

# ISYA VO Exercise

## Galaxy Clusters

### Background:

A good way to study the properties of many galaxies is by looking at a galaxy cluster. Galaxy clusters are the largest known gravitationally bound objects to have arisen thus far in the process of cosmic structure formation. clusters appear to be collections of galaxies held together by mutual gravitational attraction. Notable galaxy clusters in the relatively nearby universe include the Virgo cluster, Hercules Cluster, and the Coma Cluster. A very large aggregation of galaxies known as the Great Attractor, dominated by the Norma cluster, is massive enough to affect the local expansion of the universe. There are many galaxy clusters in the SDSS data, which may contain hundreds or even thousands of galaxies. The picture below shows a famous cluster called Abell 2255. The cluster is named after George Abell, an American astronomer who published a catalog of galaxy clusters in 1958.

### Procedure:

In this exercise, you will study the galaxies that make up **Abell 2255** using following step:

1. Launch the Navigation tool using following weblink:  
  
<http://cas.sdss.org/dr7/en/tools/chart/navi.asp>
2. Open the tool, then enter the RA and Dec coordinates of **Abell 2255**:  
**RA = 258.1292, Dec = 64.0925**. Click "**Get Image**."
3. Click **Zoom Out** (the minus sign) once or twice, and you should be able to see the whole cluster. Click on any galaxy, and its basic data should appear in the right-hand frame. Click "**Add to Notes**" to save the galaxy's data in your online notebook.
4. Click on **20-25** galaxies that you think are part of the cluster, both spirals and ellipticals, and save them in your notebook.
5. When you finish choosing galaxies and saving them to your notebook, save your entire notebook to your computer. To do that, click on the radio button next to "**CSV**" then click the "**Export**" button

to download the data as **CSV** (comma-separated value). You can then open the CSV file in any **VO Tool**, for example **VOPlot** or **TOPCAT**.

6. Try to get answers for following questions- (a) which galaxies are part of Abell 2255, and which are just other galaxies at different distances in the same part of the sky? (b) How are these galaxies similar? How are they different?
7. Make a **color-color** diagram for the galaxies you saved in notebook. Put **u-g** on the x-axis and **g-r** on the y-axis. Do you notice any patterns?
8. Try to get answers for following questions- Where on the color-color diagram are the bluer galaxies? Where on the diagram are the redder galaxies? Which part of the graph corresponds to the early (elliptical) galaxies? Which part corresponds to the late (spiral) galaxies?
9. You can find details from following article – **astro-ph/0107201**