Unveiling the structure and kinematics of the Milky Way disk with A stars

J. Ardèvol, M. Monguió, F. Figueras, M. Romero-Gómez, J.M. Carrasco

The Milky Way Revealed by Gaia: The Next Frontier
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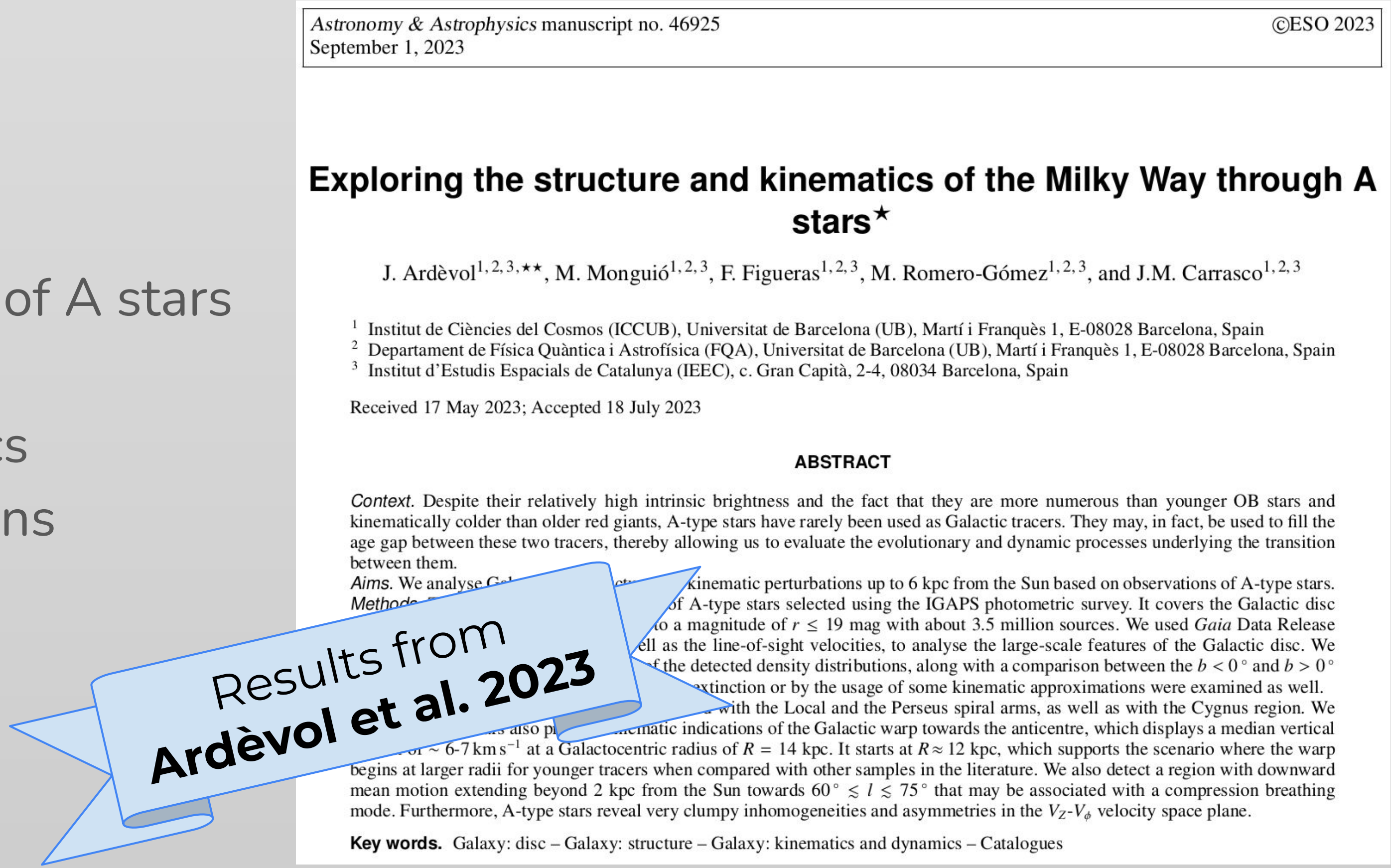

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Exploring the structure and kinematics of the Milky Way through A stars★

J. Ardèvol[1,2,3,★★], M. Monguió[1,2,3], F. Figueras[1,2,3], M. Romero-Gómez[1,2,3], and J.M. Carrasco[1,2,3]

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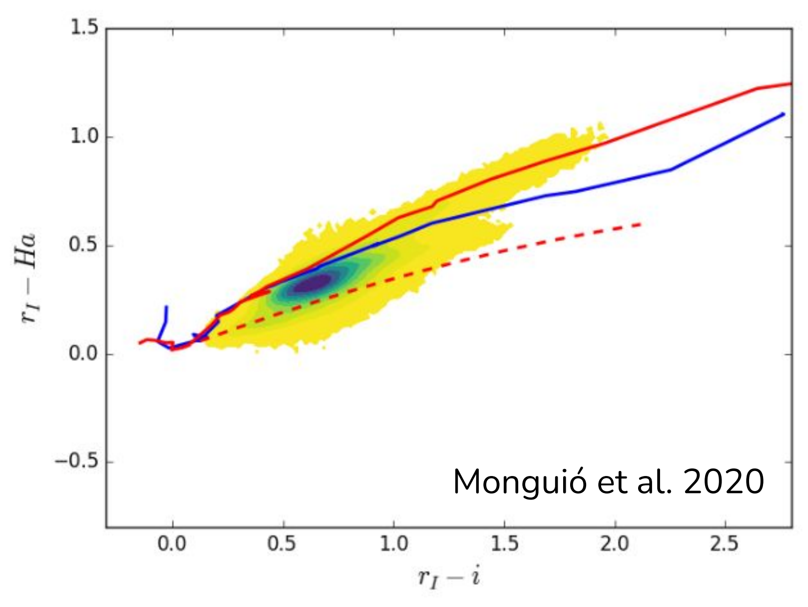
ABSTRACT

Context. Despite their relatively high intrinsic brightness and the fact that they are more numerous than younger OB stars and kinematically colder than older red giants, A-type stars have rarely been used as Galactic tracers. They may, in fact, be used to fill the age gap between these two tracers, thereby allowing us to evaluate the evolutionary and dynamic processes underlying the transition between them.
Aims. We analyse Gal... kinematic perturbations up to 6 kpc from the Sun based on observations of A-type stars.
Metho... of A-type stars selected using the IGAPS photometric survey. It covers the Galactic disc ... to a magnitude of $r \leq 19$ mag with about 3.5 million sources. We used *Gaia* Data Release ... ell as the line-of-sight velocities, to analyse the large-scale features of the Galactic disc. We ... f the detected density distributions, along with a comparison between the $b < 0°$ and $b > 0°$ ... extinction or by the usage of some kinematic approximations were examined as well. ... with the Local and the Perseus spiral arms, as well as with the Cygnus region. We ... also p... ematic indications of the Galactic warp towards the anticentre, which displays a median vertical ... of $\sim$ 6-7 km s^{-1} at a Galactocentric radius of R = 14 kpc. It starts at $R \approx 12$ kpc, which supports the scenario where the warp begins at larger radii for younger tracers when compared with other samples in the literature. We also detect a region with downward mean motion extending beyond 2 kpc from the Sun towards $60° \lesssim l \lesssim 75°$ that may be associated with a compression breathing mode. Furthermore, A-type stars reveal very clumpy inhomogeneities and asymmetries in the V_Z-V_ϕ velocity space plane.

Key words. Galaxy: disc – Galaxy: structure – Galaxy: kinematics and dynamics – Catalogues

Catalogue

- A stars
- Selection
  - IGAPS
  - *Gaia* DR3

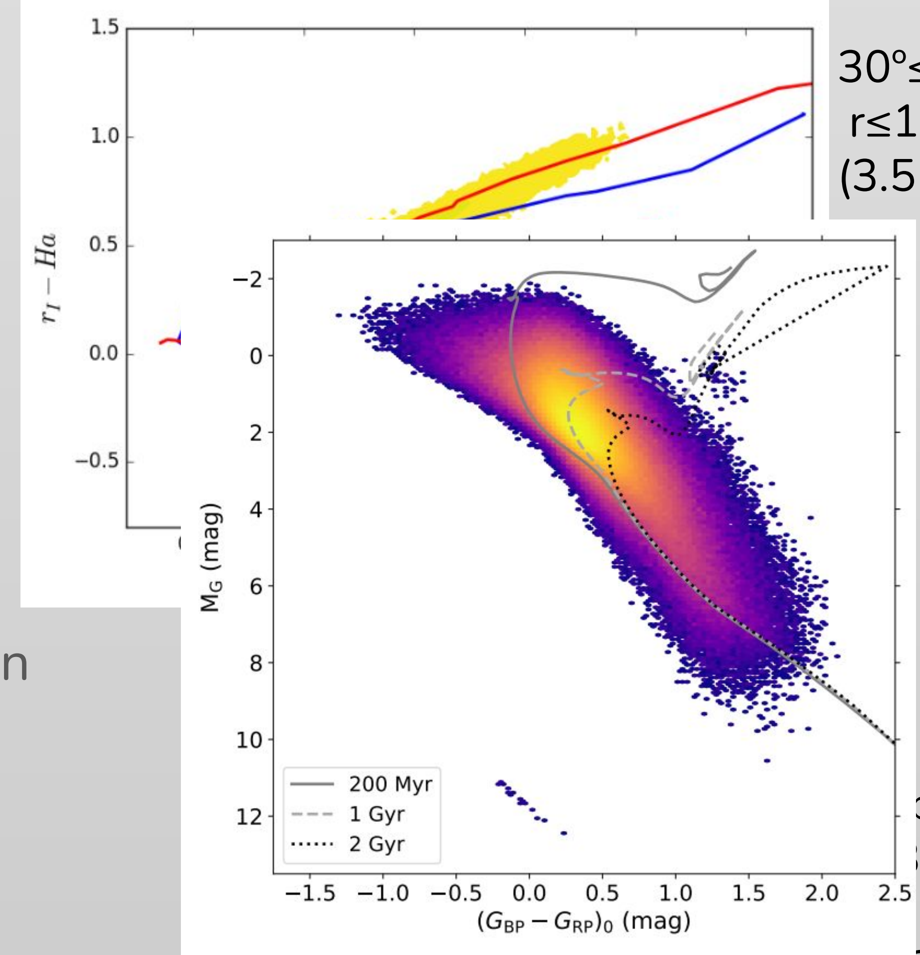


30°≤l≤215° & |b|≤5°
r≤19 mag
(3.5M)

parallaxes + proper motions
(~3.5M)
line-of-sight velocities
(~32k)

Catalogue

- A stars
- Selection
  - IGAPS
  - *Gaia* DR3
- Low contamination

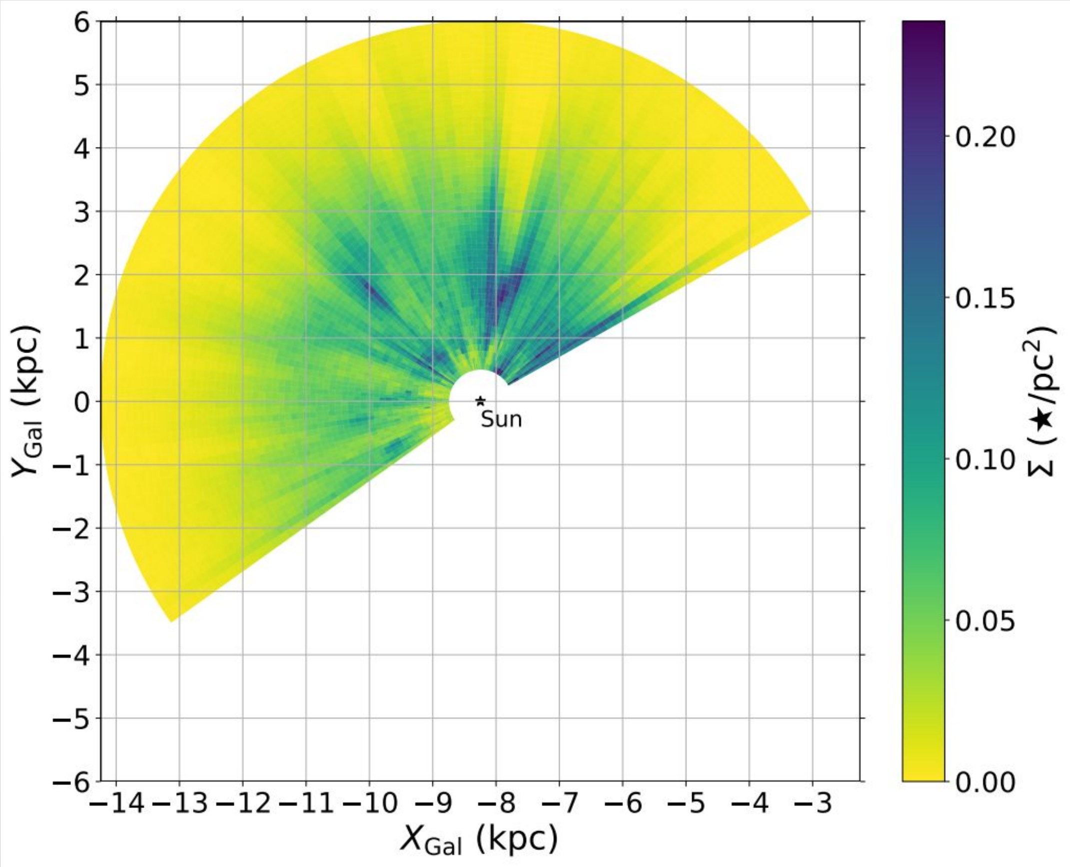


30º≤l≤215º & |b|≤5º
r≤19 mag
(3.5M)

proper motions
.5M)
ht velocities
(~32k)

Structure

$0 < \sigma_\varpi/\varpi \leq 0.3$
(~1.4M)



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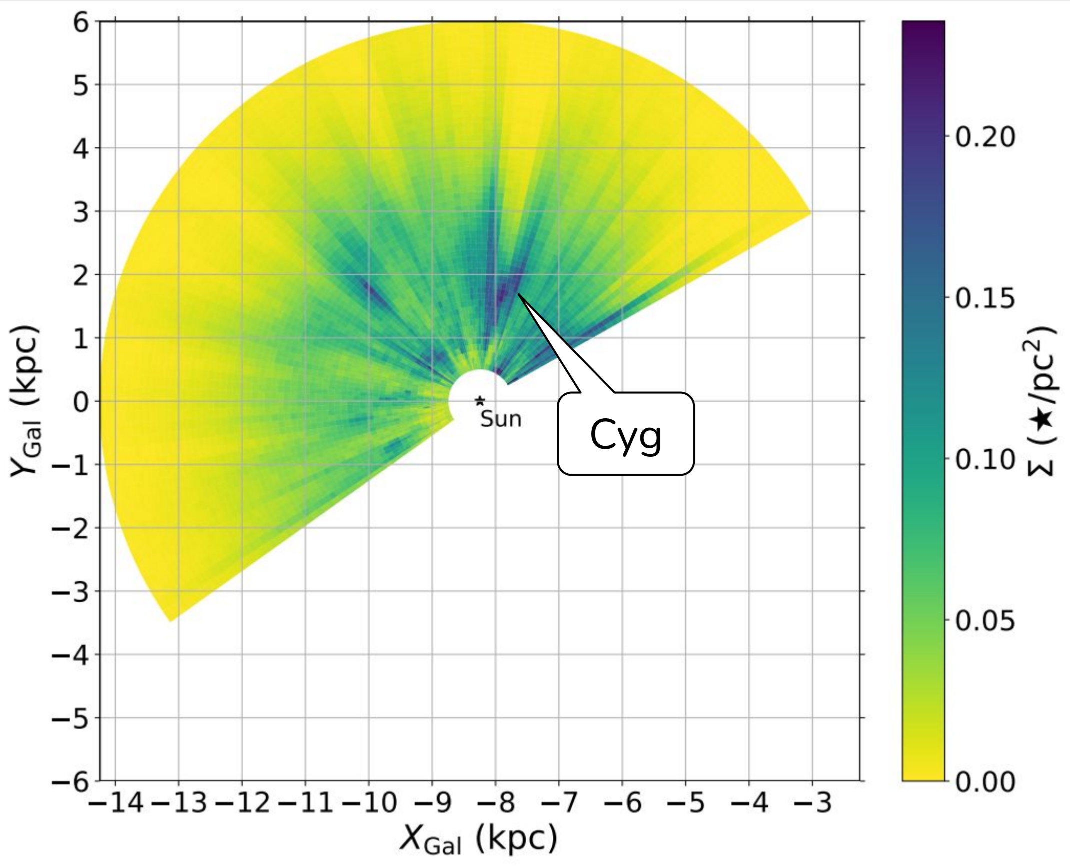

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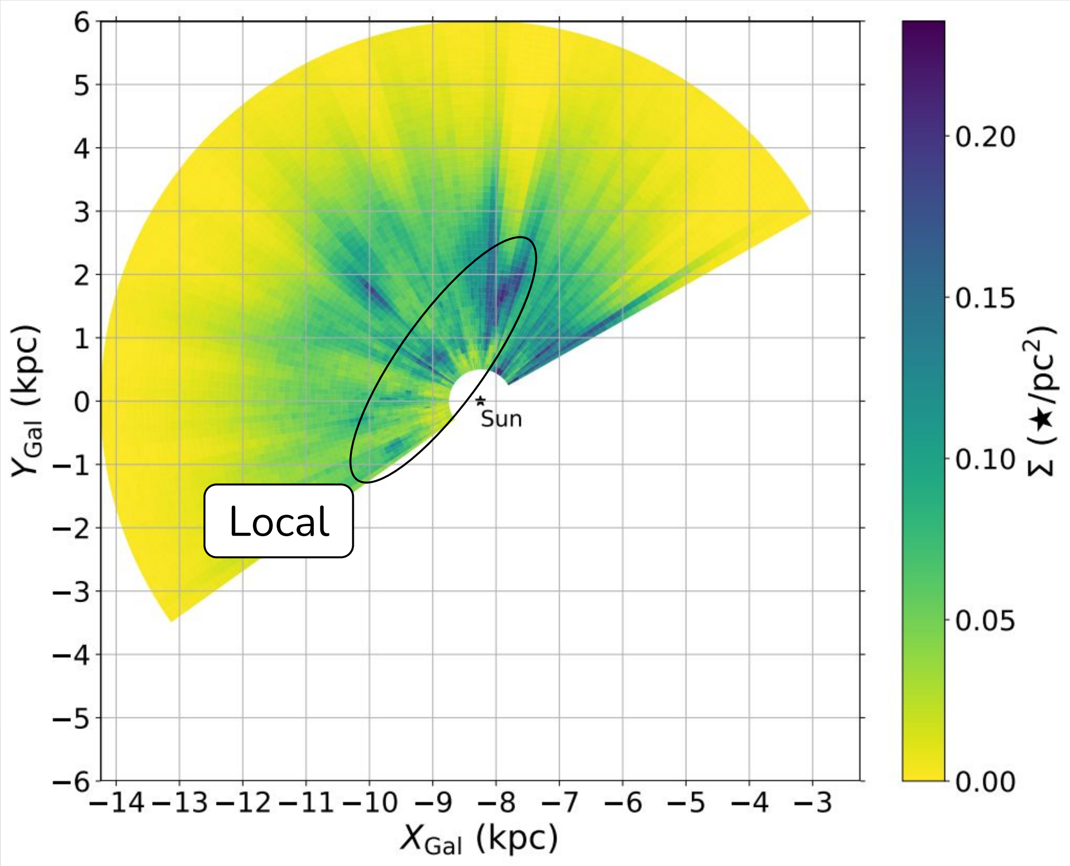

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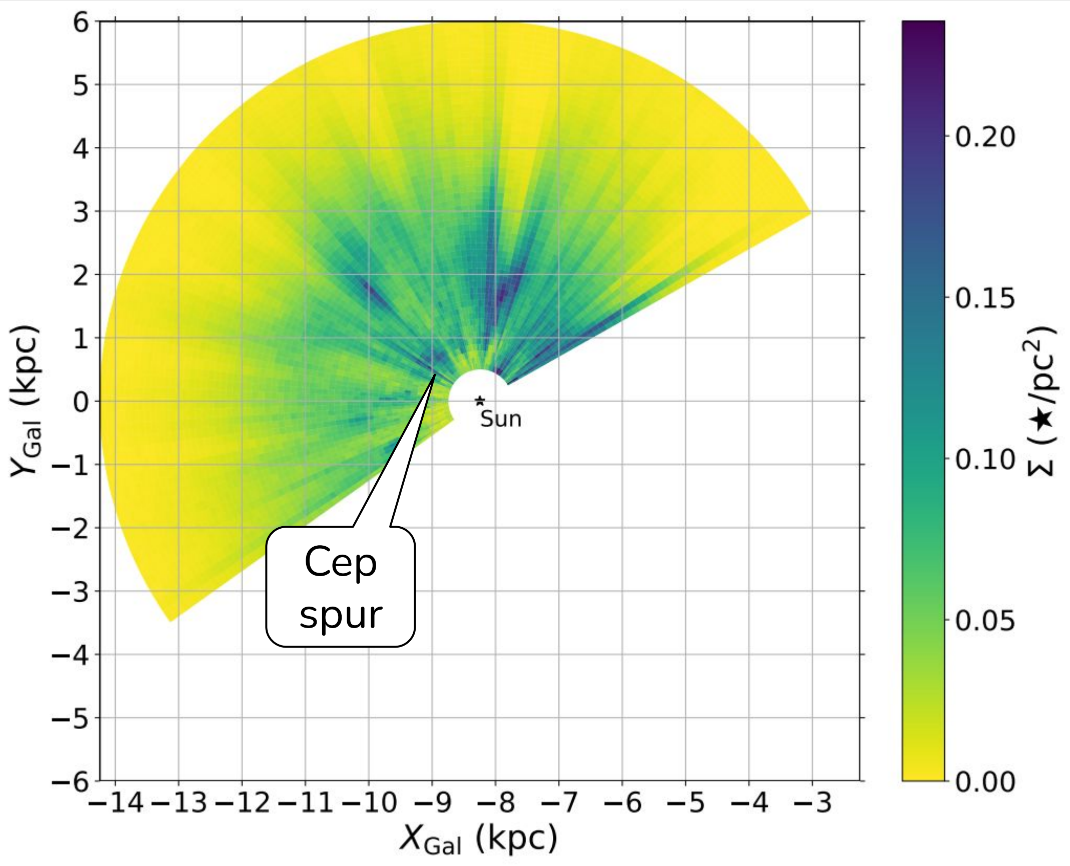

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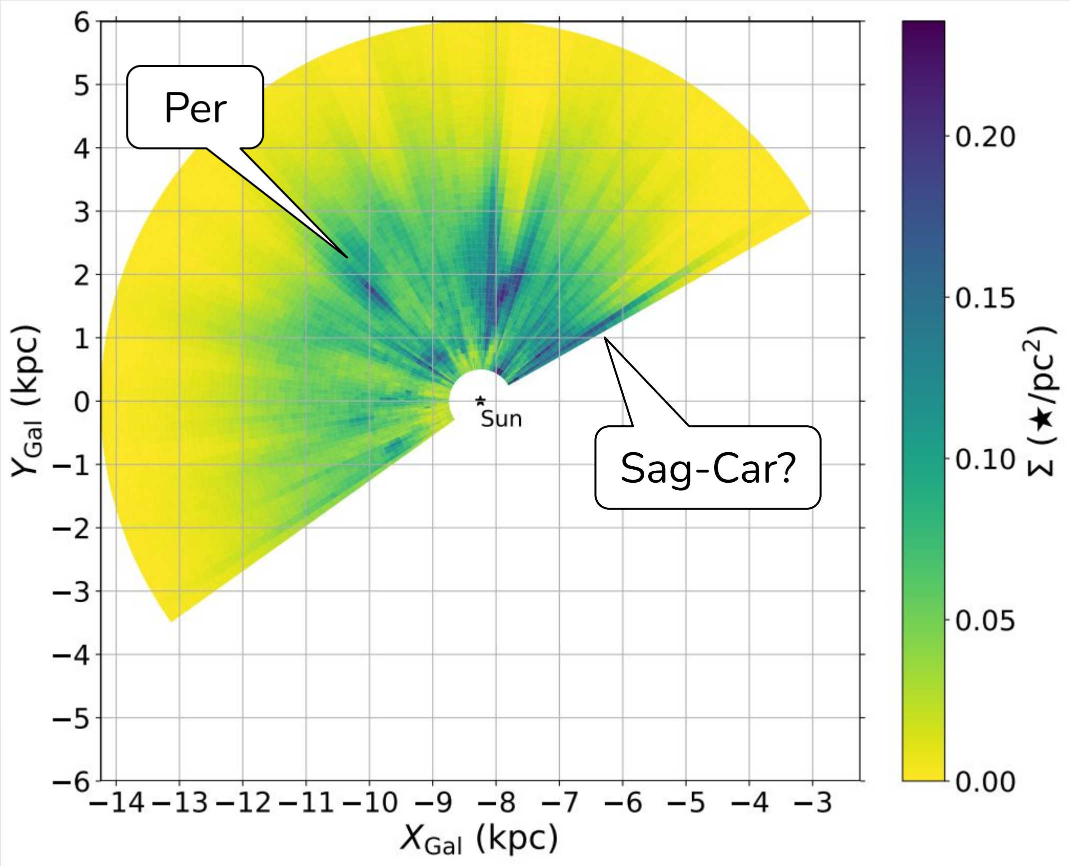

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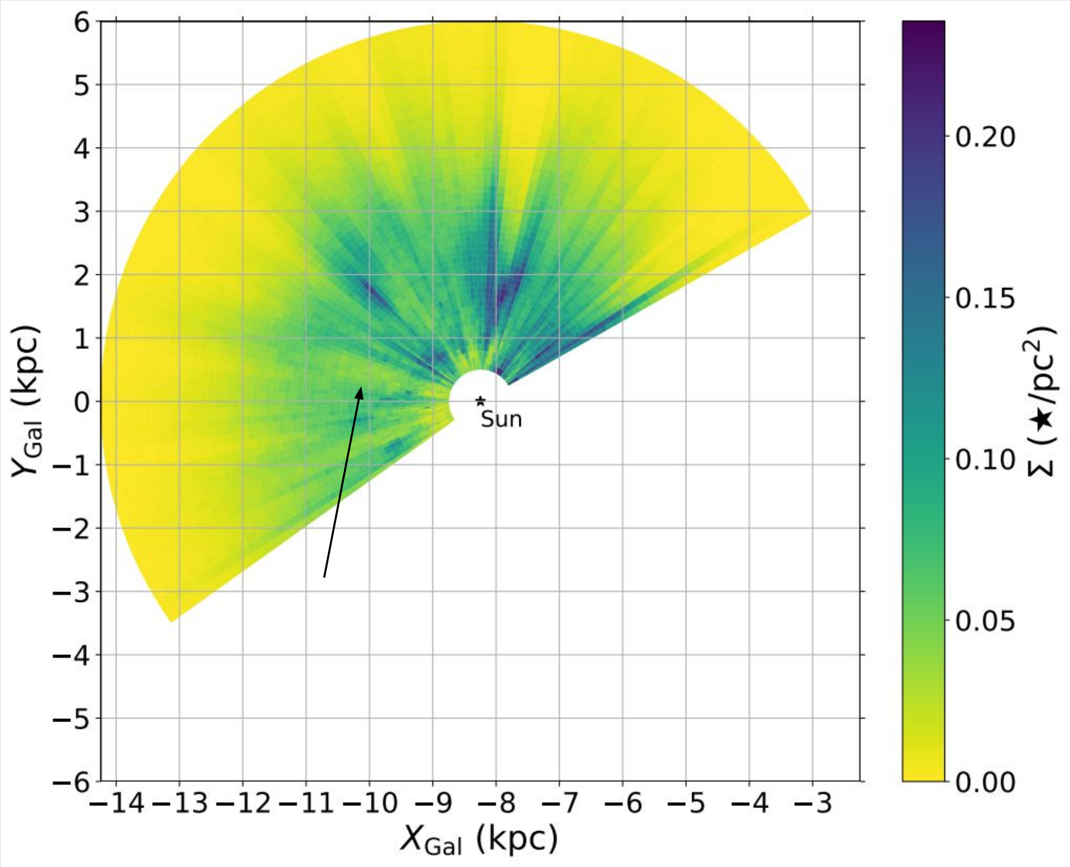

Structure

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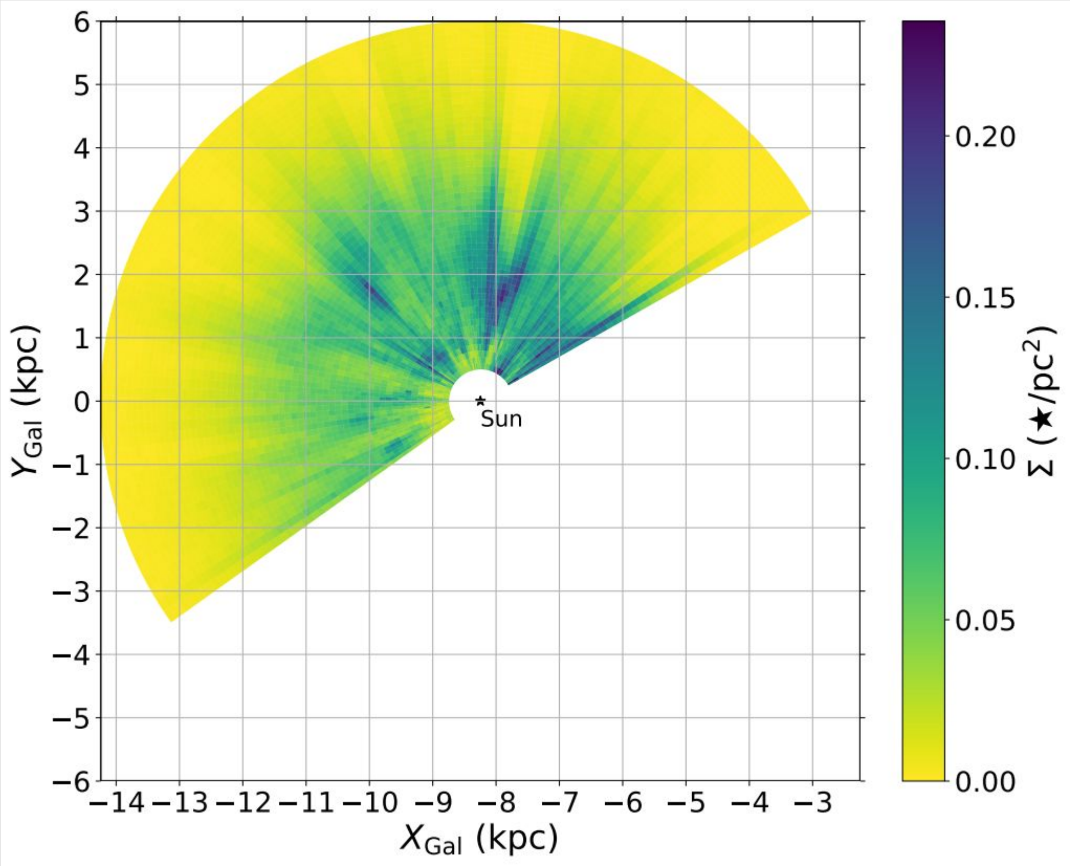
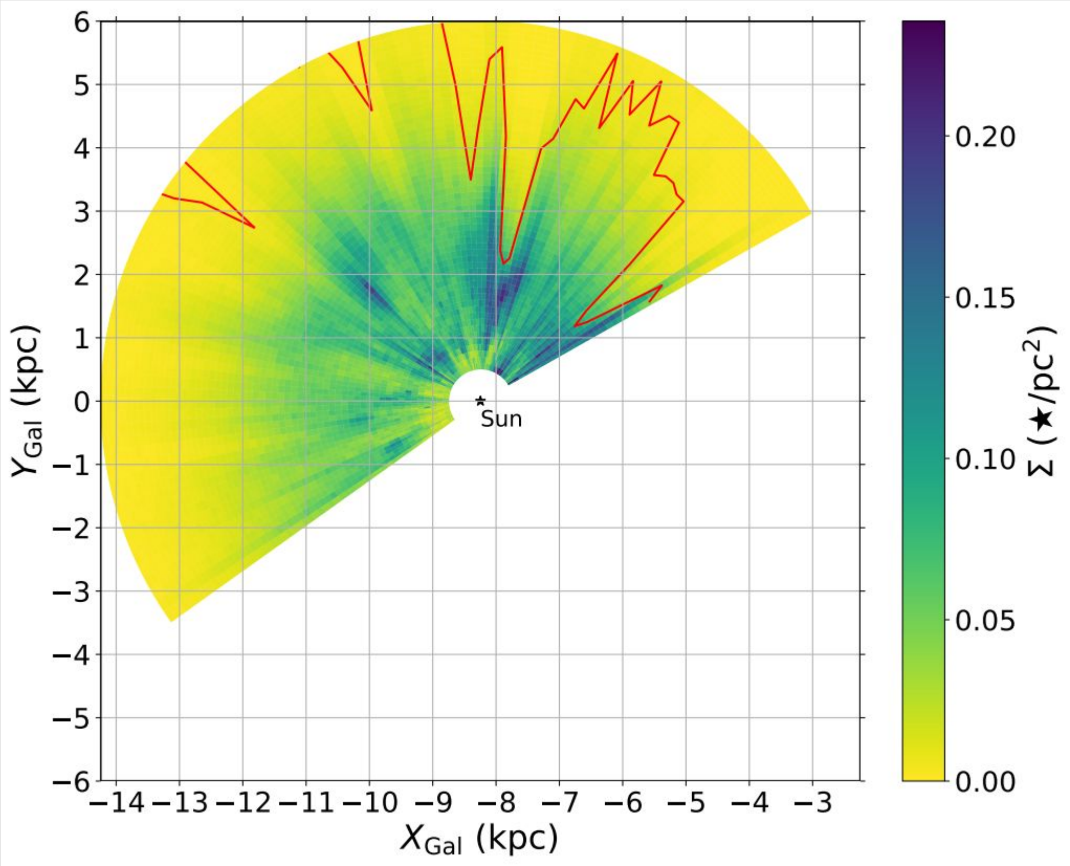


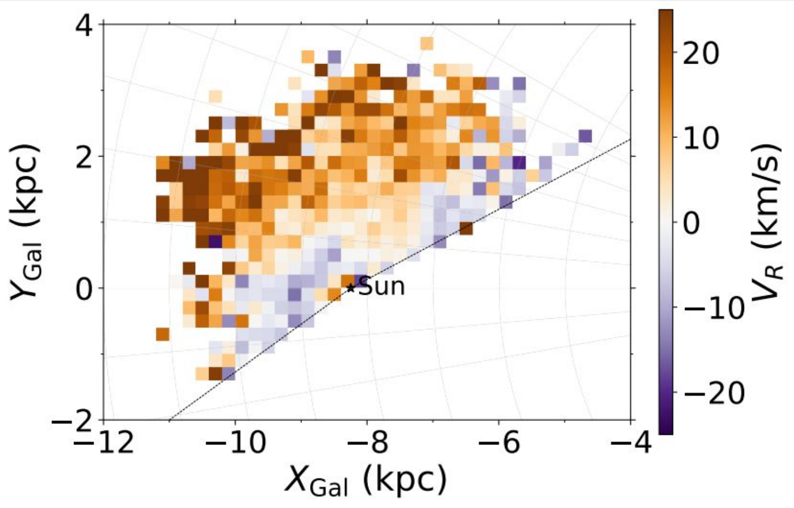
Completeness distance estimation

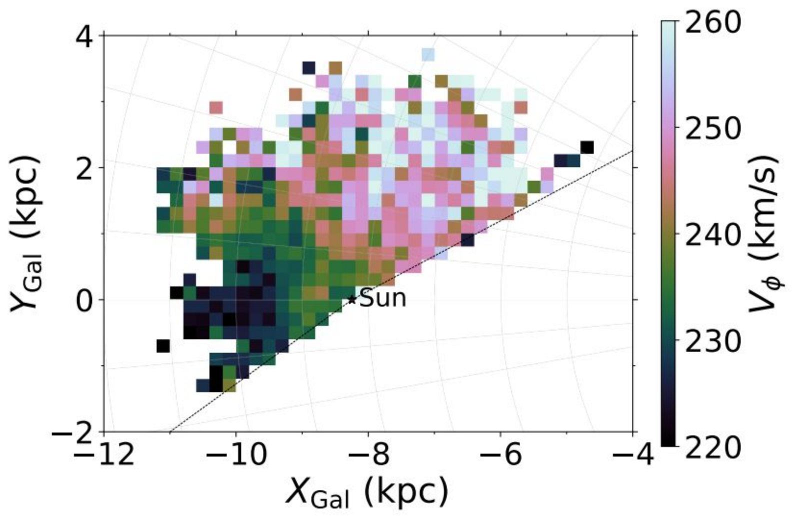
$0 < \sigma_\varpi / \varpi \leq 0.3$
(~1.4M)

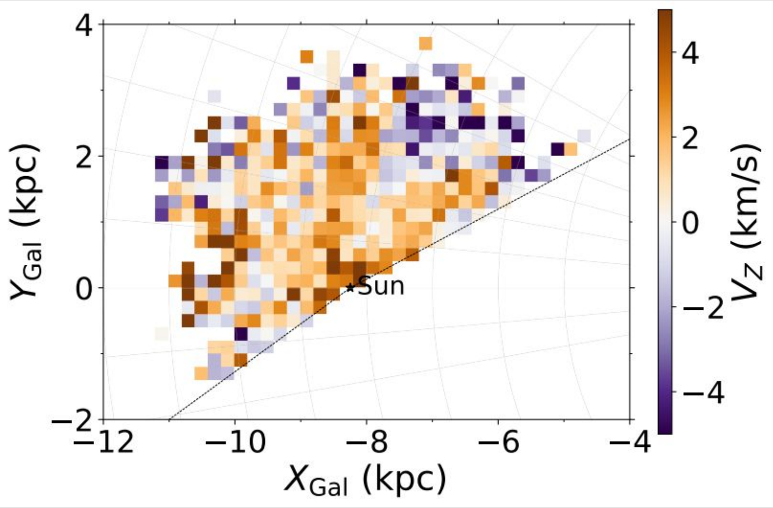


Kinematics: 6D

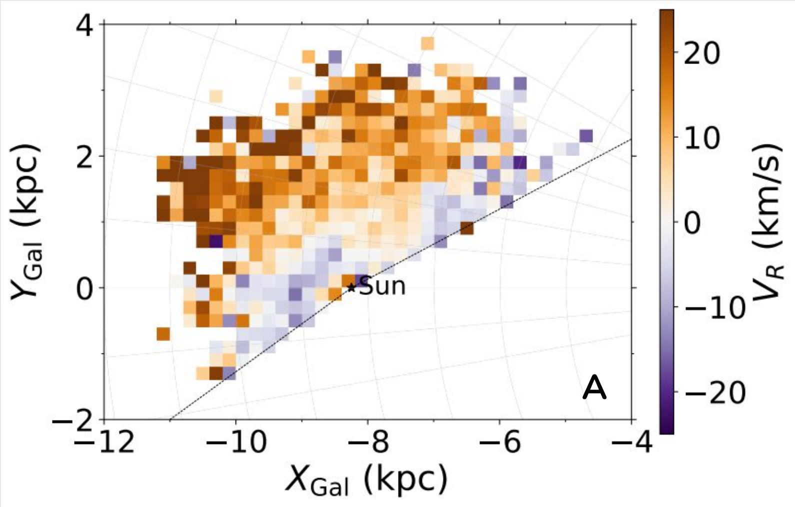
line-of-sight velocities
and $0 < \sigma_{\varpi}/\varpi \leq 0.3$
(~30k)

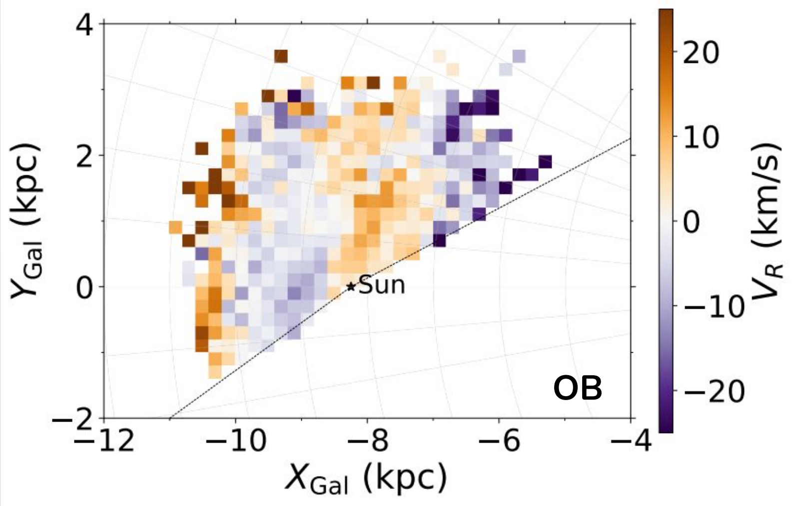


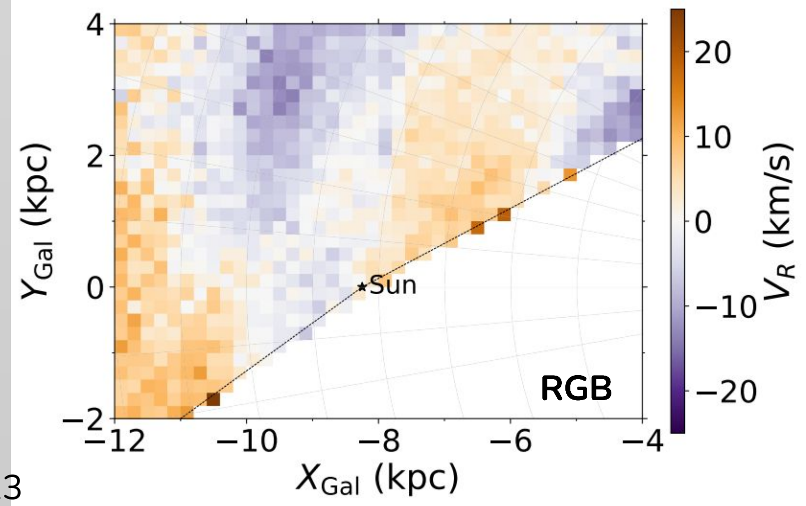




Kinematics: 6D - V_R

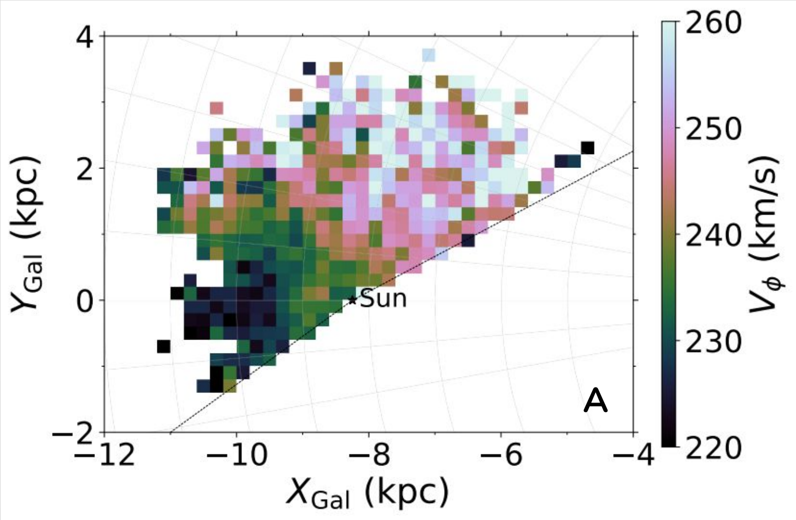


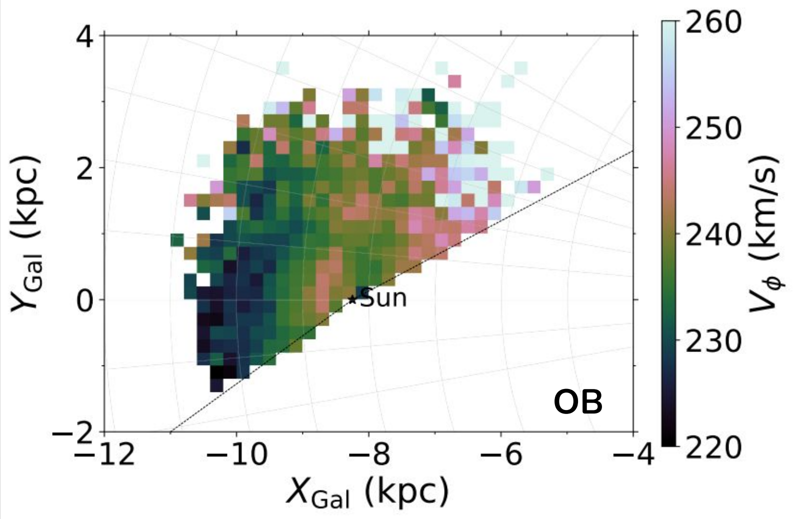


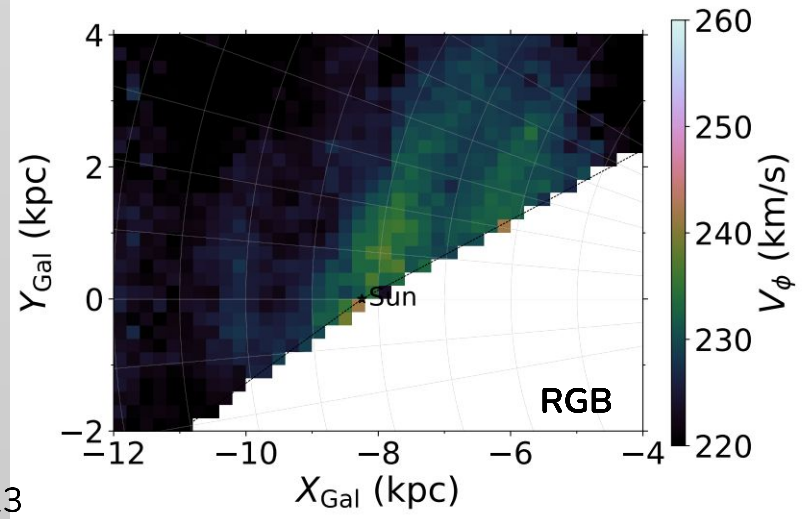


Gaia Collaboration, Drimmel et al. 2023

Kinematics: 6D - $V_{\varnothing}$

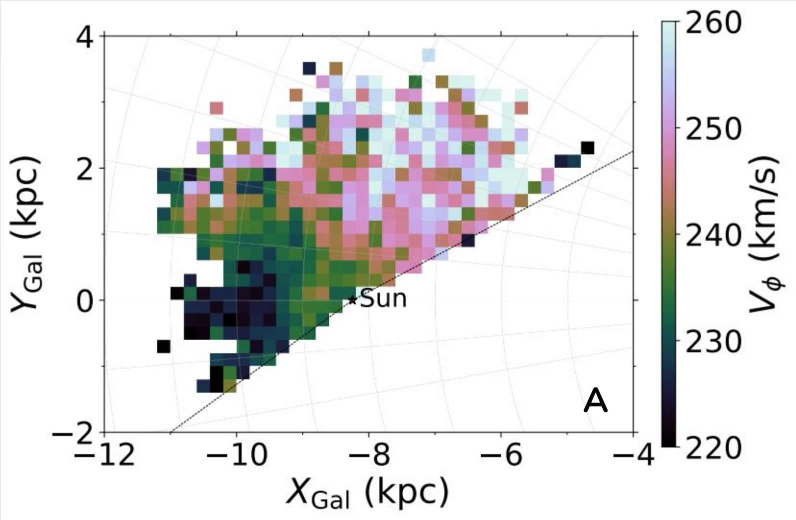




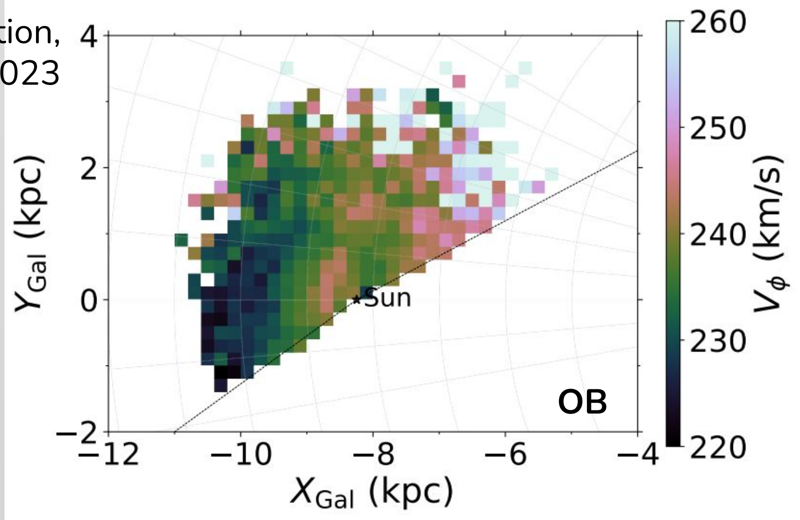


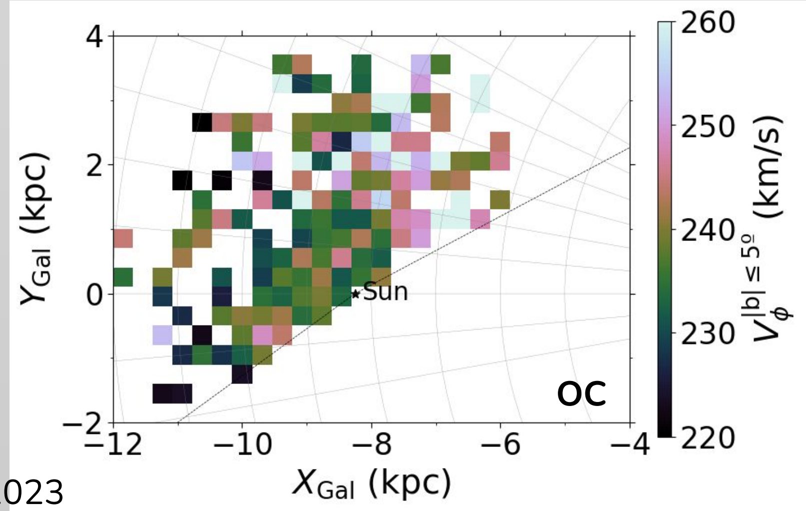
Gaia Collaboration, Drimmel et al. 2023

Kinematics: 6D - $V_{\varnothing}$



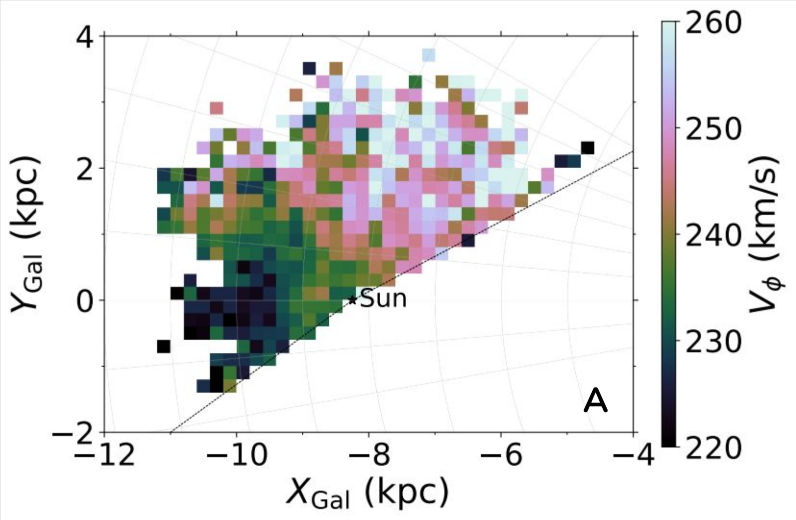
Gaia Collaboration, Drimmel et al. 2023





Hunt et al. 2023

Kinematics: 6D - $V_{\varnothing}$



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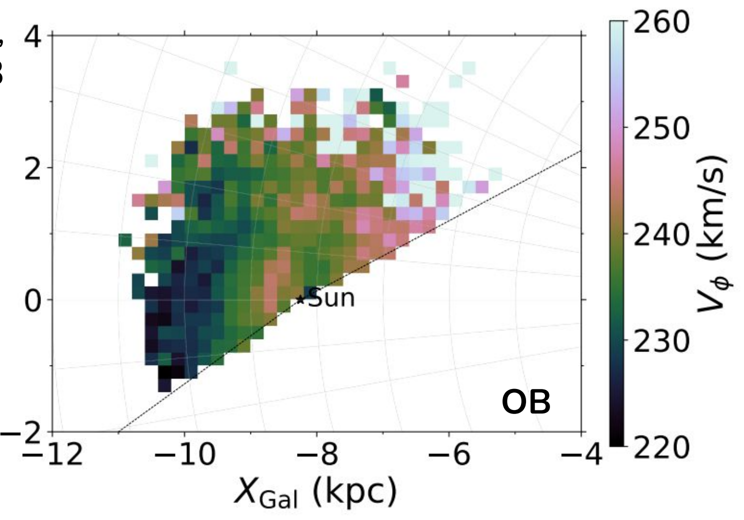
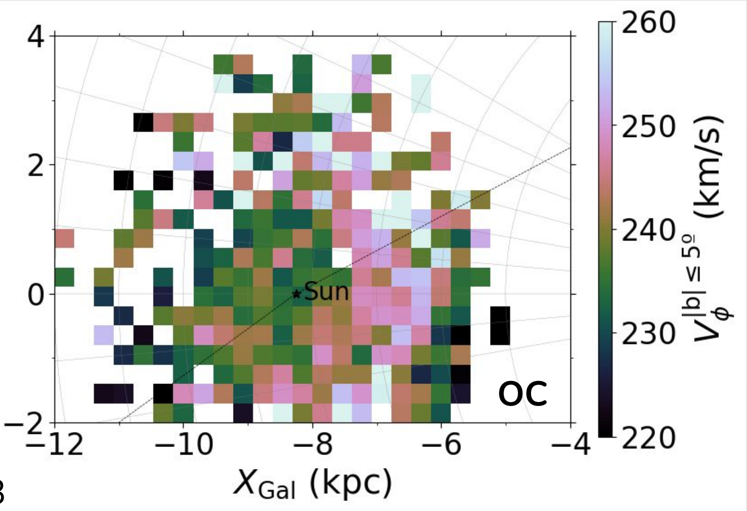
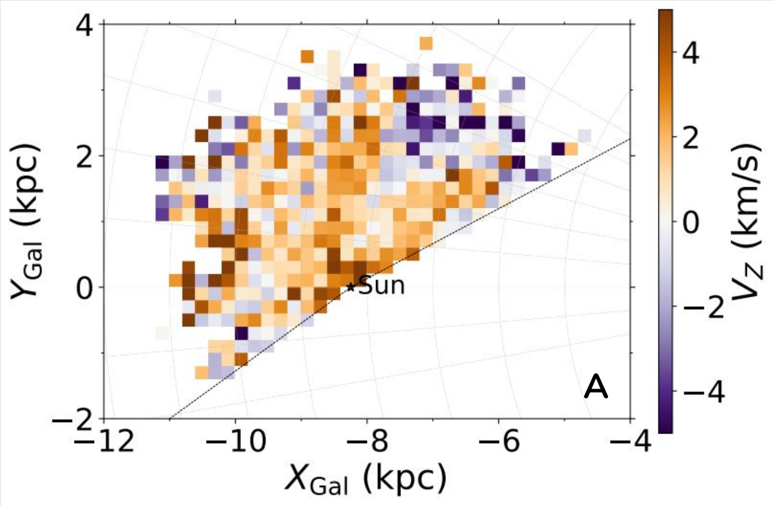
Drimmel et al. 2023

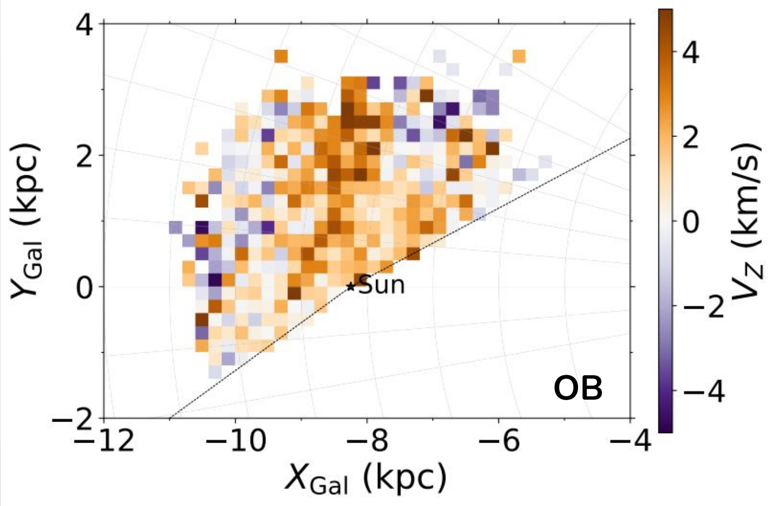


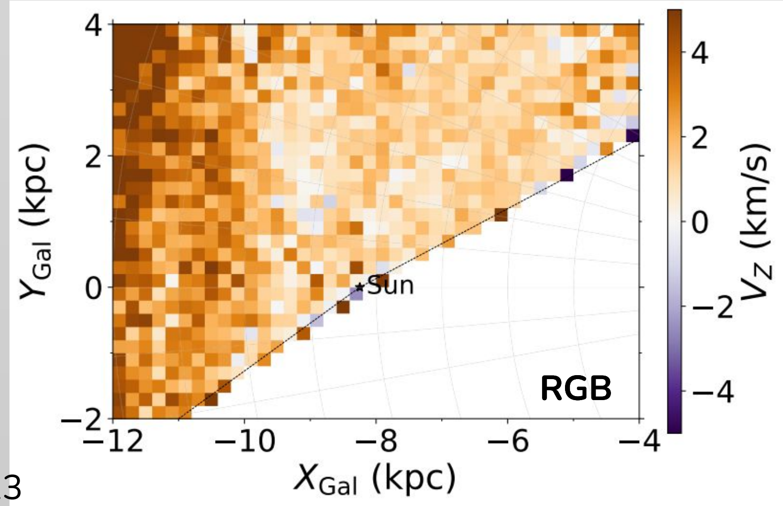


Hunt et al. 2023

Kinematics: 6D - V_Z

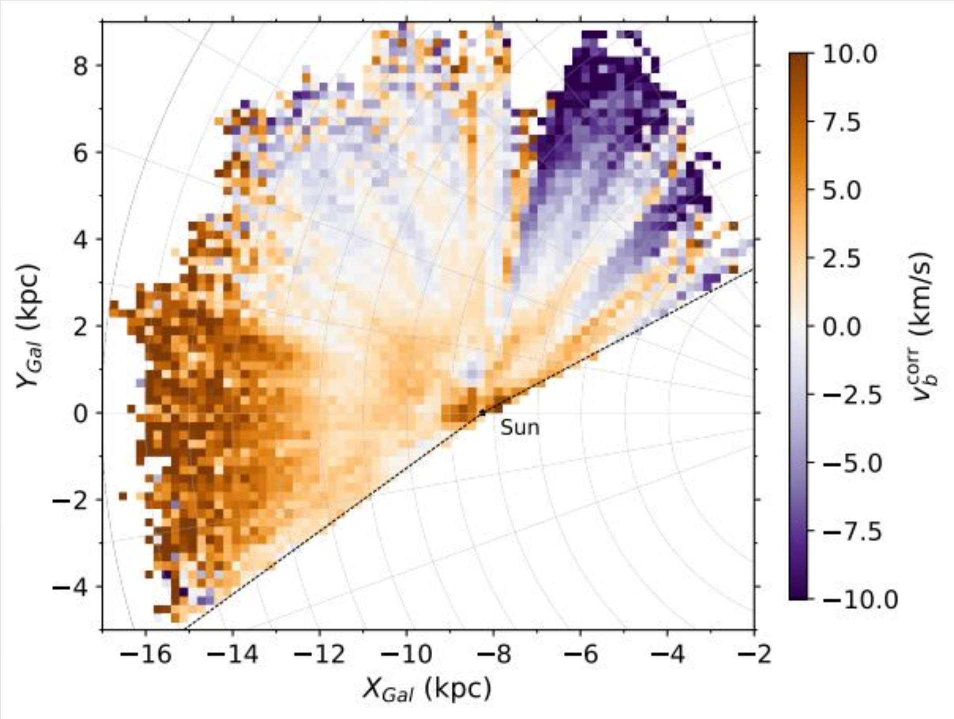






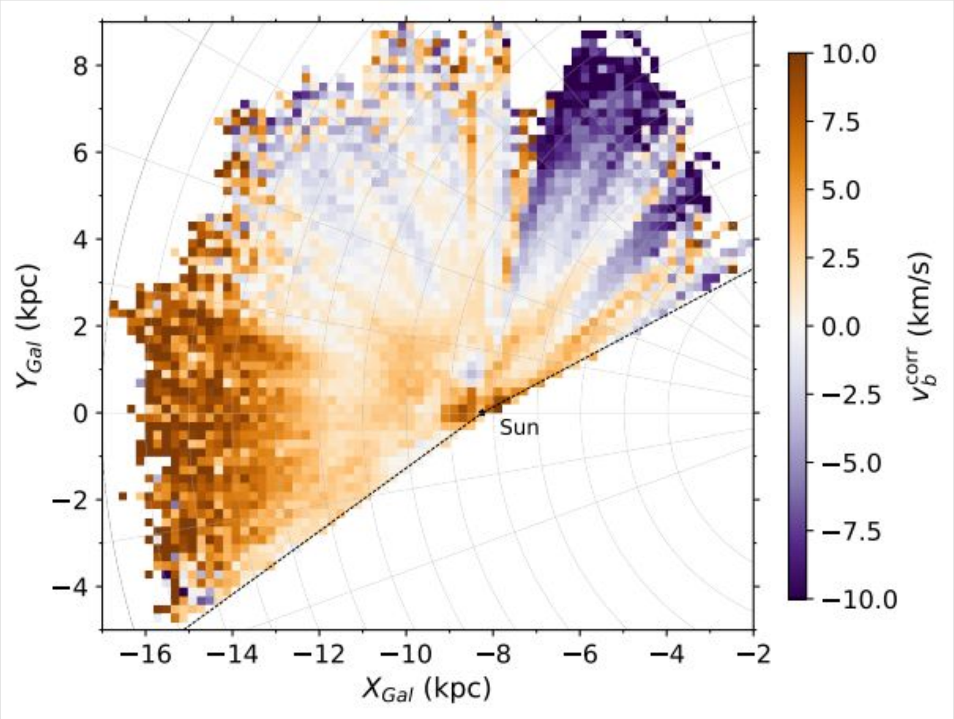
Gaia Collaboration, Drimmel et al. 2023

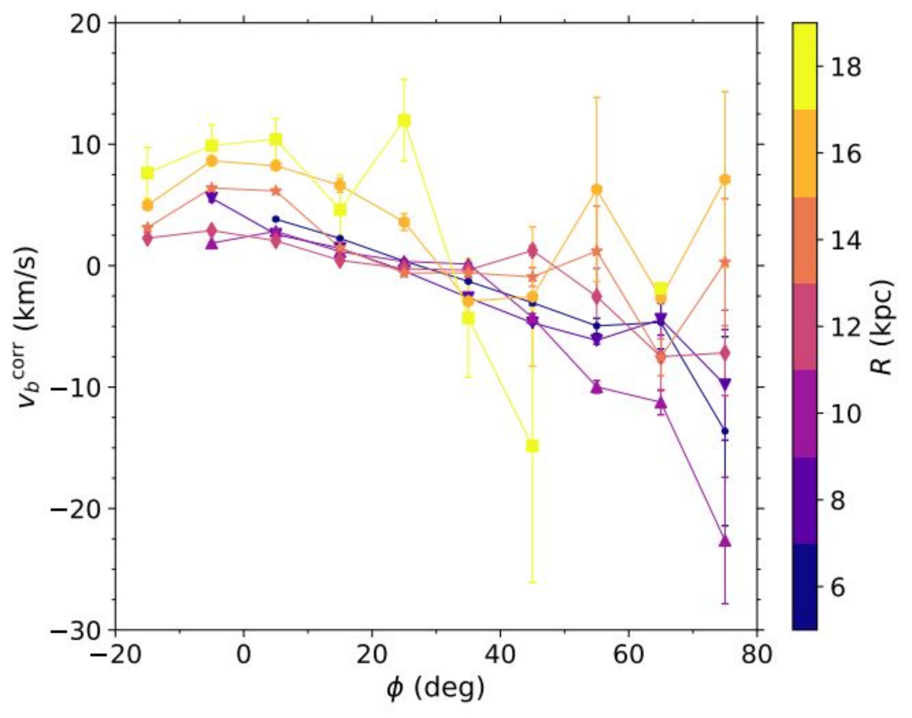
Kinematics: warp



$0 < \sigma_{\varpi}/\varpi \leq 0.5$
(2M)

Kinematics: warp





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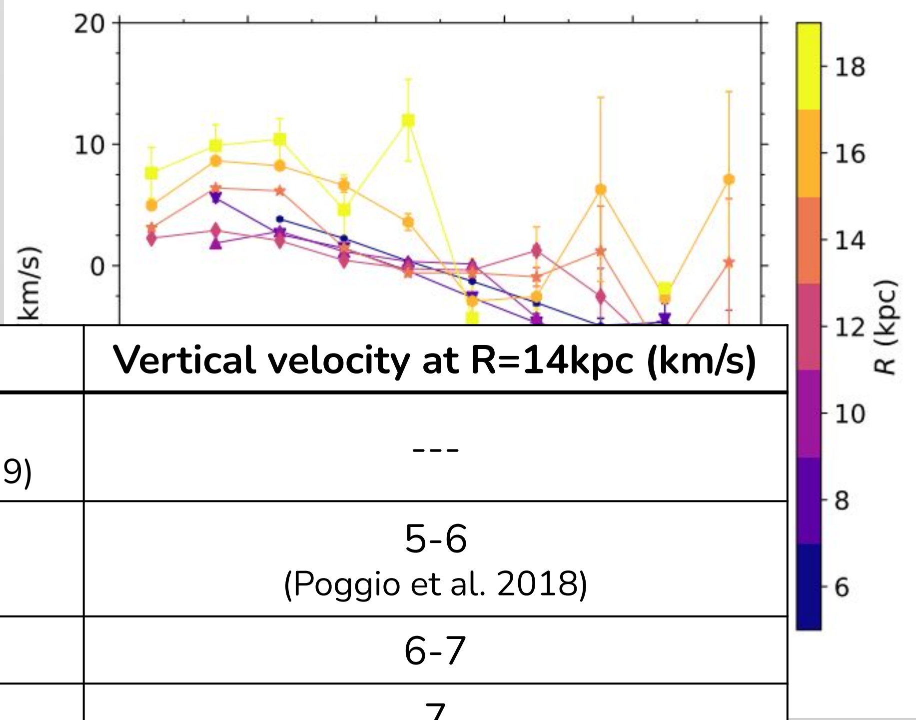
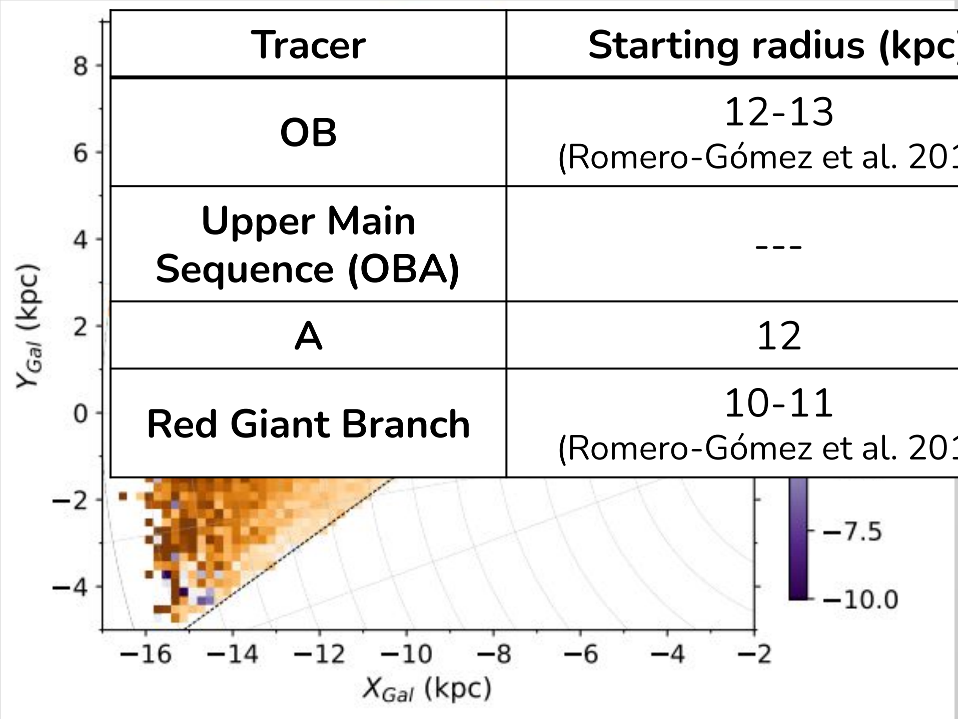
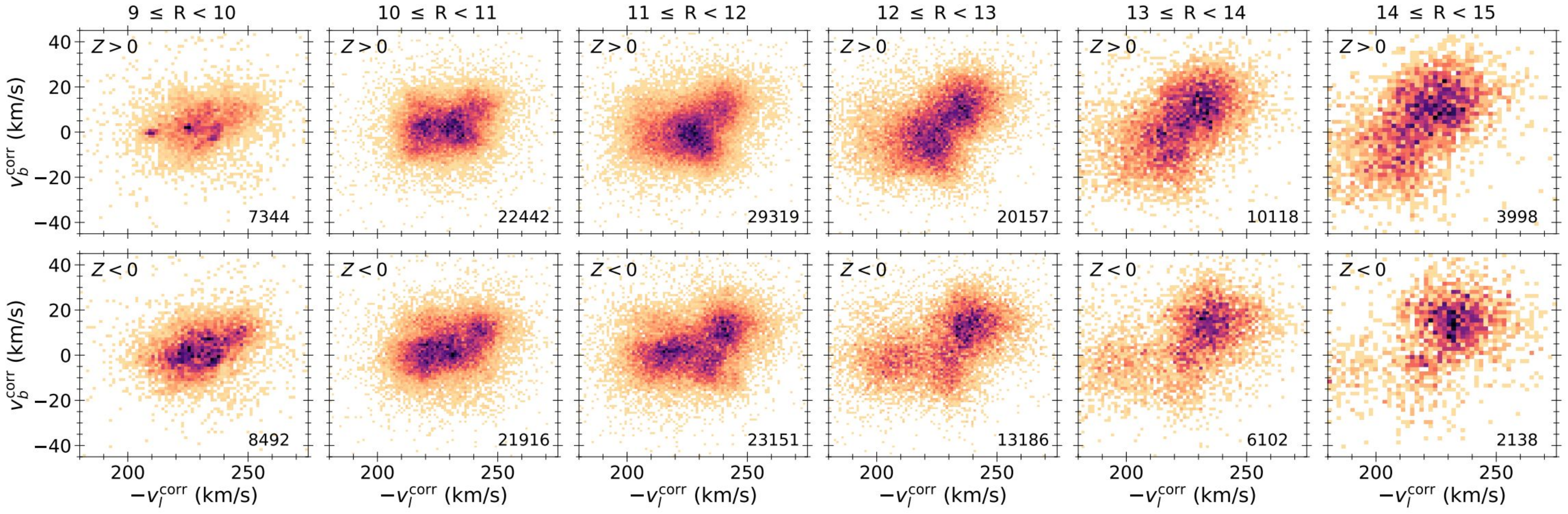




Tracer	Starting radius (kpc)	Vertical velocity at R=14kpc (km/s)
OB	12-13 (Romero-Gómez et al. 2019)	---
Upper Main Sequence (OBA)	---	5-6 (Poggio et al. 2018)
A	12	6-7
Red Giant Branch	10-11 (Romero-Gómez et al. 2019)	7 (Gaia Collaboration, Drimmel et al. 2023)

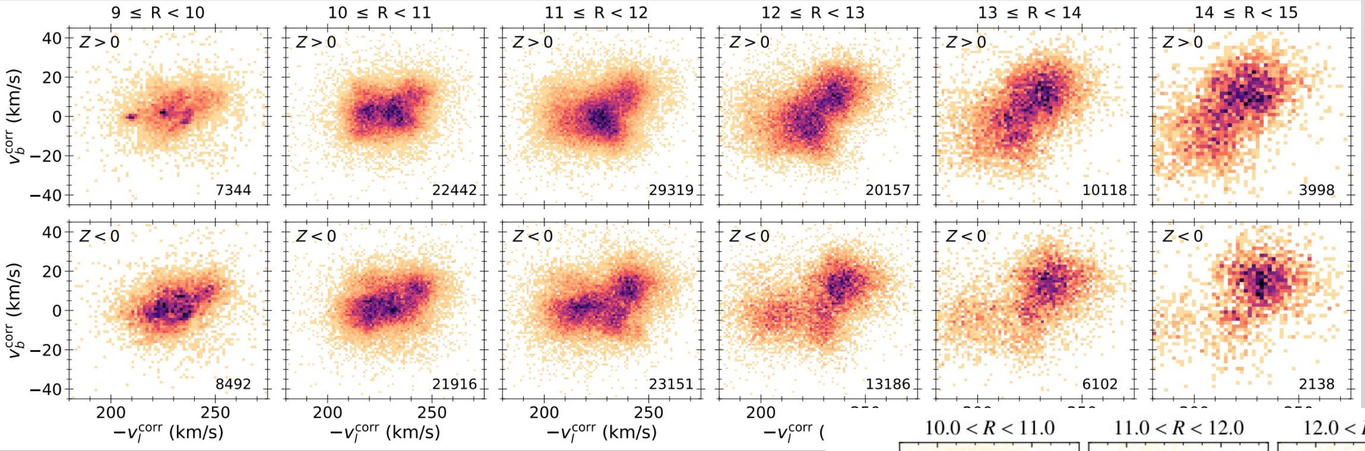
$0 < \sigma_{\varpi}/\varpi \leq 0.5$
(2M)

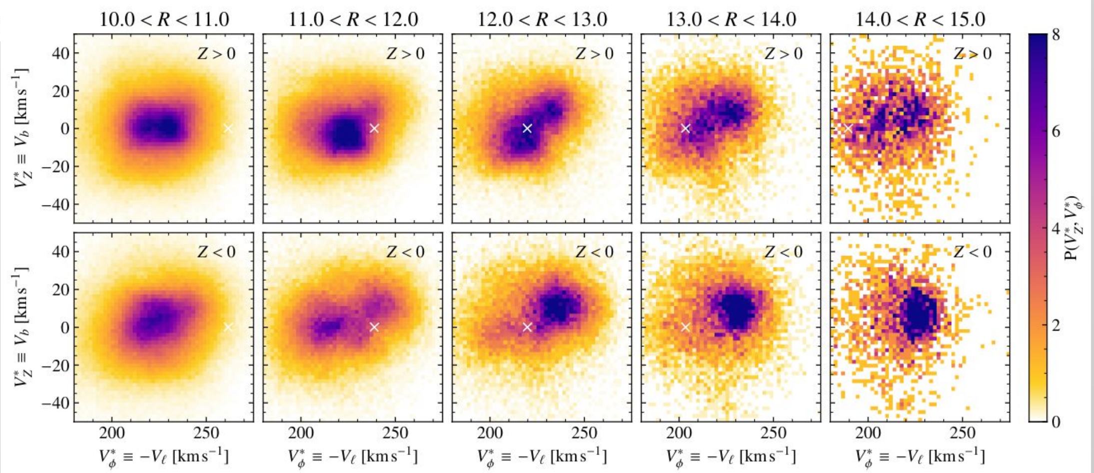
Kinematics: substructure



170°≤l≤190° $0 < \sigma_\varpi / \varpi \leq 0.5$

Kinematics: substructure

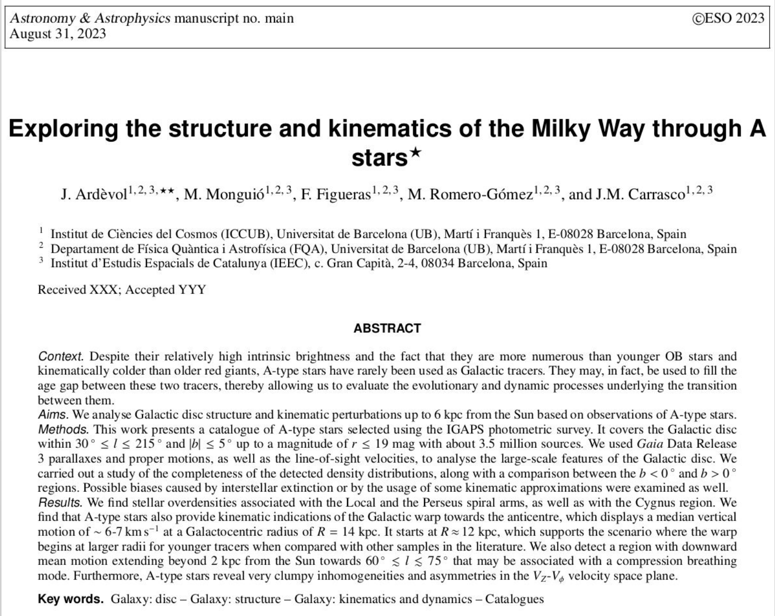




Gaia Collaboration, Antoja et al. 2021

Conclusions / Take-home messages

- ❖ A stars are intermediate-age tracers
- ❖ Catalogue of 3.5M A stars at CDS
- ❖ Spiral arms overdensities
- ❖ 6D kinematic perturbations
- ❖ Galactic warp
- ❖ Good kinematic tracers
- ❖ Future: southern counterpart and increase the 6D sample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Received XXX; Accepted YYY

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Aims. We analyse Galactic disc structure and kinematic perturbations up to 6 kpc from the Sun based on observations of A-type stars.
Methods. This work presents a catalogue of A-type stars selected using the IGAPS photometric survey. It covers the Galactic disc within $30° \leq l \leq 215°$ and $|b| \leq 5°$ up to a magnitude of $r \leq 19$ mag with about 3.5 million sources. We used *Gaia* Data Release 3 parallaxes and proper motions, as well as the line-of-sight velocities, to analyse the large-scale features of the Galactic disc. We carried out a study of the completeness of the detected density distributions, along with a comparison between the $b < 0°$ and $b > 0°$ regions. Possible biases caused by interstellar extinction or by the usage of some kinematic approximations were examined as well.
Results. We find stellar overdensities associated with the Local and the Perseus spiral arms, as well as with the Cygnus region. We find that A-type stars also provide kinematic indications of the Galactic warp towards the anticentre, which displays a median vertical motion of ~ 6-7 $\mathrm{km\,s^{-1}}$ at a Galactocentric radius of $R = 14$ kpc. It starts at $R \approx 12$ kpc, which supports the scenario where the warp begins at larger radii for younger tracers when compared with other samples in the literature. We also detect a region with downward mean motion extending beyond 2 kpc from the Sun towards $60° \lesssim l \lesssim 75°$ that may be associated with a compression breathing mode. Furthermore, A-type stars reveal very clumpy inhomogeneities and asymmetries in the V_Z-V_ϕ velocity space plane.

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