Study of the stellar populations of the Milky Way in CFHTLS fields

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Brief summary

Aim : To obtain new constraints on the thick disc and then to generate a new model of the thick disc.

To improve our knowledge of the thick disc formation.

Method : We use new data of the CFHTLS and simulations obtained with the Besançon model.

We analysed the metallicity distribution perpendicular to the galactic plane.

Results : The data do not confirm the standard thick disc either in Hess diagrams or metallicity distributions.

Canada-France-Hawaii Telescope Legacy Survey (CFHTLS)

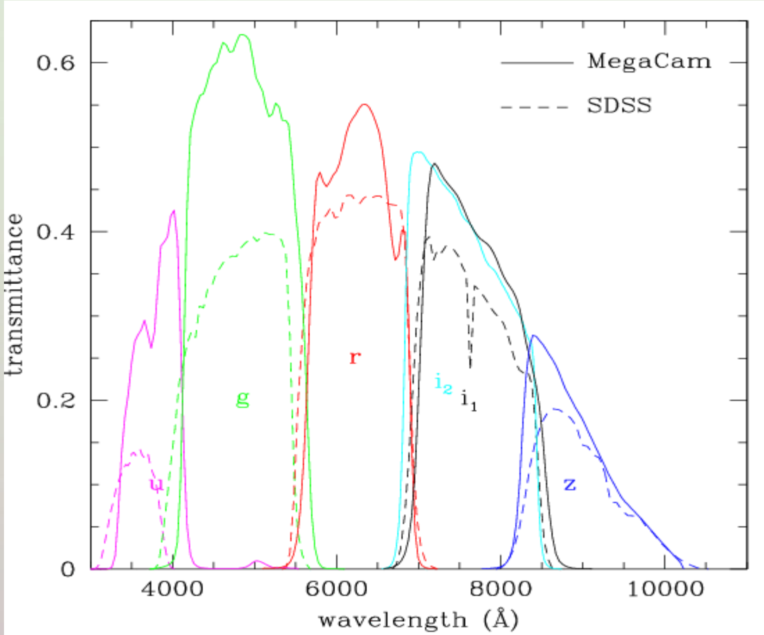
- 3.6 m telescope, coordinated by the National Research Council of Canada (NRC), Centre National de la Recherche Scientifique (CNRS) and Hawaii university
- ~ 5 years of data acquisition and calibration (2003 - 2008) using MegaCam (1°x1°, 340 M pixels) in CFHT
- 3 surveys :

  1) Deep fields : 4 fields = 4 deg^2, SuperNovae Legacy Survey (SNLS), early universe

  2) Wide fields : 4 fields= 170 deg^2, large scale structures, galaxy distribution, stellar populations

  3) Very Wide fields : ecliptic band = 410 deg^2, solar system (Kuiper belt), g, r, i

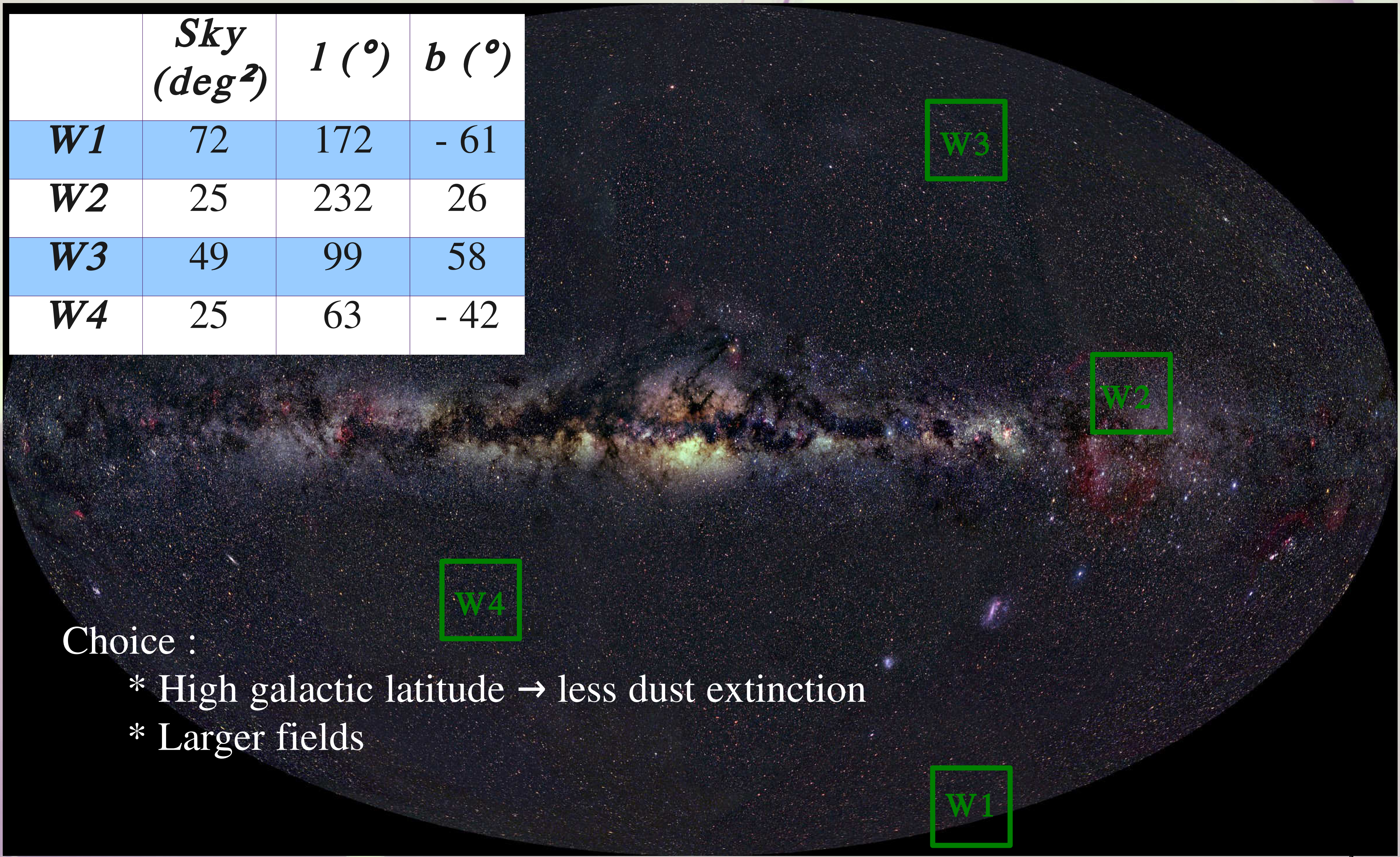
→ Observations : filter set (u*, g', r', i', z')



Source : MegaCam ugriz filter set Website

Canada France Hawaï Telescope Legacy Survey (CFHTLS)

	Sky (deg²)	l (°)	b (°)
W1	72	172	- 61
W2	25	232	26
W3	49	99	58
W4	25	63	- 42



Choice :

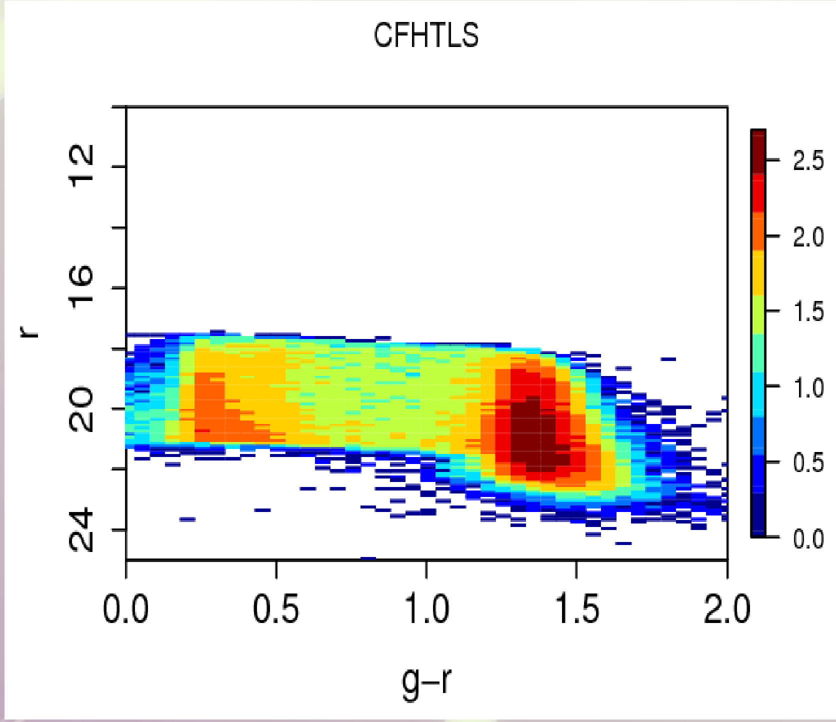
* High galactic latitude → less dust extinction
* Larger fields

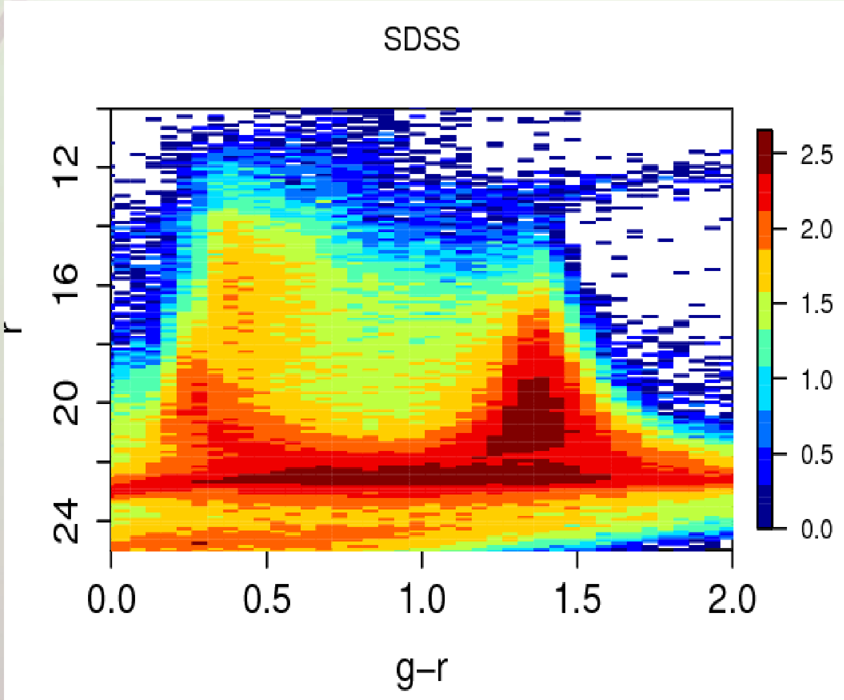
Data used in this work

- CFHTLS – W1 and W3
- SDSS stars in the same fields (field associated to W1 covers 4/5 of W1- CFHTLS)
- Simulations from the Besançon model (Robin et al 2003)

→ transformations (u*, g', r', i', z') ——► (u, g, r, i, z) SDSS

→ We complement CFHTLS with SDSS at bright magnitudes

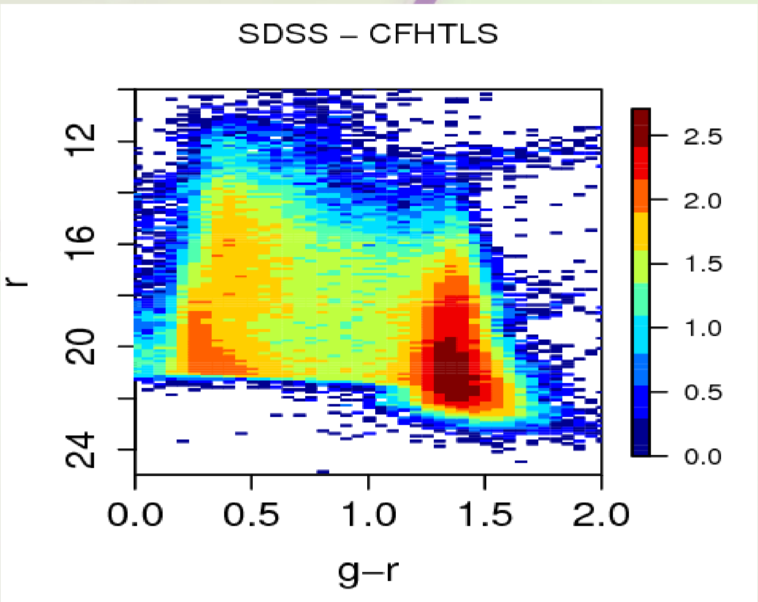




Hess diagrams, W3, before « mixing »

Final catalogs

After assembling SDSS and CFHTLS data, we obtain :

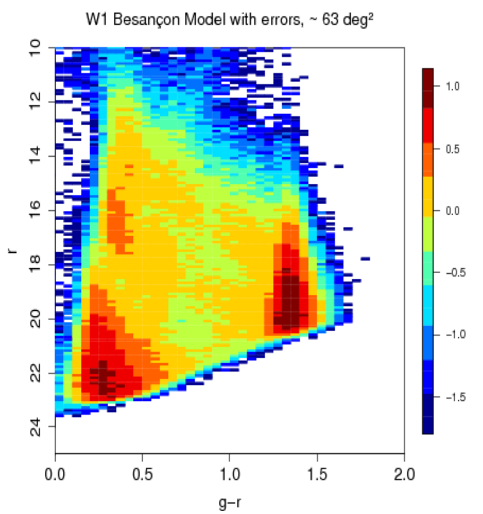


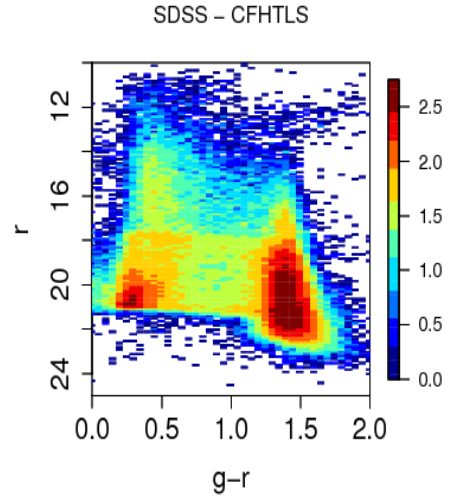
W3 : Hess diagram, new catalog generated

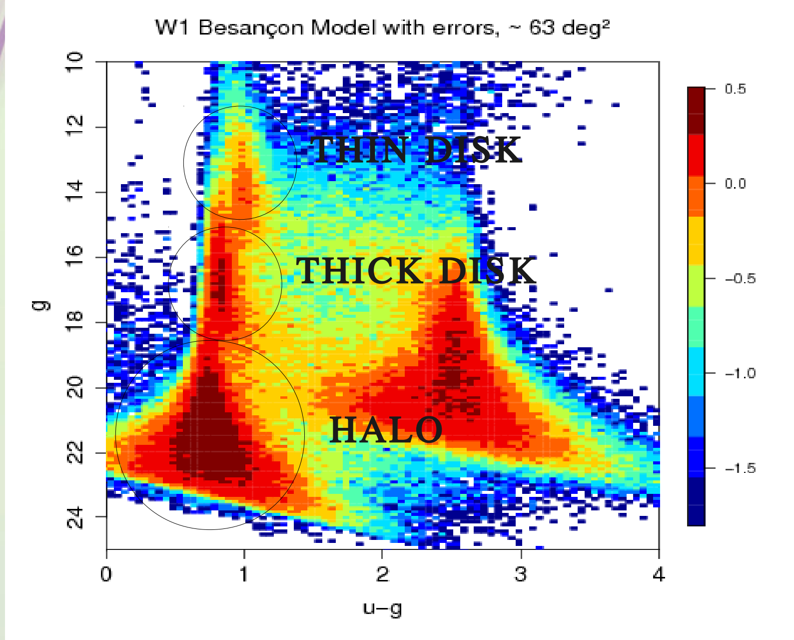
In W1 SDSS data represent only 15% of the sample
In W3 they represent 30%

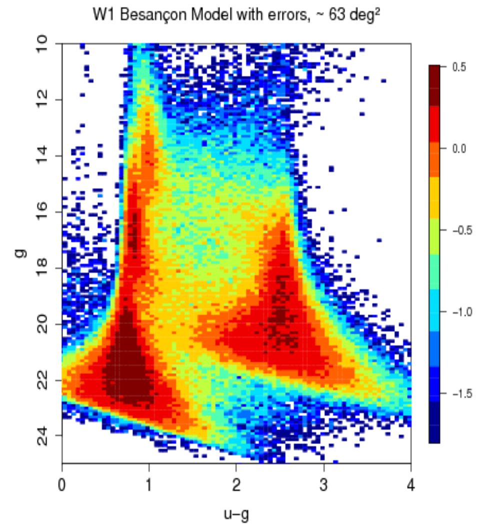
Comparisons to simulations

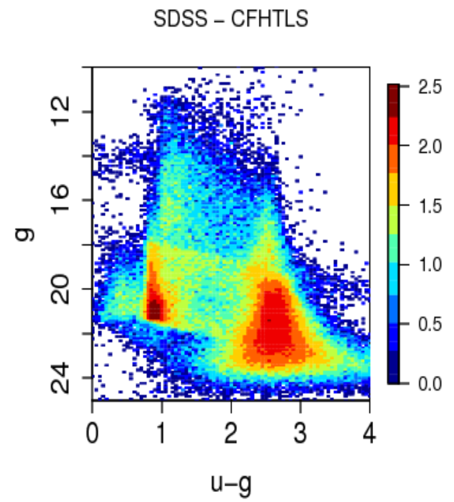
W1

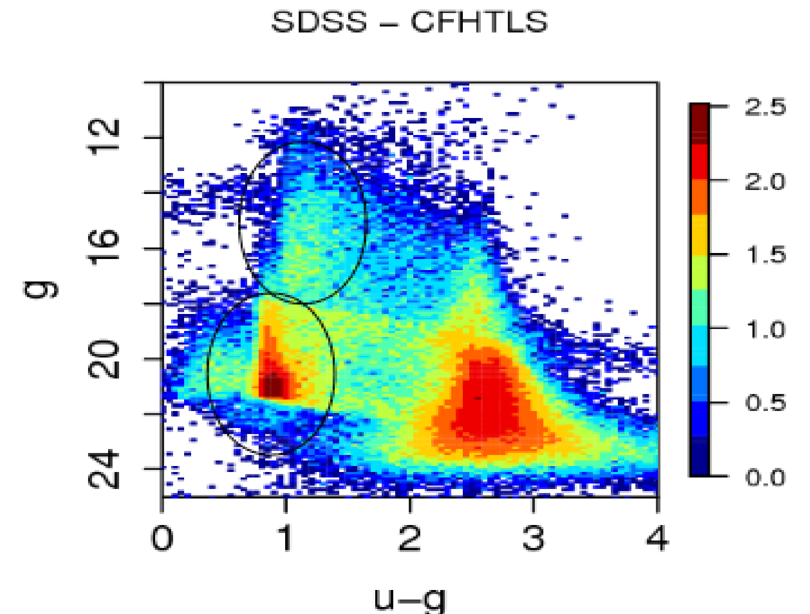












Metallicity and photometric distance

$$[Fe/H] = A + Bx + Cy + Dxy + Ex^2 + F y^2 + Gx^2 y + Hxy^2 + Ix^3 + Jy^3$$

(Bond et al 2009)

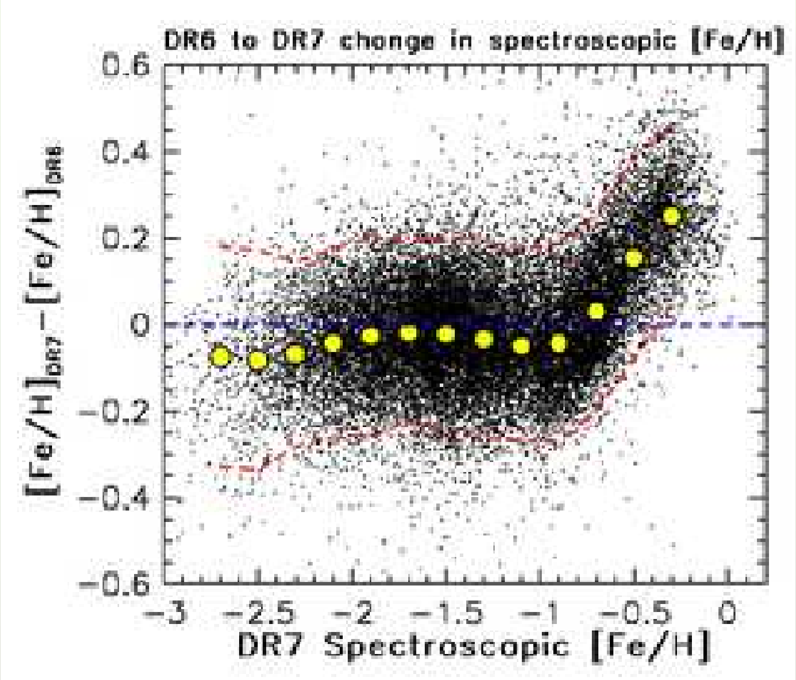
- $x = u\text{-}g$, $y = g\text{-}r$
- $(A - J) = (-13.13, 14.09, 28.04, -5.51, -5.90, -58.68, 9.14, -20.61, 0.0, 58.20)$

Z = D sin(b), D the distance to the Sun

Photometric distances :

$$M_r = M_{r0} + \Delta M_r$$

- $M_{r0} = -5.06 + 14.32*(g\text{-}i) - 12.97*(g\text{-}i)^2 + 6.127*(g\text{-}i)^3 - 1.267*(g\text{-}i)^4 + 0.0967*(g\text{-}i)^5$
- $\Delta M_r = 4.5 - 1.1*[Fe/H] -0.18*[Fe/H]^2$



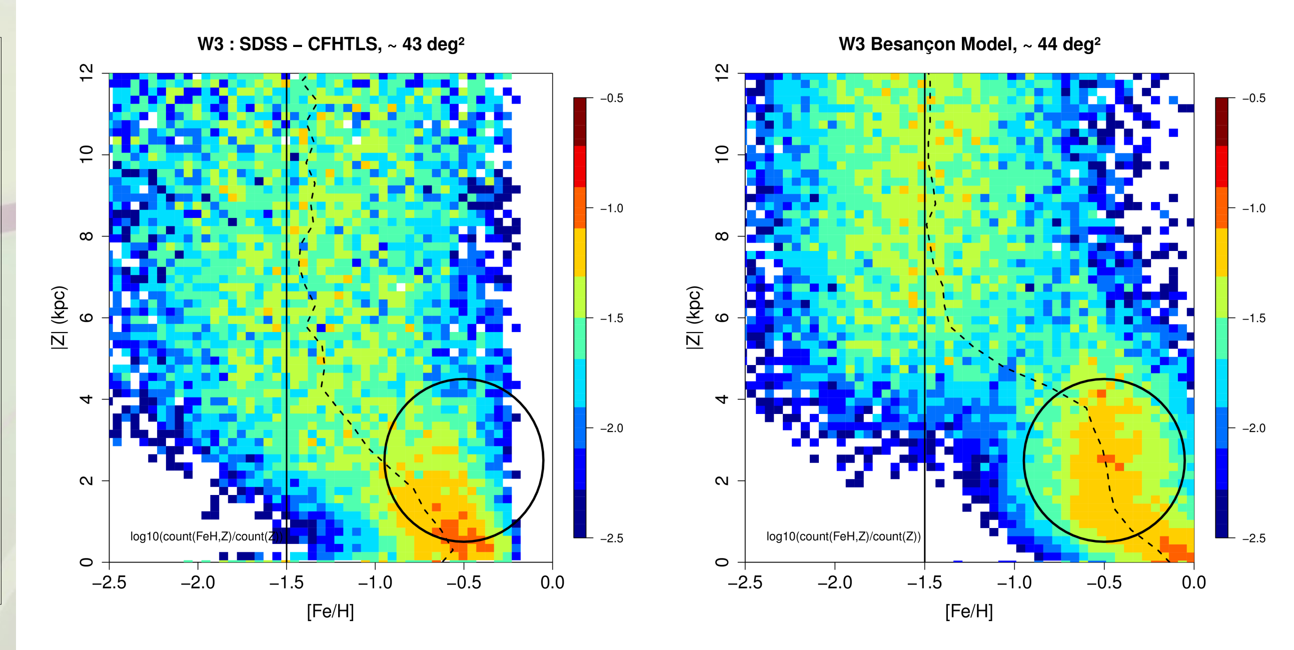
Bond et al 2009, Difference in metallicities in DR6 and DR7 as a function of DR7

Comparisons to simulations of Besançon model

3 distinct populations :
Thin and thick discs, halo

Thick disc Besançon model

- <[Fe/H]> = -0.5, $\sigma_{[Fe/H]}$= 0.3 dex
- Scale height h_z= 800 pc
- Age = 11 Gyr
- Local mass density ρ_0= 6.8 % of thin disc local density



– Besançon model : Standard model different from data
– Model shows an evident distinct thick disc which doesn't show up in the data

Possible effects : the absorption

A comparison of absorption values of several authors (see Tab 1.) leads to the conclusion that **the estimate of extinction in the CFHTLS W1 & W3 fields is uncertain. (Tab 1)**

	W1	W3
Schlegel et al. (1998)	0.087	0.038
Hakkila et al. (1997)	0.054 ± 0.176	0.083 ± 0.233
Arenou et al. (1992)	0.100 ± 0.155	0.057 ± 0.150
Jones et al. (2011)	0.113 ± 0.191	0.120 ± 0.187

Tab. 1 : Av extinction values in W1 and W3 from different models,

The effect of extinction was estimated by calculating errors on distances and metallicities (Tab 2.).

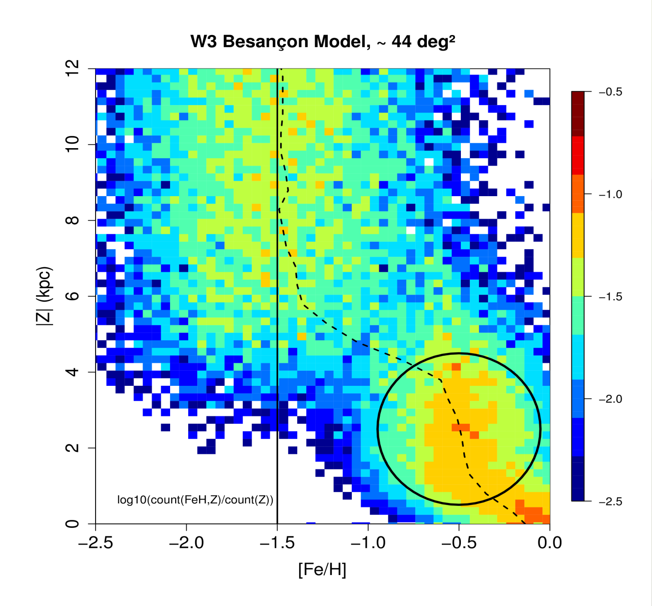
	Dist		[Fe/H] (dex)	
	W1	W3	W1	W3
Schlegel et al. (1998)	10%	4%	0.02	0.007
Jones et al (2011)	14%	15%	0.015	0.02

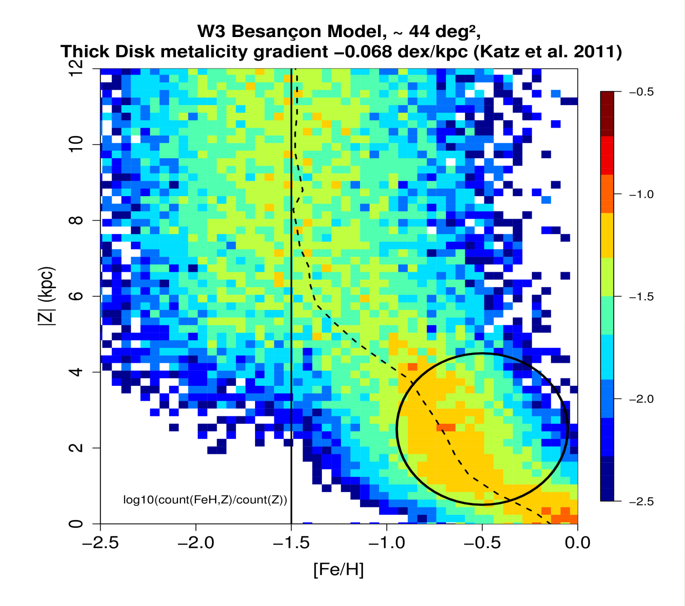
Tab. 2 : Extinction effect. Errors on distances and metallicities are given for W1 and W3.

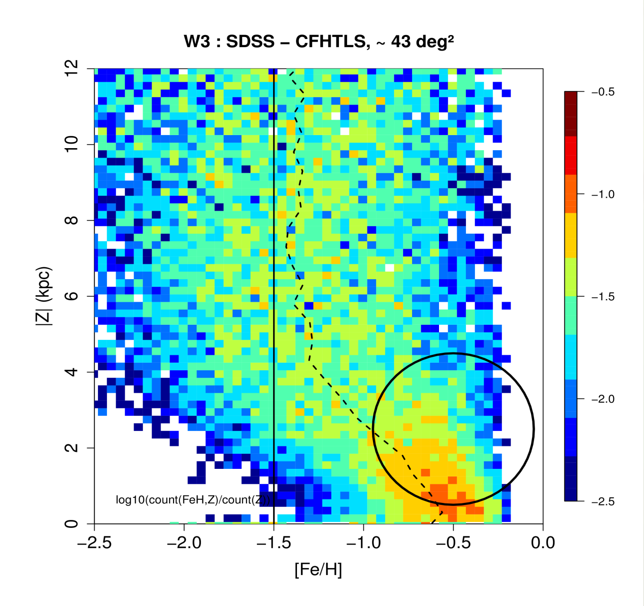
Dust extinction not corrected

Possible effects : the metallicity gradient

We added to the thick disk simulated stars a **metallicity gradient of – 0.068 dex/kpc (Katz et al., 2011)**.



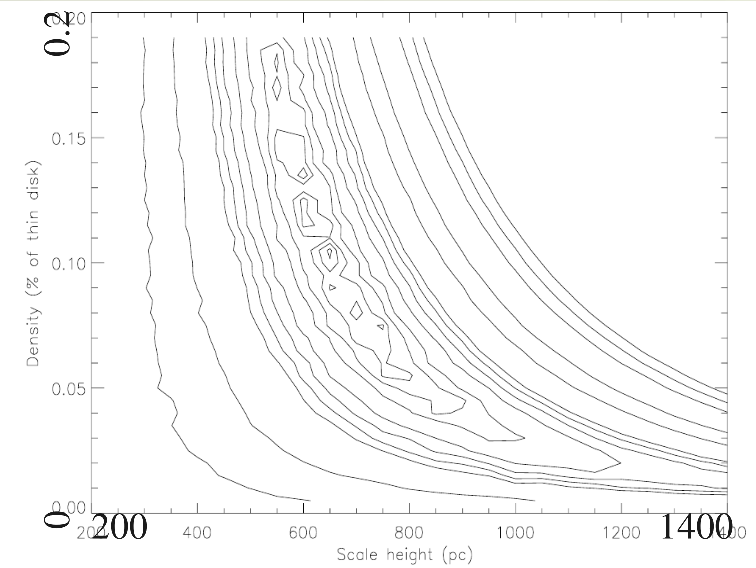




The agreement between the model and the data in (z – metallicity) distributions has not been improved.

A scale height problem?

The allowed range of thick disc scale heights is large, due to (hz, in-plane density) degeneracy.



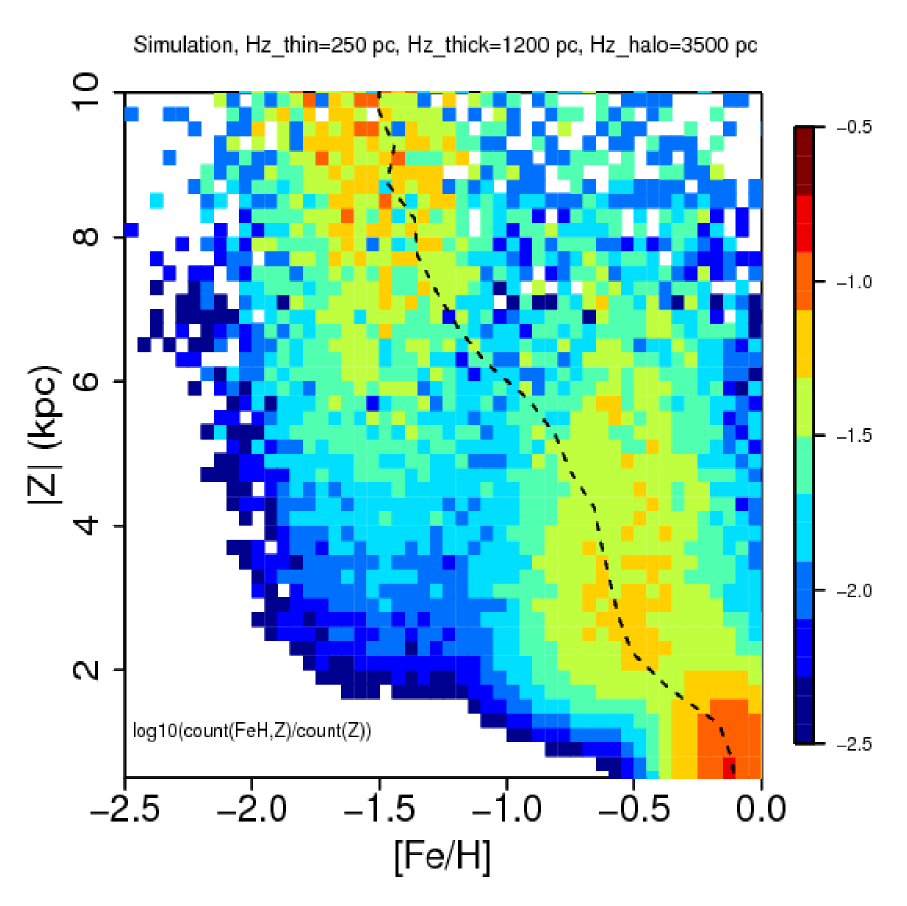
Chen, B et al, 2001, Correlation between scale height and density in the thick disc (SDSS data at the poles)

Alternative thick disc :

H_z = 1200 pc, 2% normalization, <[Fe/H]> = - 0.5 dex

Thin disc : H_z = 250 pc, <Fe/H> = - 0.1 dex

Halo : H_z = 3500 pc (exponential), <Fe/H> = -1.5 dex



Discrete, exponential thick discs with H_z in (750 -1200 pc) do not reflect correctly CFHTLS – SDSS data

Conclusions

The CFHTLS Wide fields do not seem to show a thick disk component represented by a distinct pattern between 1 and 4-5 kpc in the z-metallicity distribution as predicted by a standard Milky Way star count model.

Perspectives :

- Create a new model of stellar population synthesis with a detailed description of the HR diagram in order to test a set of parameters of the thick disk. We aim to achieve a good agreement between the data and the model on large scales and in the solar neighborhood.
- Make then an analysis with larger data sets such as the SDSS - DR8.