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Mapping the inner stellar halo of the Milky Way from 2MASS and SDSS-III/APOGEE survey

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Abstract

The Besançon Galaxy model (BGM) is used to compare the infrared colour and [M/H] metallicity distributions of stars with those from 2MASS and APOGEE observations taking the selection function of the data into account, across a large volume of the inner part of the Galaxy. For this purpose we model the mass density distribution of the inner stellar halo by a 6-parameters double power-law model, and reconstruct the behaviour of the rotation curve in the inner part of the Milky Way.

1. Introduction

To perform detailed studies on the kinematics of stars in the Milky Way and its components, as well as to interprete the upcoming six-dimensional phase-space data set produced by the Gaia space mission, a more elaborated description of the Galactic potential of the Milky Way is required. With this purpose, and taking advantage of the well described density profiles for each component of the Besançon Galaxy model (Robin & Crézé, 1986a, 1986b; Bienaymé, Robin & Crézé 1987, Robin et al. 2003, 2012, 2014), a three dimensional model for the gravitational field for the inner part of the Milky Way, is currently assembled and modeled (Fernández-Trincado et al., 2015a, 2015b, in preparation) and will be tested using the available surveys (2MASS and APOGEE DR12).

2. Methodology

In this study we choose a modified double power-law density model (Zhao 1997) to model the density profile of the inner stellar halo of the Milky Way. The density law is given in Eq. 1:

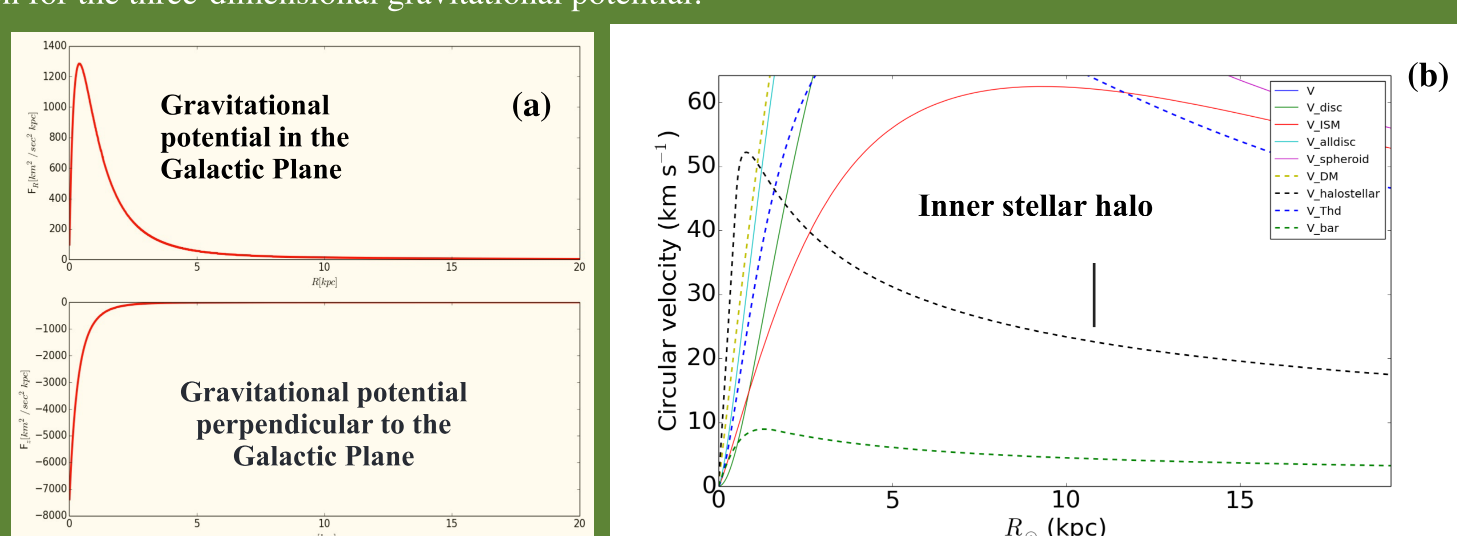
$$\rho(r)=\rho_0\left(\frac{r}{r_{core}}\right)^{-\gamma}\left[1+\left(\frac{r}{r_{core}}\right)^{\alpha}\right]^{(\gamma-\beta)/\alpha} \qquad (1)$$

with r = $\{X^2 + (Y^2/p) + (Z/q)^2\}^2$. Then, ($p=1$, q , α, β, γ, r_{core}, ϱ_0) are fitted to the set of data with which the model predictions are going to be compared. An analysis of 2MASS+SDSS photometric data (Robin et al, 2014) lead to an oblate spheroid with q=0.77. A re-analysis of the same data with this modified law gave the same flattening. We considere APOGEE DR12 data to map the inner part of the Galaxy. The halo stars can be selected using metallicities [M/H] < -1.0 dex. We use these data to study the transition between both power-laws (Fernández-Trincado et al. 2015a, in prep)

3. Preliminary result: Rotation curve for the inner stellar halo

We approximate the density profile given by Eq. (1), by a superposition of homogeneous spheroids (e. g. Schmidt et al. 1956, Pichardo et al. 2014), to construct an analytic expression for the three-dimensional gravitational potential.

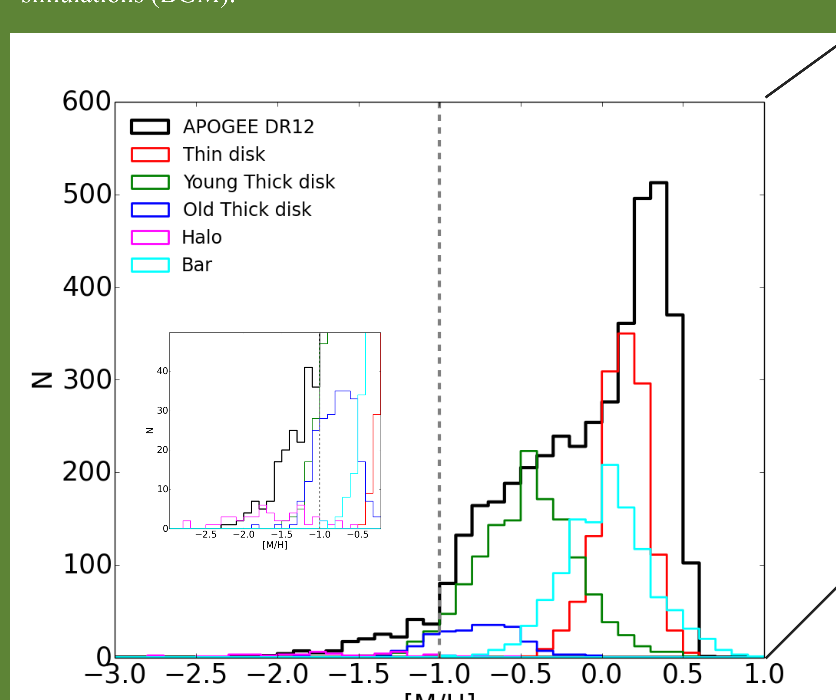
Fig. 1: The gravitational field produced by the mass density distribution in Eq. (1) is shown in panel (a), and by clarity only the force fields produced by the inner stellar halo is shown (red line - panel a). The circular velocity along of the Galactic plane is shown in panel (b) for the inner stellar halo (dashed black line).



4. On-going work

Figure 2 shows the metallicity distribution function (MDF) for 45 Apogee fields (see Fig. 3) and the simulated regions that have been surveyed in spectroscopy. The BGM is used with the assumed mass density distribution presented by Robin et al. (2014). However, this density profile does not reproduce the number of stars observed beyond [M/H] < -1 dex (black MDF in Fig. 2) for the inner part of the Milky Way. Currently we are fine tuning the parameters of the mass density distribution given in Eq (1), using our model and comparing predictions with metallicity data to the existing SDSS-III data of the central region of the Galaxy.

Fig.2: Metallicity distribution for APOGEE DR12 compared with model simulations (BGM).



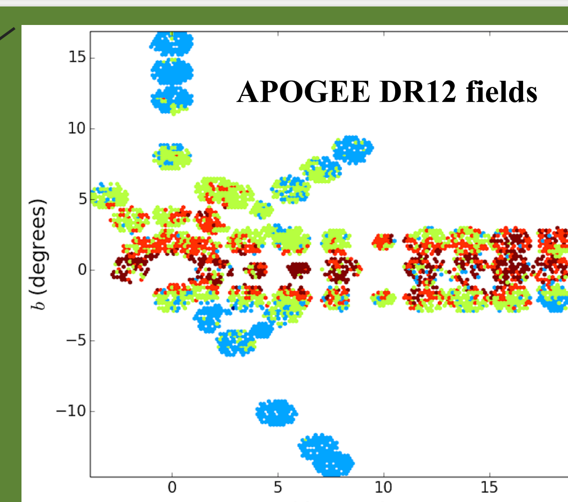


Fig. 3: Spatial distribution of 45 APOGEE DR12 fields used in our analysis. The colour coding corresponds to the extinction (AKs) from Schlegel map.

Acknowledgments

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