

# ASTRONOMY DATA IN SCHOOLS: GAIA

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## Abstract

Star clusters are groups of stars that formed from the same molecular cloud, at the same distance, of the same age, varying only in mass. They are unique objects for which we can find stellar parameters using the Hertzsprung-Russell diagram. Gaia is an ESA astrometric and photometric survey to study a billion stars of our Galaxy. We shall study the importance of using Gaia data to study star clusters. I shall demonstrate use of TopCat with Gaia data for analysis of the star cluster NGC 1960 and will be used to find the distances to a known star cluster for school students from The Bush School Methow Campus, Mazama, Washington, USA. This was on an online mode with the help and supervision of Chandru Narayan.

## So, What are Stars, Constellations, Clusters?

### Stars

A constellation is a group of stars that appears to form a pattern or picture like Orion the Great Hunter, Leo the Lion, or Taurus the Bull. Constellations are easily recognizable patterns that help people orient themselves using the night sky. There are 88 recognised constellations. These stars may not be at the same distance and may not be gravitationally bound.

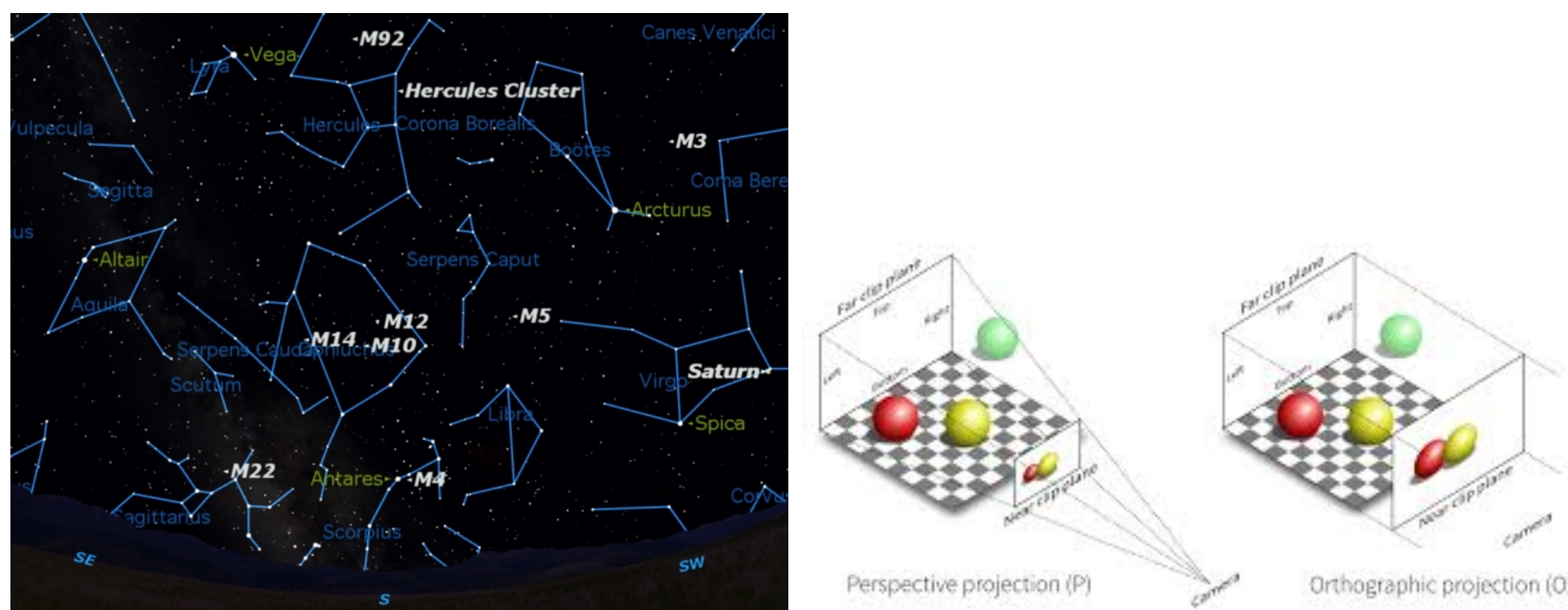


Fig. 1: Constellations, 2D projection of 3D patterns

Star clusters are groups of stars born from the same molecular cloud, at the same distance and of the same chemical composition. Hence if one knows the distances to individual stars and their velocities, it would be possible to identify cluster members. This is the opportunity that Gaia provides us with.



Fig. 2: NGC 1960: The Star Cluster

## ESA Gaia

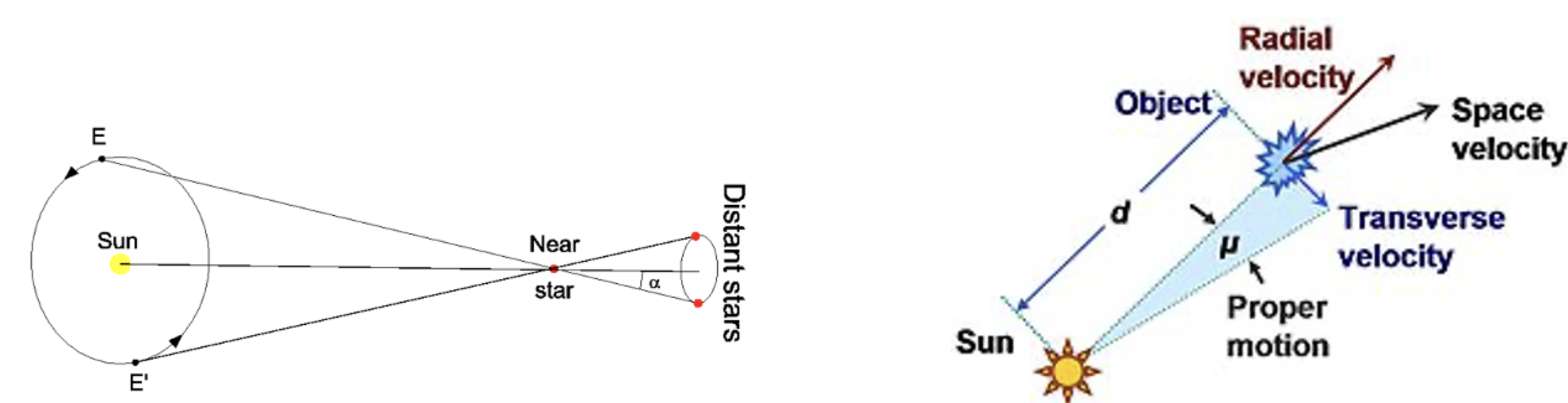


Fig. 3: Gaia

The data from Gaia is in 6 important parameters: The Sky Coordinates (Right Ascension RA and Declination Dec), distance (parallax), proper motions (in RA and Dec) and radial velocities and their errors. The distance is therefore  $\frac{1}{parallax}$  pc.



Fig. 4: Look, my method is better.

The students were first introduced to star clusters and the HR Diagram. The students used TopCat itself to download the data of a star cluster, in this case, NGC 1960 in an area of 20 arc min. The proper motion plot can be used to identify cluster members, which can then be confirmed using the vector sky plot. Field stars which do not lie in the distance range defined by the user can be filtered out using a parallax histogram.

## Analysis with TopCat

We shall do the analysis using TopCat <http://www.star.bris.ac.uk/~mbt/topcat/>. It can be installed on various platforms and does not have compatibility issues. It stands for Tool for OPERations on Catalogues And Tables.

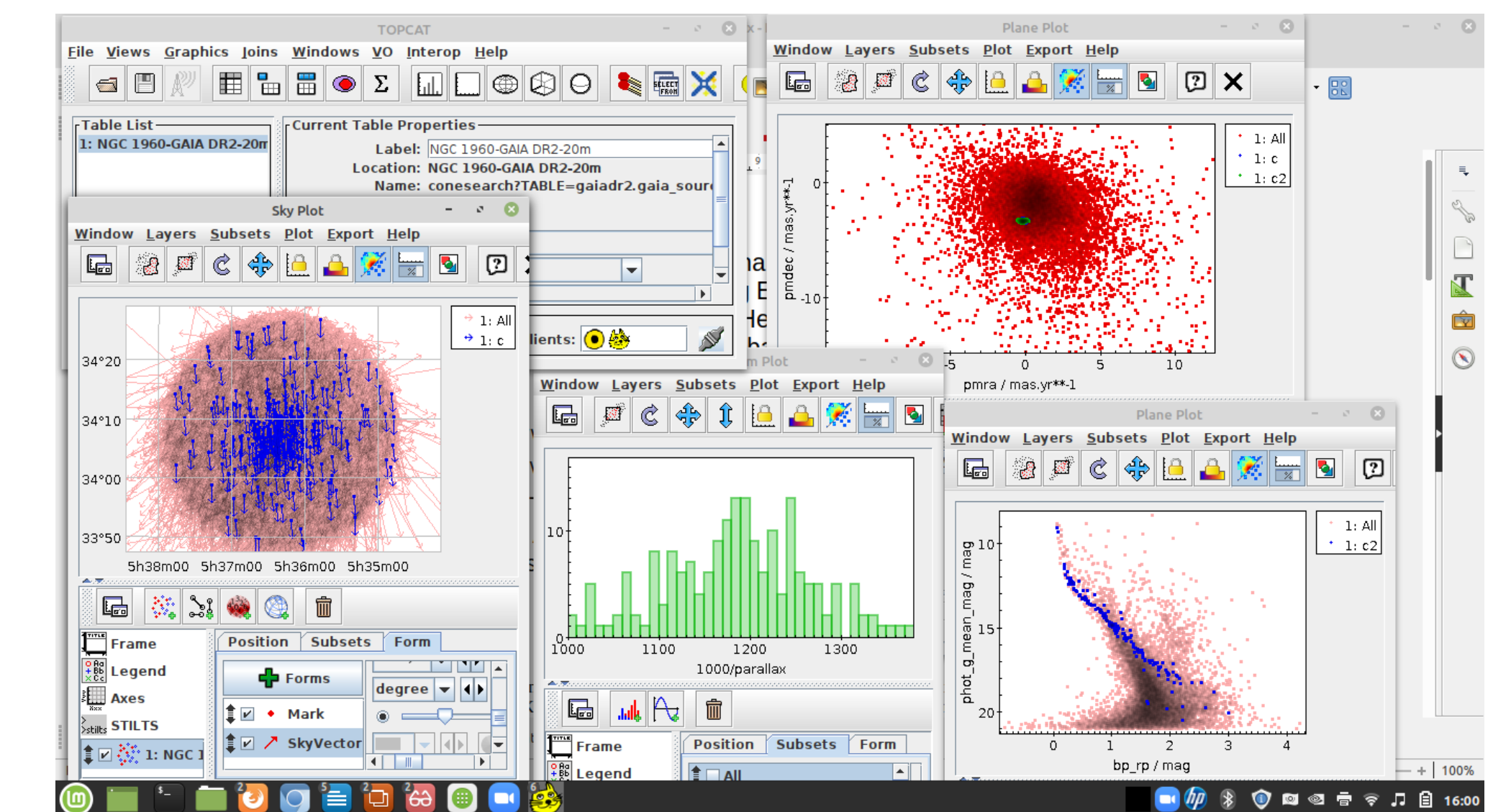


Fig. 5: Analysis for NGC 1960

The analysis was repeated using Jupiter Notebooks for the students who knew python. It was a good exercise in coding skills.

## Results

The goal of the present paper is to demonstrate how school children can be introduced to Gaia data using TopCat, a Virtual Observatory Tool. Similar exercises can be planned using Gaia data to give students a feel of the data and its potential.

Virtual Observatory tools like ESASky can also be used to help students visualize the data and can be planned in future.

## References

- Hasan P., Hasan S.N., Astronomy Data, Virtual Observatory and Education, arXiv:2104.10088
- Hasan P., Hasan S.N., Astronomy Education in Covid Times, arXiv:2104.06305