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Title	Extended Main-sequence Turnoff as a Common Feature of Milky Way Open Clusters
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(Georgy et al. 2014) and have metallicity, $Z = 0.014$, and similar age, distance modulus, and reddening as those listed in Table 1. Unfortunately, rotating models are not available for stars less massive than $\sim 1.7 M_{\odot}$. We note that, while in young clusters like NGC 2287 and NGC 2099 both fast rotators and slow-rotator stars are needed to reproduce the broad MS, the eMSTO of old clusters seems consistent with fast rotators alone. The poor quality of the fit could be due to the modeling of several second-order parameters that characterize the end of the core hydrogen burning phase, including the parameterization of the inclination angle, which strongly affects the stellar luminosity and effective temperature (see D’Antona et al. 2015 for details). Nevertheless, the comparison between data and simulations corroborates the conclusion that stellar rotation is mainly responsible for the observed eMSTOs and the broadened MSs.

5. Summary and Discussion

We have presented the first analysis of 12 open clusters in the Milky Way in the context of multiple stellar populations. Our results suggest that the multiple photometric sequences observed by *Gaia* in the CMDs of these nearby objects belong to the same phenomenon present in MCs clusters, and interpreted as due to stellar rotation and/or age spreads.

Since the early discoveries, the eMSTOs have been considered a common feature of the CMDs of LMC and SMC clusters younger than ~ 2.5 Gyr whereas the CMDs of Galactic open clusters were thought to be similar to simple isochrones. This picture has been challenged by the recent findings of eMSTOs in four Galactic open clusters younger than ~ 1 Gyr, namely NGC 2099, NGC 2360, NGC 2818, and NGC 6705 (Bastian et al. 2018; Marino et al. 2018a).

We exploited the *Gaia* DR2 to analyze the CMDs of 12 Galactic open clusters younger than ~ 1.5 Gyr. We carefully separated cluster stars from field stars by using proper motions and parallaxes from *Gaia* DR2 and corrected the photometry of clusters members for differential reddening. We find that all the analyzed clusters show the eMSTO. In addition, all the clusters younger than ~ 700 Myr exhibit a broadened upper MS, whereas the bottom of the MS is narrow and well defined. The appearance of certain photometric features depending on age is similar to that observed in MCs clusters.

We statistically subtracted field stars with cluster-like proper motions and parallaxes from the CMD of candidate cluster stars, thus demonstrating that eMSTOs and broadened MSs are not due to residual contamination from field stars. We calculated for each cluster the synthetic photometry of a simple population of stars with the same age, metallicity, binary fraction, and observational errors. The comparison between the observations and the simulated CMDs reveals that the eMSTOs and the broadened MSs are due neither to observational uncertainties nor to unresolved binaries. These facts demonstrate that eMSTOs and broadened MSs are intrinsic features of the CMDs of the analyzed open clusters.

To investigate the physical mechanisms that are responsible for the eMSTO, we first compared the CMDs of cluster members with isochrones with different ages. The eMSTOs of the analyzed open clusters are consistent with stellar populations with different ages in close analogy with what has been observed in MC clusters with similar ages. The FWHM of the age spread ranges from about 70 Myr in the ~ 150 Myr old cluster NGC 3114 to ~ 260 Myr in ~ 1.1 Gyr old NGC 5822.






Interestingly, the derived age spread correlates with the cluster age, with old clusters having on average larger age spread than young clusters. A similar trend between the FWHM of the age distribution and the cluster age is present among Magellanic-Cloud clusters and is interpreted as an evidence that rotation is mainly responsible of the eMSTO. Indeed, in a simple stellar population, fast rotators appear younger than coeval non-rotating stars with the same age.

We compared the CMDs of cluster members with synthetic diagrams derived from Geneva models and find that the eMSTOs and the broadened MSs are consistent with coeval stellar populations with different rotation rates. These findings suggest that rotation is mainly responsible for the eMSTOs and the broadened MSs observed in Galactic clusters, and this corroborates direct spectroscopic evidence that stars with different rotation rates populate the eMSTOs of NGC 6705 and NGC 2818 (Bastian et al. 2018; Marino et al. 2018b) and that the blue and the red MS of NGC 6705 are populated by slow rotators and fast rotators, respectively (Marino et al. 2018b).

Our investigation of 12 Galactic open clusters demonstrates that the eMSTO and the broadened MS are not a peculiarity of MC star clusters but are common features of Galactic open clusters. Coeval stellar populations with different rotation rates are likely responsible for the eMSTO and the broadened MS of the analyzed clusters.

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