

# **Study of The Coma Cluster (Abell 1656)**

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**NOTE: sections refer to the shorter guide “Study of the Coma cluster Abell 1656”**

Retrieve an image of the cluster and obtain a sub-catalog of SDSS-DR7 galaxies with photometric data of galaxies in the cluster area.

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## **Aladin**

### **load image:**

location: A1656 -> click Allsky opt

zoom 4x

### **check field of view of the display:**

draw a 40' vector having activated the “dist” button next to the stack

delete the plane of the vector: select the plane with a click, then right-click to get the menu and select “Delete”

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### **load SDSS Catalog:**

Catalog server -> surveys -> select SDSS-DR7 with target a1656, radius 40', check all columns

### **keep only SDSS galaxies (cl=3):**

select SDSS plane (click plane in the stack)

Catalog->create filter->advanced mode->columns in loaded catalog ->  $\{cl\}=3$  {draw}

-> Apply filter -> Export

### **rename filtered catalog “SDSSgalaxies”:**

select plane Filter.src-> right click -> properties: type new name “SDSSgalaxies”

### **Start Topcat and broadcast Aladin table to Topcat:**

Tools->VOTools->Topcat

NOTE: for a better control of the software versions it may be better to have both Aladin and TOPCAT already running independently from the beginning of the use case.

select SDSSgalaxies (click plane in the stack)

Interop->broadcast selected plane->Topcat

## Topcat

Control window (CW): **change label** to "SDSSgalaxies"

**View column names and info (check/uncheck to hide):**

CW->Views->Column information

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**Explore table with the Table Browser:**



Verify quality of data:

CW->sort "Q": few "Q=2", all others "Q=3":OK

Verify mode of observation:

CW->sort "mode": mostly "mode=1", several "mode=2" (we keep them for now) etc etc

**Explore the whole Table:**



CW->Row Statistics window (RSW)

**Explore subsets of the whole Table:**



CW->Subsets->type expression for selection->read RSW

Note: in the RSW, use menu "Display" to check the parameters you want to be displayed in the RSW

Note: For clarity, discard dummy subsets after having read info from Row Statistics.

Create a sample of galaxies with both photometry and spectroscopic redshift in the SDSS-DR7 catalog. Determine the completeness of the sample. Determine the optimal 'rPmag' magnitude limit in order to have

the most complete redshift sample with still a significant number of galaxies.

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**Select galaxies with positive redshifts:**

CW->Subset window (SW)-> add new subset -> expression: "zsp > 0", name = zsp

**View Table statistics for galaxy subset with zsp>0:**

RSW-> view subset zsp-> 520 galaxies, max rPmag=20.395, median z=0.02515

**WOW! Coma at about z=0.023 => zsp useful column!**

**Extract table for zsp subset from table 'All' of SDSSGalaxies):**

Table browser (TB)-> Subsets->Apply subset zsp

**Size of zsp sample:**

CW-> Select table "zsp" -> SW: 520 records

**Extract table for rPmag limited subset, with  $rPmag_{lim} = rPmag_{max} = 20.395$ :**

CW-> SW-> create new subset -> expression:  $rPmag \leq 20.395$ , name=rPmag20

Table browser (TB)-> Subsets->Apply subset rPmag20

**IMPORTANT NOTE:** In Topcat, expressions do not differentiate small/capital letters and 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.

**Size of rPmag20 sample:**

CW-> Select table "rPmag20"-> SW: 4122 records

**520/4122 => Completeness=13%, not good enough.**

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**Open Histogram window (HW):**

HW-> X-Axis: rPmag , check only subsets zsp and rPmag20

**Create subsets of SDSSgalaxies and zsp with  $rPmag \leq 17.77$ :**

CW-> select table "All" -> SW create new subset with expression:  $rPmag \leq 17.77$ , name=rPmag17

CW-> Select table "All" -> SW create new subset with expression: "rPmag <= 17.77 && zsp > 0", name=zsp17

**Subset rPmag17 has 594 records, subset zsp has 487 => completeness=83% OK!**

**Clean up list of subsets:**

SW: discard all subsets but zsp17 and rPmag17

**broadcast subsets to Aladin:**

CW: select zsp17

Interop-> send table to Aladin

Verify the quality of the catalog we have extracted from SDSS.

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**Aladin**

**rename transmitted planes**

right click on transmitted plane->properties-> change label to zsp17 and select yellow squares

**Topcat**

CW: select rPmag17

Interop-> send table to Aladin

CW-> discard table SDSSgalaxies

**Aladin**

right click on transmitted plane->properties-> change label to rPmag17 and select red crosses

delete all planes on the stack but rPmag17, zsp17, and DSScolor

**broadcast zsp17 and rPmag17 back to Topcat**

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**Topcat**

CW-> **rename** tables zsp17 (n=487) and rPmag17 (n=594)

**Identify and remove stars from rPmag17:**

CW-> scatter Plot Window (**PW**): table rPmag17, x axis = rPmag, y axis = rPmag

PW-> zoom region rPmag<12 (bright-wards of big gap)

PW-> new subset from visible -> transmit to Aladin (no name needed)

**Aladin****review bright objects transmitted by Topcat:**

select the first record of the list: the corresponding source appears centered on the display

zoom 64x

browse the whole list under the display with the arrows under the stack



we find that => **all sources brighter than rPmag=12.000 are stars**

**Topcat****create new subset without stars:**

CW->sort rPmag-> TB: select with the cursor galaxies with rPmag<12.

TB->Subsets from unselected->name "rPmag17ok"->add

TB->Subsets->Apply Subset->rPmag17ok

**transmit new subset to Aladin**

RSW-> Interop->Send row subset rPmag17ok to->Aladin

**Aladin**

catalog->create new plane selected sources->one table

select plane Selected.src->properties-> rename plane "rPmag17ok"

**Topcat****create subset of galaxies rPmag<17.77 and no redshift:**

CW->table rPmag17->sort zsp

TB->select galaxies without redshift with the cursor-> Subsets -> Subset from selected rows

->name rPmag17noz->add

**broadcast rPmag17noz to Aladin**

CW->Row Subsets:rPmag17noz

CW->Interop->Send table to Aladin (if necessary, rename plane in Aladin "rPmag17noz")

Search for a redshift catalog of galaxies in A1656 using Vizier. Use published catalog(s) in order to improve the completeness of the redshift sample in Coma. Produce a “final” spectroscopic catalog by merging SDSS and the catalog(s) found with Vizier.

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### Aladin

On the stack, check rPmag17noz,zsp17,DSS Colored, uncheck others

#### Retrieve catalog with redshifts of galaxies in Coma:

Catalog Server: optical+redshift, target is already A1656, radius=1degree -> Submit

Catalogs found: we select J/AJ/126/2152 of Rines+ -> submit

Stack: check J/AJ/126/2152/Galaxies, uncheck other related tables -> right click -> broadcast selected table to Topcat

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### Topcat

#### Match Rines+ table with rPmag17noz table:

CW->Joins->Pair match: max error 5.0 arcsec, Table 1=rPmag17noz, Table 2=galaxies -> Go

Output table: match(N1,N2) -> rename to “zrines”

**NOTE:** in zrines, verify the names of the columns with numeric values for ra,dec! Those are the names to be used in what follows!

#### Plot matched galaxies and display on Aladin

PW-> zrines, x axis:RAJ2000\_1, y axis:DEJ2000\_1, flip x axis. OK!

CW-> Interop -> send table to Aladin

## Aladin

uncheck all planes, leave zrines and J/AJ/126/2152/Galaxies (and DSScolor)

select plane zrines->right click->select all objects in selected planes

NOTE: If no records are selected under the display in Aladin, by passing with the mouse on one record the corresponding galaxy is highlighted on the Aladin display, in Topcat->PW, and in Topcat->TB.

### Verify matches are reasonable:

sort records by increasing separation (click on column name)

click on first record

zoom 64x

select records with the “down”/”up” blue arrows :  the corresponding

galaxy is displayed and it is possible to verify that relative positions of rPmag17(matched) and of

Rines+ entries have no problems that should keep us from using them.

**Matched catalog is OK! We join it to zsp17.**

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## Topcat

### Add column with integer cz to zsp17:

TB->right click->create synthetic column: name “czsp”,expression “toInteger(zsp\*300000)”

### Concatenate tables zrines with zsp17:

CW->Joins->Concatenate tables with: Base Table: zsp17, Appended Table: zrines

column assignment: czsp->cz , all other columns as suggested

### output and final table: FinalCatalog

CW-> rename concat(1+5) to FinalCatalog

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## Basic physical properties of the Coma cluster

### Identify members of Coma along the line-of-sight:

HW-> select FinalCatalog, x axis: cz-> select 0-15,000 km/s, width=200km/s, reset y axis with vertical arrows of toolbar

Note: if necessary zoom again around the main peak of the redshift distribution until the peak is approximately symmetric

HW->Subset->new subset from visible->name Coma->add

### Compute mean redshift and velocity dispersion:

RSW-> Subset Coma  $N_{\text{mem}}=492$

$$\langle cz \rangle = 7000\text{km/s} \quad SD = 1131\text{km/s}$$

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### Display the luminosity function:

HW-> Table: FinalCatalog, check only subset Coma, x axis: rPmag, width=0.2 mag, reset y axis with vertical arrows of toolbar

## THE END

## LIST OF ABBREVIATIONS

CW – Control Window

HW – Histogram Window

PW – Scatter Plot Window

RSW – Row Statistics Window

SW – Subset Window

TB – Table Browser