Computing Project for CTA200: Galaxy Pairs and 24μm Star Formation Rates

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The goal of this project is to familiarize yourself with both the photometric redshift catalogs and 24μm-MIPS imaging that cover the GCLASS galaxy clusters.

Identifying Cluster Members

1) Using either `Python` or `IDL`, read in each of the ten photometric redshift catalogs from your data directory: `/PHOTOZ/PHOTOZ_CATS`.

2) Determine how many galaxies are likely cluster members, i.e. have a photometric redshift (given by the `z_peak` column in the catalogs) within ± 0.05 of the cluster redshift (listed in the GCLASS table in your summary document). You can use the equation: $|z_{phot} - z_{cluster}|/(1 + z_{phot}) \leq 0.05$.

3) Repeat the process for $|\Delta z| \leq 0.1$ — how many more cluster members does this add?

4) Make a table with your results.

Calculating Distance to Nearest Neighbor

1) Using your photometric-redshift cluster catalogs (with $|\Delta z| \leq 0.1$), for each cluster member calculate the distance to the nearest neighboring galaxy in the cluster. There is a pre-defined `IDL` routine for this called `gcirc`, which calculates the great circle distance between two galaxies. You might be able to find an equivalent routine in `Python`.

2) Plot the number of cluster galaxy "pairs" as a function of distance, i.e. make a histogram of separation distances. Make sure galaxies are not double-counted (i.e. each cluster member is only in a single pair).

Matching to the 24μm-MIPS Images

1) Match your photometric-redshift cluster catalogs to the 24μm galaxy positions (using the SWIRE catalogs in `mips/catalogs`).

- You will have to first get the RA and Dec for the photo-z members by matching the `id` column in the `/PHOTOZ/PHOTOZ_CATS` to the `id` column in `/PHOTOZ/PHOTOM_CATS`.
- You can then search for 24μm galaxy counterparts in the SWIRE catalogs by identifying 24μm galaxies within 3 arcsec of the cluster member positions. RA and Dec are in decimal degrees within both catalogs.
- There is a pre-defined routine in `IDL` called `srcor` which finds the closest match between catalogs within a critical distance. I have also included an example `IDL` code of matching the spec-z catalogs to the MIPS catalogs in `codes`. Feel free to adapt these into `Python` if you prefer.

2) Include the number of 24μm MIPS-detected photo-z cluster members into your table.

3) Calculate the clustercentric radius (the distance from the cluster center to the galaxy position) for each 24μm MIPS-detected photo-z cluster member. You can take the cluster center as the position of the brightest cluster galaxy (BCG), listed in Table 1 in van der Burg 2014.

4) Plot the 24μm flux (for each MIPS-detected photo-z cluster member) as a function of clustercentric distance, for each galaxy cluster separately.

5) (Extra) For all 24μm-detected photo-z cluster members, calculate their star formation rate and now plot the star formation rate as a function of clustercentric distance.

- The easiest way to do this is to first use the Chary and Elbaz 2001 templates to convert the 24μm flux into an infrared luminosity ($L_{\rm IR}$). The 24μm flux is listed in the `flux` column in the SWIRE catalogs. You can download pre-written `idl` routines from David Elbaz's webpage. The main routine is called `chary_elbaz_24um.pro`.
- You can then use the Kennicutt 1998 relation to convert the infrared luminosity ($L_{\rm IR}$) into a star formation rate, using the equation: SFR (M$_\odot$ yr^{-1})$= 4.5 \times 10^{44}$ $L_{\rm IR}$ (erg s^{-1}).