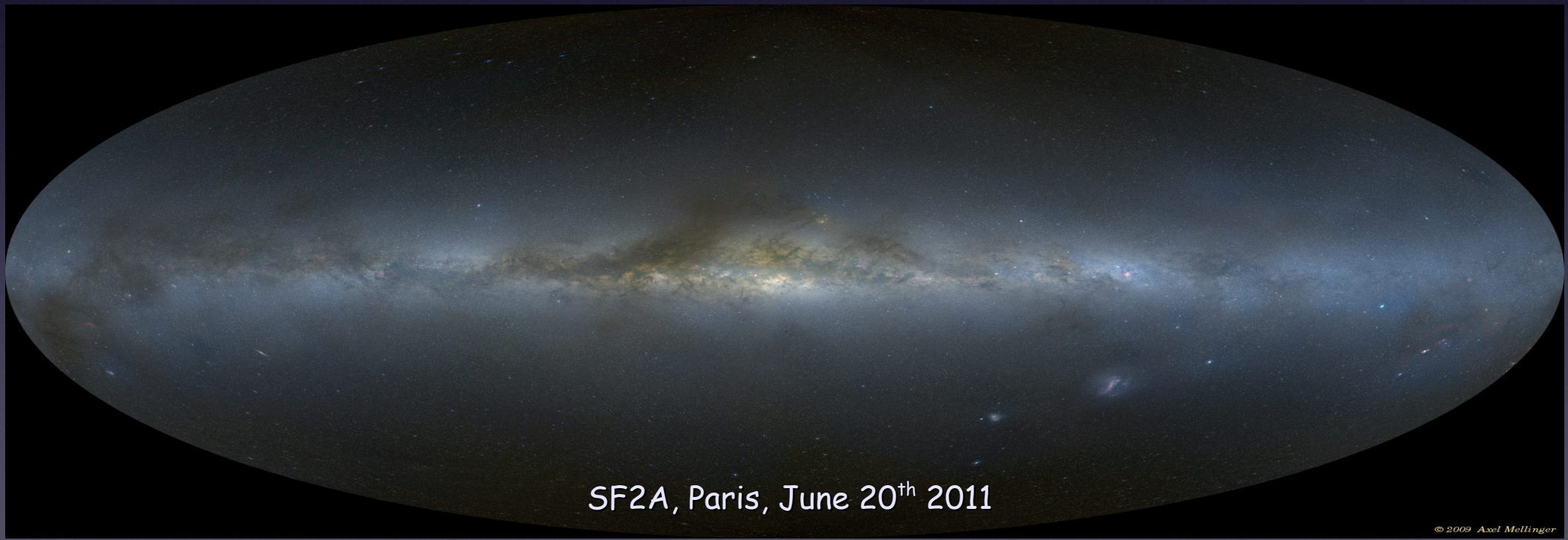
Probing the characteristics of the thick disc outside the Solar neighborhood

Kordopatis Georges

A. Recio-Blanco, P. de Laverny, G. Gilmore, V. Hill, R.F.G. Wyse, A. Helmi, A. Bijaoui, O. Bienaymé, M. Zoccali

Observatoire de la Côte d'Azur, laboratoire Cassiopée



SF2A, Paris, June 20th 2011

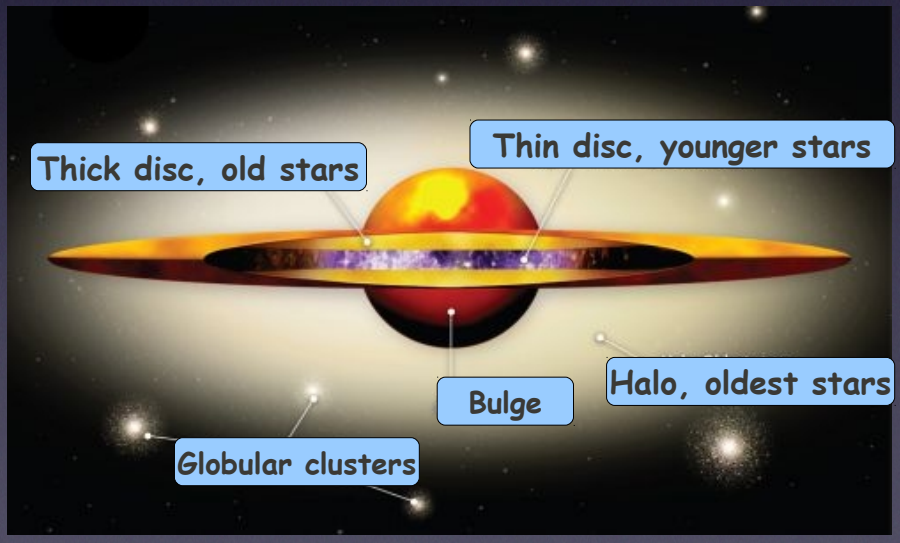
The Milky Way's thick disc

- Existence suggested by Gilmore & Reid (1983)
  - Old population
  - Rotational lag higher than the thin disc (V_{lag} ~ - 50 km/s)
  - More metal poor and alpha enhanced

Different ways to form the thick disc:

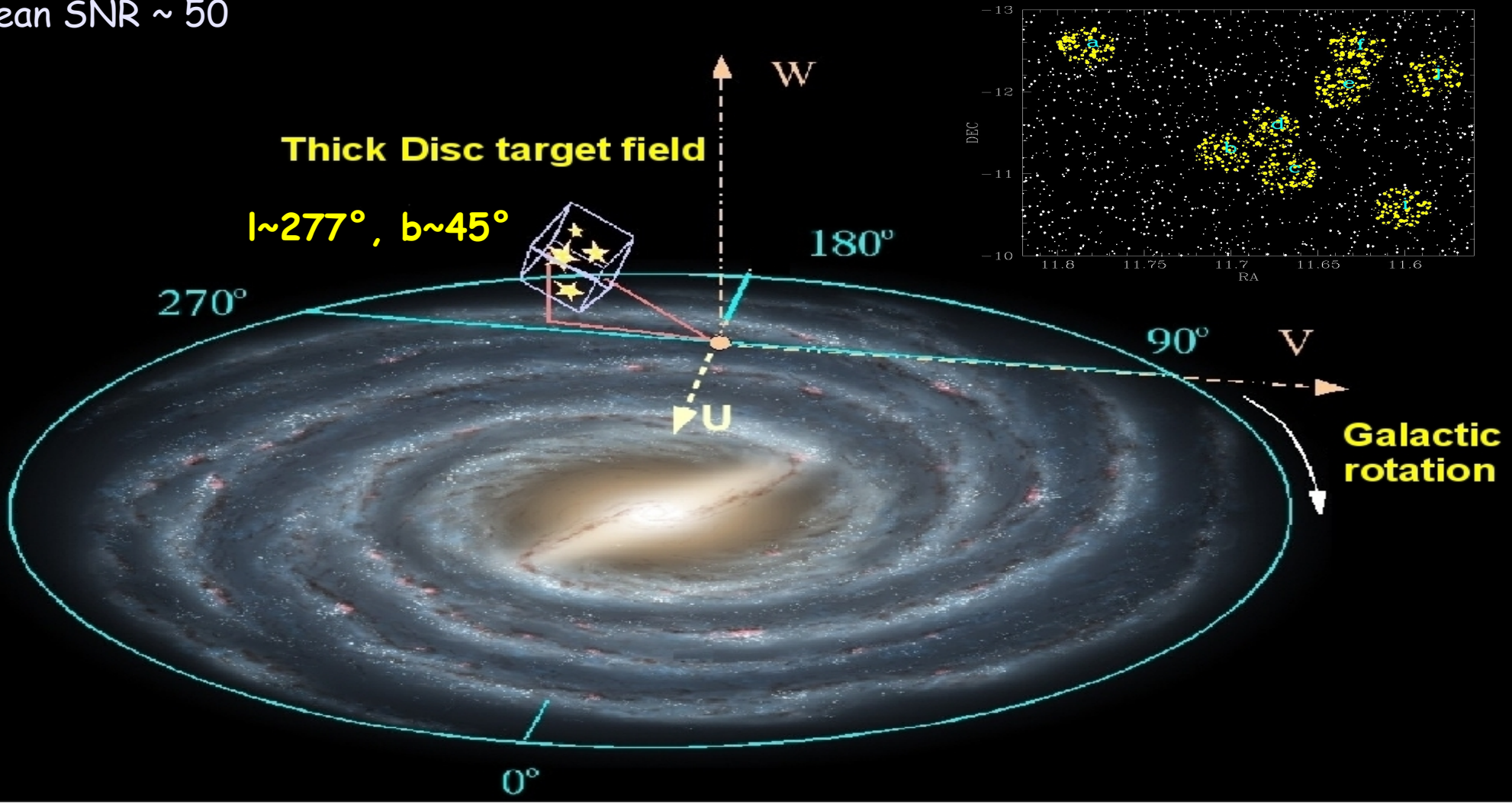
- Radial migration ? (*Schonrich & Binney 2009, Roskar et al 2008 ...*)
- Minor mergers ? (*Villalobos & Helmi, 2008 ...*)
- Accretion of a massive satellite ? (*Abadi et al. 2003 ; Brook et al. 2005*)

- Need to compare model predictions with observations!
  - Scale height & length ? [M/H] ? Kinematics ? Vertical gradients? => Large statistics are mandatory



The FLAMES survey

689 LR8 spectra of stars , outside the Solar neighborhood (14 < m_v < 18.5)
Ojha et al. (1994): Proper motions + photometry
FLAMES/GIRAFFE: R~6500, λ=8400-8810 Å (c.f. Gaia/RVS low resolution mode)
Mean SNR ~ 50

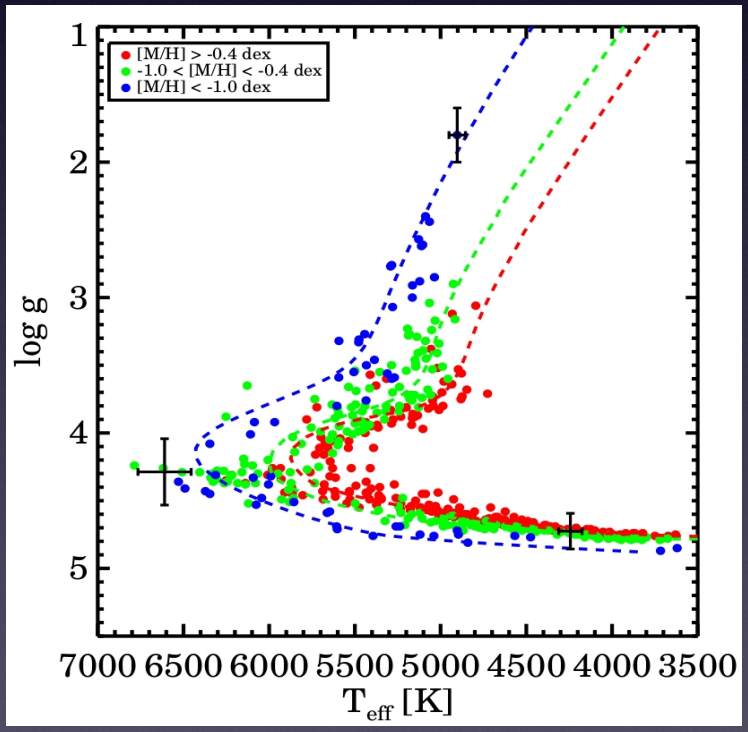


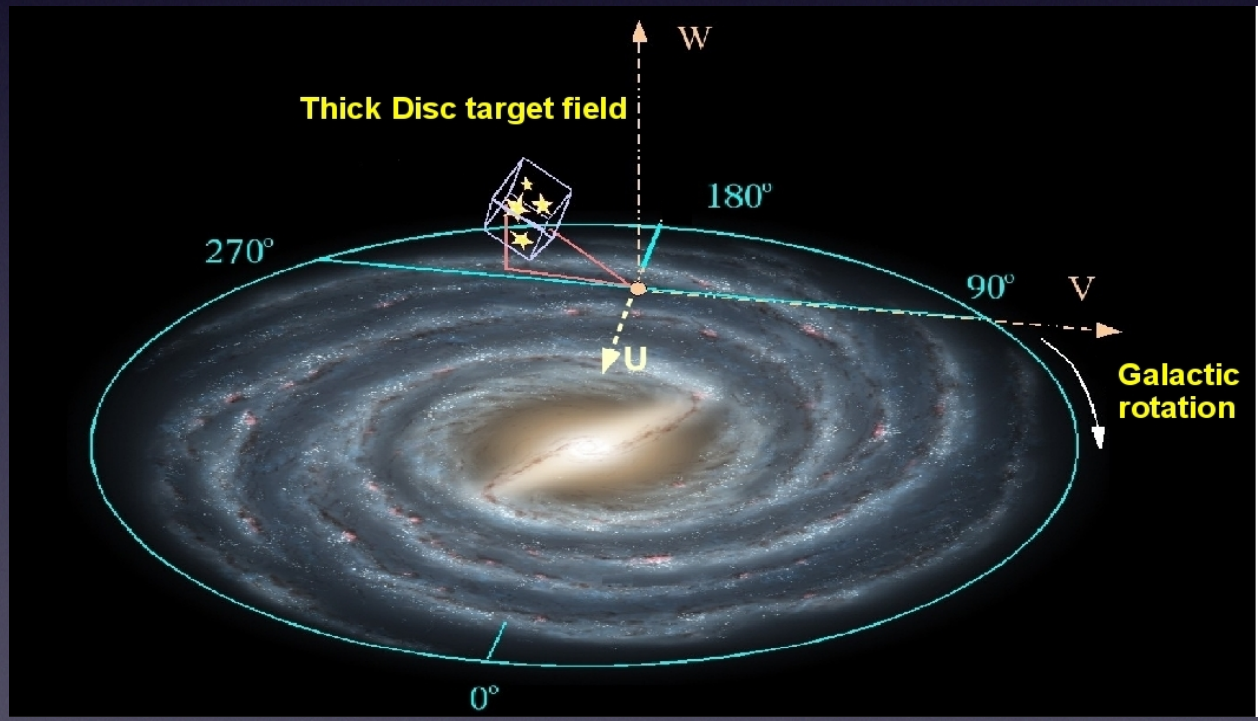
Chemical & kinematic characterization of the observed sample

(Kordopatis et al. 2011b)

Teff + logg + [M/H]

(This work: DEGAS & MATISSE alg.)





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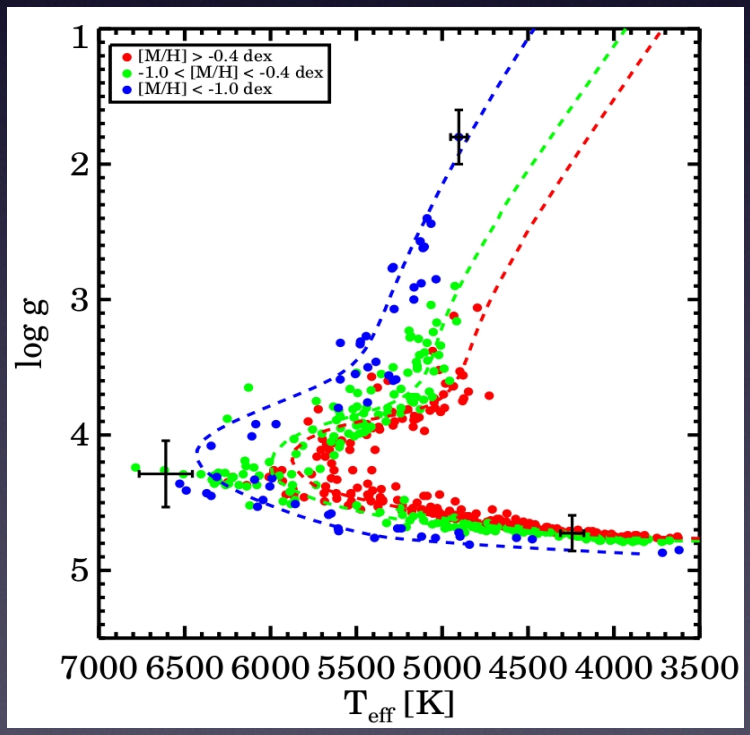
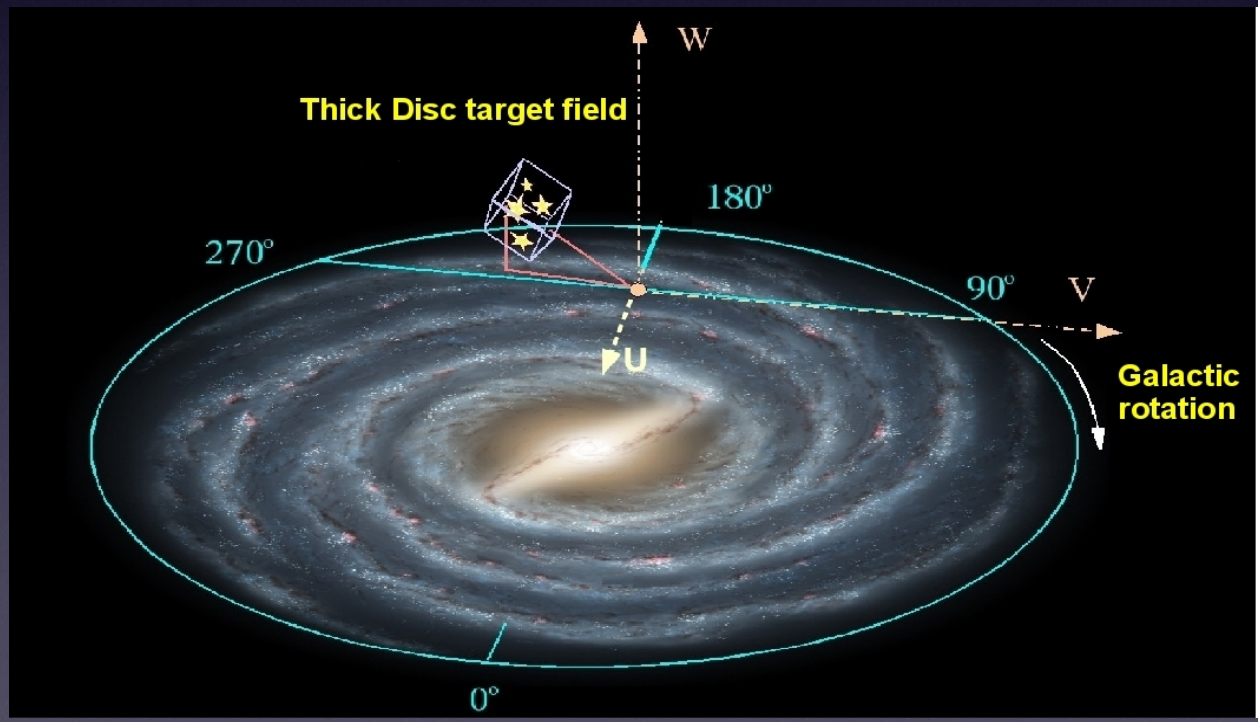
+

V mag ; (B-V) (Ojha et al. 1994)

} Distances

(Y^2 isochrones)





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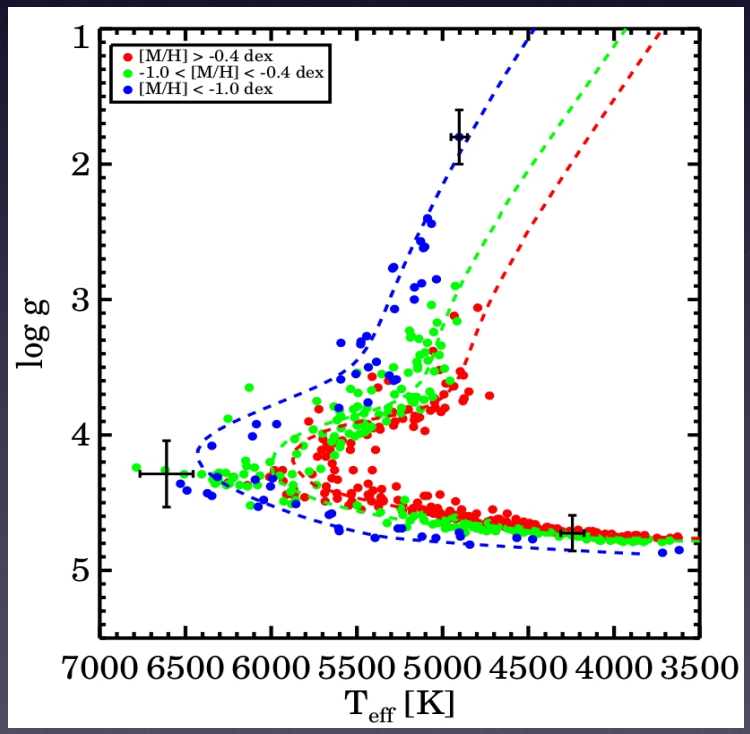
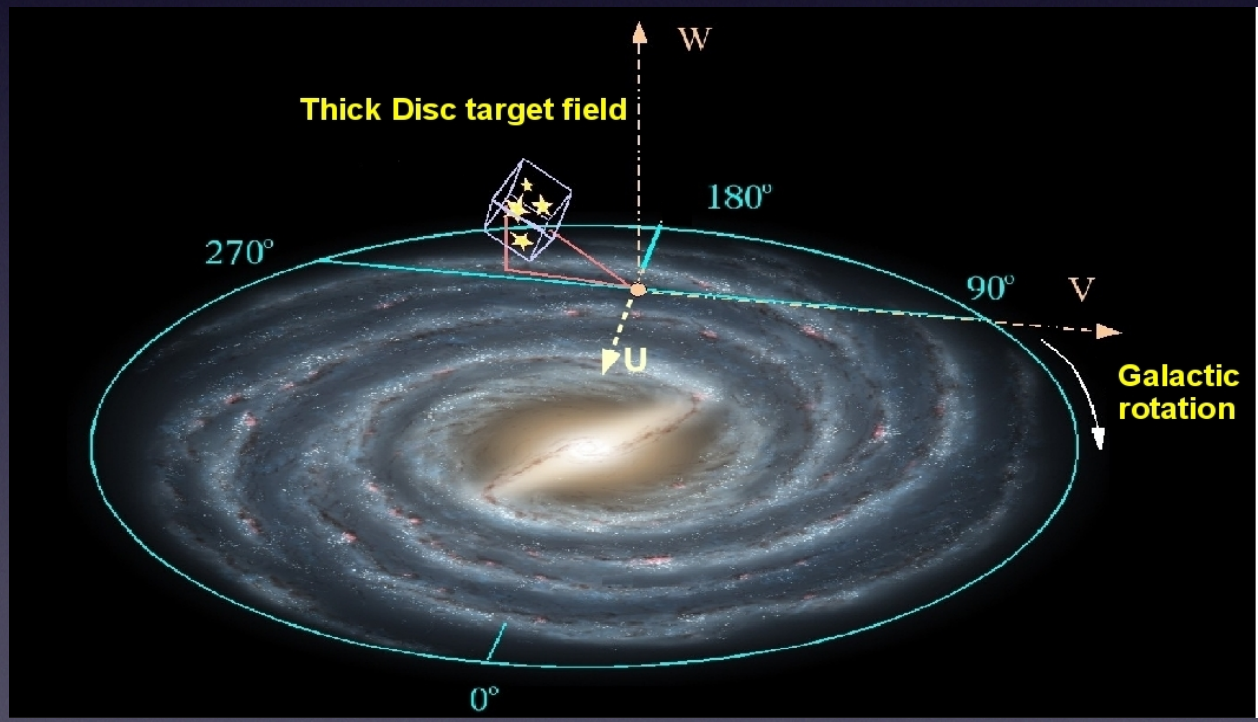
l, b
+
Distances
+
V_{rad}, μ_l, μ_b





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l, b
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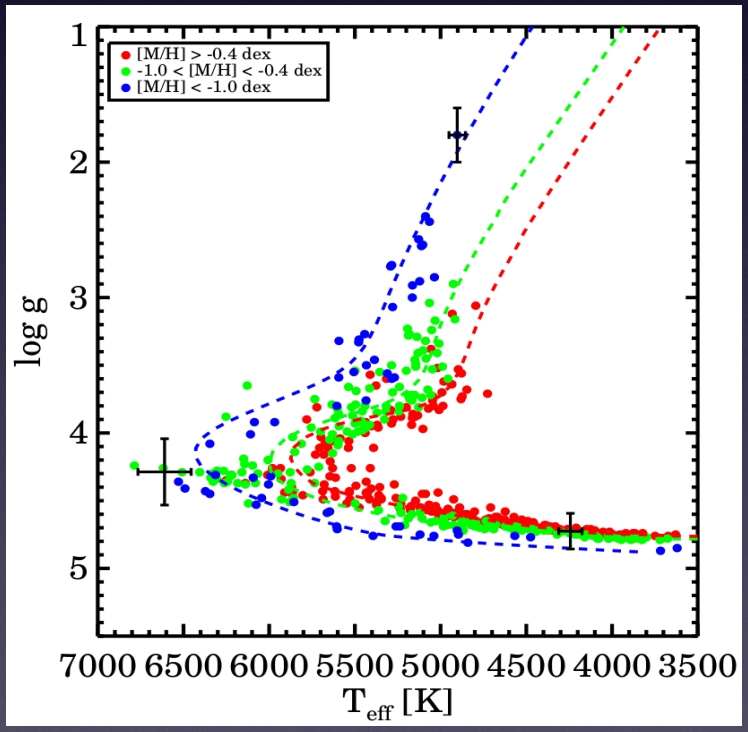
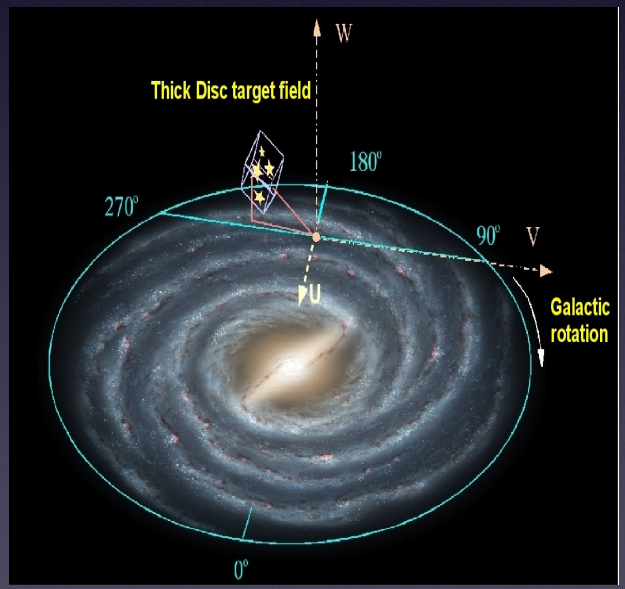
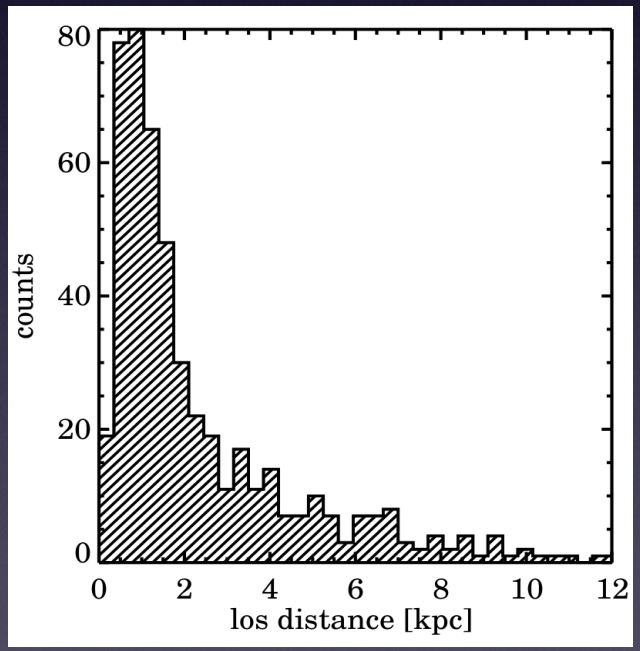
V_{rad}, μ_l, μ_b

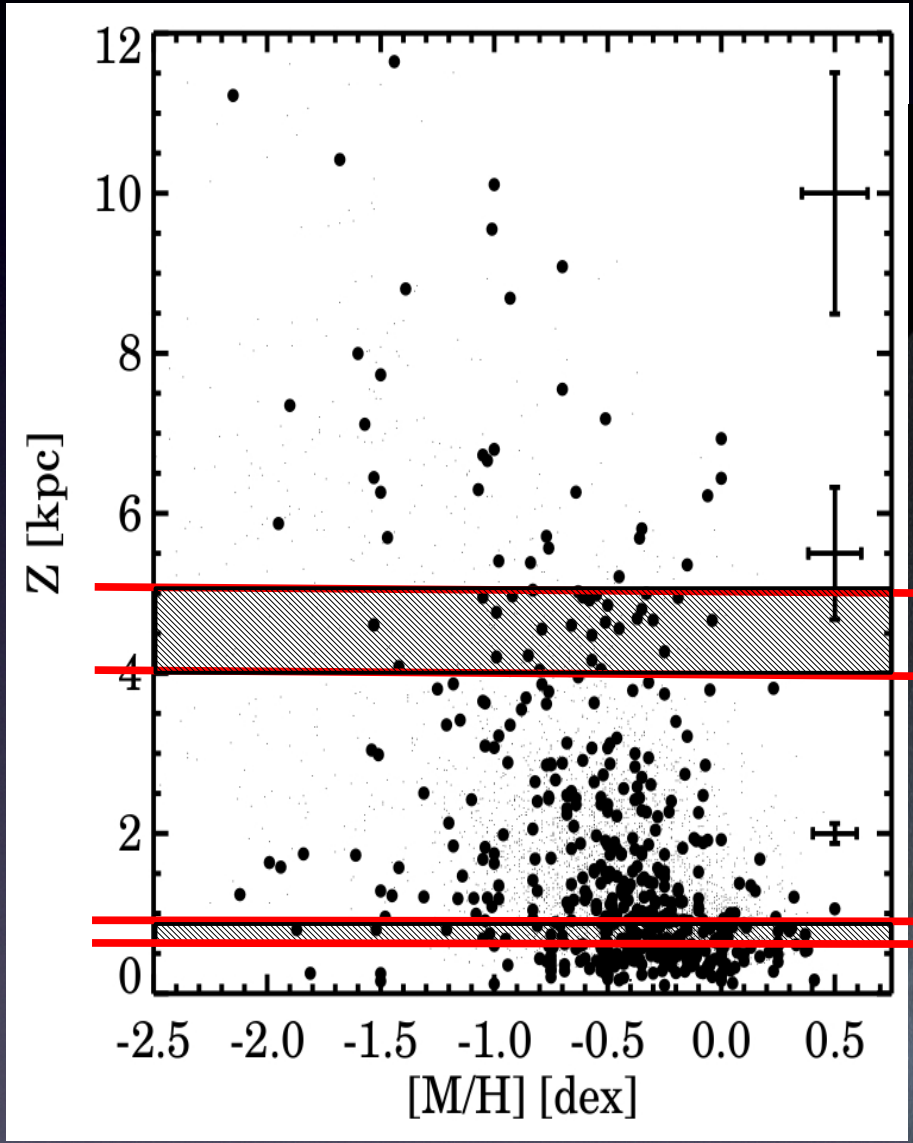
⇒ Positions: X,Y,Z
velocities:U,V,W(+Vφ)
Orbital eccentricities







Selection of the Galactic components*

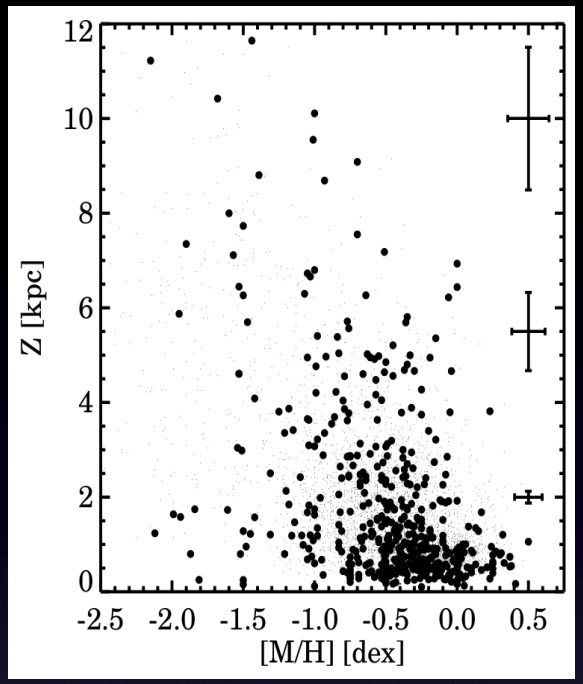


* According to their position
Advantage: weak priors
But: Pollution from other components

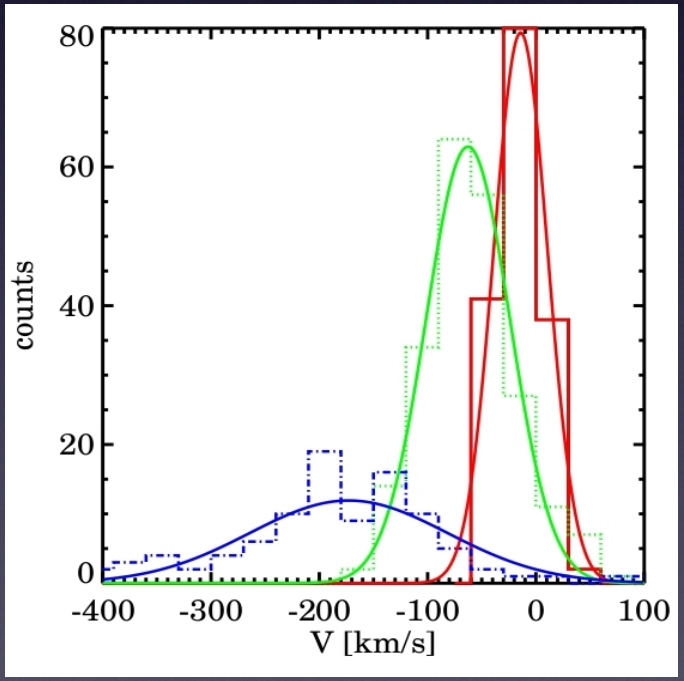
~Halo: Z > 5 kpc

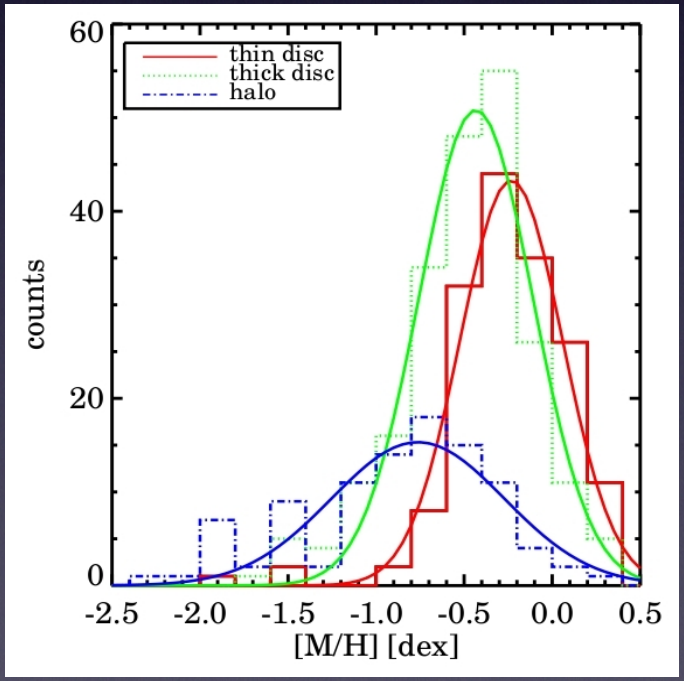
~Thick disc: 1 < Z < 4 kpc

~Thin disc: Z < 800pc

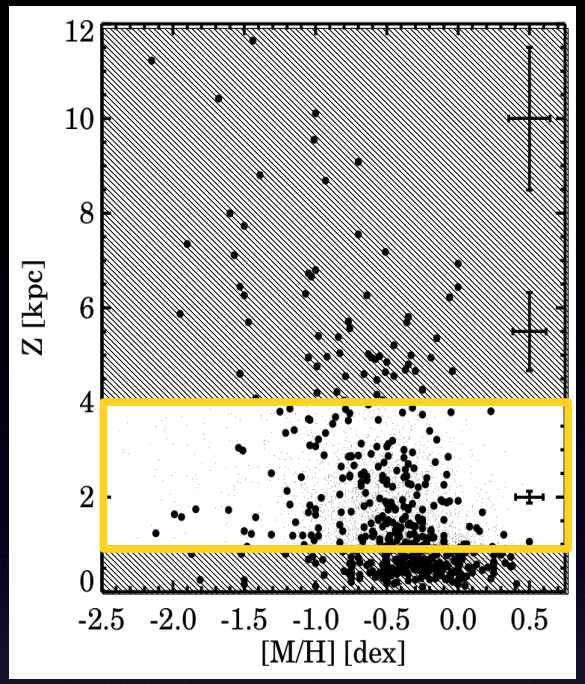


	V lag (km s^{-1})	σu (km s^{-1})	σv (km s^{-1})	σw (km s^{-1})	[M/H] (dex)
Thin disc	-20 ± 1	43 ± 2	32 ± 1	24 ± 1	-0.27 ± 0.01
Thick disc	-70 ± 3	71 ± 6	56 ± 4	52 ± 3	-0.48 ± 0.02
Halo	-198 ± 20	234 ± 38	149 ± 26	161 ± 37	-0.89 ± 0.05





Thin disc, thick disc & halo are distinct populations: [M/H] + kinematics



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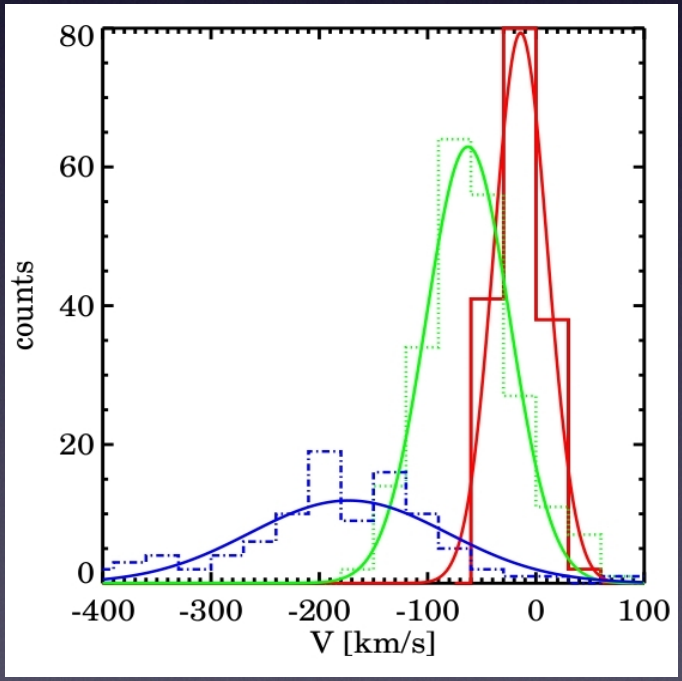
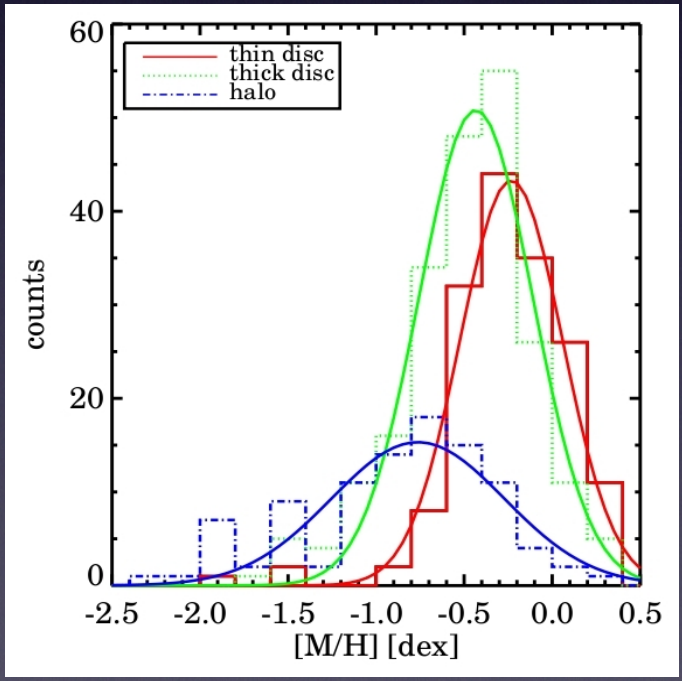
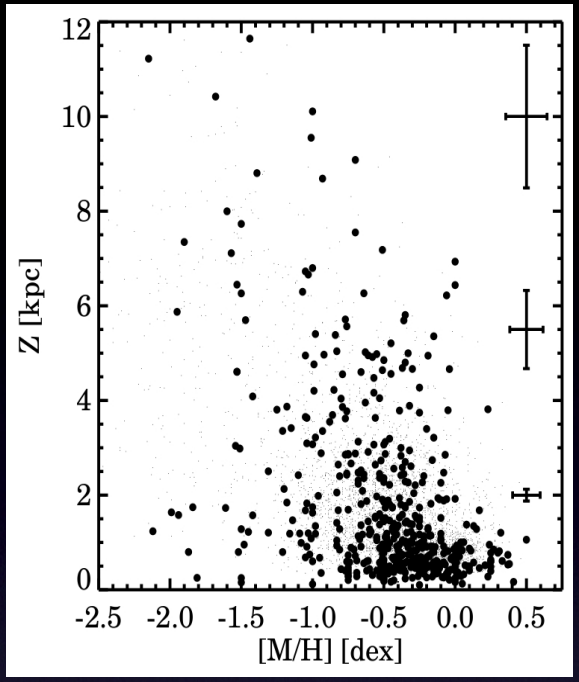




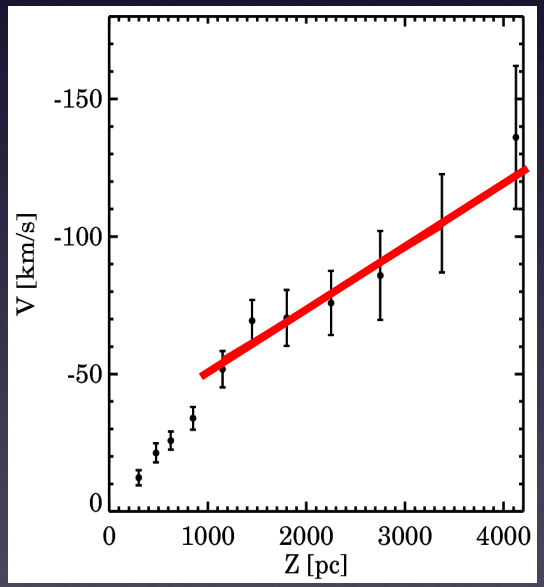
Thick disc:

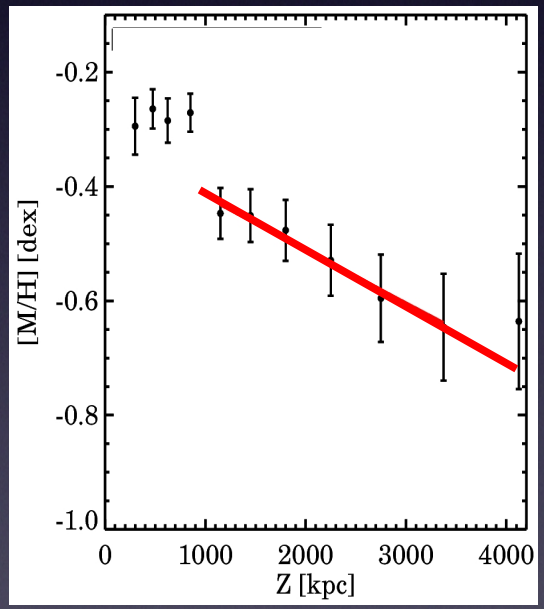
=> Kinematics: rotational lag greater than the one expected (cf. Gilmore et al. 2002)

=> [M/H] similar to the canonical disc



Vertical gradients



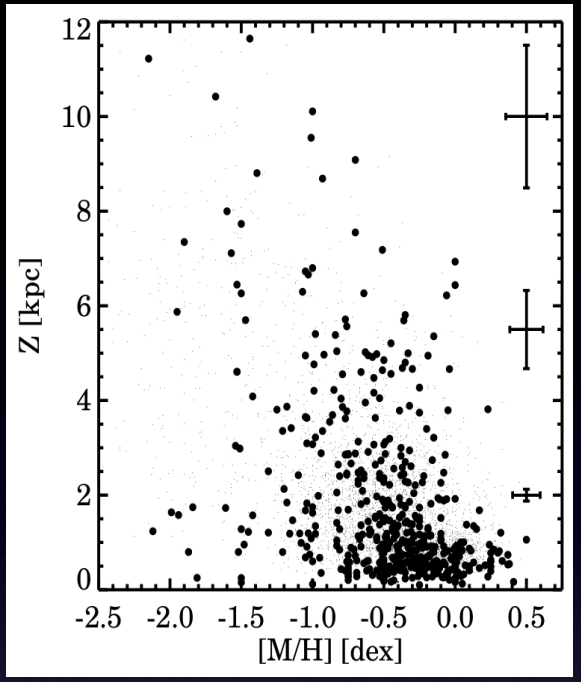


For 1 < Z < 4 kpc:

$\partial V/\partial Z = -21 \pm 6$ km s^{-1} kpc^{-1}

$\partial [M/H]/\partial Z = -0.09 \pm 0.04$ dex kpc^{-1}

Are they intrinsic to the thick disc ?



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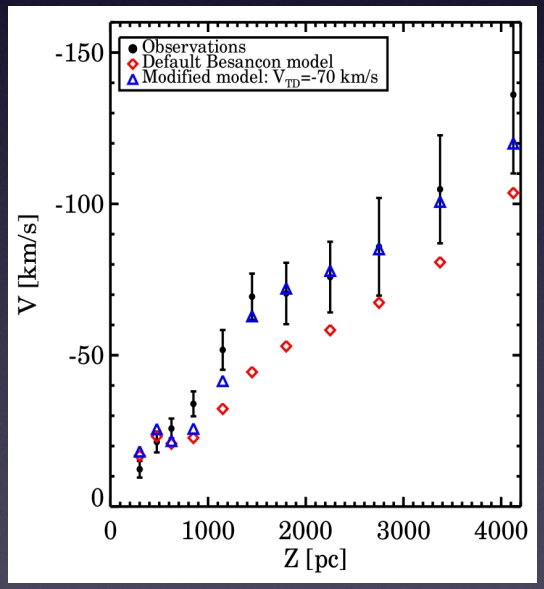
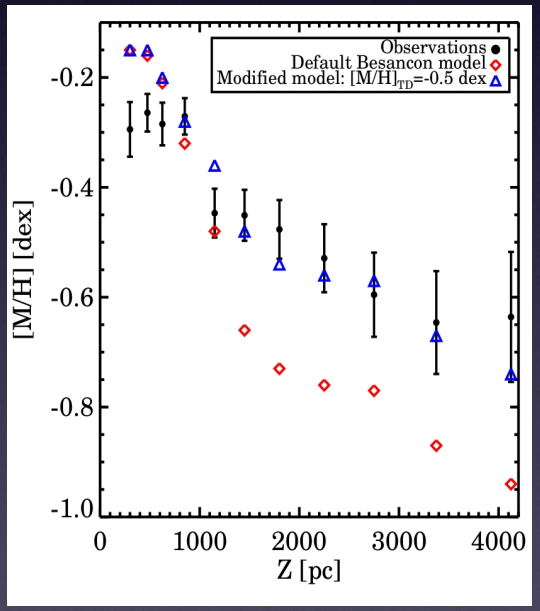




Comparison with the Besançon* model:

=> Gradients can be explained as as a smooth transition between the Galactic components

Scale heights & radial scale lengths

Jeans Equations*:

$$\frac{\sigma^2_{V_\phi}}{\sigma^2_{V_r}} - 2 + \frac{2r}{h_r} - \frac{v_c^2 - \overline{v_\phi}^2}{\sigma^2_{V_r}} + \frac{\sigma^2_{V_Z}}{\sigma^2_{V_r}} = 0 \quad \& \quad \frac{\partial ln \sigma^2_{V_Z}}{\partial Z} - \frac{1}{h_Z} + \frac{K_Z}{\sigma^2_{V_Z}} = 0$$

* we assume $\rho(z) \sim \exp(-z/h_z)$

- Thin disc : $h_r = 3.1 \pm 0.2$ kpc
  $h_z = 220 \pm 10$ pc

(cf. Juric et al. 2008)

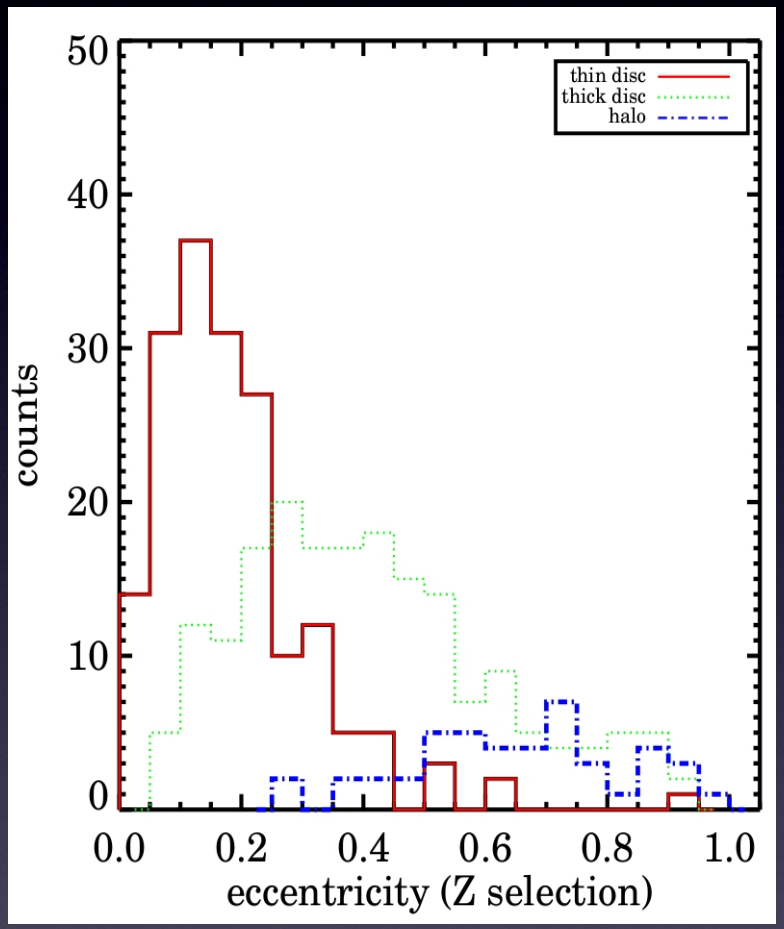
- Thick disc: $h_r = 3.4 \pm 0.5$ kpc
  $h_z = 845 \pm 50$ pc

} No dependence to the [M/H]

=> No evidence of accreted satellite relics (≠ Gilmore et al. 2002)

=> In disagreement with pure migration mechanism (≠ Schonrich & Binney 2009)

Orbital eccentricity distributions



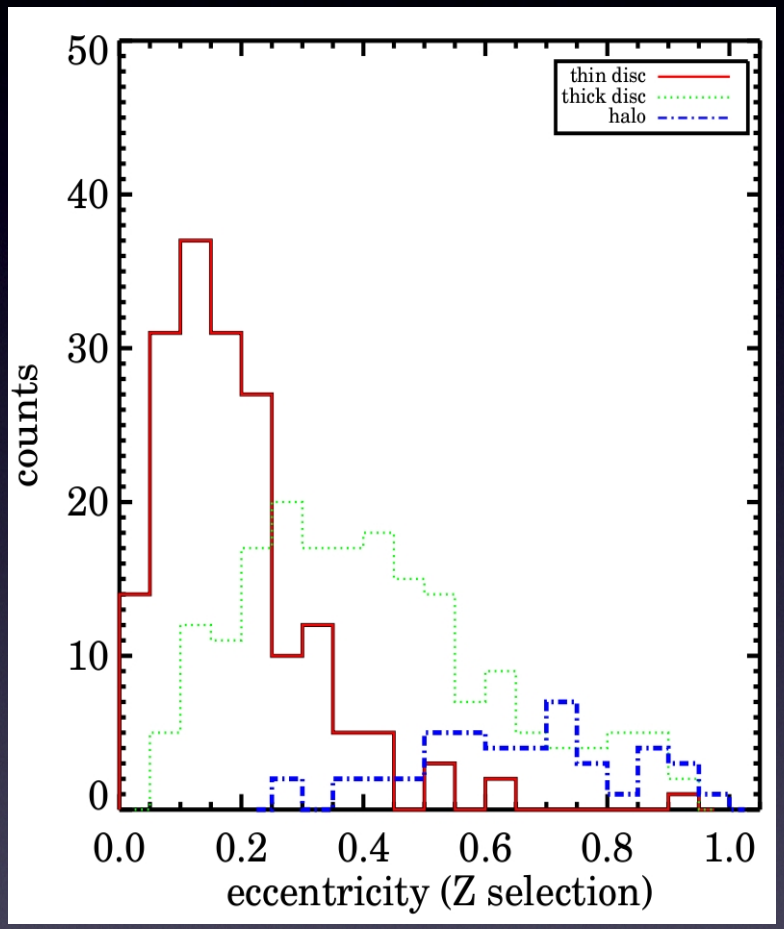
Thin disc: circular orbits, some contaminators

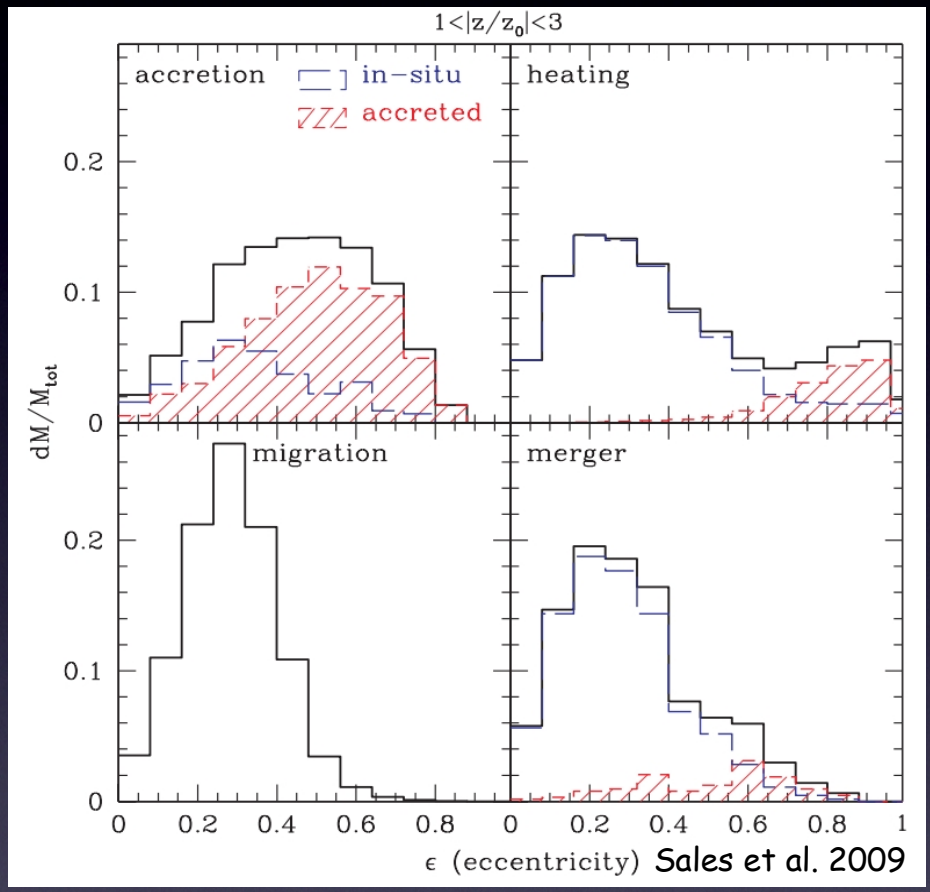
Thick disc: centered at rather low eccentricity

Halo: high eccentricity

*Assumed Galactic potential:
NFW halo, Hernquist bulge, Miyamoto-Nagai Disc

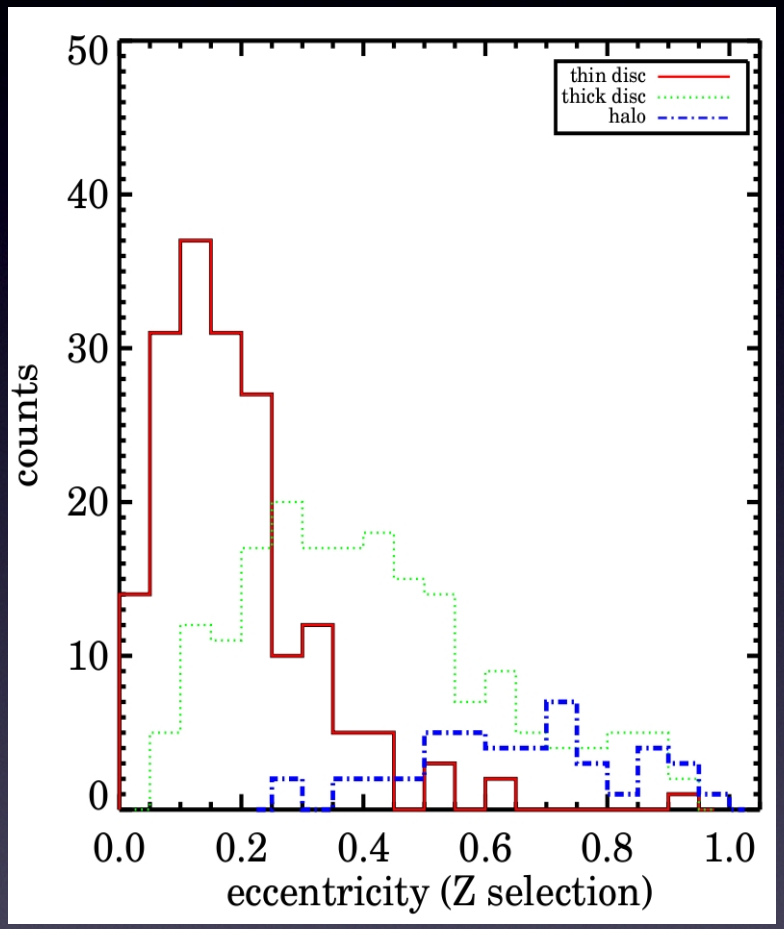
Orbital eccentricity distributions

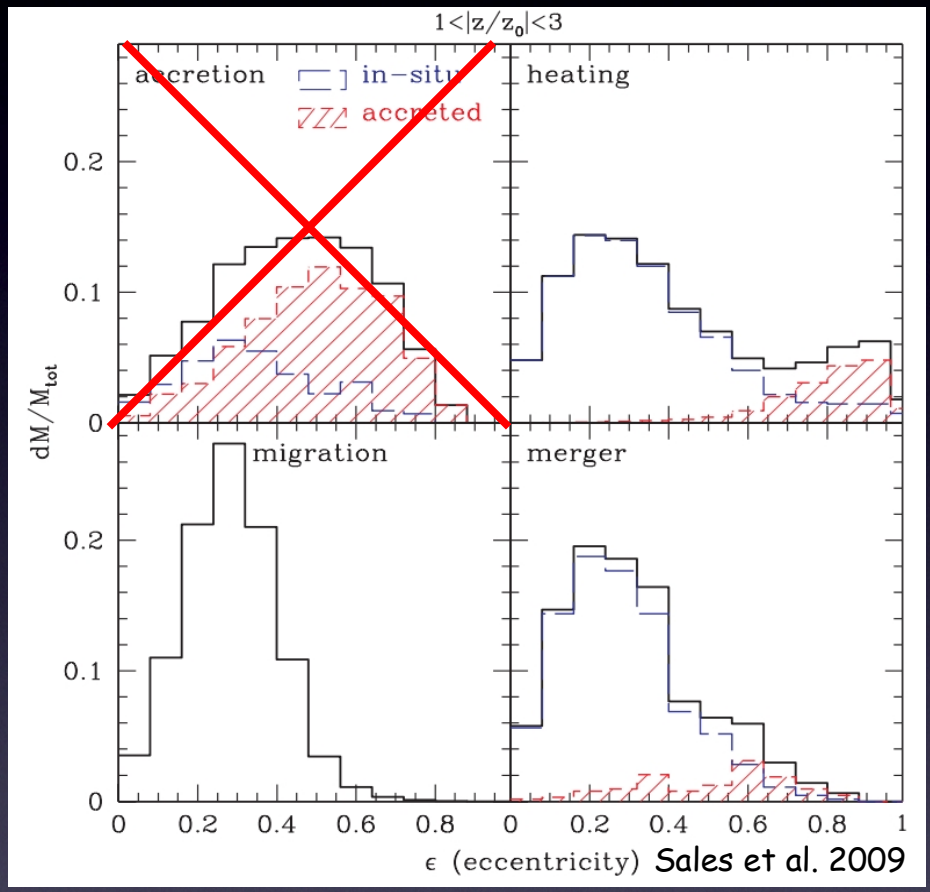




Sales et al. (2009) & Di Matteo et al. (2011): stars formed *in situ* have a lower eccentricity distribution

Orbital eccentricity distributions





In situ formation of the stars of the thick disc ?

BUT: criteria being debated

A change in the merging conditions can change the ecc. distribution

Conclusions & Perspectives

- Thin disc, thick disc & halo => distinct populations
- Thin and thick disc have similar h_r (~3 - 3.5 kpc)
- hz_thin=220pc, hz_thick=850 pc
- Vertical gradients explained as smooth transitions of the Galactic populations
- No evidence of satellite relics
- Radial migration to form the thick disc: Not the dominant mechanism

=> Scenario of thick disc formed from minor mergers is favored

- Similar work being done with stars observed towards the south Galactic pole
- ESO-Gaia survey (FLAMES) & Gaia: thousands (millions!) of stars


Merci de votre attention
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