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Inferring the sub-stellar and stellar initial mass function of nearby young moving groups

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Based on astrometry and photometry from Gaia Data Release 3 (GDR3), we identified five known Nearby (< 200 pc) Young (< 100 Myr) stellar co-Moving Groups identifying 186 new candidate members. We inferred their Initial Mass Function in the mass range from $0.04 M_\odot$ up to $5 M_\odot$, and considered for recovery and contamination rates. Our preliminary results show that those IMFs are more consistent with a single stellar IMF with characteristic masses around 0.08 $M_\odot$, smaller than the typical 0.2 $M_\odot$ expected for a system-IMF.

The solar neighborhood is populated with Nearby (< 200 pc) Young (< 100 Myr) stellar co-Moving Groups (NYMG; e.g. Torres et al. 2006; Gagné & Faherty 2018; Kerr et al. 2021. Although their origin is a matter of debate, their ages are expected to be one order of magnitude smaller than their dynamical timescales around the Galaxy, supporting the idea of these groups as remnants of stellar populations scattering across the galactic disc.

The NYMGs are ideal candidates for the observational study of the Initial Mass Function (IMF) not only due to their proximity and low extinction but also because their youth guarantees that only their most massive stars have evolved out of the main sequence. This implies that their mass distribution should be similar to their IMF in most of the stellar and sub-stellar mass ranges. However, only a few determinations of the IMF of these groups have been carried out (e.g. Gagné et al. 2017). This is primarily due to the observational challenge posed by their wide spatial distribution, a direct consequence of their proximity, as well as a significant contamination of the samples by field stars.

We used the DBSCAN algorithm on the five-dimensional space of Galactic Cartesian position and tangential velocities in the Local Standard of Rest (LSR) of all the stars from GDR3 (Gaia Collaboration et al., 2023) to identify members from five known NYMGs: β-Pictoris, Tucana-Horologium, TW-Hya, Collinder and PL8.

We used of a model of the Gaia Object Generator (GOG, Antiche et al. 2014) to model the distribution of the field stars in order to quantify the statistical significance of our detection. This synthetic model together with simulated NYMGs allowed us to quantify recovery and contamination rates. Finally, we used Bayesian inference to estimate the masses of both detected and synthetic stars, and to estimate recovery and contamination rates per mass bin. This method led us to a preliminary determination of the IMF for the detected groups in the mass range $0.04 < M/M_\odot < 5$.

We found a total of 186 new candidate members for the studied NYMGs whose membership requires spectroscopic confirmation in future studies. Additionally, we found that the inferred IMFs are more consistent with a single stellar IMF with a characteristic mass close to 0.08 $M_\odot$, smaller than the typical 0.2 $M_\odot$ of a system-IMF.

Improvements in our methods to estimate and correct incompleteness and contamination rates are part of an ongoing project toward a more robust determination of the IMF in several NYMGs.

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