Galaxies and Cosmology Homework/Activity #1
Due January 22th.

Here is a list of galaxies and their type designation from the Hubble Atlas of galaxies

Ellipticals
NGC 4278  E1
NGC 4406  E3
NGC 4486  E0
NGC 4697  E5

Spirals
NGC 718   Sa
NGC 3898  Sa
NGC 4254  Sc
NGC 4303  Sc
NGC 4433  SB
NGC 4569  Sb
NGC 5005  Sb
NGC 6181  Sc

Use the NED (NASA/IPAC Extragalactic Database) website to do the following –
   a. Determine the current “official” galaxy classification
   b. Collect values of photometry in U, B, V, J, H, K bands and determine the colors
   c. Examine an image of the galaxy

Part a. The type is given in the general “Objects – By Name” search and is listed under Basic Data. The form of the classification is from the de Vaucouleurs system, which is in the format:
   General type, Bar-ness, ring-ness, sub-type
For example, if a galaxy is given as SAB(rs)bc, it is a spiral (S), with intermediate bars (AB),
   with intermediate rings (rs), and is sort of between a spiral type b and c (bc). Under the Hubble
scheme, this would have been just a Sbc.
Ellipticals are given generally in the normal way, but can have some other information as well,
   which you can ignore.

Part b. For the UBV photometry, use the following reference code to average values for UBV –
   Reference code: 1991RC3.9.C...0000d. There are generally 2-3 values for each band, so average
   those to get the individual UBV values.

For the JHK photometry, use the values given in the 2MASS survey, which are labeled as J_tot, J_total, J_s_total, or something similar.

Once you have individual value for UBVJHK, determine the values of U-B, B-V, J-H, and H-K –
   yes it is just subtracting the given values. Also note that negative values are possible when you
do this, so don’t assume the answer is positive. The difference of photometric bands give you a
“color” measurement. Typically the larger the color value, the redder the object.

Once you have values for U-B, B-V, J-H and H-K, graph them up in the following way – one graph with B-V versus U-B, and the other with H-K versus J-H. You’ll want to keep track of the galaxy types in graphs, mainly which are spirals and which are ellipticals. These types of graphs are known as “color-color diagrams” and are useful graph for determining characteristics of stars and other objects.

Part c. You also need to examine an image of the galaxy. Several are visible as JPEGs at the NED website, but you might find other images elsewhere on the internet. Either way, make sure it is a visible light image (most are).

Part c. Answer these questions –

1. Looking at the images, do you agree with the classifications that are given by NED? In particular when there are designations that indicate the strong presence of a ring or bar, do you think those are correct? For the ellipticals you should check to see that they have the correct number, like E5 and so on. List and explain all instances where there are inconsistencies between what you see/measure and what is given by NED.

2. Do the color-color diagrams provide a way of distinguishing the different galaxy types, specifically do the ellipticals and spirals have distinct locations on the color-color diagrams?

3. If you observed a very distant galaxy with the following characteristics –
   U-B=0.8
   B-V=1.0
   J-H=0.65
   H-K= 0.25
   can you determine its likely type, elliptical or spiral? If so, what type is it?

4. If you observed a very distant galaxy with the following characteristics –
   U-B=0.25
   B-V=0.6
   J-H=0.73
   H-K=0.34
   Can you determine its likely type, elliptical or spiral? If so what type is it?

5. Where would you place Irregular I galaxies (ones with lots of large scale star formation) on your color-color diagrams? Just give general locations (upper left, lower right, etc) or likely color values.

Make sure you turn in your data, any graphs you create and the answers to the above questions.