ASTRON 330: Galaxies

Class 10 exercise: Color-Mass diagrams and Galaxy SEDs

Feb 26, 2025

1) Open TOPCAT. Download the file "manga_njmtrim1.csv" from Canvas and load it into TOPCAT: **File -> Load Table**. This file contains the position (RA/DEC) and UV+optical magnitudes of a subset of MaNGA galaxies. To see the table you just uploaded click on the icon that looks like the one at the right

2) Now we want to match this table to the WISE (Wide-field Infrared Survey Explorer) to get the galaxies' mid-Infrared magnitudes. To do the crossmatch click on the Icon that looks like the one shown at the right. In the window that comes up set **VizieR Table ID/Alias: WISE.** Under **Input Table** select the one you just uploaded into Topcat. Use a **Match Radius = 3.0 arcsec.** Then click **Go.** In a few seconds Topcat should show that you have a new table. You now have GALEX ultraviolet magnitudes (FUV, NUV) SDSS optical magnitudes (u, g, r, i, z) and WISE mid-infrared magnitudes (W1, W2, W3, W4). See the figure below.

FUV NUV u g r i z   W1 W2 W3 W4
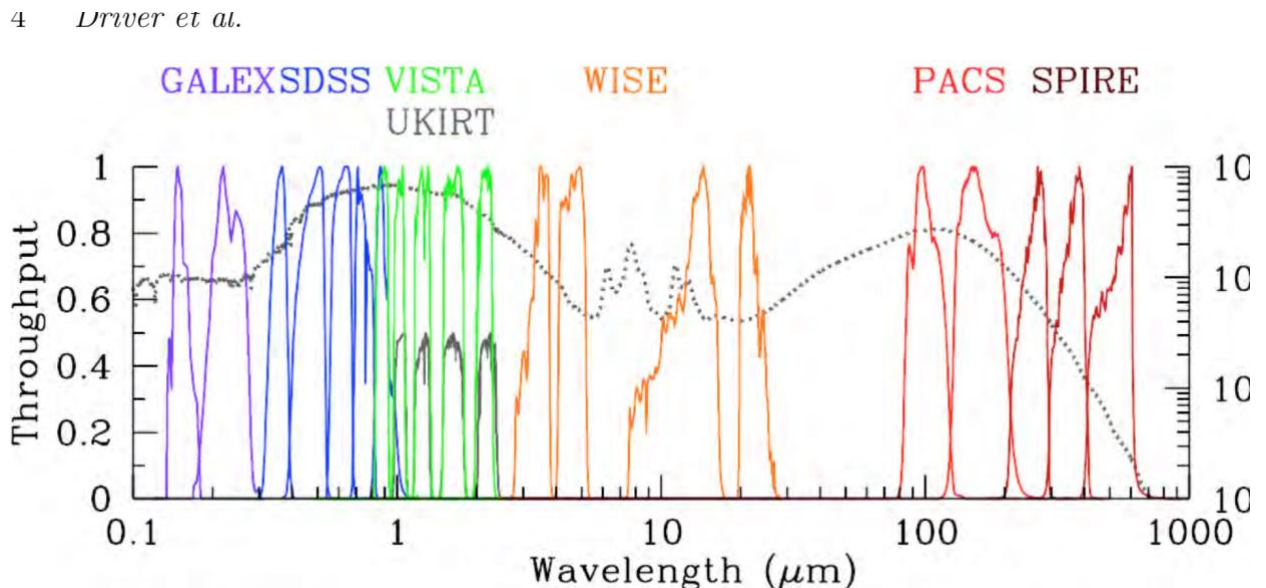
3) We are ready to plot our galaxy color-mass diagram. Click on the icon that looks like the one at the right and it will pull up a new window. Make sure the table including WISE data is the one you're plotting (it will have a name like 1xWISE). On the x-axis we want to show the galaxy stellar mass so set **X: LOG_MASS.** On the y-axis we want the color so set **Y: NUV_MAG - I_MAG.** Use **Axes** and **Range** to zoom in on the main locus of points. You don't need to display all the outliers.

4) Now let's look at a few more galaxies on your plot. Click on the icon with the lightning bolt in the main TOPCAT window. Click on **Display HiPS cutout** (it may also say "**Display Cutout Image**" in your version of TOPCAT)**.** Set RA Column: RA, Dec Column: DEC, **Field of View: 1 arcmin** (it may also be the dimension in pixels along with the scale, e.g. 0.4 arcseconds [per pixel] - do the math so the cutouts are approximately 1 arcminute large). For **HiPS Survey/Cutout Service**, select **SDSS9/color** (I found it under the successive drop-downs for Sky -> Optical -> SDSS)**.** Then click on a point on your plot and a color image of the galaxy should appear!

5) Now we want to define some subsets that we'll call: "Red Sequence" and "Blue Cloud". In the main window click on the icon like the one shown on the right. Then draw a shape that encloses the red sequence. Click on the icon again, give the subset a name ("Red Sequence") then click **Add Subset**. Do the same for the blue cloud. Display the red sequence and blue cloud subsets as different colors (perhaps… red and blue), and any points belonging to neither group as grey or black. *Save your plot to submit in Canvas.*

6) Use the icon at the right to make a new plot. Continue using the table including WISE values, and keep LOG_MASS on the x-axis. On the y-axis we want **W2mag - W3mag.** W2 traces old stars whereas W3 traces dust heated by young massive stars or active galactic nuclei (supermassive black holes). **Larger values of W2-W3 mean there is a larger fraction of hot dust,** since the the magnitude scale is backwards.

7) Now go to Subsets and add your "red sequence" and "blue cloud" subsets. *Save your plot to submit in Canvas.*

8) Now do the reverse: in the plot of W2mag-W3mag vs. LOG_MASS, create subsets for galaxies with hot dust (large W2-W3) and galaxies without hot dust (small W2-W3). Go back to your plot of NUV_MAG-I_MAG vs. LOG_MASS and display these subsets. *Save your plot to submit in Canvas.*

9) Think about the following questions and submit your responses in Canvas

(a) What type of galaxies have the most hot dust? Why do you think this is?

(b) Are there red sequence galaxies whose W2-W3 colors suggest they have hot dust? If so, what properties do those galaxies tend to have? Examine their SDSS images in addition to considering their location on your mass-color plots.

(c) Are the galaxies without hot dust all confined to the red sequence? If there are exceptions (galaxies with blue NUV-i color but no hot dust), what properties do those galaxies tend to have? Examine their SDSS images in addition to considering their location on your mass-color plots.

(d) Can you suggest a reason a galaxy might be bright in the near-UV despite its other properties?

Summary – Submit the following in Canvas

1. Plot of NUV-i vs. log(Mass), showing red sequence and blue cloud subsets.

2. Plot of W2-W3 vs. log(Mass), showing red sequence and blue cloud subsets.

3. Plot of NUV-i vs. log(Mass), showing hot-dusty and no-hot-dust subsets.

4. Responses to 9a-9d above.