Evolution of the galactic discs: the two first years of the Gaia-ESO survey

G. Kordopatis

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& the Gaia-ESO consortium

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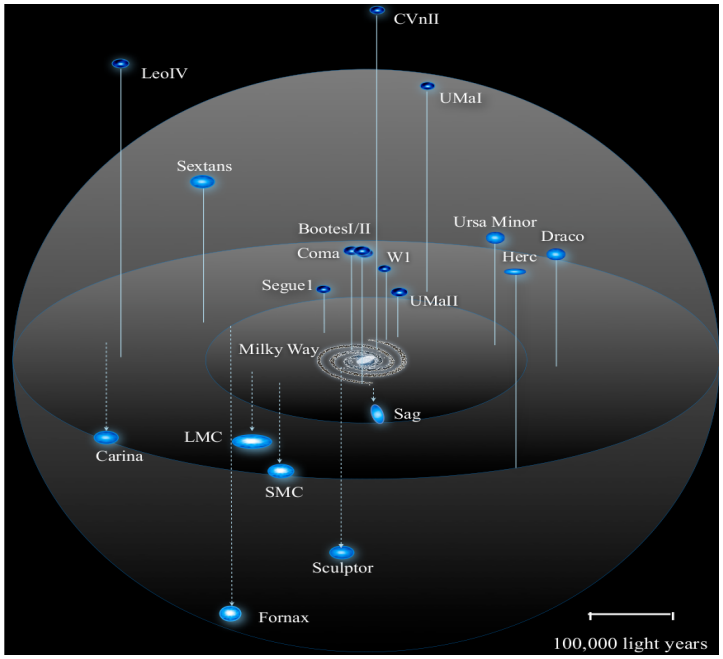
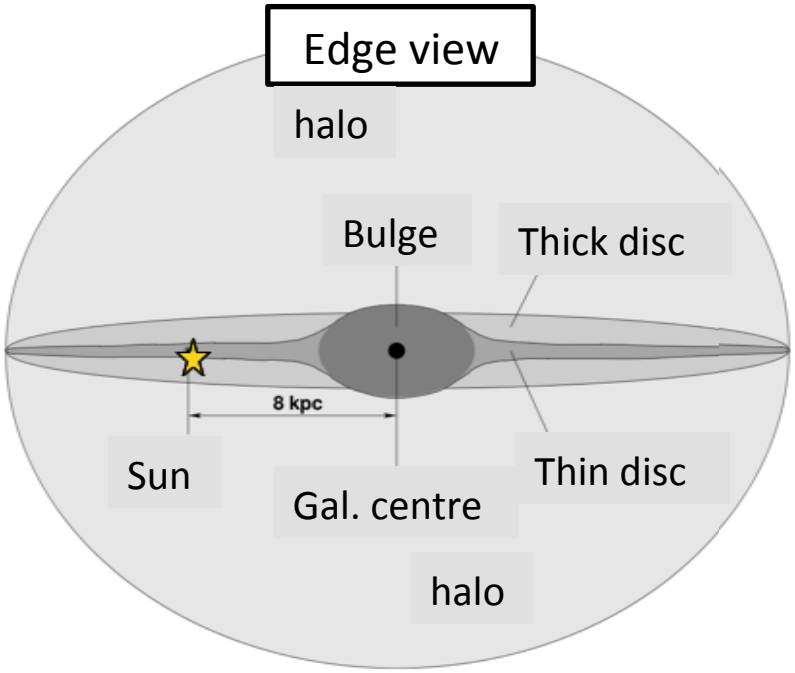
The Milky Way galaxy



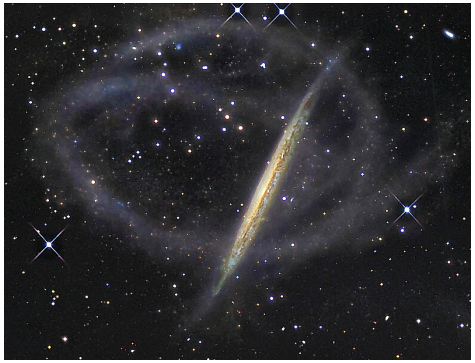


- **Thin disc:** Young stars, metal-rich**,** gas rich, rotationally supported
- **Bulge:** Old stars (~10 Gyr), large spread in [M/H]
- **Halo:** Old stars (~11-13 Gyr), pressure supported, no gas, metal-poor
- **Thick disc:** Old stars, kinematically hotter than the thin disc, intermediate [M/H]

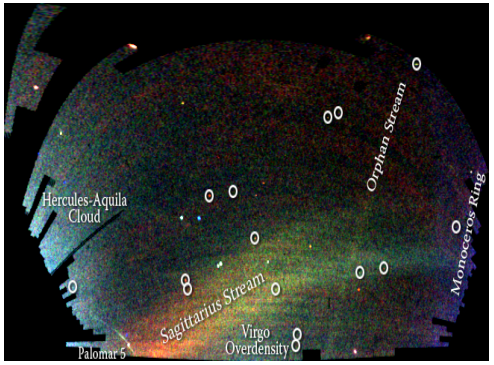
How were these structures formed?
➔Unique opportunity to study the stars individually in great detail

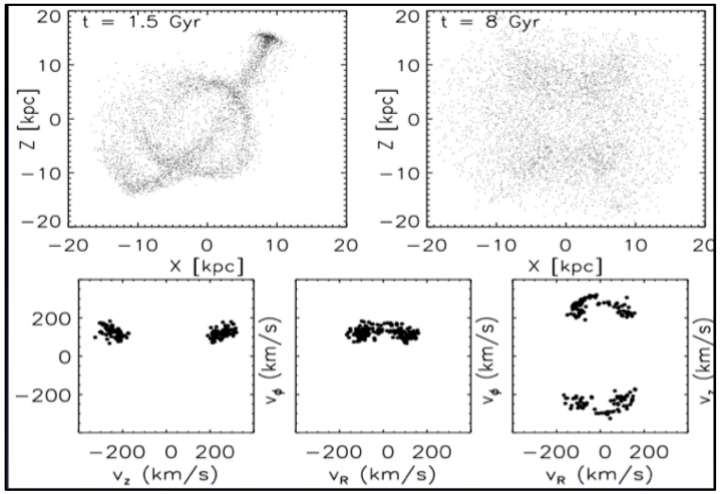
The fossil records: 1) positions & kinematics

NGC 5907 *(credits: R.J. Gabany)*

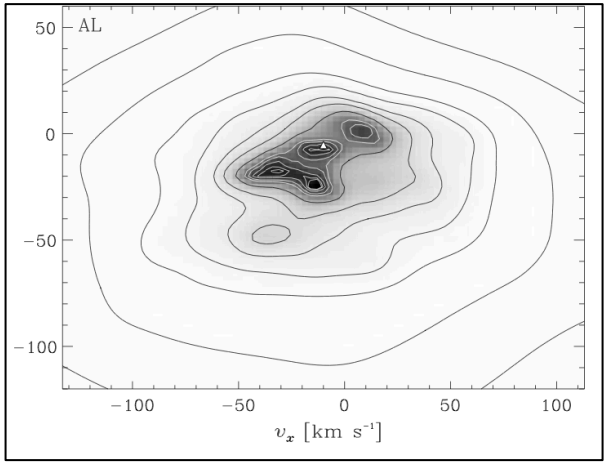


Milky Way *(Belokurov+06)*





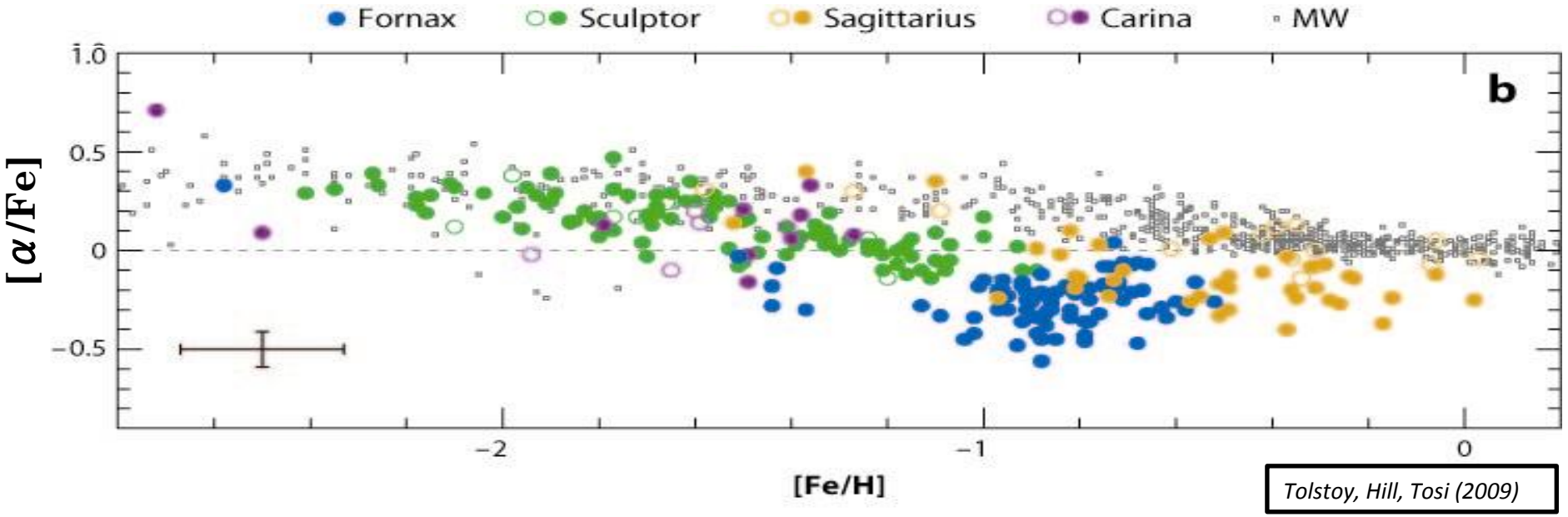
Simulation of the accretion of a galaxy (Helmi+02)



Moving groups in the disc (Dehnen+98)

Accretions & secular events can be detected from positions and kinematics

The fossil records: 2) chemistry



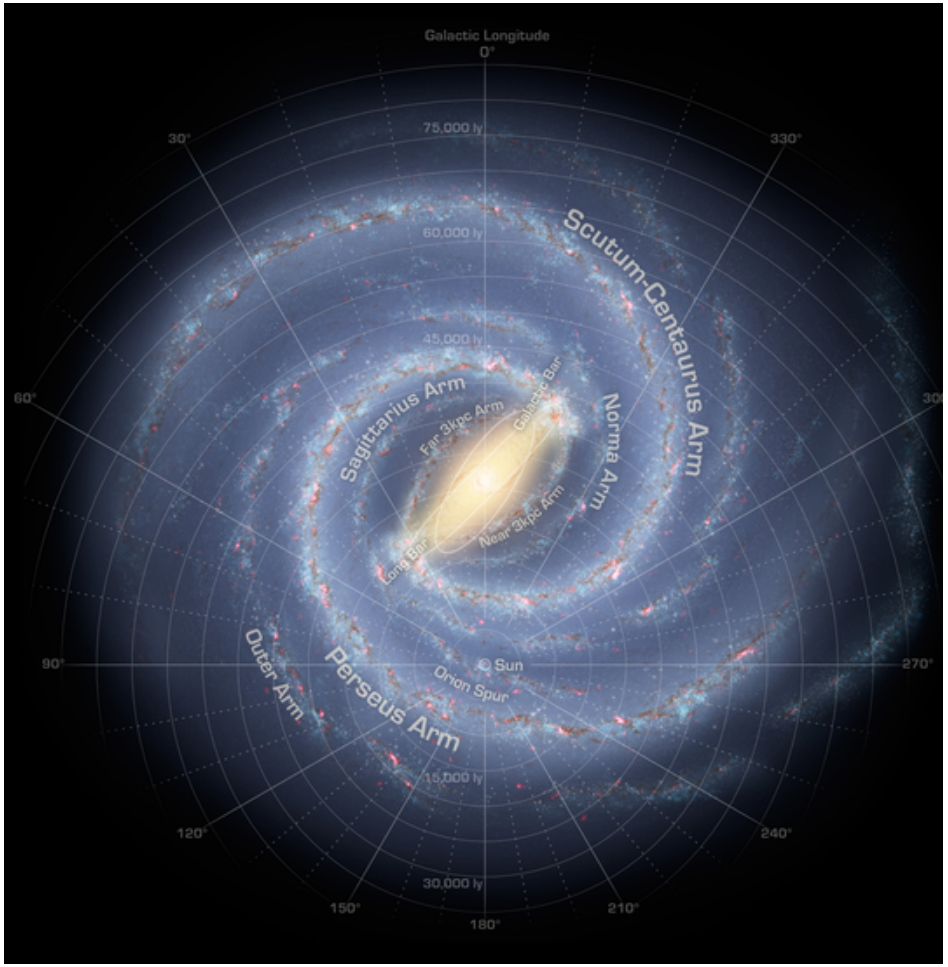
Tolstoy, Hill, Tosi (2009)

Chemical tagging:

- Different environments have different elemental ratios at a given time because of ≠SFR, outflows…

➔Different populations can be identified chemically
➔ **Need of large datasets**

Galactic archaeology
The Gaia era



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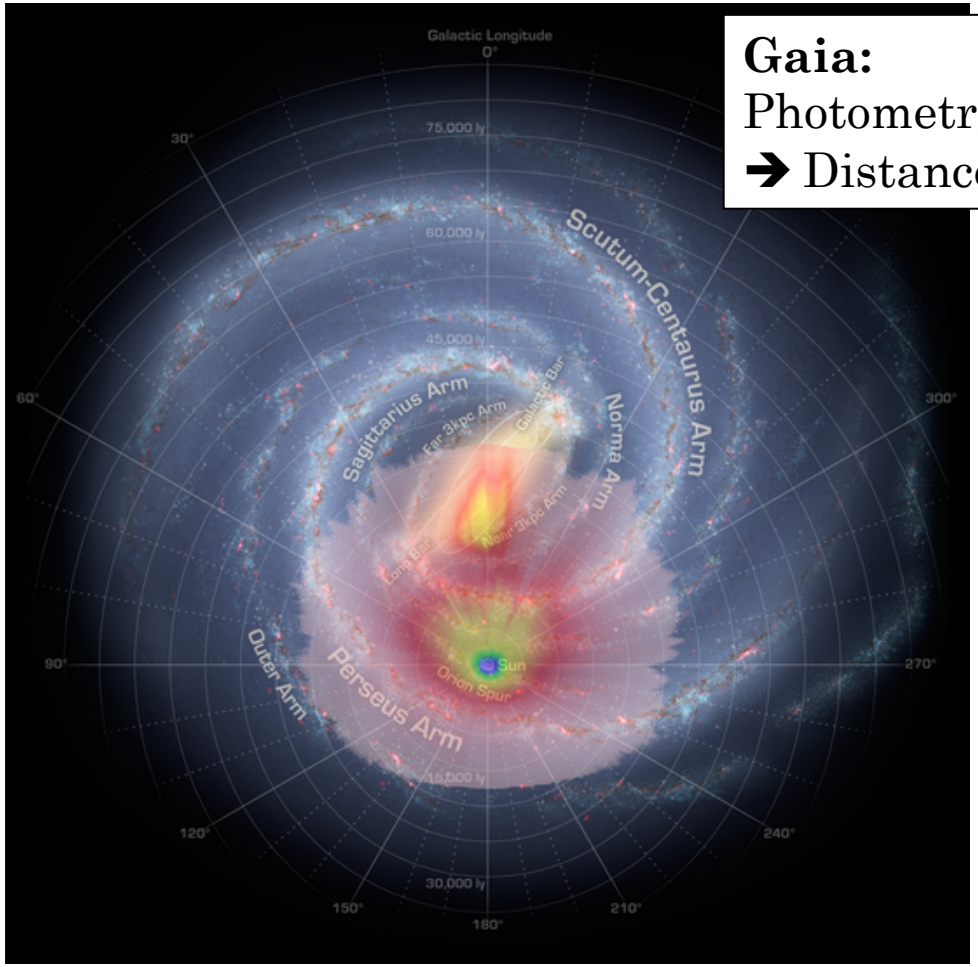
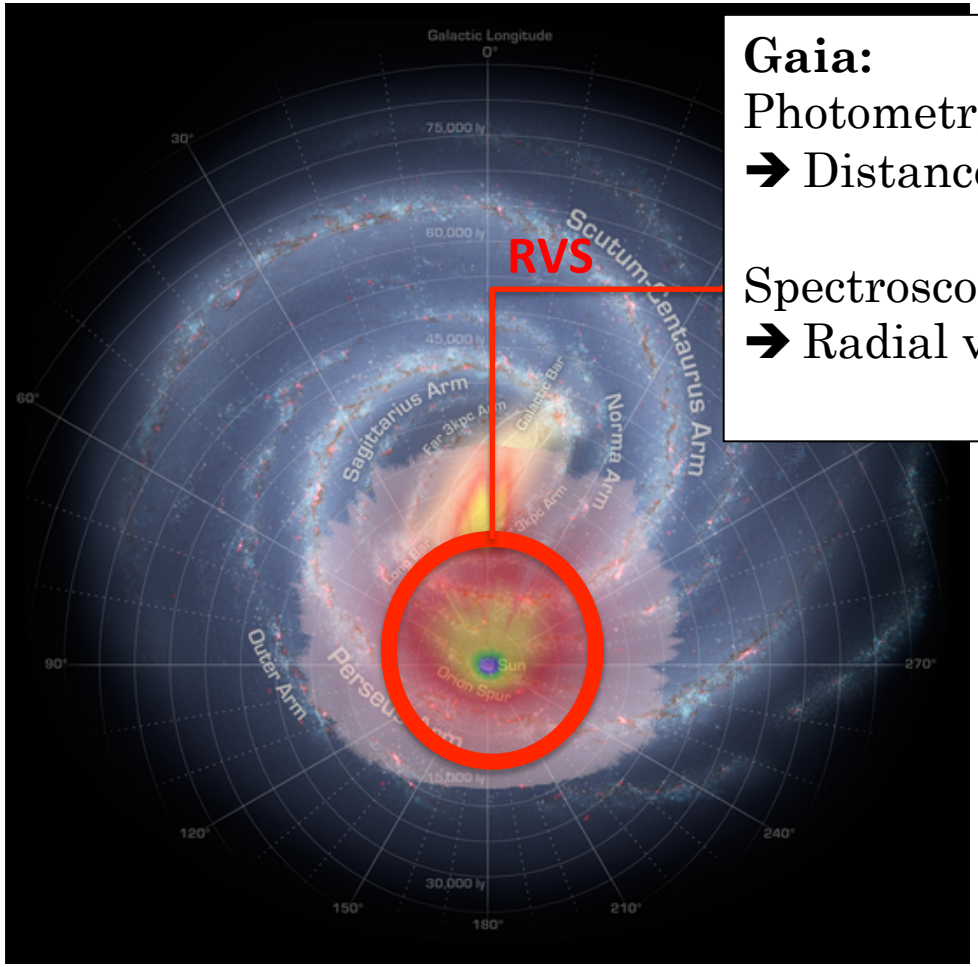


Gaia:
Photometry, astrometry: V<19
➔ Distances, proper motions

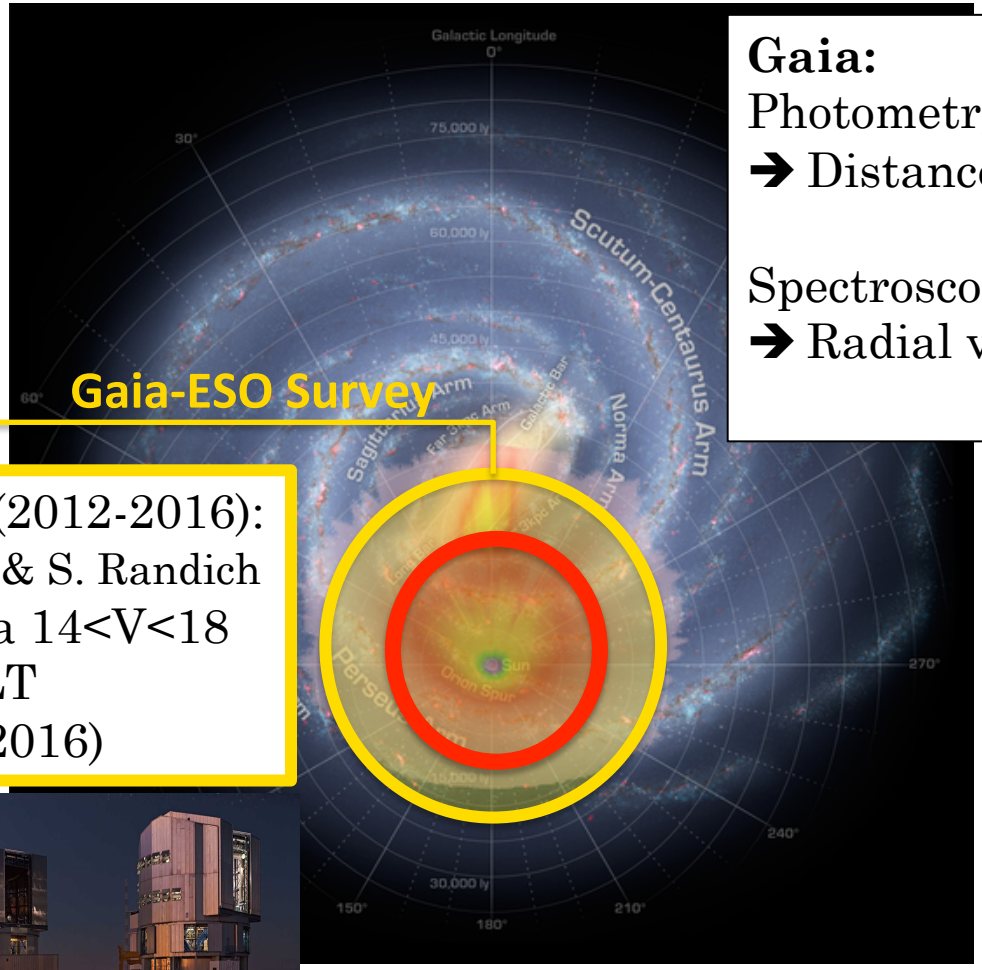
Galactic archaeology
The Gaia era



Gaia:
Photometry, astrometry: V<19
➔ Distances, proper motions

Spectroscopy: V<16
➔ Radial velocity, abundances
V<14

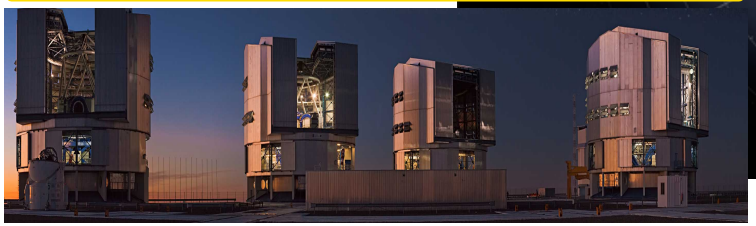
Galactic archaeology
The Gaia & Gaia-ESO era



Gaia:
Photometry, astrometry: V<19
➔ Distances, proper motions

Spectroscopy: V<16
➔ Radial velocity, abundances V<14

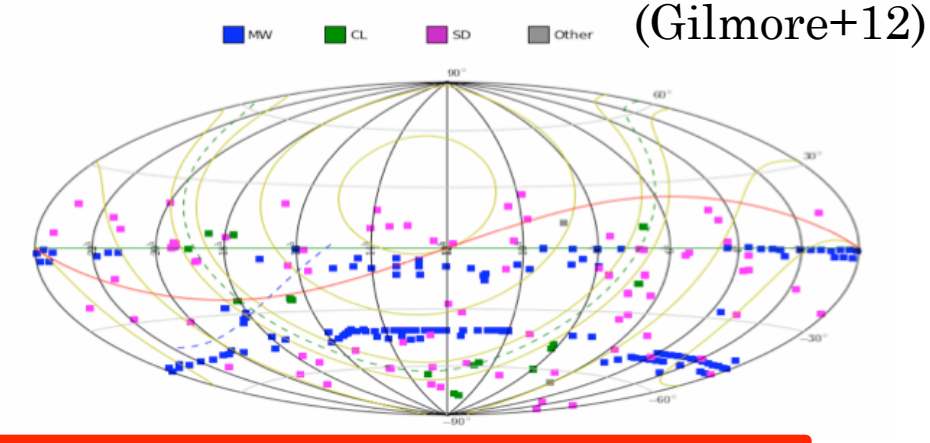
Gaia-ESO Survey (2012-2016):
P.I.: G. Gilmore & S. Randich
➔ High-res spectra 14<V<18
➔ 300 nights @ VLT
➔ N=10^5 targets (2016)



Gaia-ESO Survey

PIs: G. Gilmore & S. Randich

(Gilmore+12)



- 14<V<18
- R~20 000 (& 40 000)
- 300 nights @VLT (2012-2016)
- N=10^5

➔ **Homogeneous overview of kinematics and abundances of young, mature and old stellar populations**

- Consortium: 400+ members (FR: ~50 members)
- T_{eff}, log(g), [M/H], [α/Fe], [X/Fe]
  - GIRAFFE WP: A. Recio-Blanco (Nice) (80% of the targets)
  - UVES WP: R. Smiljanic (Torun, Poland)

- 2 internal Data-Releases : 25 000 targets

The *Gaia*-ESO Survey: the Galactic thick to thin disc transition★,★★

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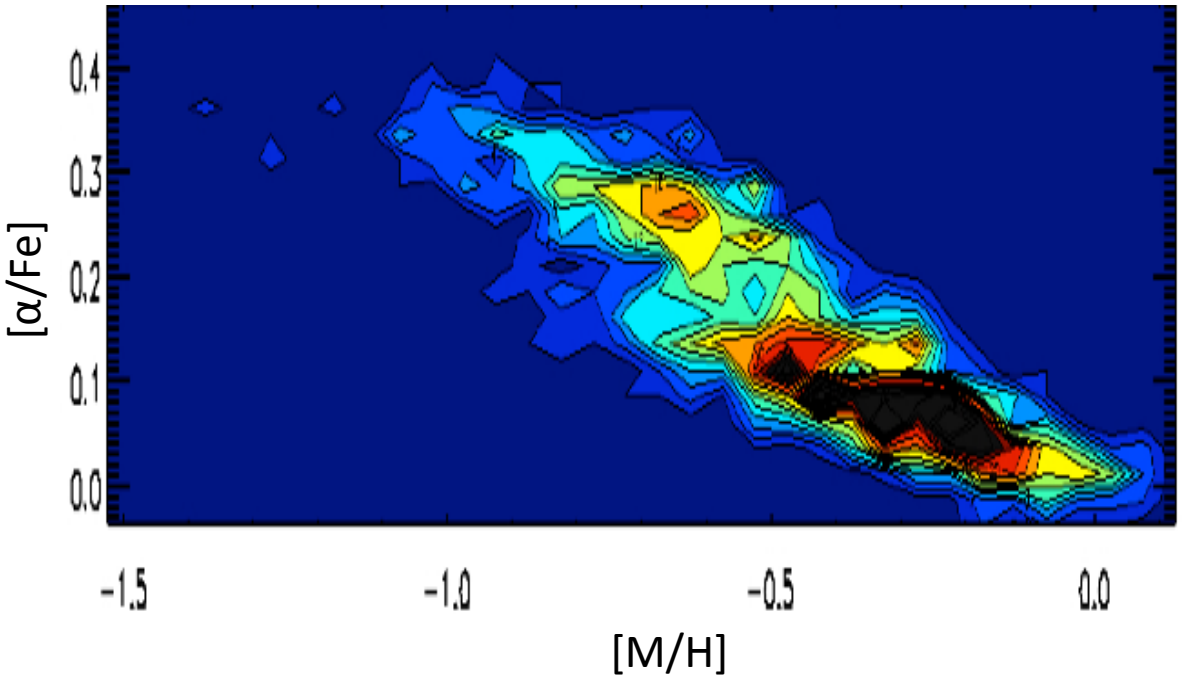

Chemical abundances for stars 5<R<10 kpc

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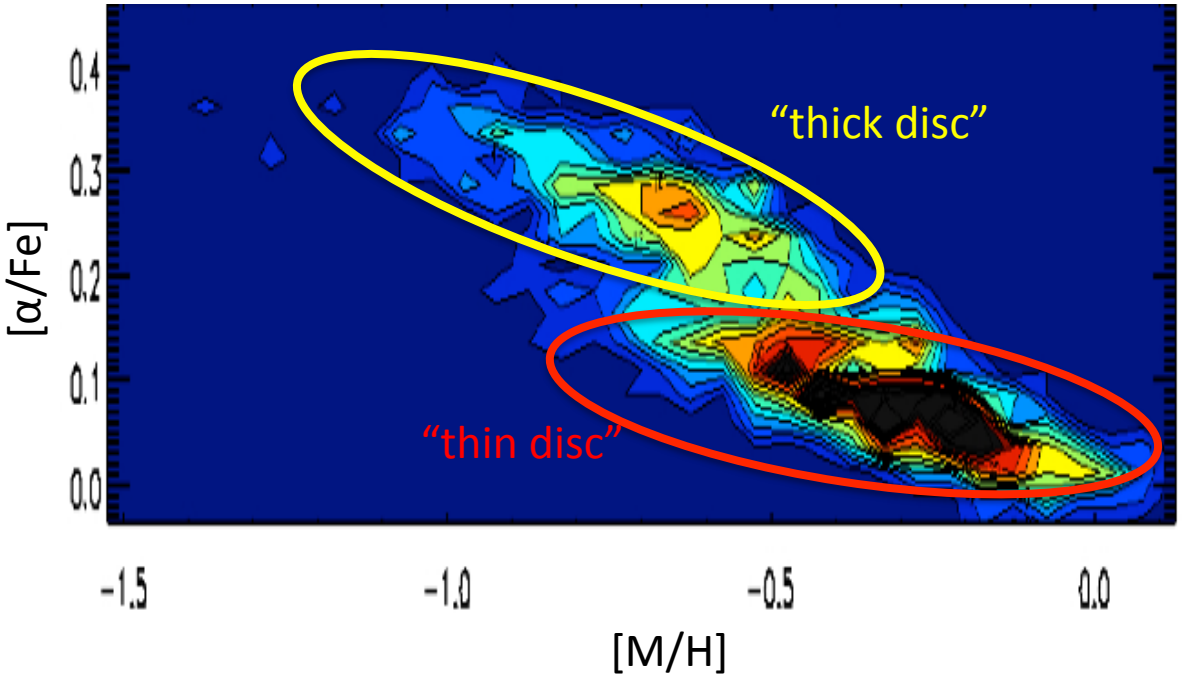
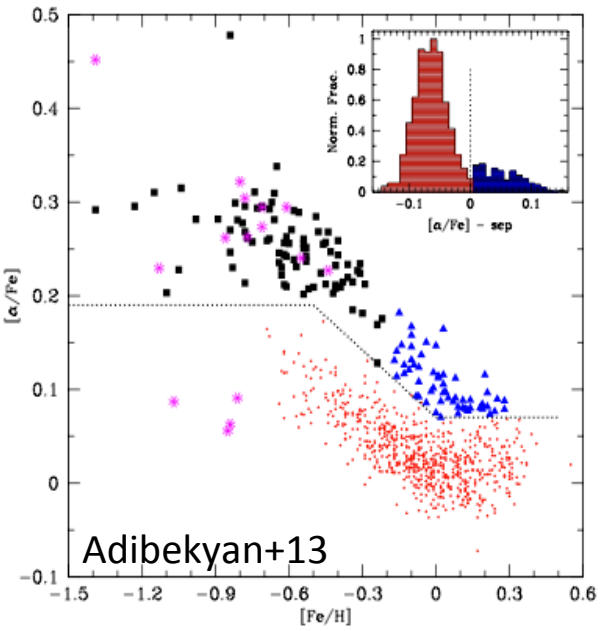


Chemical abundances for stars **5<R<10 kpc**



Chemical abundances for stars **7.9<R<8.1 kpc**

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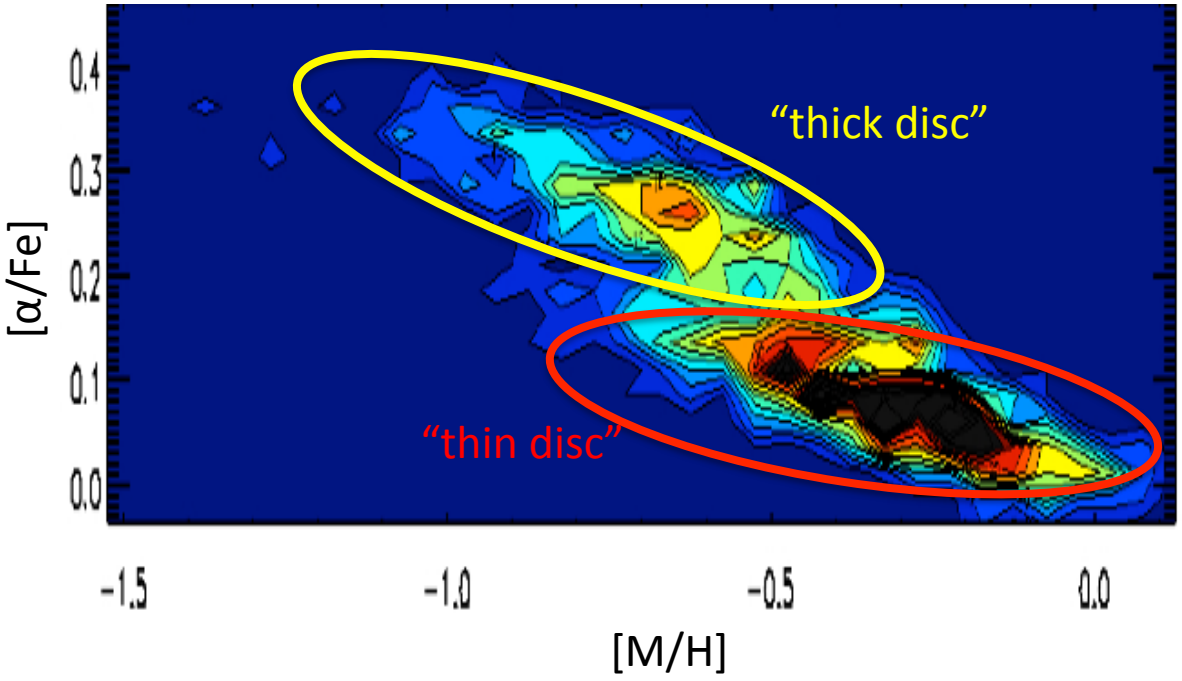

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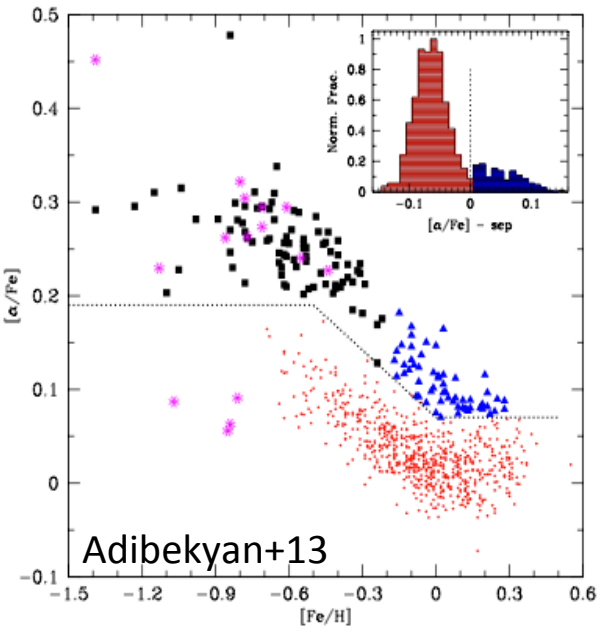

Chemical abundances for stars **7.9<R<8.1 kpc**

➔ Double chemical sequence identified also far from the Solar neighbourhood

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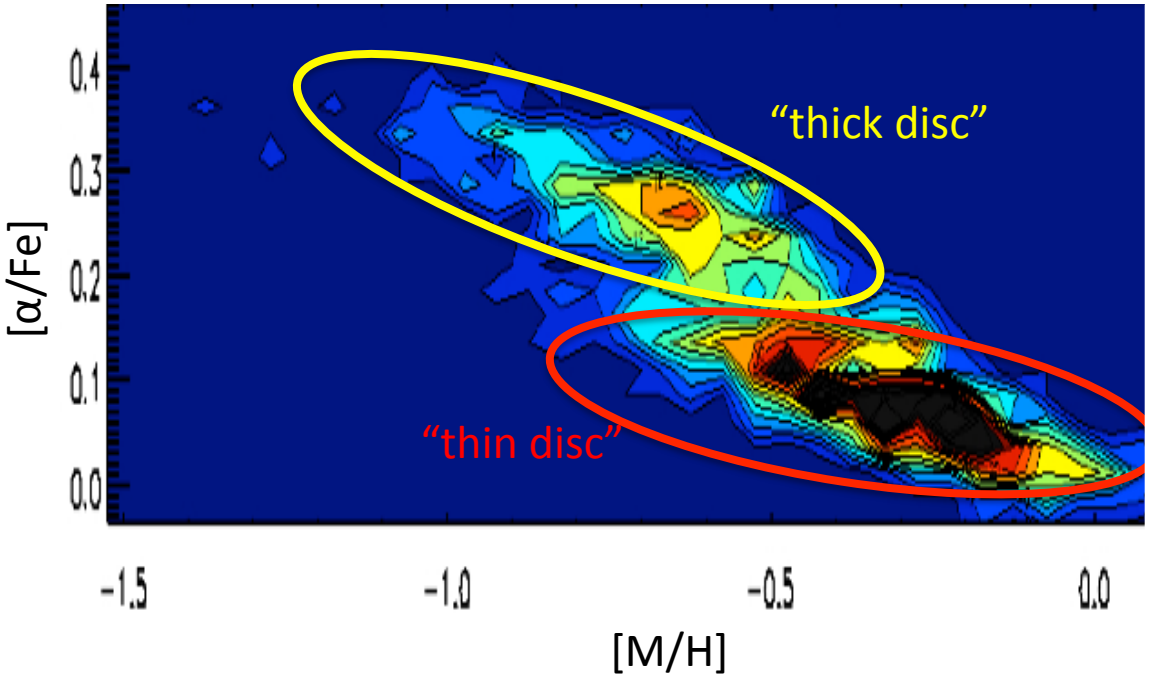

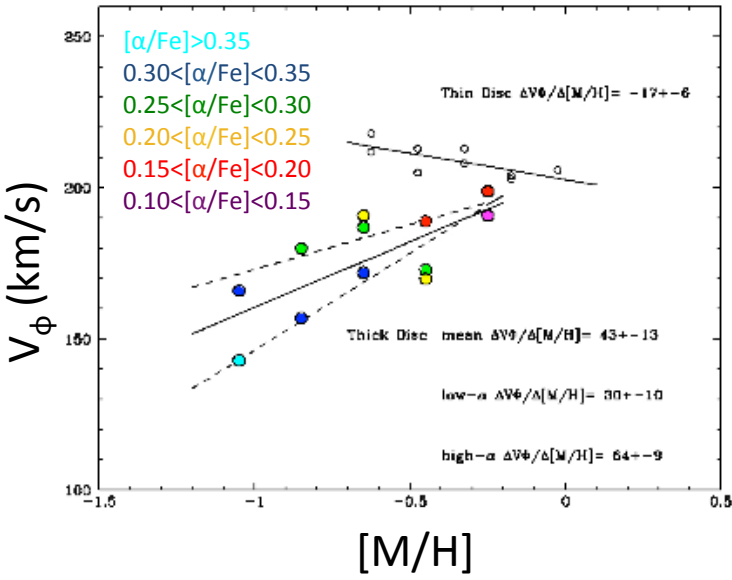

Chemical abundances for stars 5<R<10 kpc

➔ Thick disc: different chemo-dynamics compared to the thin disc

The Gaia-ESO Survey: the chemical structure of the Galactic discs from the first internal data release ⋆

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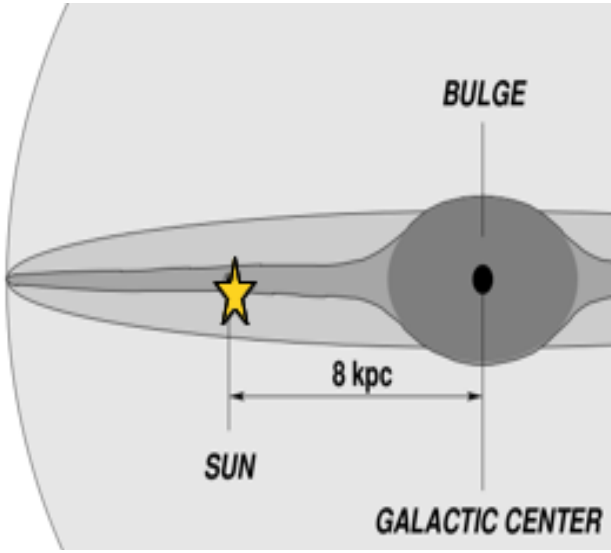
Individual abundances for 8 elements: Mg, Si, Ca, Ti, Cr, Ni, Y



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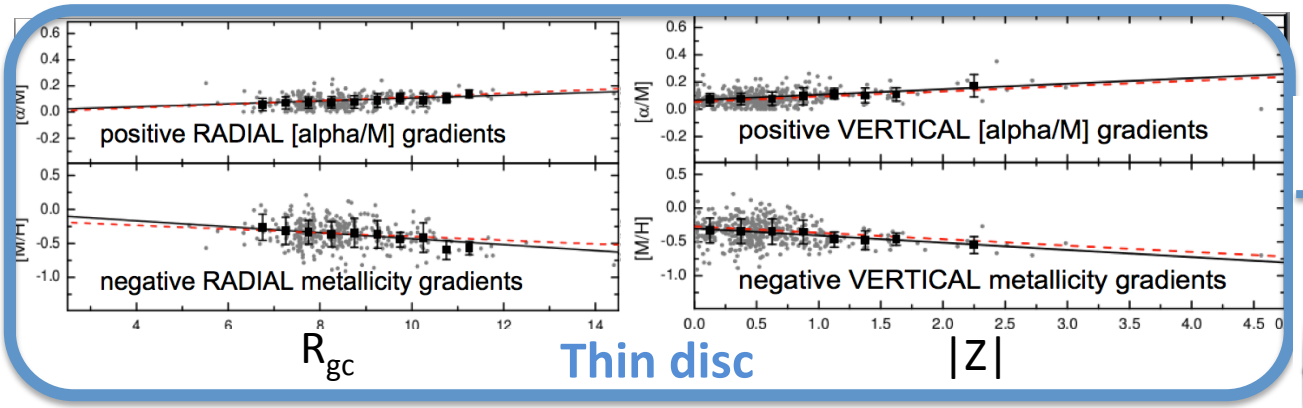

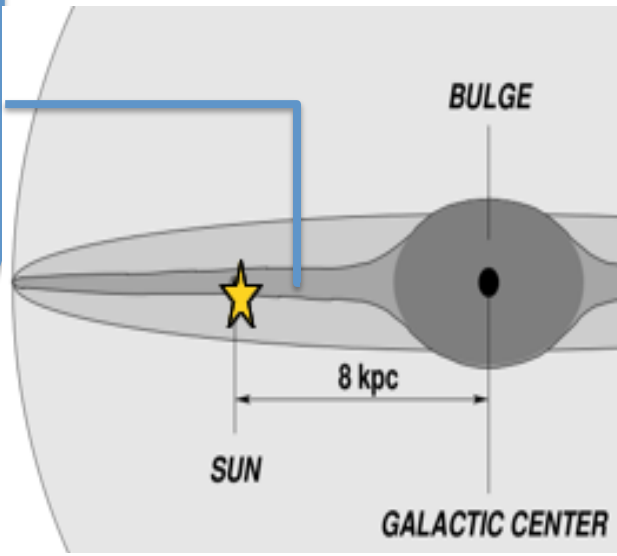

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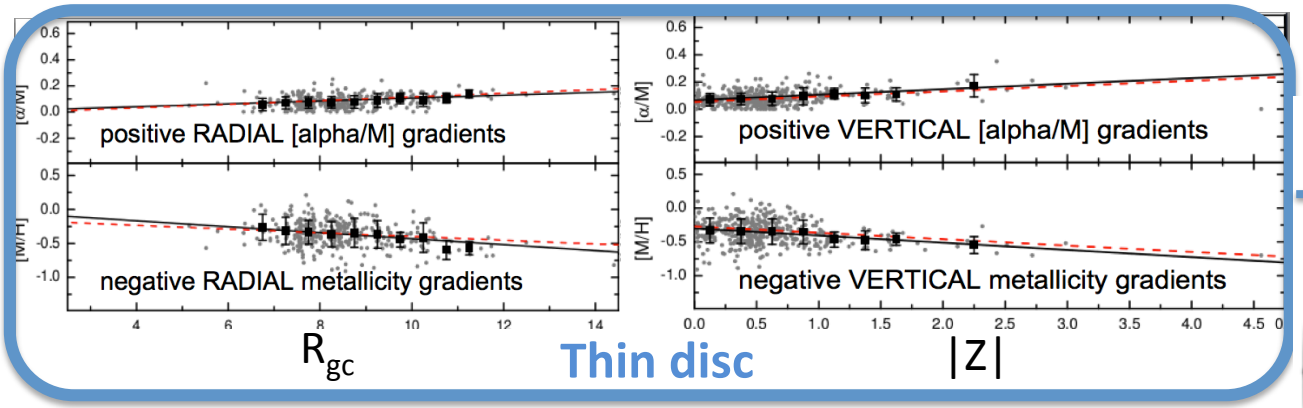

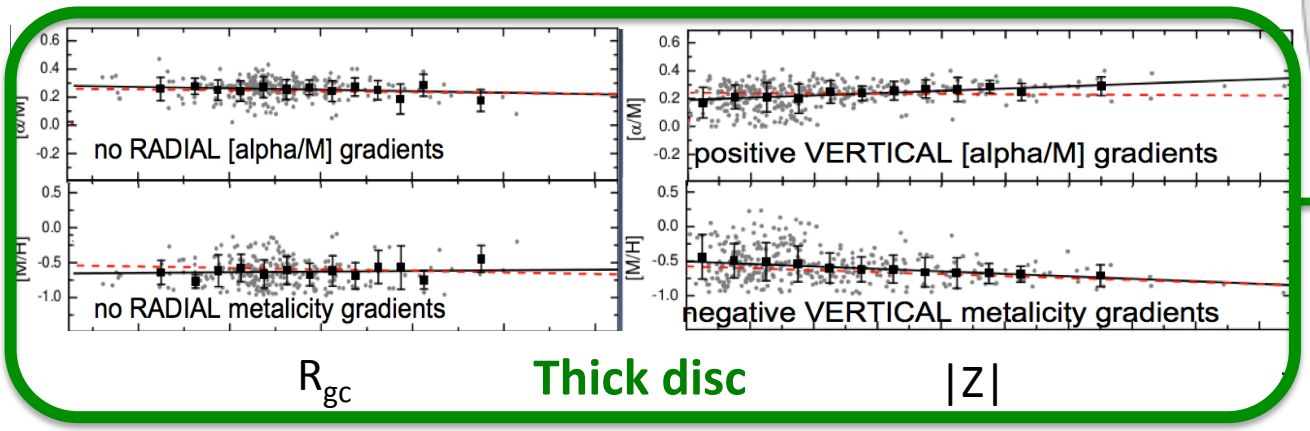

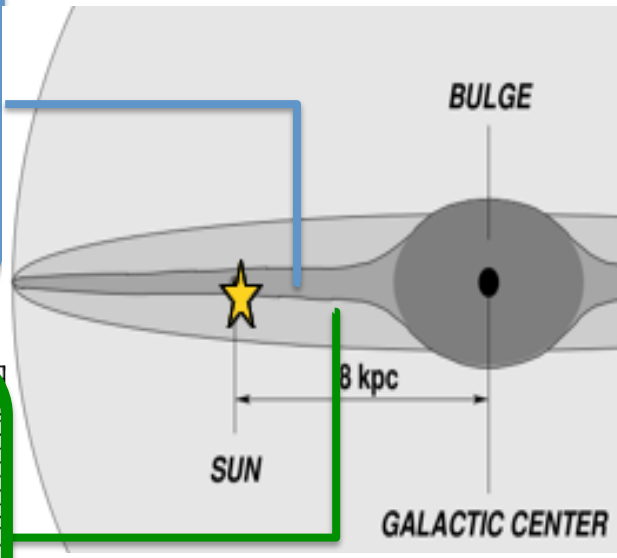

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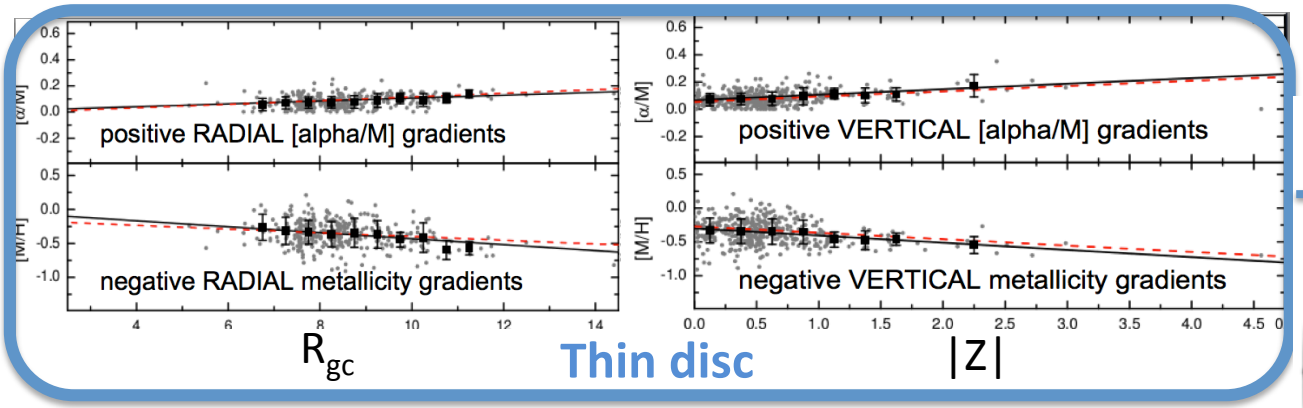
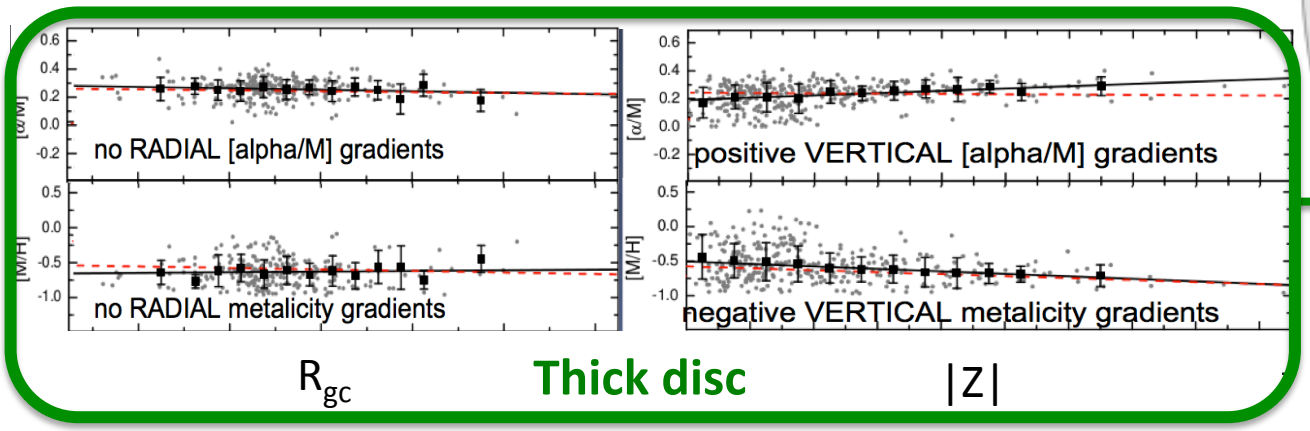
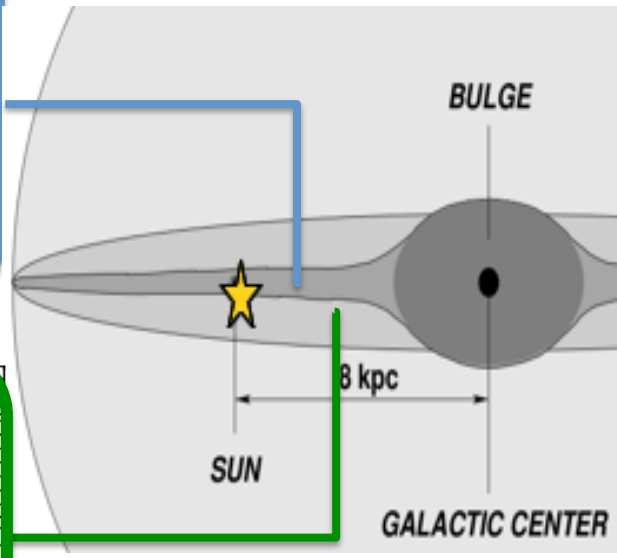




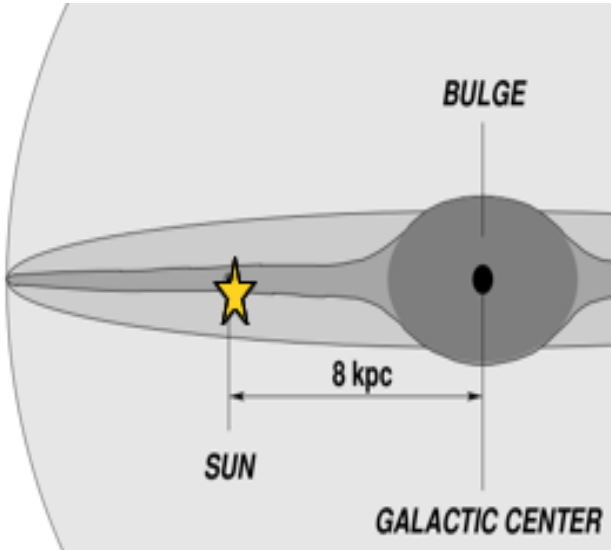


➔ **Different processes redistributing the stellar populations**

The Gaia-ESO Survey: Characterisation of the $[\alpha/Fe]$ sequences in the Milky Way discs*

G. Kordopatis[1], R.F.G. Wyse[2], G. Gilmore[3], A. Recio-Blanco[4], P. de Laverny[4], and GES builder

(To be submitted)



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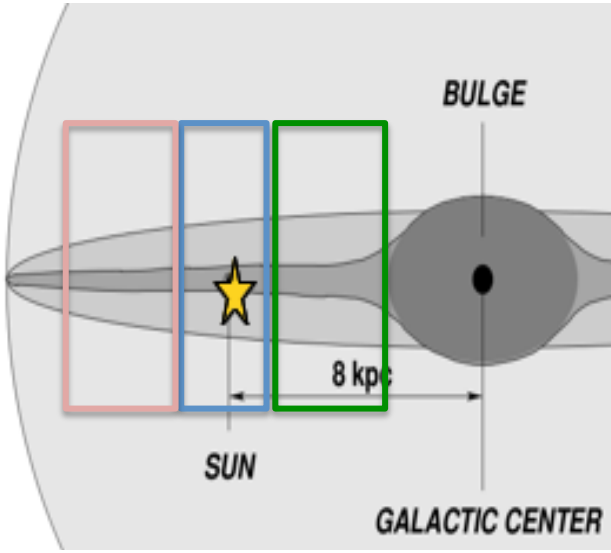

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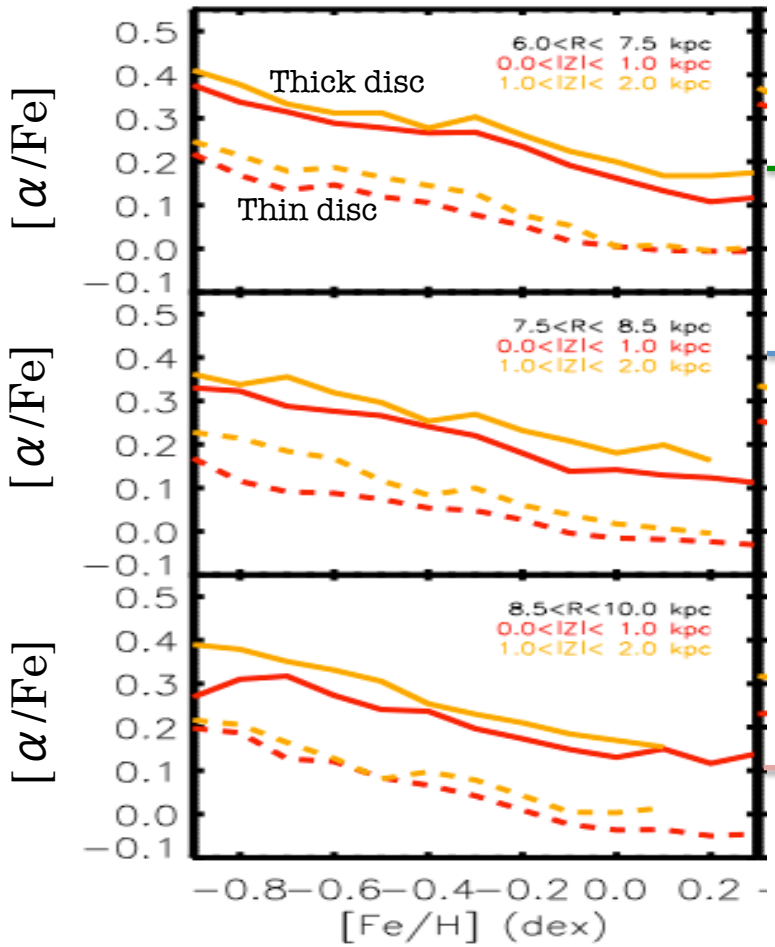
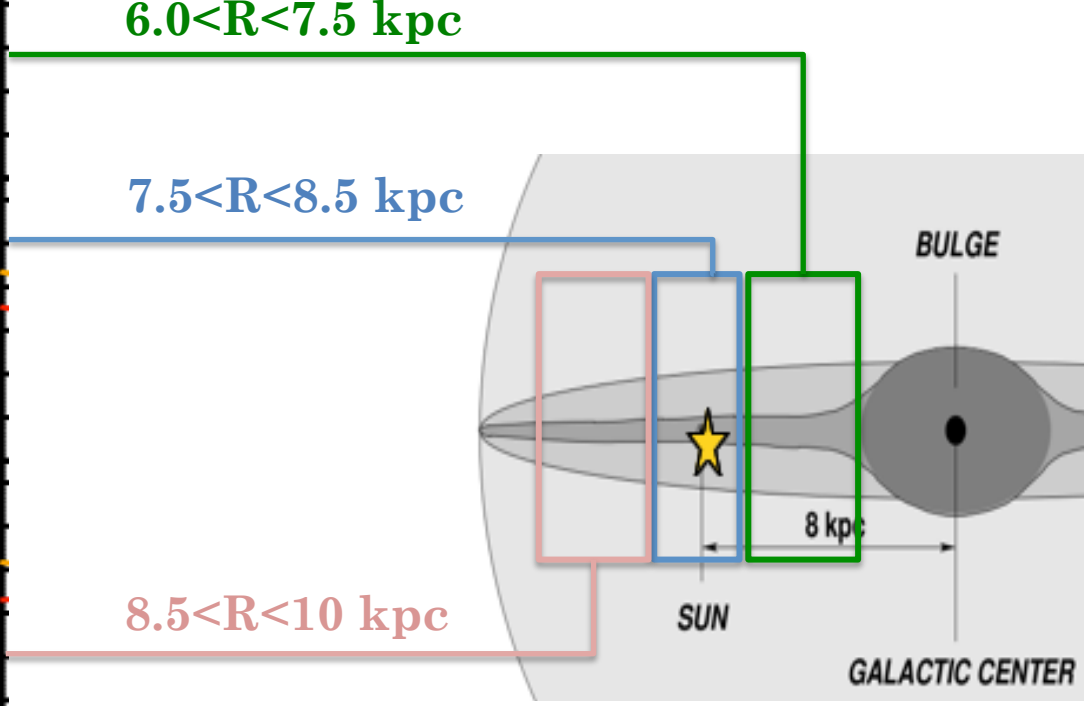
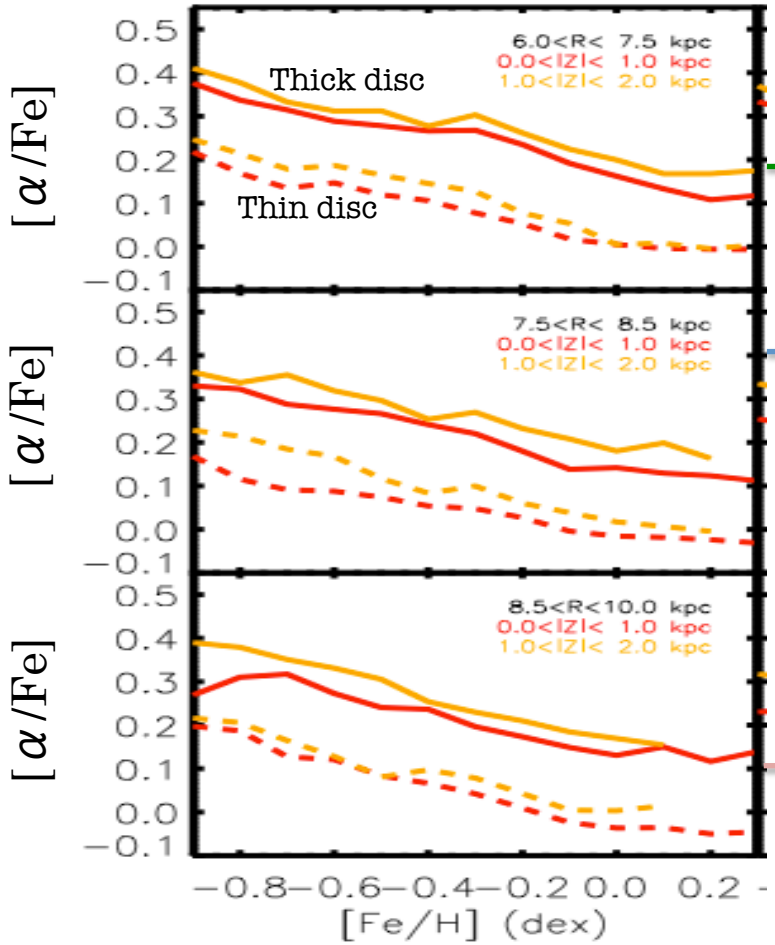


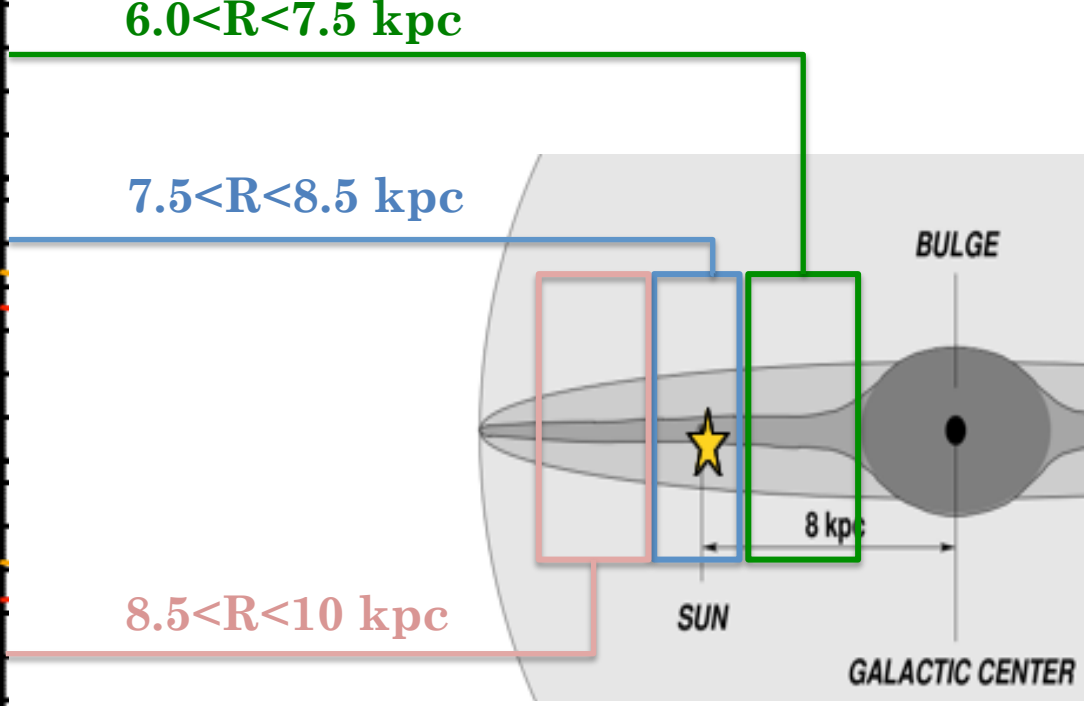


The Gaia-ESO Survey: Characterisation of the [α/Fe] sequences in the Milky Way discs*

G. Kordopatis[1], R.F.G. Wyse[2], G. Gilmore[3], A. Recio-Blanco[4], P. de Laverny[4], and GES builder

(To be submitted)





- Thin disc: seen down to -0.9 dex
- Thick disc: up to Super-Solar values

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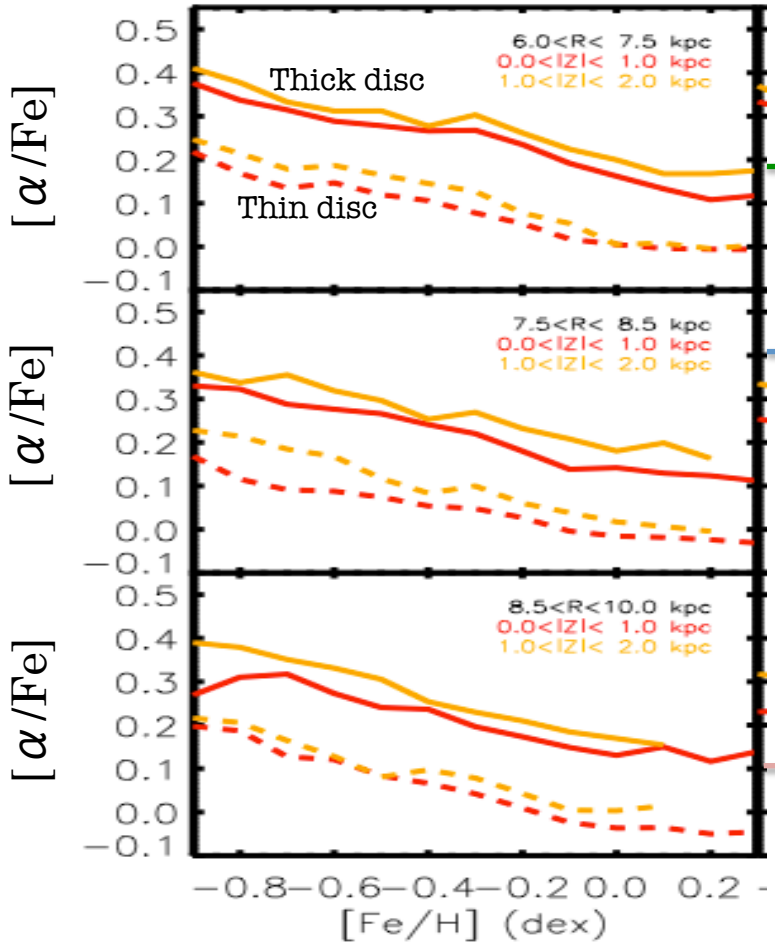
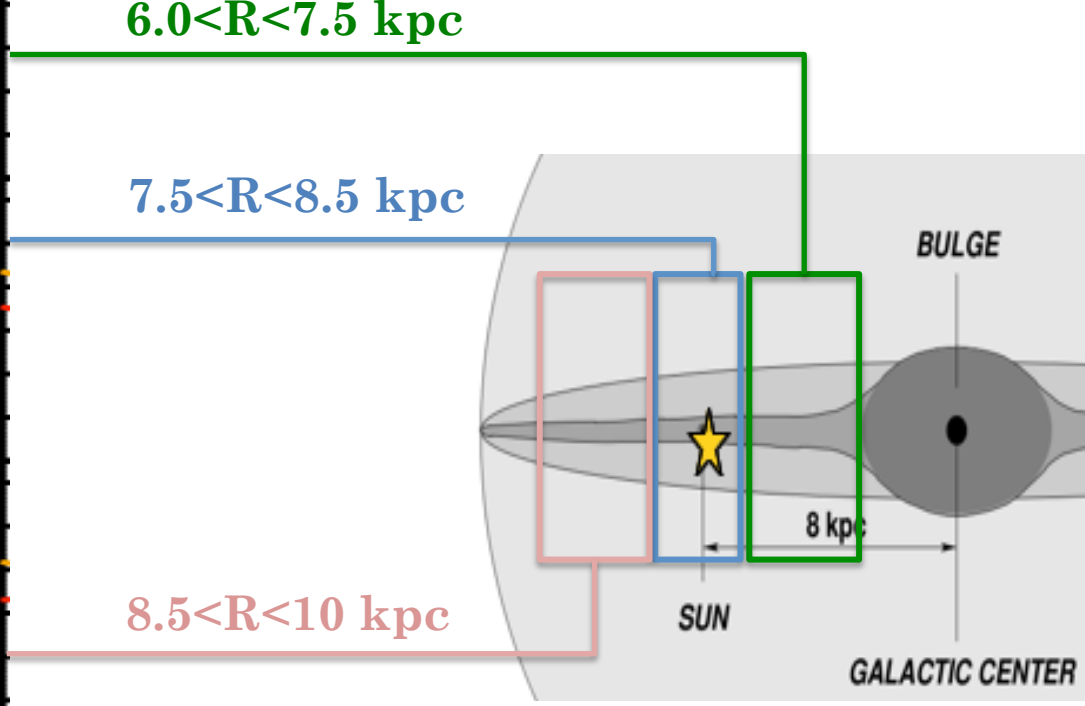




- Thin disc: seen down to -0.9 dex
- Thick disc: up to Super-Solar values

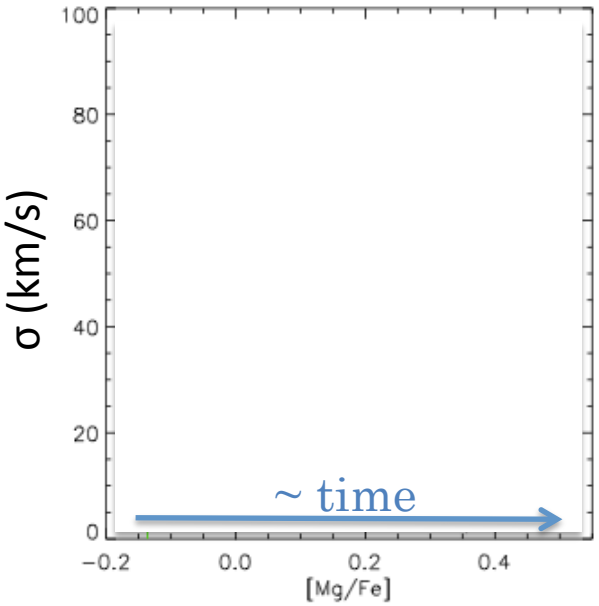
➔ Thick disc: Stars formed in a turbulent disc? (e.g.: Haywood+13)

➔ Thin disc: Inside-out formation?

The Gaia-ESO Survey: New constrains on the Galactic disc velocity dispersion and its chemical dependencies *

G. Guiglion[1], A. Recio-Blanco[1], P. de Laverny[1], G. Kordopatis[2], V. Hill[1] + other contributors

(To be submitted)



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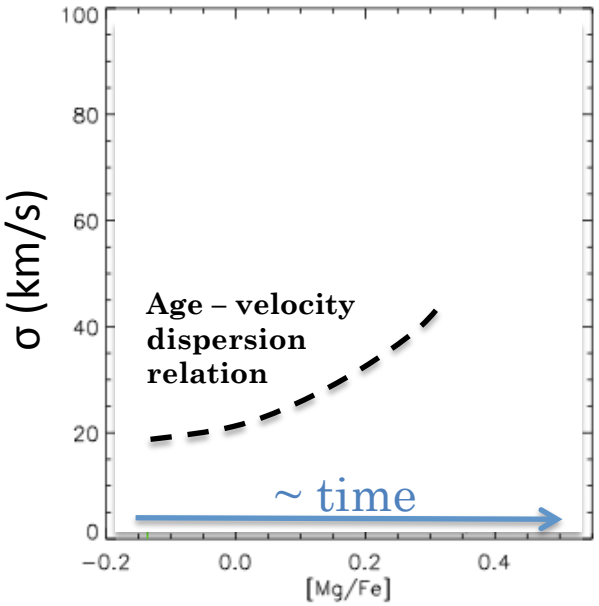

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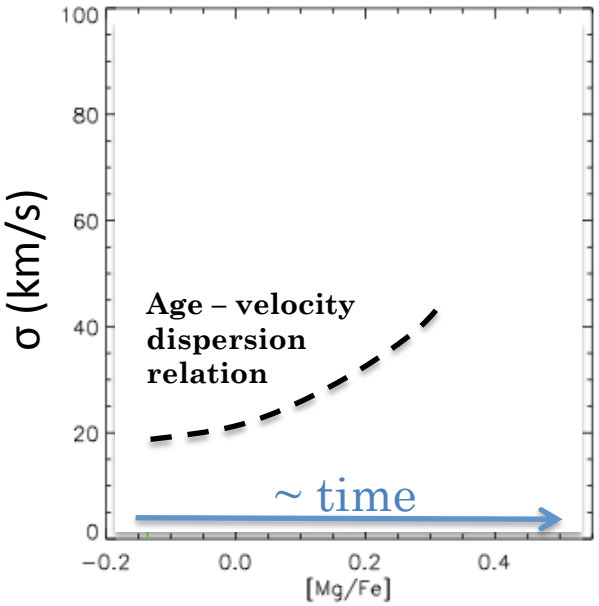
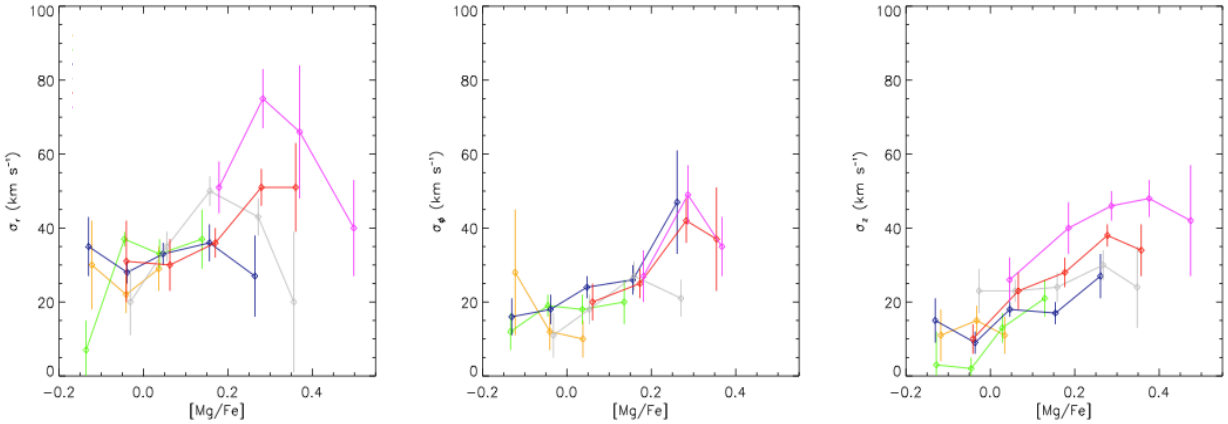


(σ_R σ_ϕ σ_Z) for various metallicity cuts



<[Fe/H]>=+0.27 <[Fe/H]>=+0.04 <[Fe/H]>=-0.15
<[Fe/H]>=-0.35 <[Fe/H]>=-0.53 <[Fe/H]>=-0.86

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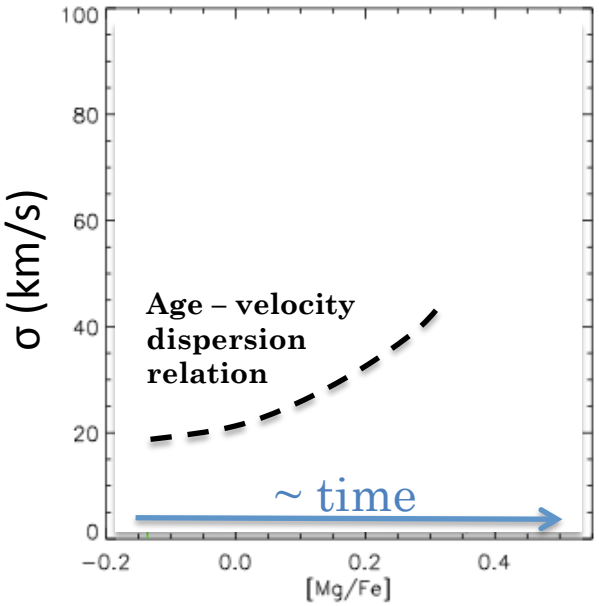

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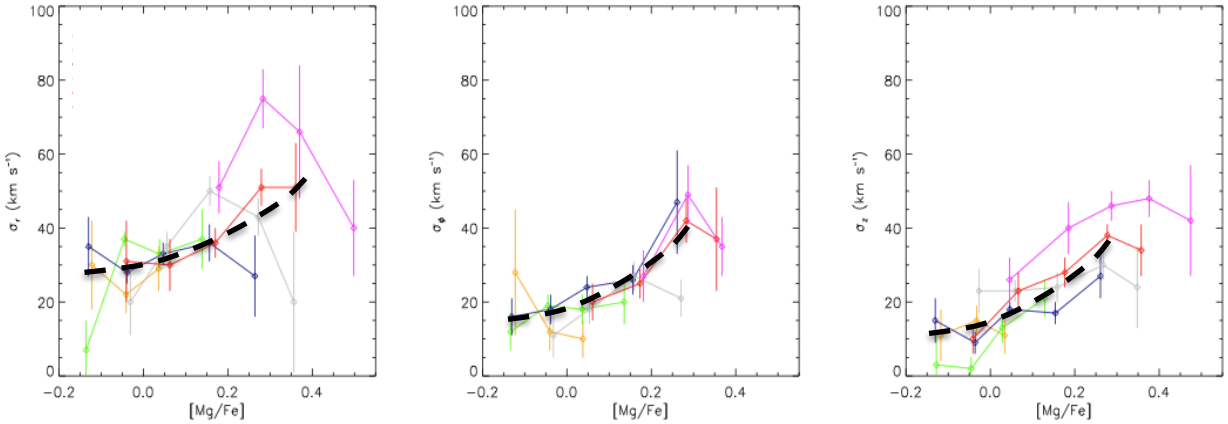

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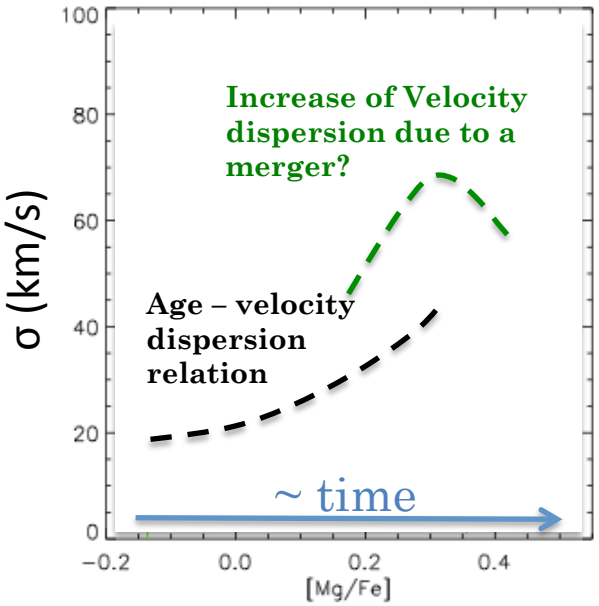
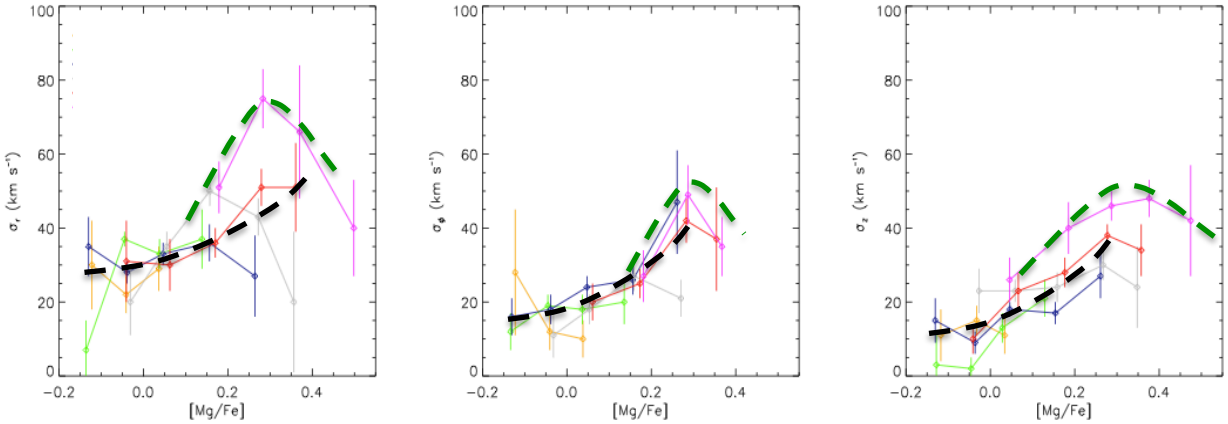


(σ_R σ_ϕ σ_Z) for various metallicity cuts



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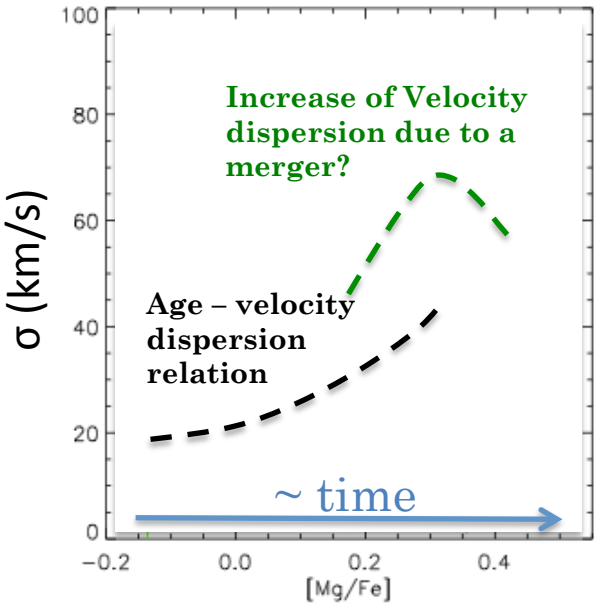
Evidence for the last major merger?

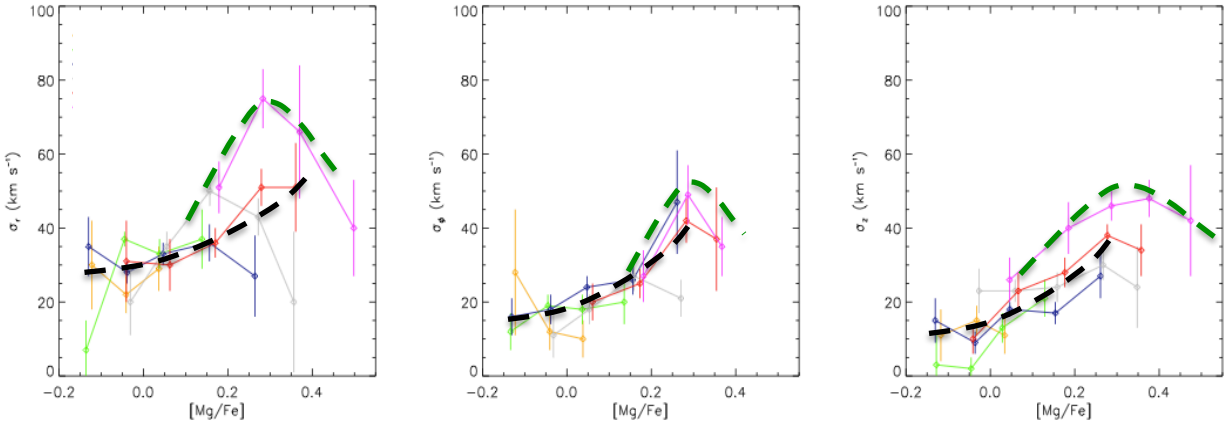
The Gaia-ESO Survey: New constrains on the Galactic disc velocity dispersion and its chemical dependencies *

G. Guiglion[1], A. Recio-Blanco[1], P. de Laverny[1], G. Kordopatis[2], V. Hill[1] + other contributors

(To be submitted)



(σ_R σ_ϕ σ_Z) for various metallicity cuts



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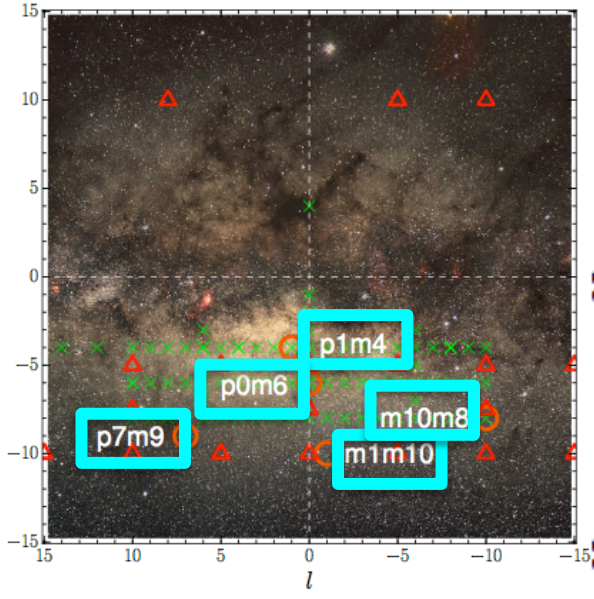
<[Fe/H]>=-0.35 <[Fe/H]>=-0.53 <[Fe/H]>=-0.86

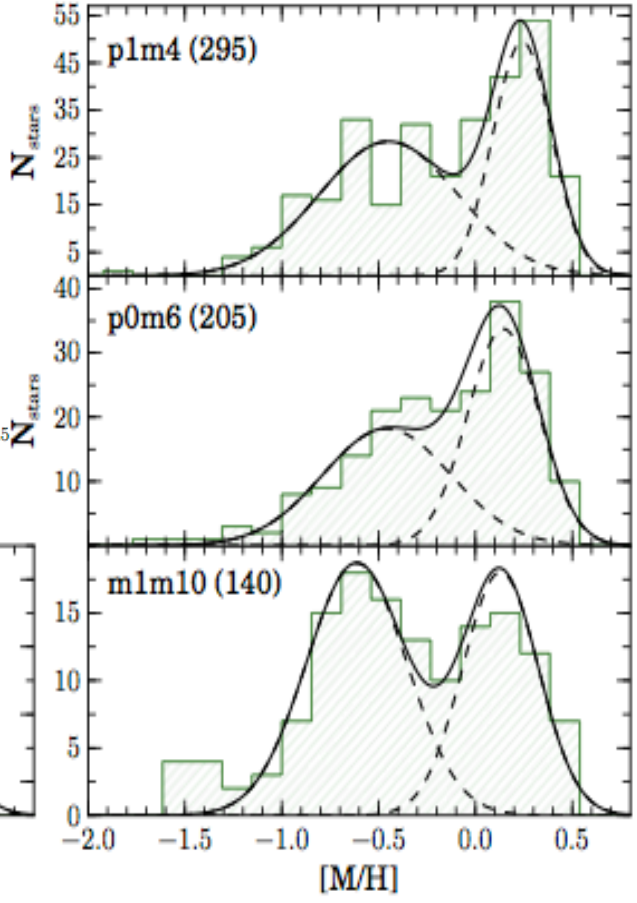
Evidence for the last major merger?

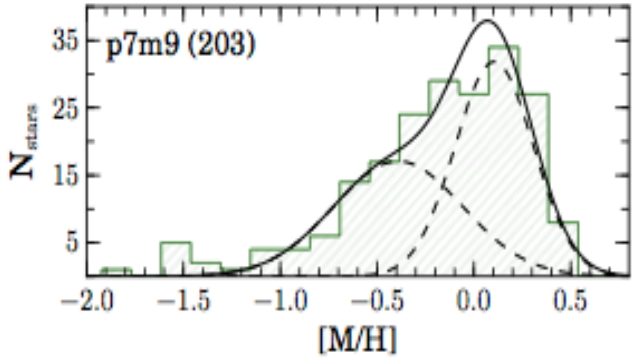
➔ 10 Gyr ago? (Minchev+14)

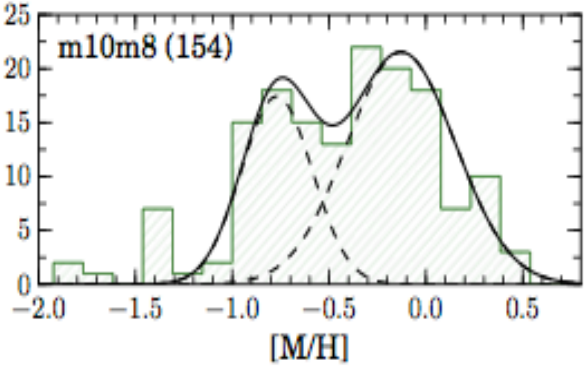
The *Gaia*-ESO Survey: metallicity and kinematic trends in the Milky Way bulge★

A. Rojas-Arriagada[1], A. Recio-Blanco[1], V. Hill[1], P. de Laverny[1], M. Schultheis[1], C. Babusiaux[2], M. Zoccali[3,4], D. Minniti[3,4,5,6], O. A. Gonzalez[7], S. Feltzing[8], G. Gilmore[9], S. Randich[10], A. Vallenari[11], E. J. Alfaro[12], T. Bensby[8], A. Bragaglia[13], E. Flaccomio[14], A. C. Lanzafame[15], E. Pancino[13], R. Smiljanic[16,17], M. Bergemann[9], M. T. Costado[12], F. Damiani[14], A. Hourihane[9], P. Jofré[9], C. Lardo[13], L. Magrini[10], E. Maiorca[10], L. Morbidelli[10], L. Sbordone[18], C. C. Worley[9], S. Zaggia[11], and R. Wyse[19]







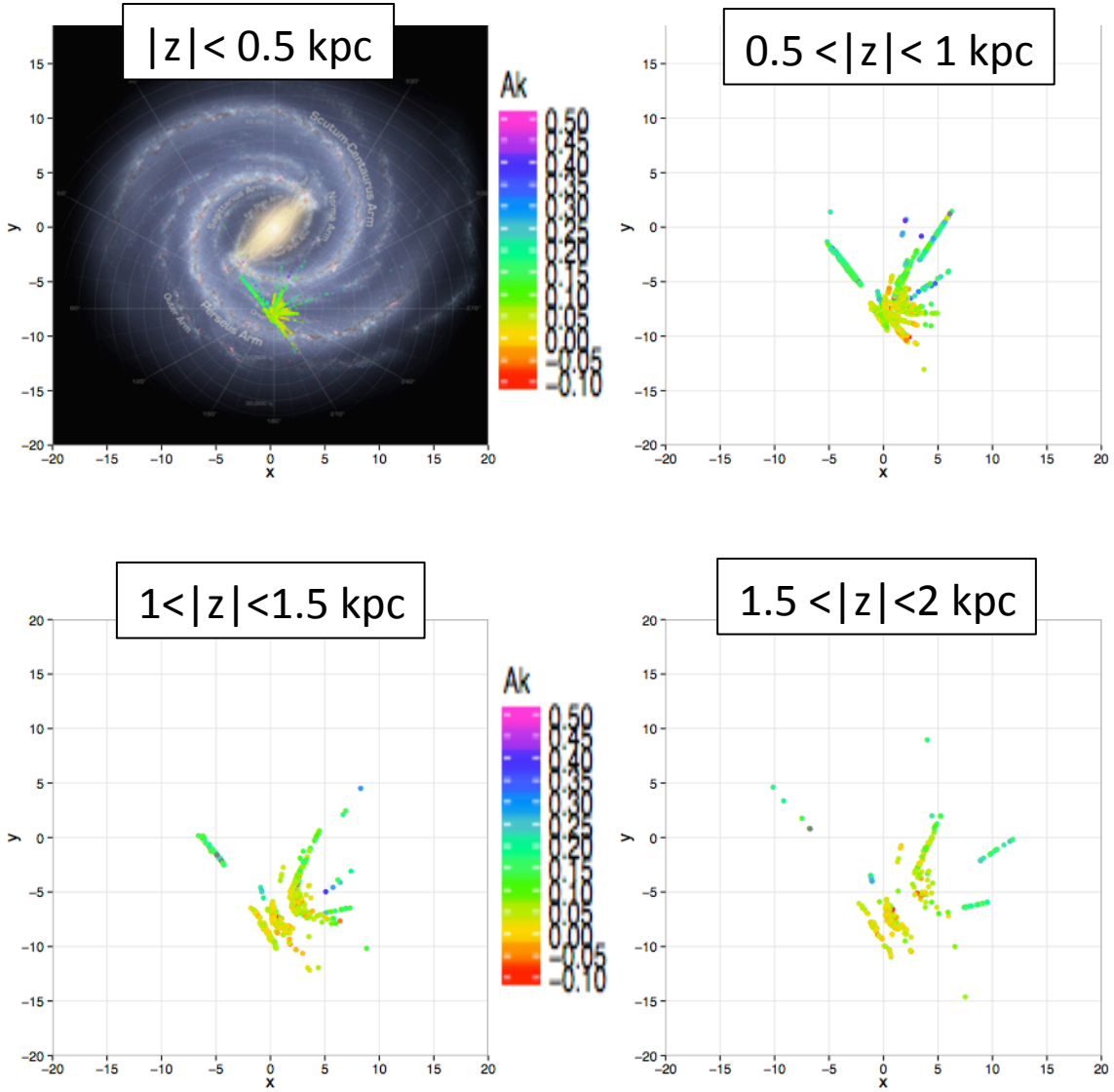


varying proportions of stars:
(i) metal-rich boxy shaped component, with bar-like kinematics
(ii) metal-poor more extended rotating structure dominating far from the plane.

The Gaia-ESO Survey: Tracing interstellar extinction★

M. Schultheis[1], G. Kordopatis[2,3], A. Recio-Blanco[1], P. de Laverny[1], V. Hill[1], G. Gilmore[3], E. J. Alfaro[4], M.T. Costado[4], T. Bensby[5], F. Damiani[6], S. Feltzing[5], E. Flaccomio[6], C. Lardo[7], P. Jofre[3], L. Prisinzano[6], S. Zaggia[8], F. Jimenez-Esteban[9,10], L. Morbidelli[11], and A.C. Lanzafame[12]

(Submitted)



- E(J–H)/E(J–K) not dependent on the angle from the Galactic centre nor the Galactocentric distance.
- uniform extinction law in the SDSS ugriz bands and the near-IR JHKs bands.
- Extinction maps with mean colour-excesses and constant extinction coefficient can be used without introducing any systematic errors.
- dust scale height:

$h_z = 152 \pm 14$ pc

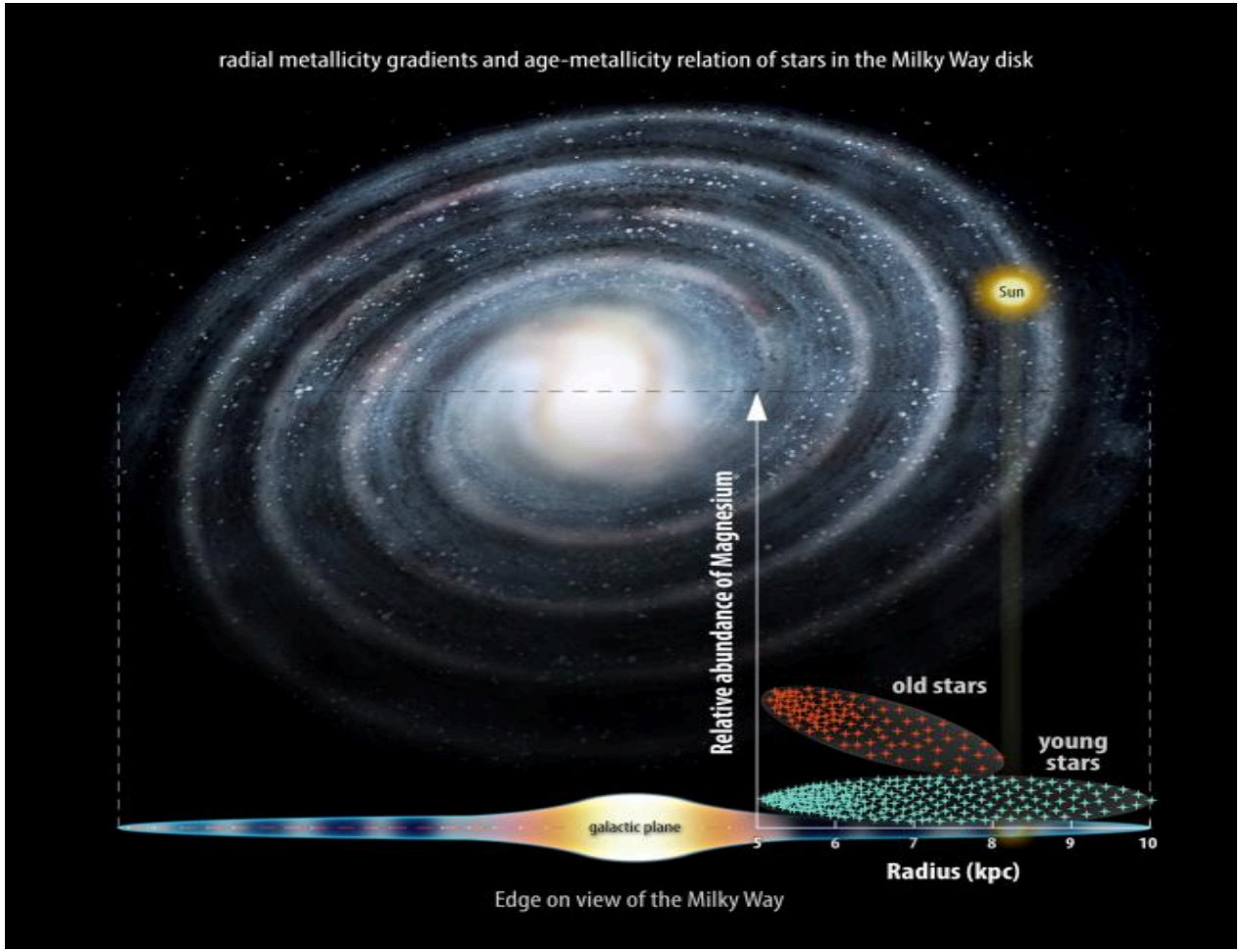
Perspectives

- Future GES data releases:
  - Three times as many targets in the next 2-3 years
- Combination with precise proper motions (and parallaxes!) of Gaia.
- Future instruments:
  - WEAVE, MOONS, 4MOST…

THANK YOU FOR YOUR ATTENTION

The *Gaia*-ESO Survey: radial metallicity gradients and age-metallicity relation of stars in the Milky Way disk★

M. Bergemann[1], G. R. Ruchti[2], A. Serenelli[3], S. Feltzing[2], A. Alves-Brito[4,23], M. Asplund[4], T. Bensby[2], P. Gruiters[5], U. Heiter[5], A. Hourihane[1], A. Korn[5], K. Lind[1], A. Marino[4], P. Jofre[1], T. Nordlander[5], N. Ryde[2], C. C. Worley[1], G. Gilmore[1], S. Randich[6], A. M. N. Ferguson[10], R. D. Jeffries[11], G. Micela[12], I. Negueruela[13], T. Prusti[14], H.-W. Rix[15], A. Vallenari[16], E. J. Alfaro[21], C. Allende Prieto[7], A. Bragaglia[16], S. E. Koposov[1,8], A. C. Lanzafame[24], E. Pancino[17,9], A. Recio-Blanco[18], R. Smiljanic[19,20], N. Walton[1], M. T. Costado[21], E. Franciosini[6], V. Hill[18], C. Lardo[17], P. de Laverny[18], L. Magrini[6], E. Maiorca[6], T. Masseron[1], L. Morbidelli[6], G. Sacco[6], G. Kordopatis[1], and G. Tautvaišienė[22]



➔**Evidence of inside-out formation of the (thin) disc**