The star formation history of the young open cluster NGC 2244

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Abstract A star formation history (SFH) is the stellar record of the various processes that shaped a galaxy or an open cluster since its birth to its current physical state. Studying the NGC 2244 cluster, and in particular its massive star population, can improve our understanding of its formation mechanism, stellar evolution, feedback, and provide the basis for a better understanding of the formation of extragalactic star clusters. Probing the initial conditions of star formation (e.g. Initial Mass Function, initial rotation, multiplicity status, initial chemical composition) will allow to derive the birth and early-stage properties (projected rotational velocity distribution, multiplicity status, 3D kinematics, etc.) needed to construct the star formation history of NGC 2244 and to see if a single star-formation mechanism can be responsible for the wide range of properties that we observe for massive stars.

The sample

Our database is a crossmatch between astrometric Gaia DR3 data, spectroscopic Gaia-ESO Survey (GES) data and photometric TESS data. Our sample consists of **59 intermediate and high-mass stars (9 O-type and 50 B-type stars)**. On average, **3 to 5 epochs** are available for each star. The membership determination has been done following the criteria given by [1].

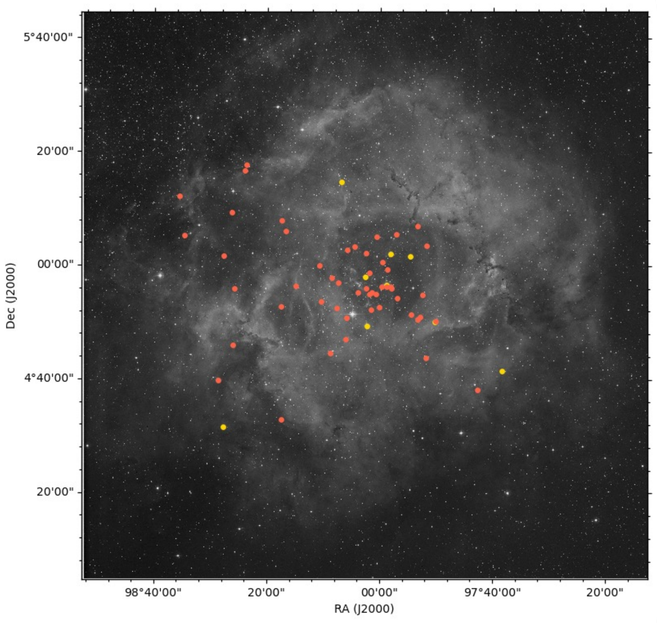
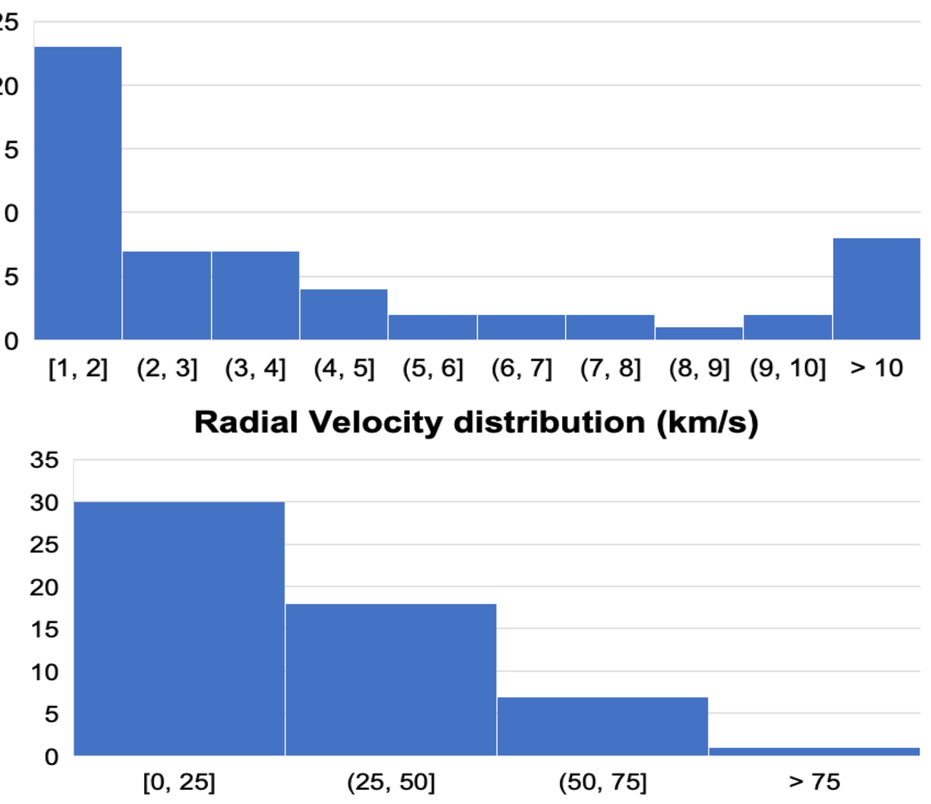


Figure 1 : Representation of the sample on a DSS image of NGC 2244.



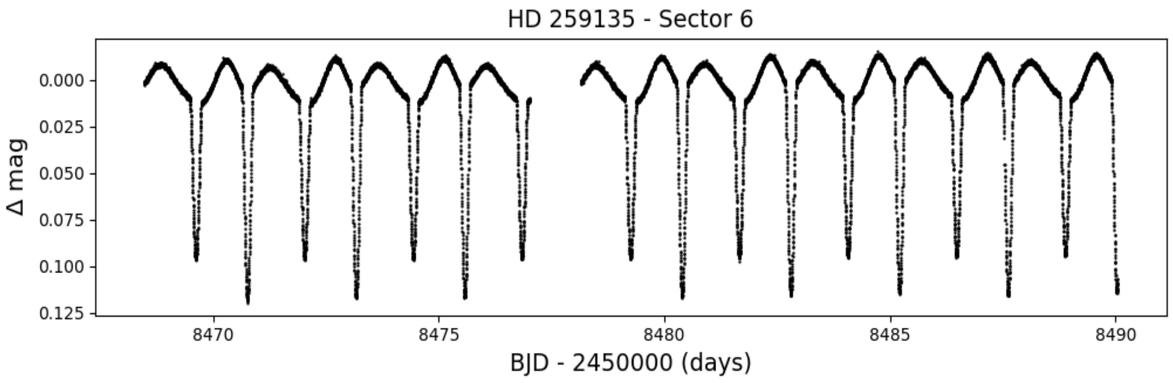


Figure 2 : TESS light curve of HD 259135 obtained during the TESS light curve analysis of this work. This target has been analysed in details by [3].

Multiplicity status

For stars with several available epochs, a first **observed binary fraction** has been drawn by using the statistical criteria of [2] based on radial velocities (RV) that have been measured either using a Gaussian fit or a Cross-Correlation Function (CCF). The use of this criteria led to an observed binary fraction of **~ 60% for O-type stars and ~ 27% for B-type stars**. Those fractions will be corrected for the observational biases to obtain the intrinsic binary fraction. Furthermore, we are examining the TESS light curves to search for possible eclipsing binaries.

Following steps / wider context

After the derivation of the intrinsic binary fraction, spectral disentangling will be applied to binary systems for which enough spectra are available. The stellar parameters (projected rotational velocity, effective temperatures, surface gravities and abundances) will then be derived for all the stars (either single or multiple, making use of the spectral disentangling). Those parameters will be compared to Geneva [4] and/or BONN [5] evolutionary tracks to obtain the predicted ages and initial masses of the stars that will allow to derive the star formation history of the NGC 2244 cluster.

Open questions

The aims of this PhD project are to probe the initial conditions of the star formation inside a set of clusters, notably NGC 2244, and to characterise the nature and the frequency of post-interaction products in order to bring key information to tackle the following questions concerning cluster evolution :

i. How will open star clusters evolve with respect to ages, stellar density and initial conditions ?
ii. Is the projected rotational velocity distribution uniform across open clusters with different ages or is it dependent on other propeties such as the cluster density ?
iii. What are the properties of post-interaction products ? How does that impact the binary fraction ?

References

[1] *Lim, B., et al., 2022, AJ, 163, 266*
[2] *Sana, H., et al., 2013, A&A, 550, 22.*
[3] *Hensberge, H. et al., 2000, A&A, 358, 553*
[4] *Ekström, S., et al., 2012, A&A, 537, A146*
[5] *Brott, I., et al., 2011, A&A, 530, A115*