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A non-universal IMF in the Milky Way

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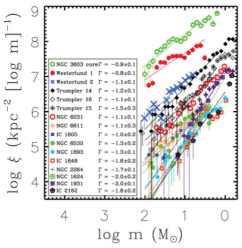
Current status of the observations

We do not know the initial stellar mass function in every corner of the Galaxy or inside every other galaxy where stars are forming, but from the little we know, there is no strong evidence that it is invariant. Some examples:

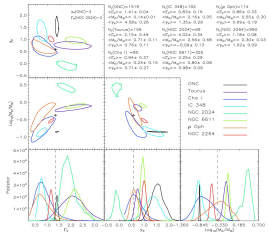
Current limitations in IMF studies

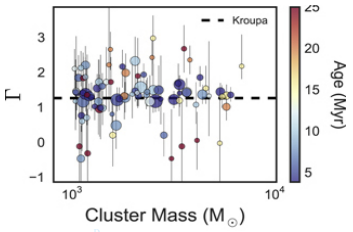
- Small number of clusters, when in reality 10000-100000 clusters (depending on the clusters mass range, shape of the initial cluster mass function, and the Galactic SFR) are forming in the MW per cycle of 10-12 Myrs.
- Mostly low mass clusters (i.e., small number of stars).
- Poor estimates and account of all the uncertainties.

→ Need a different approach



Milky Way clusters: Lim et al. (2015)


Milky Way clusters: Dib (2014)



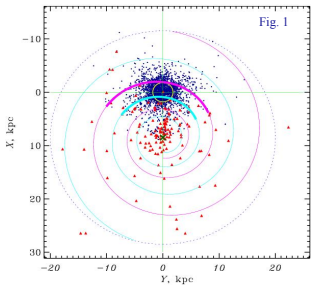
M31 clusters: Weisz et al. (2015)

A new approach: Matching the observed fraction of isolated O stars in clusters with Monte-Carlo models – Dib, Schmeja & Hony (2017)

Observations: MWSC survey

The Milky Way Stellar Cluster (MWSC) survey (Kharchenko et al. 2013, Fig.1) contains 342 clusters that could, based on their age harbour O stars.

- The fraction of single (i.e., unique in the cluster) O stars ($M_* > 15\ M_{sol}$) is ~13 %
- The fraction of lonely O stars (single+absence of massive B stars) is ~ 4 %



Monte-Carlo models

- Measure how much stellar mass is formed in the Galaxy per cycle = lifetime of a 15 M_{sol} star
- Distribute this mass on stellar clusters for a given initial cluster mass function (ICLMF) characterized by lower/upper limits and a power low exponent.
- For each cluster of a given mass, select the combination of parameters of the IMF for a TPL function and draw (system) stellar masses.
- Assign ages to clusters that are randomly drawn from the age distribution of young clusters in the MWSC survey

Applying corrections to synthetic clusters

- For each system mass in the cluster, assign a binarity probability (calibrated from observations)
- For each binary system, assign the mass of the binary and secondary (calibrated from observations)
- Apply a correction for stellar evolution, i.e, massive primaries and secondaries whose ages are less than the assigned age of the cluster are removed from the statistics
- Correct the cluster mass function for completness, using the content in low mass B stars.
- Correct for runaway O stars

→ Measure the fractions of single and lonely stars

We test various families of the distribution functions of the IMF parameters (Fig. 2)

Going from universal set of parameters (i.e., delta functions) to broad Gaussian distributions

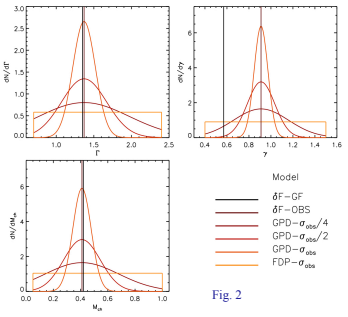


Fig. 2

Main result

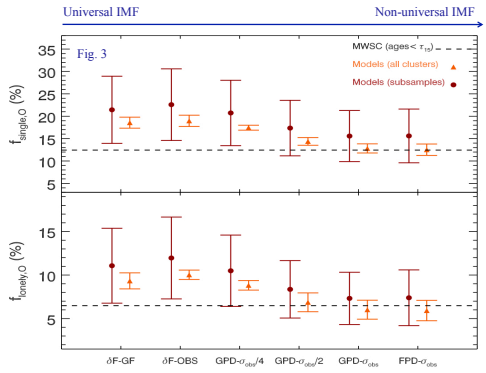


Fig. 3. Comparison of the fractions of single and lonely O stars in the observations (dashed-lines) and in the models. The yellow points are measurements using the entire ensemble of clusters in the cluster mass function (The ones that pass the filter of the completness correction). Each point and error bar are the mean value and standard deviation using 27 sampling of the ICLMF.

The purple points show the grand mean (mean of the 27 mean values) and grand standard deviation (mean of the 27 measured standard deviations) when randomly drawing 10000 subsamples of clusters that each contain 342 clusters (equal to the observational sample size) from each of the 27 samplings of the ICLMF.

Conclusion: observations of single and lonely stars in the MWSC survey are reproduced only when the parameters of the IMF have broad distributions. The required intrinsic dispersions of the parameters are:

$$\sigma_\Gamma = 0.6 \quad \sigma_\gamma = 0.25 \quad \sigma_{M_{ch}} = 0.3 M_{sol}$$

References

Dib, S. 2014, MNRAS, 444, 1957
Dib, S., Schmeja, S., Hony, S. 2017, MNRAS, 464, 1738
Kharchenko et al. 2013, A&A, 558, 54
Lim, B et al. 2015, IAU Symp.316
Weisz, D. et al. 2015, ApJ, 806, 198

Further related readings

Dib, S., Kim, J., Shadmehri 2007, MNRAS, 381, 40
Dib, S., Shadmehri,, M., Padoan, P. et al. 2010, 405, 401