Rediscovering our Galaxy
Proceedings IAU Symposium No. 334, 2017
C. Chiappini, I. Minchev, E. Starkenburg & M. Valentini, eds.

doi:10.1017/S1743921317006846

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

G. Nasello, A. C. Robin, C. Reylé and N. Lagarde

UTINAM Institute, University of Bourgogne-Franche-Comté, UMR CNRS 6213, 41 bis avenue de l'Observatoire BP 1615 25010 Besançon Cedex

Abstract. 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 Besançon Galaxy Model (BGM, Robin *et al.* 2003) 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 Lagarde *et al.*(2017), new evolutionary tracks have been introduced into the Besancon Galaxy Model (STAREVOL, Lagarde *et al.* 2012) to provide global asteroseismic and surface chemical properties along the evolutionary stages. This updated Galaxy model will allow us to constrain the thick disc structure and history using the Markov Chain Monte Carlo fitting method (MCMC). We show preliminary results applying this MCMC method on the 2MASS photometric survey.

Keywords. Galaxy: disk, Galaxy: stellar content

1. Introduction

Due to the particular location of the sun, it is difficult to constrain the Milky Way galactic disc. Yet, we know since Gilmore & Reid (1983) that there are two distinct disc populations. An old thick disc and a young thin disc. The nature of the thick disc, its history and relation with the thin disc are not well known and debated. In this work, we try to constrain the thick disc structure and age distribution with the help of a Markov Chain Monte Carlo method (MCMC). Those constraints should give us clues to improve our understanding of the thick disc.

2. Overview

Our work follows the method described in Robin *et al.*(2014). We fit photometric observations varying thick disc parameters in the simulations. The fitted parameters are the thick disc scale length (between 1500 and 4000 pc), scale height (between 250 and 1200 pc), flare slope (between -0.1 and 0.1), flare radius (between 0 and 16000 pc) and the relative density per age bin (between 0 and 6). We assume that the thick disc covers the age range from 8 to 12 Gyrs and attempt to derive the relative density in 8 age bins of 0.5 Gyr width.

Compared to Robin *et al.*(2014), we use, instead of isochrones made with Bergbush's stellar model (Bergbush & Van den Berg, 1992), a stellar grid computed with SATREVOL. This grid allow us to test multiple thick disc's ages distributions that give us a more realistic view of our galaxy than a simple single age population. In addition, STAREVOL gives us many parameters not present in Bergbush's isochrones (e.g. asteroseismic parameters, chemical properties).

We compare our simulations with 80 2MASS intermediate and high galactic latitude fields of 16 sq deg each.

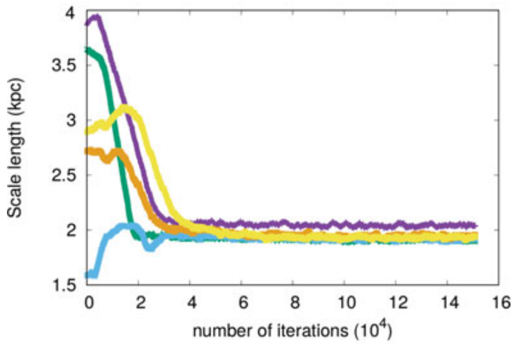

Figure 1. Evolution of the thick disc scale length during the MCMC fitting process, for 5 MCMC independent runs with randomly chosen initial values. The scale length converges at about 2 kpc after 40 000 iterations.

The thick disc parameters are constrained by maximizing the Log of the reduced likehood (see eq. 2.1. N_{sim} and N_{obs} are the number of simulated and observed stars in a given color magnitude bin.) using a MCMC scheme. Starting with randomly chosen parameters within fixed boundaries, we use a MCMC fitting method, selecting the set of parameters according to their likelihood.

$$Lr = N_{sim} - N_{obs} + N_{sim} \times log(\frac{N_{obs}}{N_{sim}}) \tag{2.1}$$

We still need to make assumption on a few thick disc parameters that can not be changed by our MCMC. The results presented here are obtained with a fixed thick disc's average metallicity of -0.5 dex and a standard deviation of 0.3 dex. The initial mass function (IMF) is also fixed. It is planned to run MCMC on simulations with differents thick disc IMF and metallicty to observe their impact.

Focusing on 2MASS survey allow us to test the thick disc without having to constrain the halo (its contribution is negligeable in 2MASS fields). However the lack of high latitude deep magnitude fields can bias the results obtained.

Except for the flare, the thick disc parameters generally converge towards the same values from one MCMC run to another, indicating a good convergence. Figure 1 is an example of this convergence for the thick disc scale length. Each iteration starts with random initial values of the parameters to fit. For each of them, scale length converges towards 2 kpc which is in agreement with values found in Robin *et al.*(2014), Bensby *et al.*(2011) and Cheng *et al.*(2012).

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https://doi.org/10.1017/S1743921317006846 Published online by Cambridge University Press