Study of the thick disc of the Milky Way from a population synthesis model

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Abstract

We use a population synthesis model (the Besancon Galaxy model Robin et al (2003)) with recently added stellar evolution models (Lagarde et al. (2017)) to constrain the thick disc structure and formation history using as fitting method the Markov Chain Monte Carlo method (MCMC) on the 2MASS photometric survey.

Introduction

The thick disc is a major component of the Milky Way but its epoch of formation and characteristics are still not yet well constrained. The BGM is a population synthesis model based on a scenario of formation and evolution of the Galaxy, a star formation history, and a set of stellar evolution models. Thanks to the work of Lagarde et al. 2017, new evolutionary tracks have been introduced into the Besancon Galaxy Model (STAREVOL Charbonnel & Lagarde 2010 and Lagarde et al 2012) to provide global asteroseismic and surface chemical properties along the evolutionary stages. Those new evolutionary tracks will help us to constrain the thick disc parameters.

Methodology

Our work follows the method described in Robin et al (2014). We fit thick disc parameters on photometric observations, varying the thick disc parameters (scale length, height, flare parameters and the age distribution). The thick disc parameters are constrained by maximizing the likelihood using a MCMC scheme : the log of the reduced likehood (Lr) is computed using eq. 1

$$Lr = Nstars_{simulated} - Nstars_{observed} + Nstars_{simulated} \times log(\frac{Nstars_{observed}}{Nstars_{simulated}}) \quad (1)$$

Observations

In order to constrain the thick disc and halo structures and formation history, we need to choose wisely our observations. We need a wide survey, in thick disc dominated area. For those reasons, we chose 80 2MASS intermediate and high latitude fields of 16sq deg each. Those fields are shown on figure 1.

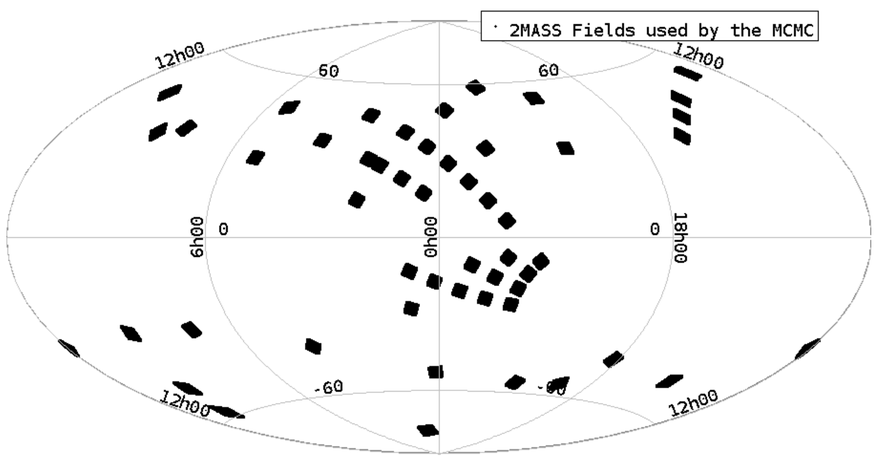

FIGURE 1 – 2MASS (in black) and fields used to adjust the simulations

Preliminary results

Except for the flare, the thick disc parameters seem to be always the same.the thick disc parameters generally converge towards the same values from one run to another, indicating a good convergence. Figure 2 is an example of this convergence for the thick disc scale length. Those results can be biased by the choice of thin disc or halo parameters, which are fixed during the fit. We need extended observations at lower latitudes, and at fainter magnitudes. Figure 3 is an example of a color magnitude diagram for CFIS data and two different thick disc and halo.

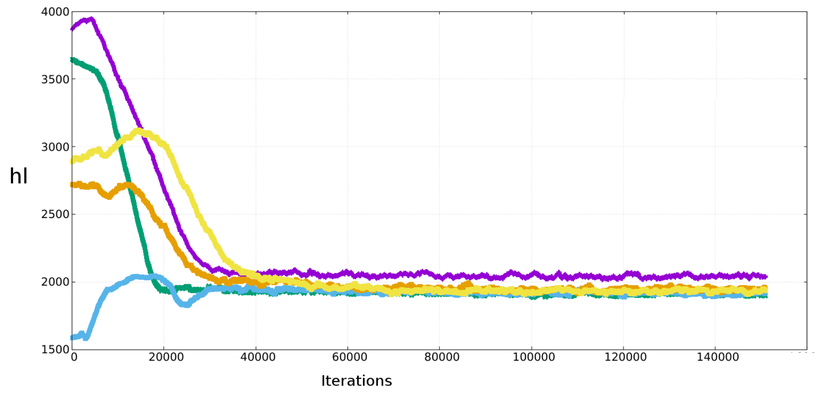

FIGURE 2 – Evolution of the thick disc scale length during the MCMC fitting process, for 5 MCMC independent runs. The scale length converges at about 2000 pc after 40 000 iterations.

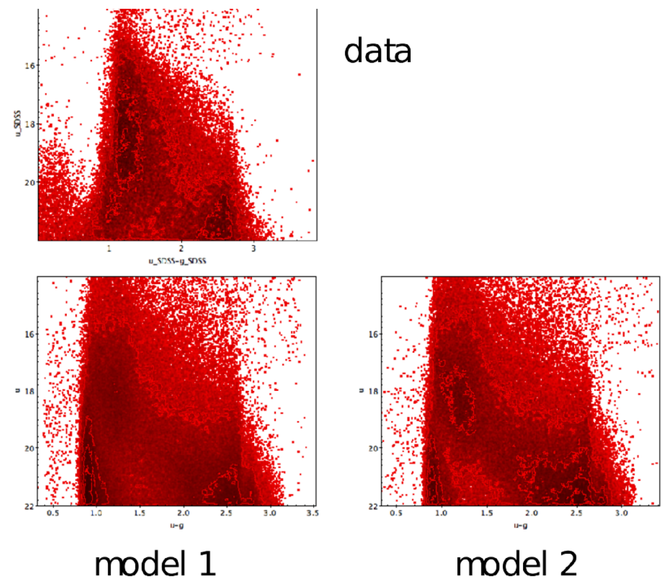

FIGURE 3 – color-magnitude diagrams of CFIS data (upper panel) and 2 simulations (lower panels) assuming different star formation scenarios for the thick disc and halo.

Perspectives

New surveys

We only have constrained the thick disc with mid low latitude 2MASS fields. We shall incorporate new observations from CFIS survey at CFHT (Ibata et al, 2017 submitted) , and from PanStarrs (Chambers et al 2017). Those surveys will be usefull to constrain the halo parameters.

APOKASC

The APOKASC catalog is a combination of spectroscopic informations, chemical abundances from APOGEE and asterosismic parameters from Kepler (Pinsonneault et al. 2014). We shall explore the reliability of the new model to improve the scenario of the formation of the thick disc.

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