

# ISYA VO Exercise

## Open cluster membership

### Background:

Open clusters play a crucial role in stellar astronomy because, as a consequence of the stars having a common age, they provide excellent natural laboratories to test theoretical stellar models. Cluster membership is vital to determine the distance, and therefore absolute magnitude, and age of A-type stars. The Aladin VO tool can be of help in determining if a star does belong to an open cluster, at various levels using following steps.

### Procedure:

1. Click on the Aladin icon on the desktop of the PC/laptop.
2. Click on the **File** button. From **load astronomical image** select **Aladin image server**, enter target **Pleiads** and radius **30 arcmin**, press **Submit**.
3. Click on **Data Tree**. Moving the cursor on the data tree **branches** one sees the field of view of the various images. **Load** J-band, POSSII image 6.4 x 6.4 deg.
4. Center the image by clicking on **zoom** and then clicking over the cluster center.
5. We now need distance information on the stars; click on **Load** again, then on **Vizie Catalogs**; enter **parallax** in the **Author, free text ...** field click **Submit**.
6. Select **The Hipparchus and Tycho Catalogues**, then go back to the **Load** window, add **/hip\_main** to **I/239** (need to do that to avoid loading more than one table, which confuses the plotting package), put in a radius of **5 deg**, then click **Submit**.
7. The catalog is now loaded (see right, above the POSSII image) and the sources are overlaid on the image. Select with the cursor the **central region**: the selected sources get highlighted and the catalog parameters appear in the window below the image; moving the cursor over a column gives the column name.
8. We now want to plot an histogram of the Hipparchus **parallaxes**; we first select with the cursor all stars in the image, then click on **Plugins** and select **VOPlot**. Select **Pix** for the x axis, then click on **Histogram**. Parallax for this cluster has to be around 8-9 mas (real value is  $8.46 \pm 0.22$  mas) and there are

many foreground stars and a few background ones. We now want to plot a color-magnitude diagram; we want first to correct for reddening, using the relation

$$(B-V)_0 = (B-V) - E(B-V) = (B-V) - 0.04$$

9. for this cluster. We need then to add a new column by **right clicking** on the catalogue plane and selecting **Add a new column**. **Name** can be **(B-V)<sub>0</sub>**. Click on **B-V** under **Pick up a column name**, and then enter **-0.04** after the column name. Then click on **Add a new column**. Scroll the bottom bar all the way to the left, and check that indeed a new column with the name **(B-V)<sub>0</sub>** has been added as the last column.
10. Now we plot Vmag vs. (B-V)<sub>0</sub> for the cluster; we go back to the Voplot window, click "Plot" and then select "Vmag" for the Y axis and **(B-V)<sub>0</sub>** for the x axis, then click **Plot** again. Then click the **Rev** button above **Vmag** to flip the Y axis. The Zero Age Mean Sequence (ZAMS) is clearly visible. **Select** sources in the top left corner by using the cursor: the corresponding sources get highlighted in the image. Note how they are mostly in the center. Click on **out** (bottom right) to see all the selected sources. Notice how most of them have parallaxes ~ 8-9 mas.
11. Now select with **VOPlot** the outliers (bottom right); look at the image, no they appear to be mostly at the edge of the field. As before, look at the parallaxes: now they are mostly foreground sources, with a couple of background objects and some ~8 mas.
12. Now we want to look for data available for selected sources in various mission archives. We then select some sources in the image, for example in the center, and then go to the Load window, click on **Missions in Vizier** and select, for example, ESO, then hit **Submit**; do the same for HST and then IUE. The pointing's for the three missions are overlaid in the image.
13. Select one IUE pointing, then click on the first column, which I highlighted. One gets the entry in the INES catalogue in the Web browser, with a link to a preview of the IUE spectrum.
14. Now select one HST pointing; an **Image** link means that there is a preview image available, a **Spectrum** link means that there is a preview spectrum (clicking on **Image** loads it in the tree.) By clicking on the **Dataset** column one is taken to the MAST archive, with information on the dataset. Clicking on the **Catalog search** link one can then request the dataset. Scrolling down and clicking on the highlighted **Proposal ID** number one gets to the proposal page, with abstract, link to published papers (if any), and a list of all the datasets belonging to that proposal.
15. Write a report on above analysis with figures and diagrams and answers the questions asked in various steps. If you have any doubt or would like to know

more, please write to **Sudhanshu Barway** at [barway@sao.ac.za](mailto:barway@sao.ac.za).

**REFERENCE**

Padovani, P. [2004, IAUS, 224, 485](#)