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Properties of galaxies in clusters and groups

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In this project the participant will develop skills to work with astronomical catalogs, perform cross identification of extended astronomical sources and exercise galaxy morphology, photometry various other information provided in the courses.

Common parts:

1. You will obtain a catalog of X-ray sources from Wang et al (2011) <https://arxiv.org/pdf/1110.1987v2.pdf> in electronic format.
2. Choose 3 X-ray luminous clusters ($L_X > 3 \times 10^{44}$ ergs/sec) and 3 X-ray groups ($L_X < 3 \times 10^{43}$ ergs/sec) from this catalog and visually inspect the region in SDSS or in Aladdin. Describe the differences you see in galaxy distribution based on what you have learned about galaxies in the courses so far.
3. Identify all galaxies with spectroscopic measurements available from SDSS and plot the distribution of the radial velocity for each of these. Identify the members based on 3-sigma clipping. Compare the mean redshift of the galaxies in each cluster (3) or group (3) you obtain with the redshift given in column 6 of the catalog. Explain the differences or similarities.
4. Obtain the photometric properties of galaxies (magnitudes in different bands and measured parameters such as half-light radius) for these clusters and groups from SDSS for all galaxies within 500 kpc around the source (Ra and Dec in column 3 and 4).
5. Plot the galaxy colour magnitude relation in (g-r vs r) and (r-i vs i) for all 6 sources separately. Discuss the similarities and differences in terms of the scatter around the colour-magnitude trend and the any offset in these two colours). Identify cluster or group members photometrically based on colour magnitude relation and describe how you do this. You can calibrate this by using the same colours for the spectroscopic members.

Project A. Students opting for this project should obtain galaxy luminosity function for early type galaxies (E, S0, Sa) and late type galaxies (Sb, Sc, Sd, irregular). For this you should either use galaxy morphology or RC3 catalog in NED. The LF should be background subtracted and thus represent the LF of galaxies in these groups and clusters. You should fit a Sechster function and report the parameters. Discuss the results.

Project B. You should obtain the morphology-density relation for clusters and group. Density can be calculated based on the 4th nearest neighbour for the member galaxies. Do this in projected sky plane and in 3D.

Project C. Obtain the luminosity centre for each cluster/group. Calculate the projected separation between the brightest group/cluster galaxy and the derived luminosity centre.

Project D. Calculate the Luminosity Mass of the cluster/group and compare it with the dynamical mass obtained from velocity dispersion of these sources. Compare these with the X-ray mass of the cluster/group in the catalog. Discuss the results.