Spectroscopic survey of Thick Disc stars outside the Solar neighborhood

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Abstract: Vertical gradients in Galactic spatial structure, kinematics and metallicity are crucial ingredients of models of Galaxy formation. The goal of this survey is to study the formation history of the Thick Disc through the detection and the characterization of possible stellar sub-populations. We present here the kinematics and the metallic properties of a large sample of stars towards the Galactic coordinates l~270°, b~47°. Stars far from the Galactic plane, are found to have a rotational velocity V ~ - 80 km/s, with a typical Thick Disc metallicity of ~ -0.4 dex, compared to the old Thin Disc which is found at [M/H] ~ -0.1 dex. In addition, an over-density of stars having -1.5 < [M/H] < -0.8 dex lying between 0.8 < *Z* < 2 kpc is found.

1. The *VLT-FLAMES* sample:

A sample of ~700 F/G stars with 14 < m_V < 18.5 has been observed towards the galactic coordinates l~270°, b~47° (see **Fig. 1**). The *LR08* set up of the *ESO VLT GIRAFFE* instrument has been used to obtain low resolution spectra (*R ~ 6500*) in the infrared CaII triplet region. We have derived the heliocentric radial velocities of all the targets having a sufficient signal-to-noise ratio (S/N), for which the proper motions of *Ojha et al. (1996)* are also available. The MATISSE algorithm was then used to obtain atmospheric parameters, from which we have derived the distances, the Galacto-centric positions and velocities.

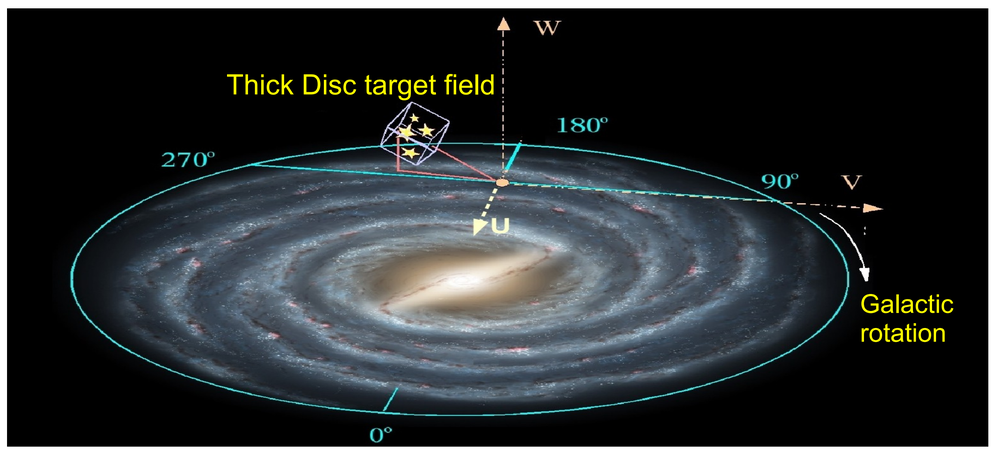

Figure 1: Scheme of the position of the observed field.

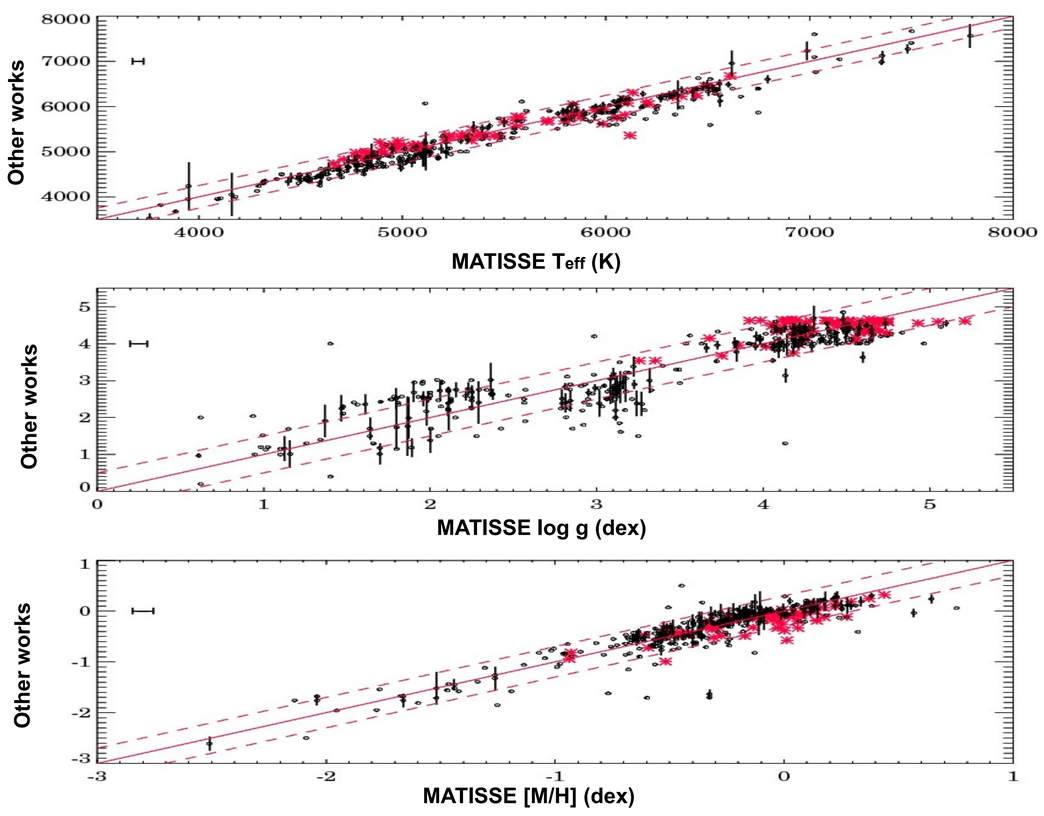

Figure 2: Comparison with the literature of the MATISSE stellar parameters estimates for stars of the *S⁴N* library (red asteriscs) and the *CFLIB* one (black dots) for *S/N* ~100. The typical relative errors of MATISSE are represented in the upper left part of each plot. The red dashed diagonal lines represent errors of +/- 250K, 0.5 dex and 0.3 dex for *Teff*, *log g* and [M/H], respectively.

2. The derivation of the atmospheric and orbital parameters:

The MATISSE algorithm (*Recio-Blanco et al., 2006*) has been adapted and trained for the *LR08* setup of *FLAMES*. MATISSE is a local multi-linear regression method that allows the determination of a stellar parameter (*Teff, log g,* [M/H]) by a simple projection of an observed spectrum on vectors derived during a learning phase. The typical accuracy in the derivation of *Teff, log g and* [M/H] for a solar-type star is, respectively, *100 K, 0.2 dex, and 0.15 dex* for spectra with a S/N~20.
MATISSE has been tested on two standard star libraries, the *S⁴N* (*Allende Prieto et al., 2004*) and the *CFLIB* (*Valdes et al., 2004*) showing a good agreement with the published values (see **Fig. 2**). These tests show that our procedure does not suffer of any biases even at low [M/H].
From the derived atmospheric parameters, the stellar distances have been estimated with the *Y²* isochrones (*Yi et al., 2001*), following the method of *Breddels et al., (2010),* with an estimated mean error of 25%. Finally, using these distances, we were then able to derive the Galacto-centric positions X,Y,Z and velocities U,V,W as well as the angular momenta and the stellar eccentricities.

3. Results:

In the **Fig. 3** below, we show the metallicity values plotted versus the *Z* distance above the Galactic plane. The Thin Disc stars (selected as having *Z* < 700 pc) have a mean [M/H] ~ *-0.1 ± 0.1 dex*, and the Thick Disc stars (selected as having 2 < Z < 4 kpc) have [M/H] ~ *-0.4 ± 0.2 dex*. An over-density of stars lying between 0.8 < *Z* < 2 kpc is found, having -1.5 < [M/H] < -0.8 dex. These stars are not clumped in the *Toomre* diagram, as we can see in **Fig. 4**, neither on any other parameter space (see *Kordopatis et al. 2010,* for more details). Finally, in **Fig. 5**, we show the stellar *V-velocity* distribution (towards Galactic rotation). We separated our sample into the stars being closer and farther than 800 pc from the Galactic mid-plane and compared the observations (red histogram) with the predictions of the *Besançon's* model (*Robin et al., 2003*). Whereas a rather good agreement is found for the stars close to the plane (dominated by the Thin Disc), the ones being farther are found to have a rotational lag of V ~ -80 km/s. This lag is greater than the canonical Thick Disc (~ -50 km/s), giving thus more evidence of the lower angular momentum Thick Disc population already identified by *Gilmore et al. (2002)* .

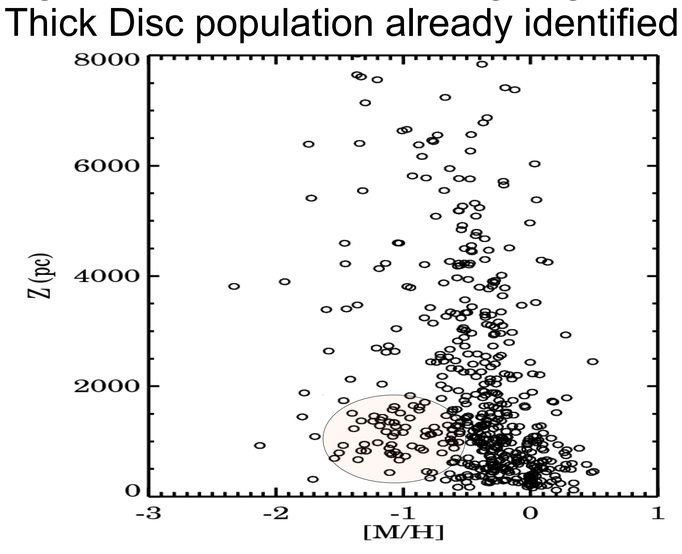

Figure 3: An overdensity of stars is found between 0.8 < Z < 2 kpc, having -1.5 < [M/H] < -0.8 dex. Thin Disc stars are found at [M/H] ~ -0.1 dex, and the canonical Thick Disc at [M/H] ~ -0.4 dex.

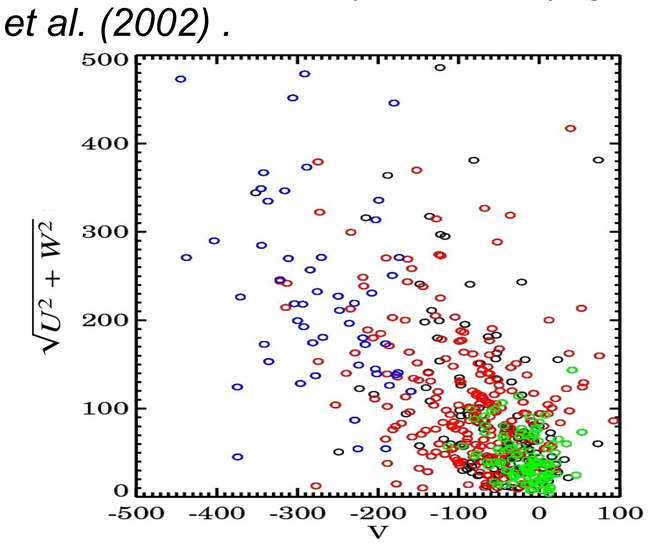

Figure 4: *Toomre* diagram of the observed targets. Thin Disc, Thick Disc and Halo candidates are plotted in green, red and blue respectively. Black circles represent targets which were not considered when characterizing these Galactic components.

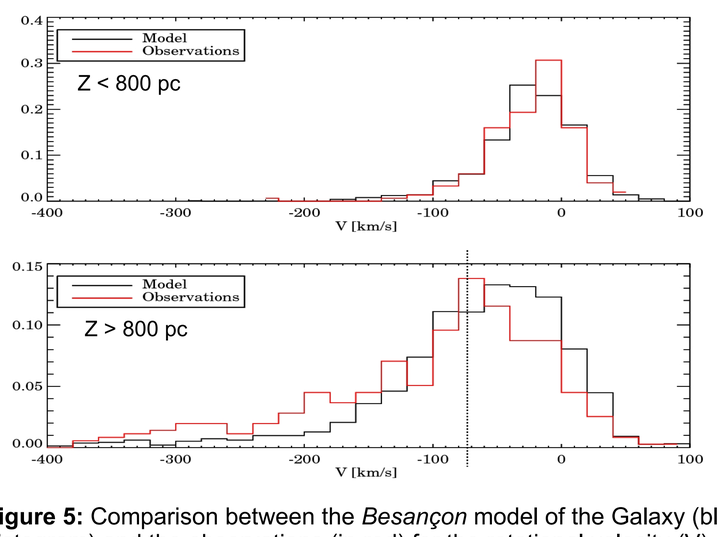

Figure 5: Comparison between the *Besançon* model of the Galaxy (black histogram) and the observations (in red) for the rotational velocity (V). Stars lying farther than 800 pc from the plane lag more than the canonical Thick Disc, having a peak at V ~ - 80 km/s

Summary:

- The MATISSE algorithm has been developed in order to treat spectra in the *LR08* setup of *FLAMES*, and derive automatically the metallic properties of our targets.
- Thin Disc stars are found at [M/H] ~ *-0.1 ± 0.1 dex* and the Thick Disc at [M/H] ~ *-0.4 ± 0.2 dex*
- An over-density of stars is found between *0.8 < Z < 2 kpc*, having *-1.5* < [M/H] < *-0.8 dex.*
- Stars far from the Galactic plane are lagging the *LSR* by *80 km/s* which is not in agreement with the values of the canonical Thick Disc lag.

References:
Allende Prieto et al. 2004, A&A, 420, 183
Breddels et al. 2010, A&A, 511, A90+
Gilmore, Wyse & Norris 2002, ApJL, 574,L39
Kordopatis et al. 2010, in prep.
Ojha et al. 1996, A&A, 311,456
Recio-Blanco, Bijaoui & de Laverny, 2006, MNRAS, 370,141
Robin et al. 2003, A&A, 409, 523
Valdes et al. 2004, ApJS, 152, 251
Wyse et al. 2006, ApJ, 639,L13
Yi et al. 2001, ApJS, 136, 417