Modelling the chemical evolution of the Milky Way thick and thin discs

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Introduction

Recently, many spectroscopic surveys have been developed in order to study the formation and evolution of the Milky Way: Gaia-ESO (Gilmore et al. 2012), APOGEE (Majewski et al. 2015), AMBRE Project (de Laverny et al. 2013).

By means of detailed chemical evolution models it is possible to predict the chemical abundances expected in stars of each Galactic components.

The Milky Way has four main stellar populations: halo, bulge, thick and thin discs.

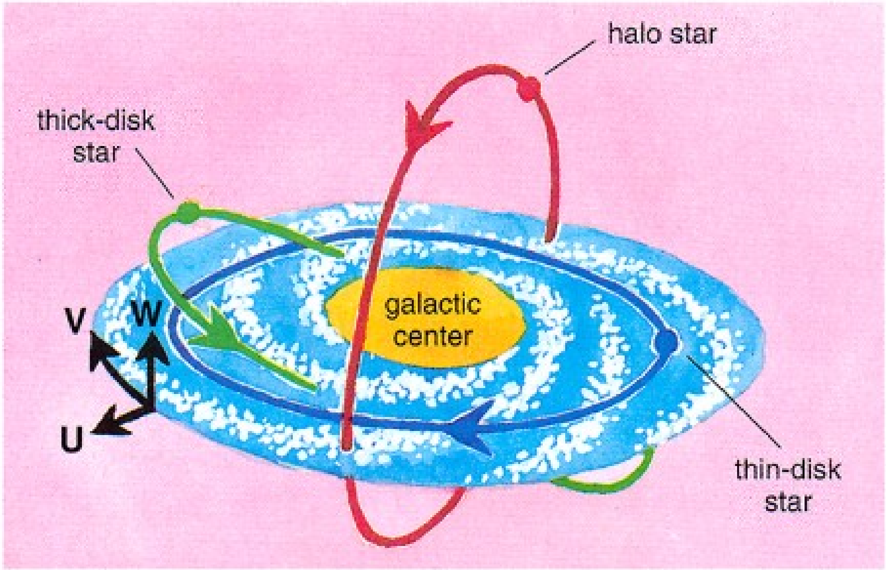
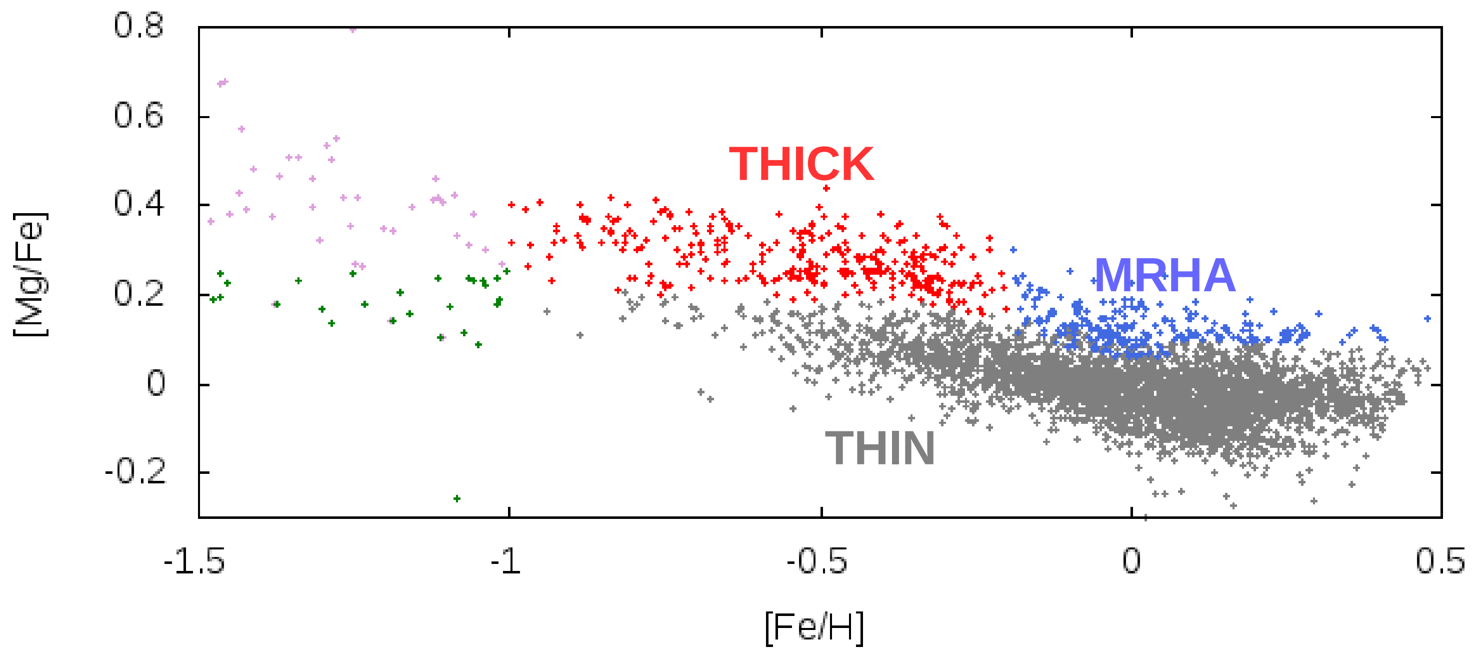


Illustration credit: Chiappini (2001).

Observational data

AMBRE data (Mikolaitis et al. 2017) show that in the abundance patterns of the α-elements there are two distinct sequences corresponding to **thick** and **thin** disc stars, and also a further metal-rich high-α **MRHA** population.



Observed [Mg/Fe] vs. [Fe/H] from Mikolaitis et al. (2017), where

$$[A/H] = log(N_A/N_H)_\star - log(N_A/N_H)_\odot$$

Chemical evolution models

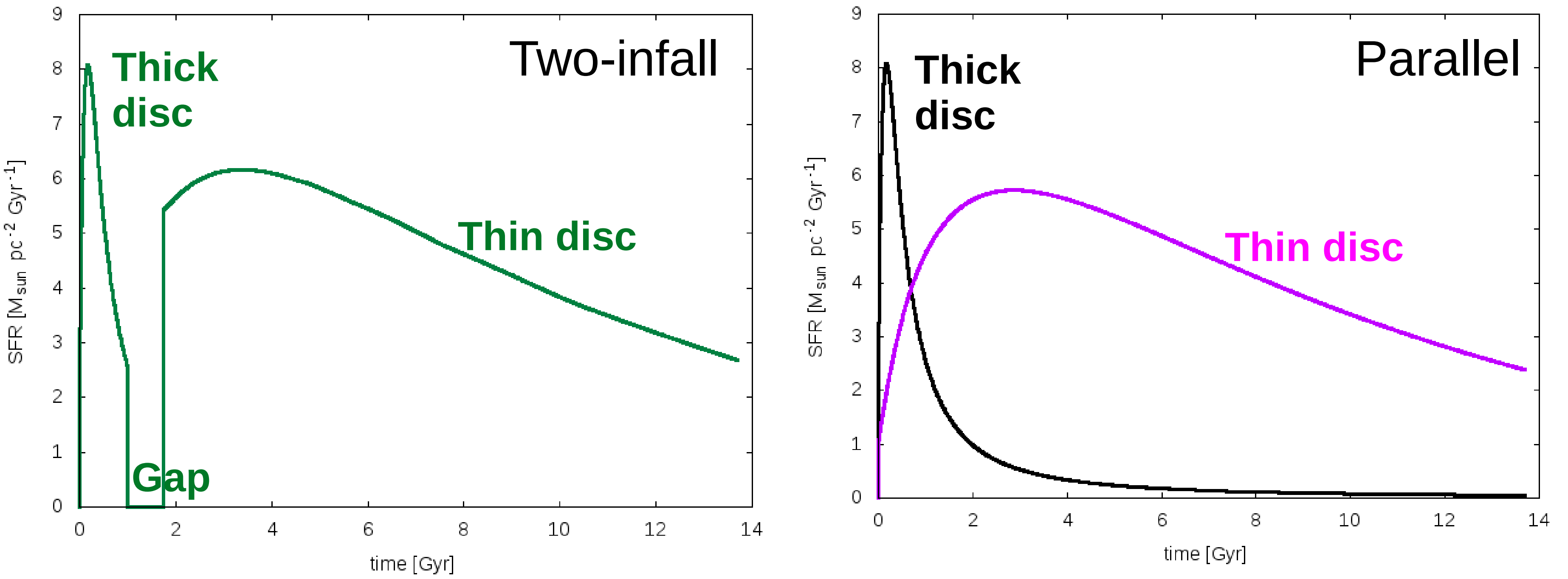
In Grisoni et al. 2017 (in press by MNRAS),

we model the thick and thin disc evolution by adopting two different chemical evolution approaches:

i) a revisited two-infall approach (Chiappini et al. 1997; Romano et al. 2010);

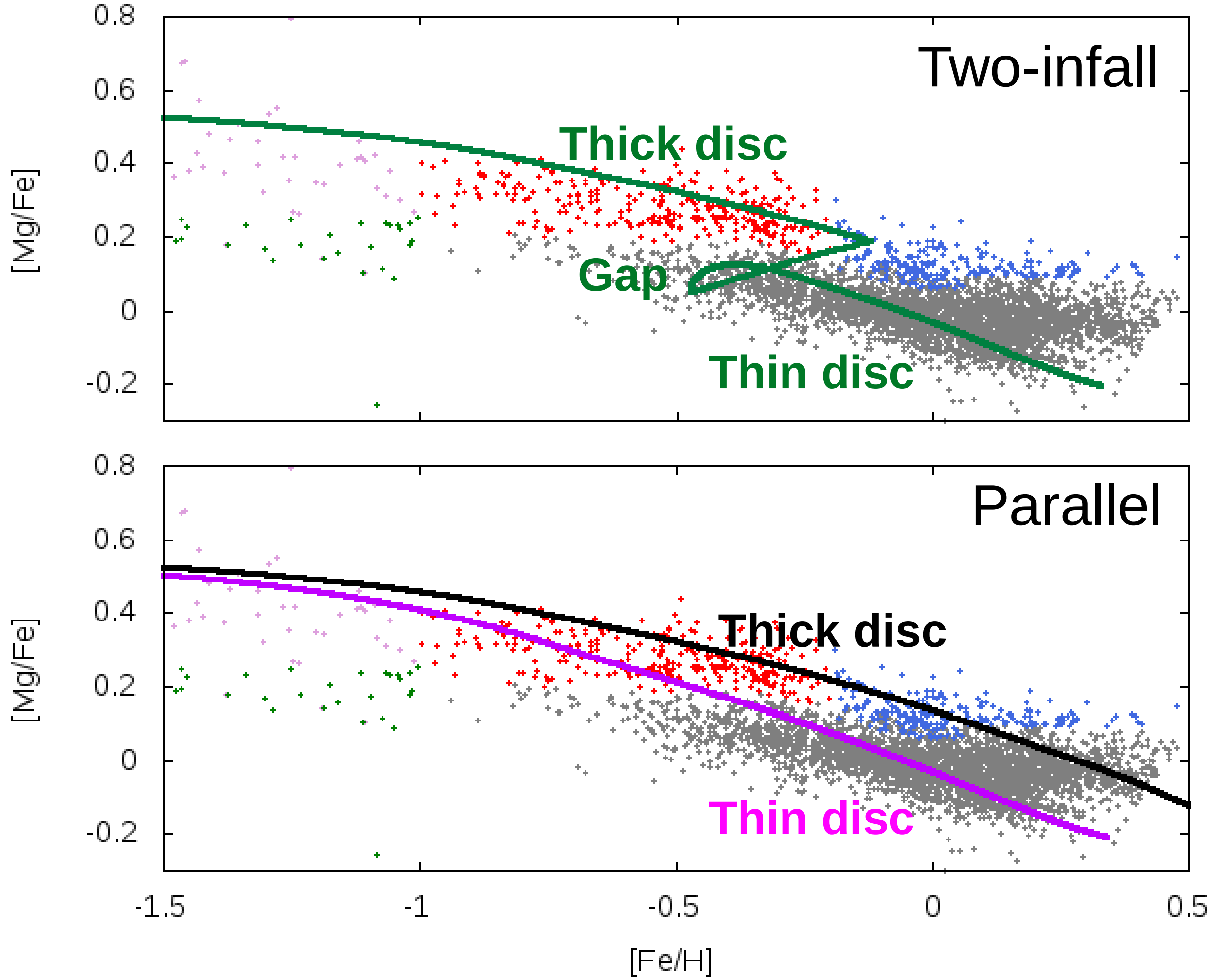
ii) a new parallel approach.

Results of Grisoni et al. 2017: i) star formation history



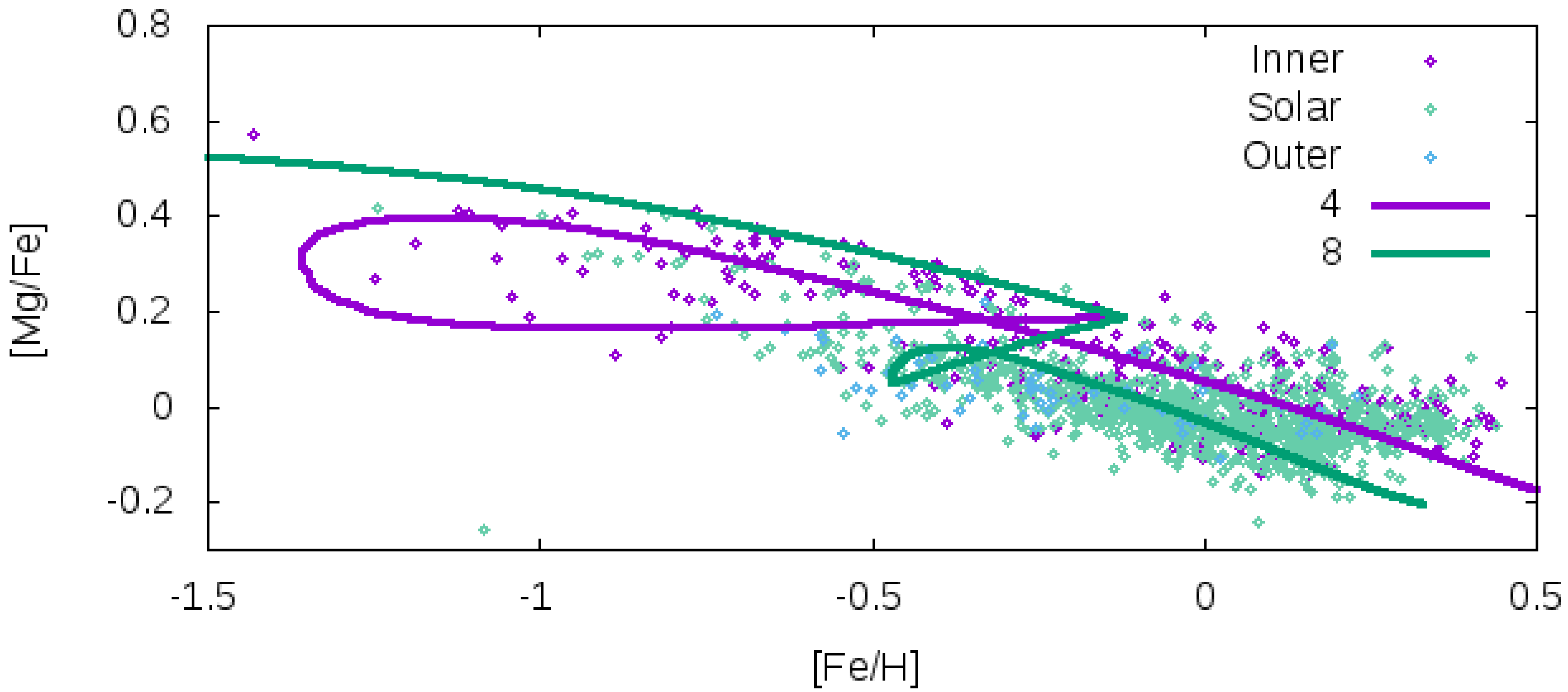
Temporal evolution of the star formation rate
for the two-infall model (left) and the parallel model (right).

ii) abundance patterns



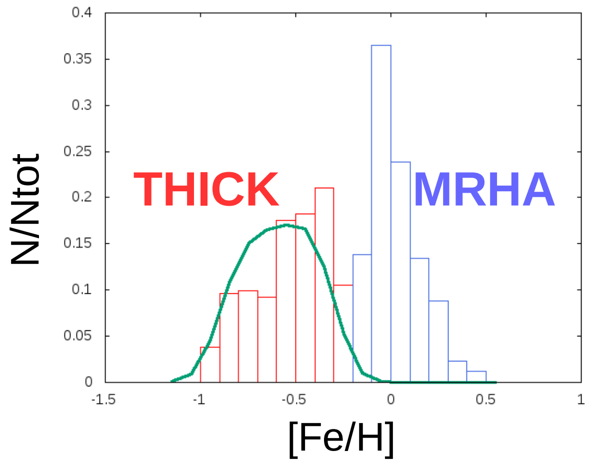
Observed and predicted [Mg/Fe] vs. [Fe/H]
for the two-infall model (upper panel) and the parallel model (lower panel).

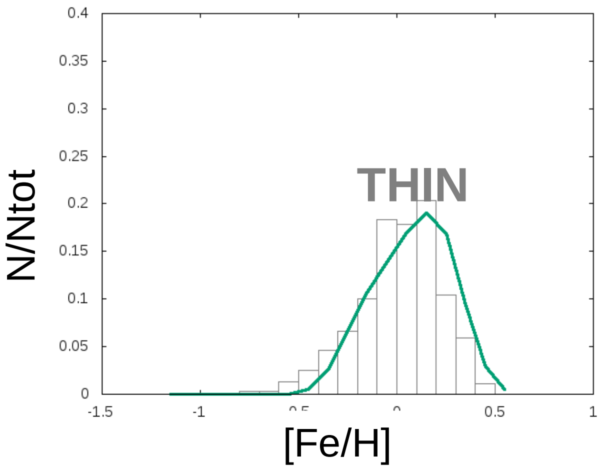
The only way to interpret the MRHA stars in terms of the two-infall model is by assuming radial migration, i.e. stars moving from other Galactocentric radii.



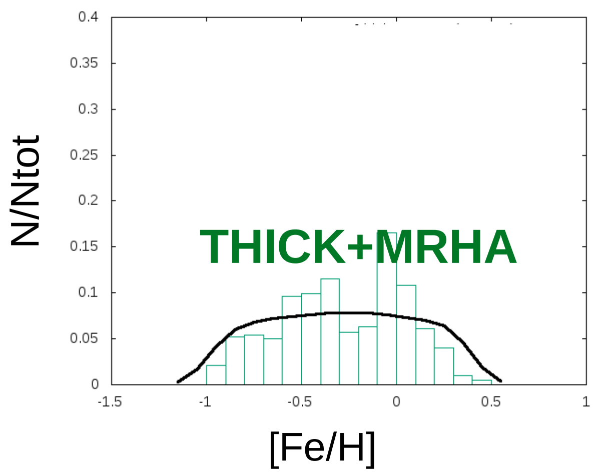
Observed and predicted [Mg/Fe] vs. [Fe/H] for the two-infall model at various Galactocentric radii (inside-out scenario).

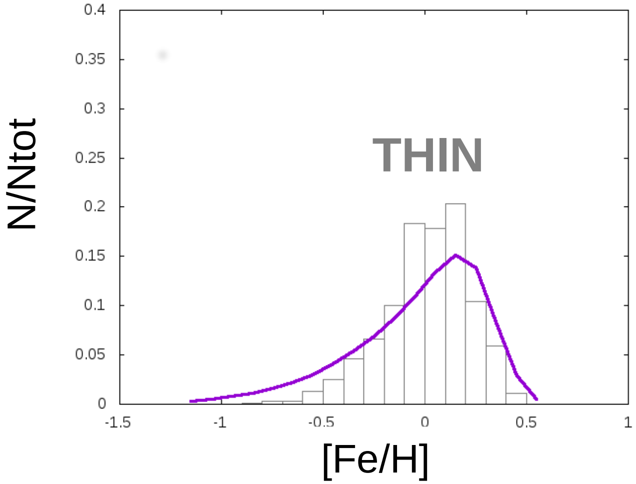
iii) metallicity distribution function





MDFs observed and predicted by the two-infall model.





MDFs observed and predicted by the parallel model.

Summary and conclusions

In Grisoni et al. 2017, we study the formation and chemical evolution of the Milky Way thick and thin discs with respect to the recent AMBRE data. We adopt two different approaches to model the thick and thin disc evolution:

i) a two-infall approach: it cannot explain the metal-rich α-enhanced stars, unless they are the result of stellar migration;

ii) a parallel approach: it can fit the metal-rich α-enhanced stars, as metal rich thick disc stars.

In both approaches, the thick disc has formed on a timescale of 0.1 Gyr, whereas the thin disc formed in 7 Gyr in the solar region. A fundamental difference between the two cases is that in the two-infall there is a gap in star formation between the thick and thin discs at variance with the parallel.

Forthcoming data from Gaia mission will be fundamental to further constrain the disc formation and evolution.