# Study of the Coma cluster Abell 1656

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**Software to launch: Aladin, Topcat**

**Goal**: Examine the Coma cluster of galaxies (Abell 1656) using VO data and tools in order to perform a quick evaluation of the mean redshift and velocity dispersion of the cluster and to inspect its luminosity function. We use redshifts and photometry (Petrosian r magnitude) of the SDSS survey and then add redshifts of the CAIRNS survey (Rines et al 2003) in order to improve the completeness of the redshift sample..

Note: there is a much more detailed printer-friendly step-by-step guide leading through the science case available here http://www.eurovo-ice.eu/twiki/bin/view/EuroVOICE/ThematicTutorial1. In This page you will also find an even more complete version of the guide in the form of a ppt-pdf presentation.

1. **Load the image of A1656** from the Allsky color atlas of Aladin. We suggest a zoom 4x or a radius of about 40' for clarity. At the distance of Coma, 40' corresponds to 1.1Mpc with ($H_0$=71 Mpc$^{-1}$km s$^{-1}$, $\Omega_V = 0.73$, $\Omega_M = 0.27$), a region large enough for our purposes. Tip: in order to check the radius of the region being displayed, draw a 40' long arrow with the "dist" button.

2. **Load the SDSS-DR7 catalog** from the All VizieR catalog server, radius 40', check retrieve all columns. Filter SDSS and leave only galaxies with \${cl}=3 {draw}. Tip: in the filter window export the filtered catalog to a new plane and rename it to SDSSgalaxies. Broadcast the filtered catalog to Topcat.

3. **Perform basic exploration and sanity check of the SDSS catalog in Topcat**. Suggestions: 1) view table data and sort various columns (e.g. quality of data "Q") to explore ranges (select the columns to be displayed with View->Column info), 2) use the Row Statits (RSW) window to check mean, deviations, ranges etc. of all columns. Select statistics to be displayed from the Display menu.

4. **Create a subset of galaxies with photometry (rPmag) and redshift in SDSS**. Use the Subset window (SW) to create the subset zsp of galaxies with positive redshift (zsp>0). Verify in the SW that the redshift range is adequate for Coma (<z> ~ 0.023). Find the faintest rPmag of the zsp subset and create a new subset rPmag20 of SDSS limited to this magnitude (rPmag$_{max}$ =20.395). Compute completeness of the zsp sample to rPmag$_{max}$ (520/4122 = 13%).

5. **Find limiting magnitude for a higher completeness of the redshift sample**. Use the histogram of both zsp and SDSS rPmag limited samples to identify best limiting magnitude for the highest level of completeness (tip: the depth of the spectroscopic sample of SDSS-DR7 is rPmag $_{lim}$ =17.77). Create a subset rPmag17 of SDSS with rPmag<=rPmag $_{lim}$ and a subset zsp17 of zsp with rPmag<=rPmag $_{lim}$. NOTE: Topcat expressions do not differentiate small/capital letters ans SDSS contains both rpmag and rPmag. If you have all columns of SDSS in your table, use \$ID of the column rather than its name.Verify completeness level (487/594=83%). Transmit subsets to Aladin

6. **Inspect the objects that are in rpmag17 bur not in zsp17 in Aladin.** Some of these objects are bright stars that have to be eliminated from our catalogs, some are galaxies for which we will search for redshifts outside SDSS. Transmit rPmag17 and zsp17 back to Topcat. Rename tables in Topcat (rPmag17 and zsp17 instead of SDSS)

7. **Eliminate bright stars from galaxy catalogs**. In Topcat plot rPmag vs rPmag for the table rPmag17. In Aladin select with the cursor the two brightest galaxies, both are brighter than

rPmag=12. Create a subset of probable stars and verify that they are indeed stars in Aladin (transmit to Aladin the subset of bright objects selected in the Topcat plot window and check them one by one at zoom 64x in Aladin) . In Topcat, create a subset rPmag17ok of rPmag17 without objects brighter than rPmag=12.00. Completeness rises slightly (487/582).

8. **Improve completeness with other sources of redshifts in Vizie**r. In Topcat create the subset rPmag17noz of rPmag17ok (use subset selection from table browser or create subset with expression !(zsp>0))and transmit it to Aladin (size=95 records). Search optical catalogs with redshifts. Load Rines+ 2003. Broadcast the Rines+ catalog back to Topcat.

9. **Find redshifts in Rines+ for galaxies without redshift in rPmag17**. Match the rPmag17noz and the "galaxies" catalogs. Use sky algorithm with 5" max error. Transmit the catalog of 45 galaxies to Aladin for inspection.

10. **Create the "final" catalog including Rines+ redshifts**. Join the new redshifts in Rines+ to the zsp17 catalog. Add column czsp=toInteger(zsp*300000) to the zsp17 catalog. Concatenate tables.The final catalog contains 532 galaxies, completeness is 532/582 = 91%.

11. **Determine cz distribution, <cz>, and dispersion in Topcat**. Isolate main peak of Coma in the histogram window, create new subset "Coma" and open the Row Statistics window: With $N_{mem}$=492, <cz>=7000 km/s and disp=1131km/s, both in excellent agreement with more refined analyses.

12. **Check the luminosity function** in the histogram window using rPmag of the Coma subset of galaxies.