Massive Stars Near and Far
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Near and far: a hunt for binary-interaction products

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Abstract. Direct observations of the products of binary interactions are sparse, yet they provide important insights on the outcome of the interaction and the physics at play. Young and intermediate-age star clusters are the ideal tool to search for, and characterize such interaction products and allow for a detailed comparison to theoretical predictions. We here report on integral field spectroscopy obtained with MUSE for several such clusters in the Magellanic Clouds.

Keywords. stars: early-type, stars: binaries, galaxies: Magellanic Clouds

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1. Theoretical predictions for stellar populations

Massive stars predominantly live their lives in binary systems in which many are close enough to interact (Sana et al. 2012; de Mink et al. 2014). Depending on the initial orbital parameters, different evolutionary pathways are possible (e.g. Podsiadlowski et al. 1992) which can lead to different end products.

In a given stellar population, the number of interaction products should be signicant. Binary population synthesis studies predict observable characteristics for post-interaction populations: a lower binary fraction, merger products above the cluster turnoff, and a population of rapid rotators (e.g., Wang et al. 2020).

2. Star clusters as laboratory to study pre- and post-interaction populations

To assess initial multiplicity properties and binary parameter distributions, B-star populations in young clusters including NGC 6231 (Banyard et al. 2022) in the Milky Way and 30 Doradus (Dufton et al. 2013; Dunstall et al. 2015) in the Large Magellanic Cloud (LMC) were studied. The number of interaction products is, however, predicted to peak in intermediate-age clusters such as the 35 Myr-old cluster NGC 330 in the Small Magellanic Cloud. The different host metallicities make a direct comparison of the observed clusters to theoretical predictions difficult. This will be remedied by a new, homogeneous set of MUSE observations of several clusters at LMC metallicity spanning an age range from 20 to 40 Myr (Fig. 1).

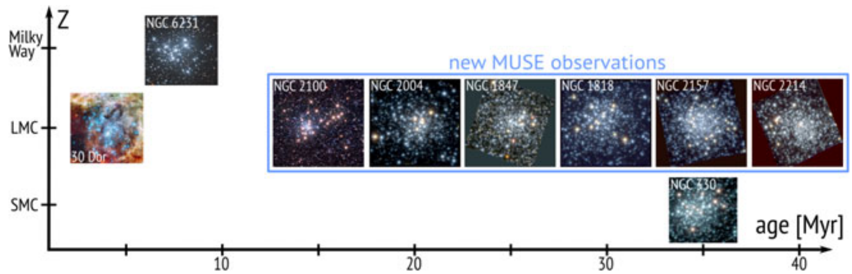

Figure 1. Observations of young massive star clusters in the Milky Way and the Magellanic Clouds.

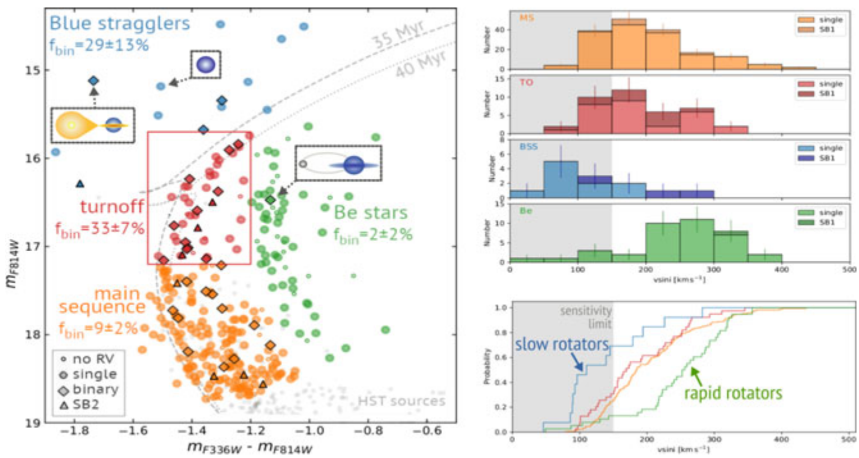

Figure 2. Observed binary fraction and rotational velocities in different CMD regions.

3. NGC 330 - a pilot study

Using six epochs of observation with integral-field spectrograph MUSE at the VLT we extract spectra of > 350 stars (Bodensteiner et al. 2020b), measure radial velocities and compute the bias-corrected binary fraction (Bodensteiner et al. 2021). With additional HST photometry (Milone et al. 2018) and TLUSTY atmospheric models (Lanz & Hubeny 2007) we estimate effective temperatures, surface gravities and rotational velocities for 200 B and Be stars (Bodensteiner et al. in prep.).

The fraction of Be stars (which are often interpreted as mass gainers in binary interactions, e.g. Pols et al. 1991; Bodensteiner et al. 2020a) is >30%, and even >50% around the cluster turnoff. The overall bias-corrected binary fraction is f_{bin}=34±8%. The color-magnitude-diagram (CMD) shows that the observed binary fraction varies strongly as a function of CMD position, as expected for a population of post-interaction stars. Additional interaction products could be the slowly rotating single blue stragglers, possible merger candidates (see Fig. 2).

4. Conclusions

The new MUSE observations of six intermediate-age LMC clusters will allow us to search for binary interaction products, to map global properties (f_{bin}, rotational velocity distribution, Be star fraction) as a function of cluster age, and to test binary population synthesis predictions.

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