5.** Based on the above question, which type of galaxy (spiral or elliptical) has an older population of stars? Explain using complete sentences.
- Q6.** Which type of galaxy (spiral or elliptical) has a mainly younger population of stars? Where in the galaxy are these young stars? Is the entire galaxy made of young stars? Explain using complete sentences.
- Q7.** Look again at galaxy NGC 4038. Was this galaxy easy to classify? If not, what do you think is happening?