Project 1: Estimating the Dynamical Mass of a Galaxy Cluster

In this short project, you will use the steps discussed in class to estimate the dynamical mass of a galaxy cluster, which is the total mass of the cluster independent of light.

For this, first, you must get information on a field with many galaxies, several of which are potential members of a cluster. We will make use of the SDSS spectroscopic data archive for this. In the interest of saving time, we will use the redshift determined by the SDSS itself for the galaxies in the field. The alternative is to download the spectrum of each galaxy, use the spectral features to determine the redshift.

There are many ways to extract the data we want from the SDSS archive. We will use an SQL query. Copy-paste the below SQL query to the SDSS page:

SELECT

s.objid,sz.ra as ra,sz.dec as dec,pz.z as photoz,pz.zerr as photozerr,sz.z as specz,sz.zerr as speczerr,b.distance as proj_sep,s.modelMag_u as umag,s.modelMagErr_u as umagerr,s.modelMag_g as gmag,s.modelMagErr_g as gmagerr,s.modelMag_r as rmag, s.modelMagerr_r as rmagerr,s.type as obj_type

FROM BESTDR16..PhotoObjAll as s

JOIN dbo.fGetNearbyObjEq(258.1294,64.0926,10.0) AS b ON b.objID = S.objID

JOIN Photoz as pz ON pz.objid = s.objid

JOIN specObjAll as sz ON sz.bestobjid = s.objid

WHERE s.type=3 and sz.z > 0.05 and sz.z < 0.20

If you are interested in knowing the details of this SQL script, talk to me. Briefly, the query will return a table with whole lot of information on galaxies with redshifts between 0.05 and 0.20 found within a 10-arcminute radius circle centred on the (RA, Dec) = 258.1294, 64.0926

Put this query in the following page (do not forget to clear the query box by hitting "clear query" before copy+pasting the above script).

http://skyserver.sdss.org/dr16/en/tools/search/sql.aspx

(1) Identify galaxies that you think are members of a cluster. For this, use of knowledge of velocity dispersions (redshift dispersions) within a cluster due to peculiar

motion. The choice of lower and upper redshift cut for cluster members will be subjective but should be guided by some logic.

(2) After the required analysis of the table of data, determine the cluster redshift, and obtain an estimate for the characteristic velocity dispersion of galaxies that belong to the cluster in units of km/s

(3) Estimate the characteristic size of the cluster in Mpc

(4) Estimate the dynamical mass of the cluster and quote the value in units of solar mass

(5) Is the estimate of dynamical mass consistent with what is expected from the luminous mass? If not, explain with the support of numbers the inconsistency.

Also, explore at least a few relevant plots that were used to arrive at values (such as a histogram of velocity dispersions of galaxies, a histogram of angular separation between galaxies and the value that you chose indicated by a vertical line, etc.