Constraining the intermediate-mass range of the Initial Mass Function using Galactic Cepheids.

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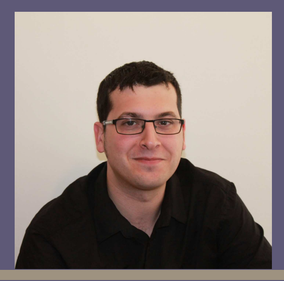
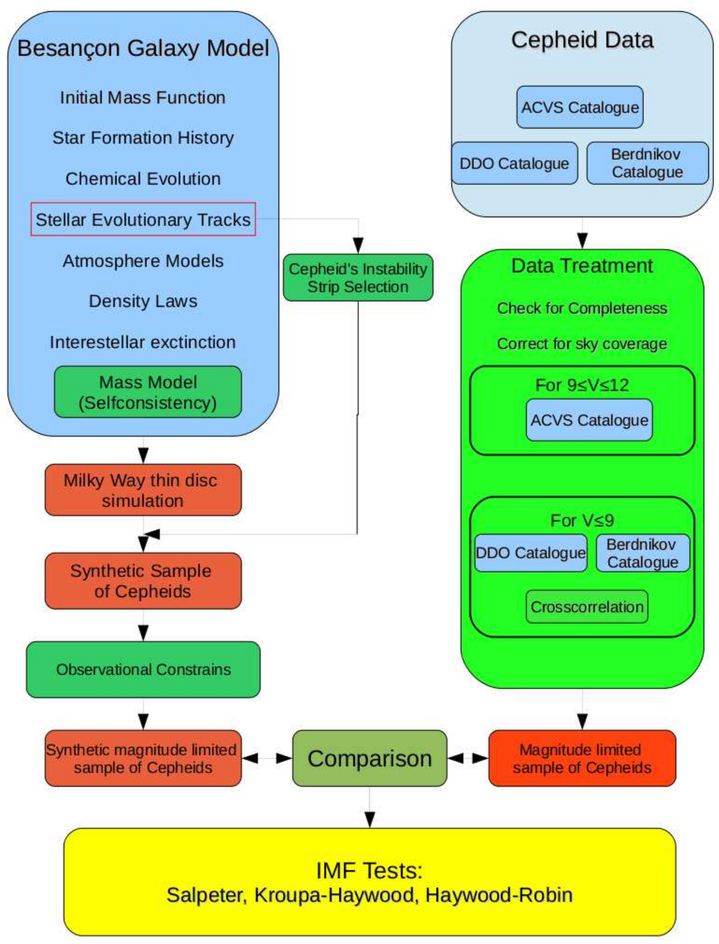


Abstract

Aims. To use the Besançon Galaxy Model and the most complete observational catalogues of galactic Cepheids to constrain the intermediate-mass range of the Initial Mass Function in the Milky Way Galactic thin Disc.
Methods. We have optimized the flexibility of the new Besançon Galaxy Model (Czekaj et al., 2014) to simulate magnitude and distance complete samples of young intermediate mass stars assuming different IMFs and Star Formation Histories (SFH). Comparing the simulated synthetic catalogues with the observational data we studied which IMF reproduces better the observational number of Cepheids in the Galactic thin Disc.
We analysed three different IMF: (1) Salpeter, (2) Kroupa-Haywood and (3) Haywood-Robin IMFs with a decreasing SFH from Aumer and Binney, 2009.
Results. For the first time the Besançon Galaxy Model is used to characterize the galactic Cepheids. We found that for most of the cases the Salpeter IMF overestimates the number of observed Cepheids and Haywood-Robin IMF underestimates it. The Kroupa-Haywood IMF, with an slope $\alpha = 3.2$, is the one that best reproduces the observed Cepheids. From the comparison of the predicted and observed number of Cepheids up to V=12, we point that the model might underestimate the scale height of young population. The effects of the variation on the model ingredients needs to be quantified.
Conclusions. In agreement with Kroupa and Weidner (2003) our study shows that the Salpeter IMF ($\alpha = 2.35$) overestimates the star counts in the range $4 \leq M/M_{\odot} \leq 10$ and supports the idea that the slope of the intermediate and massive stars IMF is steeper than the Salpeter IMF .

Global Strategy

We tested three different IMFs, comparing a synthetic magnitude limited sample of Cepheids with an observational magnitude limited sample.

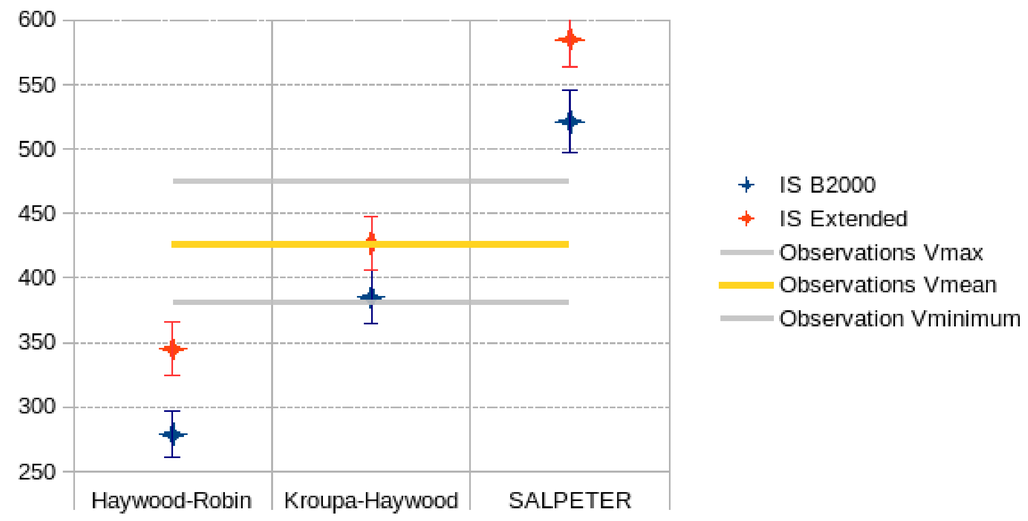


This scheme shows our strategy. Left side indicates the process used to create the synthetic sample using BGM. In the right the process to obtain the observational sample of Cepheids is shown.

Salpeter IMF overestimates the number of stars in the intermediate-mass range

$$dN/dm = \xi(m) = km^{-\alpha} = km^{-(1+x)}$$

Haywood-Robin IMF (Haywood et al 1997 and Robin et al. 2003) underestimates the total number of Galactic Cepheids. Salpeter IMF (Salpeter 1955) overestimates it and Kroupa-Haywood IMF produces of the order of the total counts of observed Cepheids.



The figure shows Cepheids counts comparison between simulations an observations.

The IMF in range $\sim 4M_{\odot}$ to $\sim 10M_{\odot}$ points towards Kroupa-Haywood IMF. ($\alpha = 3.2$)

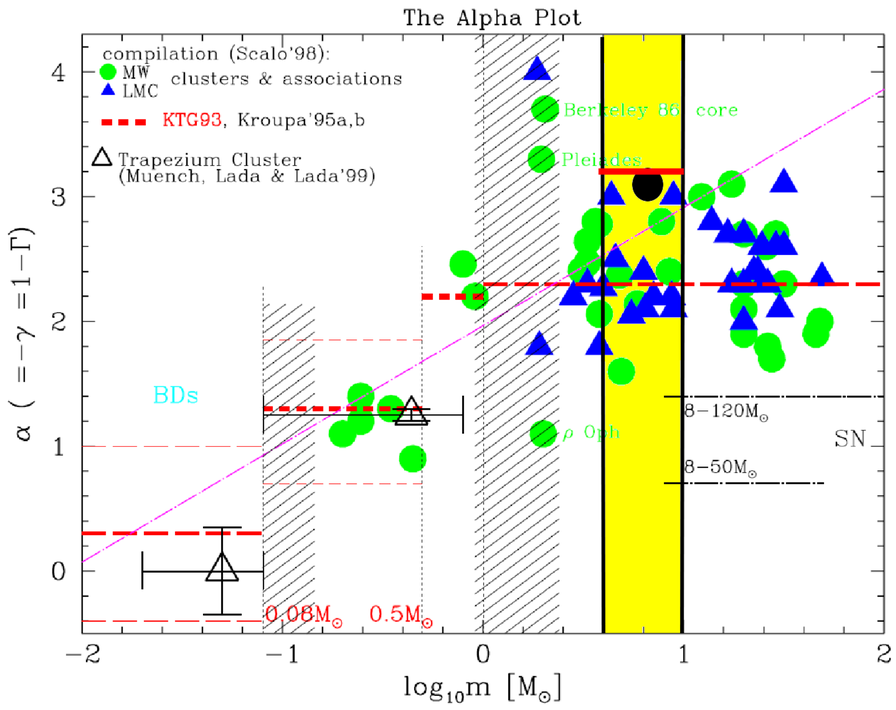
- V_{mean} is the mean apparent magnitude of a Cepheid along its period.
- V_{max} is the apparent magnitude at maximum Brightness.
- $V_{minimum}$ is the apparent magnitude at minimum Brightness.

In the figure we can see a comparison between the simulations and the observations for the total number of Cepheids up to magnitude $V \leq 12$. We used 3 different IMFs and two different boundaries of the Instability Strip.

- IS-Extended; the Extended Instability strip uses a boundaries from Fiorentino (private communication).
- IS-B2000;the Instability Strip B2000 uses the boundaries of Bono et al., 2000.

The slope of the best IMF is in the upper limit

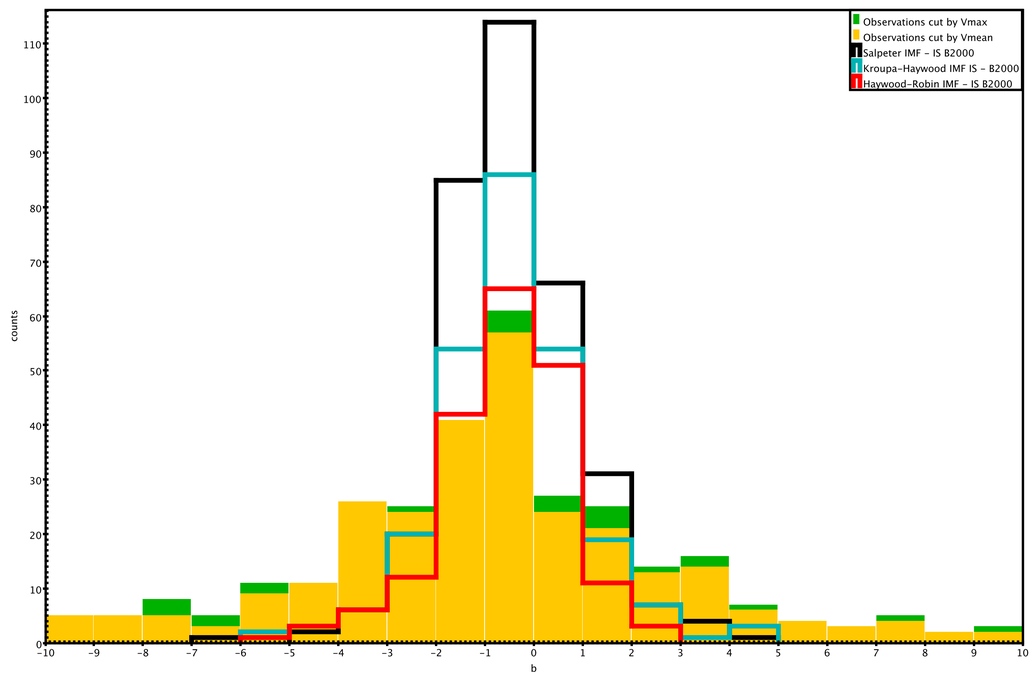
Including our results in the alpha-plot for Kroupa, 2002, we can see how inside the mass range from $\sim 4M_{\odot}$ to $\sim 10M_{\odot}$, our result falls in the upper limit region.
The slope of the Kroupa-Haywood Initial Mass function is $\alpha = 3.2$.



Our resulting slope ($\alpha = 3.2$) is shown as a red horizontal line within the yellow region , and the limits of the studied mass range (from $\sim 4M_{\odot}$ to $\sim 10M_{\odot}$) is marked with black vertical lines.

Improvements on BGM: The scale height of Besançon Galaxy Model are detected to be underestimated

It can be noticed that the latitude distribution is higher for the observations than for the simulations. This phenomena can be seen perfectly in the figure where it can be appreciated that the simulated Cepheids are more concentrated and decays faster with b. This phenomena could be caused because the BGM underestimates the values of the scale heigh for the galactic young thin disc.



Number of Cepheids as a function of galactic latitude.

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