Age Estimates of Open Clusters Using Gaia DR2

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Abstract

In a collaboration between students from three high schools, we present our preliminary results using Gaia DR2 data to refine age estimates of open clusters. We are following the basic approach presented by the Gaia collaboration (2018). We selected members based on proper motions. PARSEC isochrones (Bressan et al. 2012) were matched to our color-magnitude diagrams to define the turnoff point for each cluster. In this preliminary study, we have not examined the effects of metallicity or reddening on our age calculations. This project is a collaborative effort of high school students and teachers from three states. They analyzed data individually and later collaborated online to compare results.

This project is the result of many years of work with the NASA/IPAC Teacher Archive Research Project (NITARP).

Methods

- Initially, two clusters (NGC 2632 and Hyades) were selected from the DR2 paper (Gaia 2018) to determine if our methods were viable.
- Data were downloaded from the Gaia DR2 catalog.
- Sources without proper motion data were eliminated.
- Various cuts were applied to the data to determine cluster members.
- After visual inspection of a proper motion RA vs. proper motion Dec plot, candidate cluster members were selected (see Figure 1).
- These new candidates were further analyzed by examination of parallax vs. proper motion RA and parallax vs. proper motion Dec plots (see Figure 2).
- G-band magnitudes were adjusted using the distance modulus.
- Final candidate members were plotted in a color-magnitude diagram.
- Isochrones (Bressan et al. 2012) were overlaid to determine age based on the turn-off point (see Figure 3).
- Our methods provided similar results to those in the DR2 paper, so we applied these methods to additional clusters.

Sample Color-Magnitude Diagrams

Figure 4. IC 2391.

Figure 5. NGC 2301.

Figures 4 and 5 are color-magnitude diagrams illustrating the turn-off points and subsequent age estimates using Gaia DR2 data.

Selection of Cluster Members NGC 2632 (Praesepe)

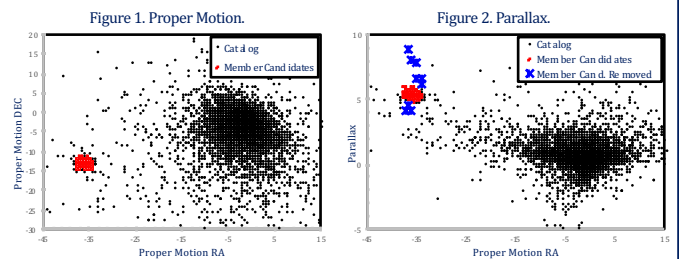Figure 1. Proper Motion.

Figure 2. Parallax.

Figure 1. Since cluster members were formed together, their proper motions are similar. All data were plotted by position to visually determine candidate cluster members.

Figure 2. For further determination of cluster members, parallax was plotted against proper motion. Similarly, members should be clumped in this parameter space.

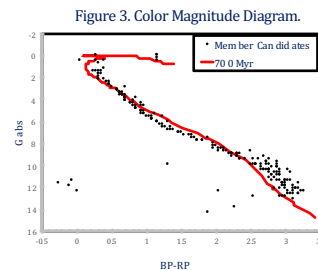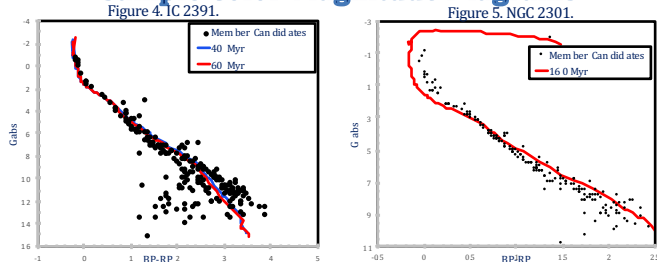Figure 3. Color Magnitude Diagram.

Figure 3. The distance modulus was applied to the G magnitudes before plotting these data against magnitudes of the other two bands (B, R). In this sample plot, we show the PARSECS isochrone (Bressan et al. 2012) corresponding to the age published in the Gaia DR2 paper, 700 Myr.

Preliminary Results

Cluster	Previously Published Age (Myr)	Gaia DR2 Age (Myr)	Our Age Estimate (Myr)
NGC 2632 (Praesepe)	730	708	700
Hyades	790	794	800
IC 2391	46	---	45
NGC 744	177	---	200
NGC 2264	9	---	10
NGC 2301	164	---	170
NGC 2360	560	955	980
NGC 2362	8	---	10
NGC 6242	40	---	75

The improved precision in parallax released in Gaia DR2 provides more accurate age estimates for open clusters.
Future work includes applying this approach to other clusters in the DR2 dataset and determining the effects of reddening and metallicity.

Bressan et al. 2012 MNRAS 427: 127B.   WEBDA (http://webda.physics.muni.cz/ocl_list.html).
Gaia DR2, 2018 A&A 616: A10.