8

Where is the blue straggler?

An analysis of M44 cluster members using color-magnitude diagrams.

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Introduction

An open cluster is a group of stars formed from the same molecular cloud at roughly the same time. They survive for a few hundred million to a few billion years. We have investigated M44, a.k.a. Praesepe or Beehive cluster, which is located 520-610 light years away, is about 740 Myr old and consists of around 750 stars[1]. Besides main sequence stars it also inhibits some red giants and white dwarfs. Moreover, reference is made to the occurrence of a blue straggler[2].

This prompted our research question: ***can we find a blue straggler in M44?***

Blue stragglers appear in Herzsprung-Russell diagram where no stars are expected: on the main sequence beyond the turnoff point of the red giants branch. With their mass, they should have evolved into red giants or white dwarfs long ago. What makes them look younger than they actually are? Nowadays it is widely accepted that a straggler started as a normal, main sequence star, but that it has been 'rejuvenated' during its evolution by acquiring extra mass. This increase may result from two, non-exclusive mechanisms: mass-transfer in a close binary or stellar collisions and merger[3].

Fig. 1: Our field of view of M44. It consists out of 2 seperate frames hereby shown with a dotted gray line in the picture to the right.

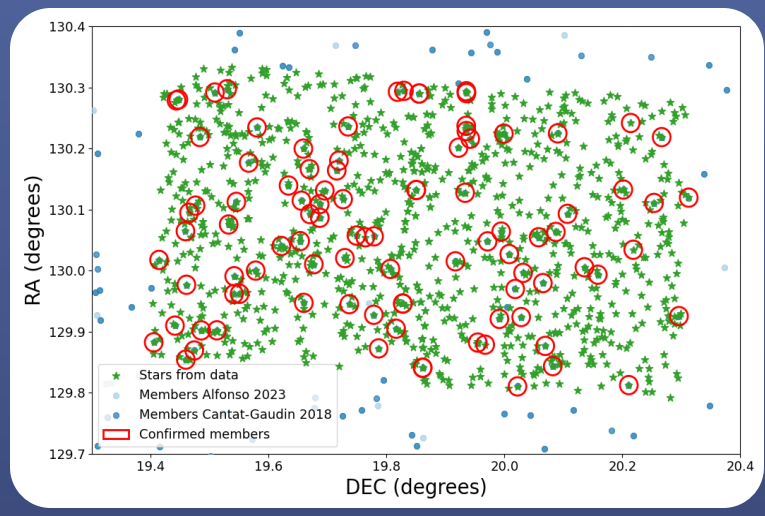

Fig. 2: Identifying the cluster members from our data. We have detected a total of 1078 stars (may include duplicates), of which 91 are members of M44.

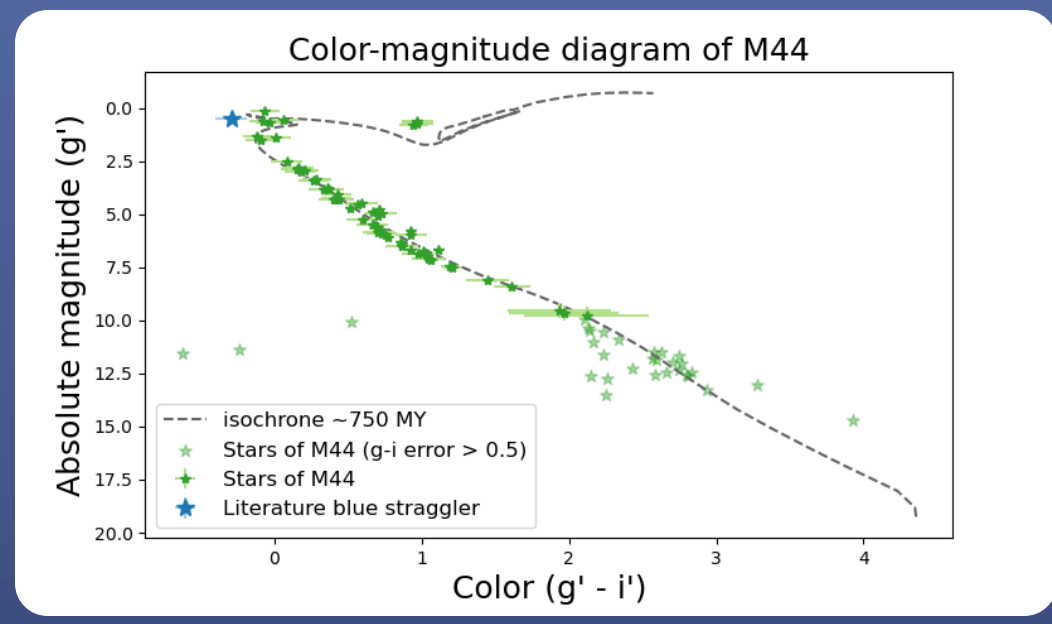

Fig. 3: Color-magnitude diagram containing our cluster stars and an isochrone corresponding to the age of M44 found in literature. In this diagram, a blue straggler has been found, further confirmed in literature[5].

Method

We started by identifying all stars in our two image frames, recorded on two separate nights (March the 6th and 7th, 2024), in the red, green and infrared (r', g' and i') filters (Fig. 1). After identification we picked cluster members from literature[1,4] and cross matched them with our image frames (Fig. 2). Next we had to determine the apparent and absolute magnitudes of our cluster stars. We did this by locating a reference star in each frame and shifting the instrumental magnitude up to the Vega apparent magnitude. Using the parallax values from the Gaia EDR3 and DR2 survey for each cluster star we determined the absolute magnitude of all cluster stars. Afterwards we plotted the absolute magnitudes against an isochrone with an age found in literature[1,5]. We then marked a known blue straggler in our diagram (Fig. 3).

Results & Conclusion

Our color-magnitude diagram (Fig. 3) shows around seven stars turning from the main sequence along the plotted isochrone. Our own isochrone fit agreed with the accepted age of 662 - 800 million years old[1]. The blue star plotted still follows the main sequence line but is outside the isochrone. We can therefore conclude that this star has a high probability of being a blue straggler. This agrees with current research on this star[5] (HD73666). We also found three possible white dwarf candidates (Fig. 3, above the legend). We acquired data of a small portion of M44 so further research could include more data of other parts of the open cluster. Further research could make use of isochrone fitting for membership evaluation.

Video explanation

(1) Alfonso, J. & Garcia-Varela, A.G. ,A&A 677,A163; (2) Lodieu, N. et al., A&A 628, A84; (3) Rain, M.J. et al., A&A 650, A67; (4) Cantat-Gaudin, T. et al., A&A 618, A93; (5) Girardi, L., CMD 3.7 input form, 8/2/2042; (5) L. Fossati et. Al., A&A 510, A8; 6. https://shorturl.at/dp8ac