# GaiaDR3 determination of the Galactic bar pattern speed

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In collaboration with L. Chemin, J. Hunt, S. Khanna, R. Drimmel, E. Poggio, P. Ramos, R. Andrae

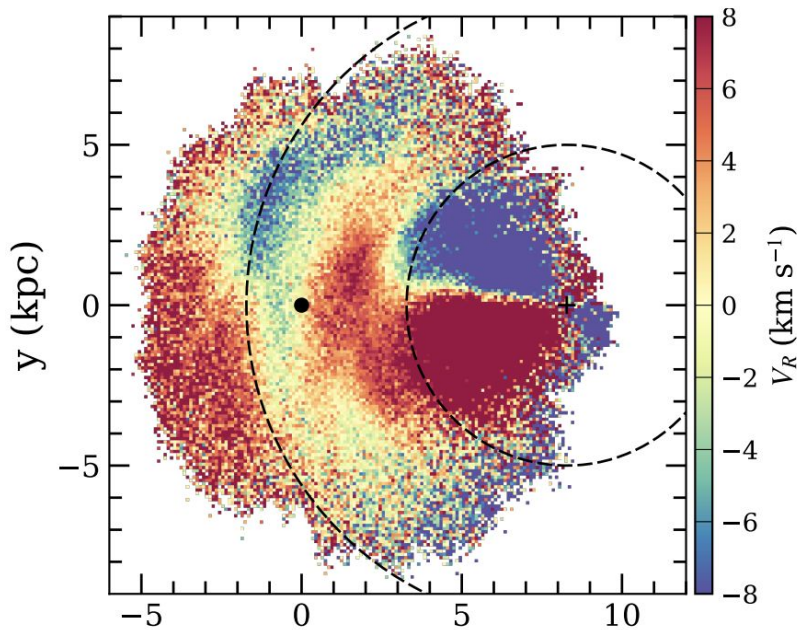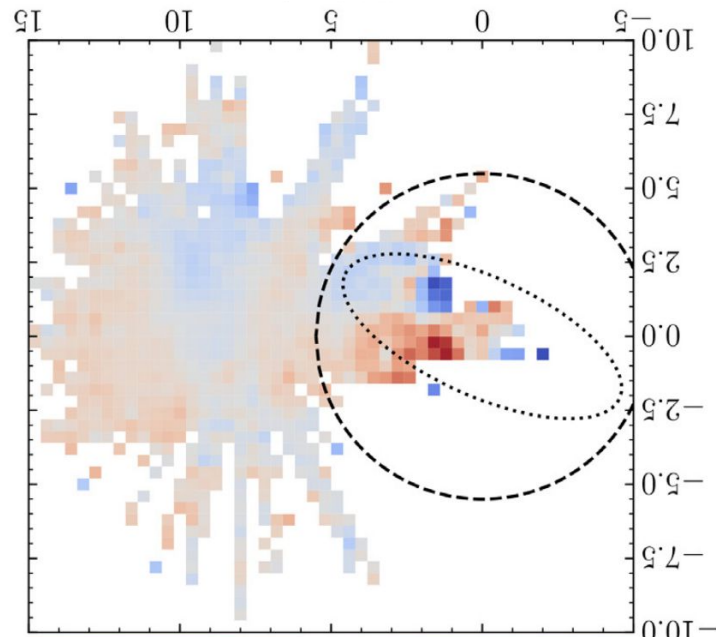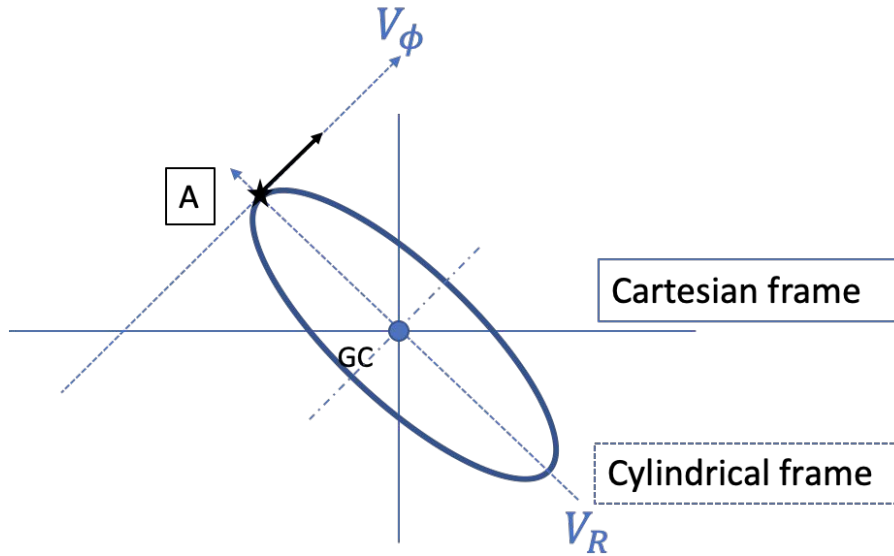Final COST Conference, Barcelona 5-7 September 2023

# Motivation



GaiaDR3, Gaia Collaboration, Drimmel, Romero-Gómez+2023

GaiaDR2+APOGEE DR16, Bovy, Leung, Hunt+2019

**Velocity vector** of a star on an **elliptical** orbit around the GC

$V_\phi$

A

Cartesian frame

GC

Cylindrical frame

$V_R$

B

Cartesian frame

GC

$V_R$

$V_\phi$

Cylindrical frame

| A | Along the major axis of the bar |
|---|---|

$V_\phi = V_{circ}$
$V_R = 0$
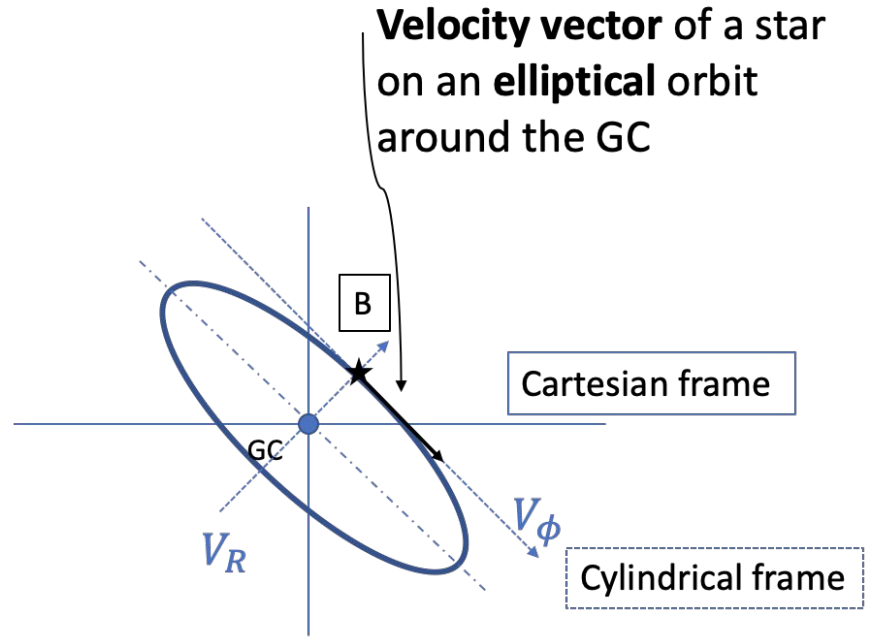
| B | Along the minor axis of the bar |
|---|---|

$V_\phi = V_{circ}$
$V_R = 0$

**Velocity vector** of a star on an **elliptical** orbit around the GC

**C**

$V_R$

$V_\phi$

C

Cylindrical frame

Cartesian frame

GC

**D**

$V_R$

$V_\phi$

D

Cylindrical frame

Cartesian frame

GC
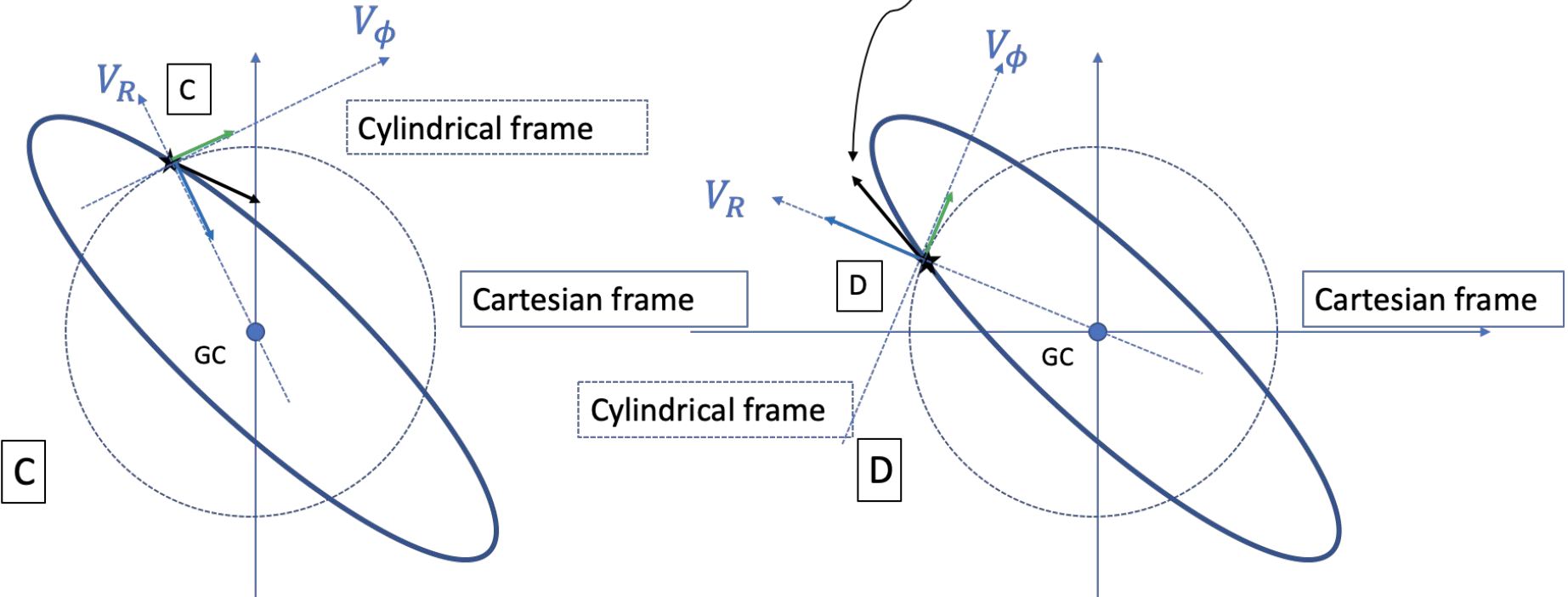
# Measuring the bar pattern speed
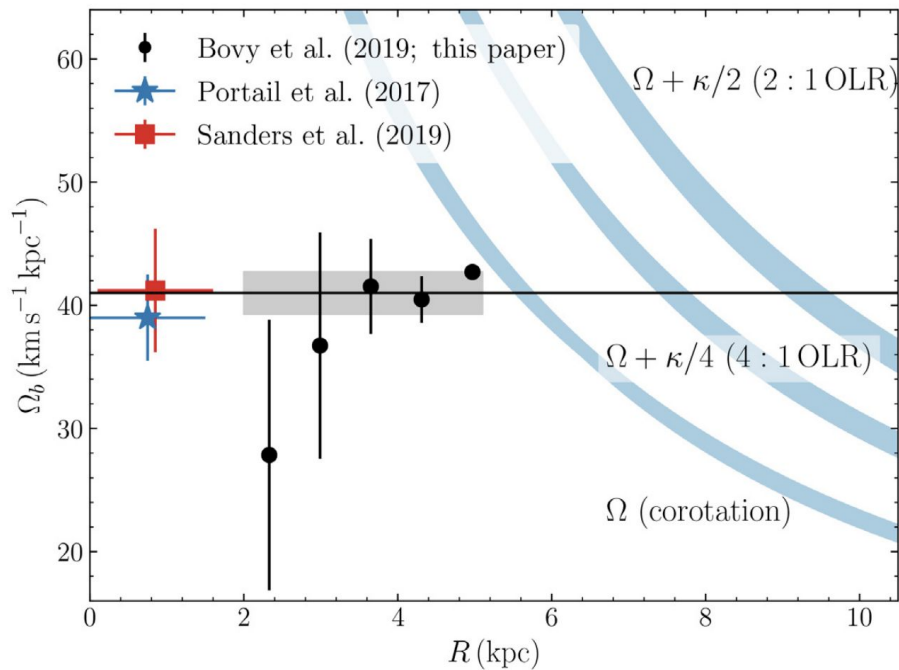
GaiaDR3, Gaia Collaboration, Drimmel, Romero-Gómez+2023
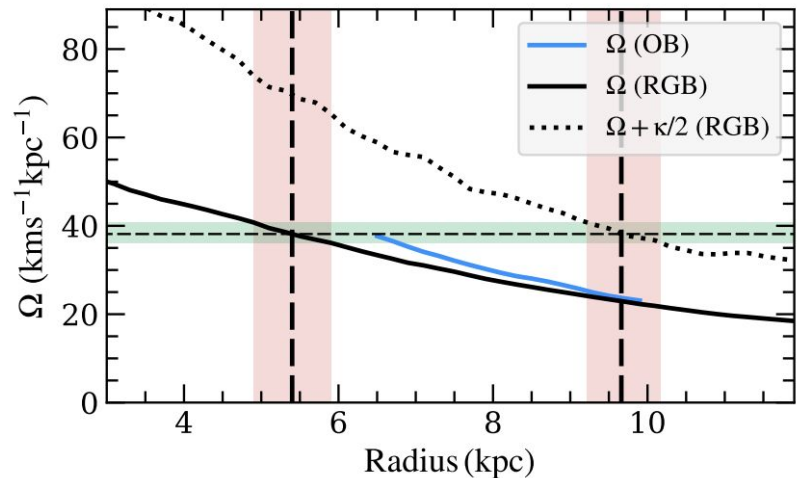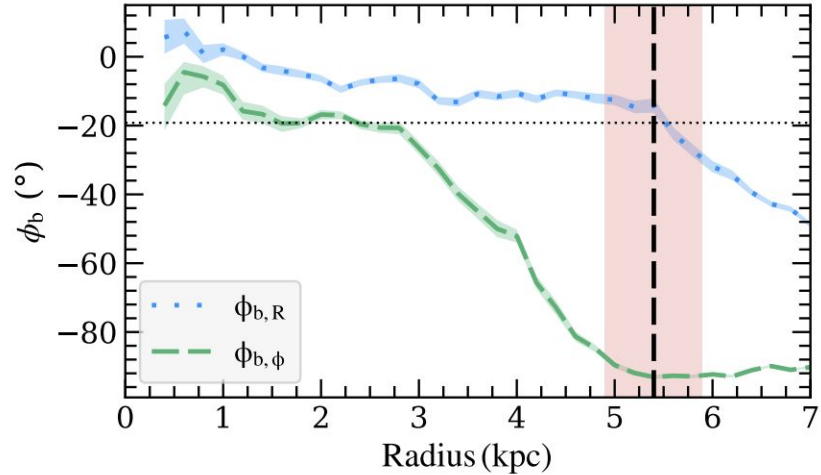
GaiaDR2+APOGEE DR16, Bovy, Leung, Hunt+2019

# In the present study

- We select **RGB stars from Andrae, Rix & Chandra (2023)** using XGBoost algorithm, which derives metallicities, effective temperatures and gravities trained using APOGEE stellar parameters and including CatWISE magnitudes.
- The catalogue now contains about **12M RGB stars** in the Galactic plane.
- We make NEW 3D velocity maps in cylindrical coordinates, **now taking into consideration the correlations** between the astrometric variables and propagated to the galactocentric coordinates.
- New velocity correlation maps show **vertex deviation of the local velocity ellipsoid**.

# New velocity and correlations maps
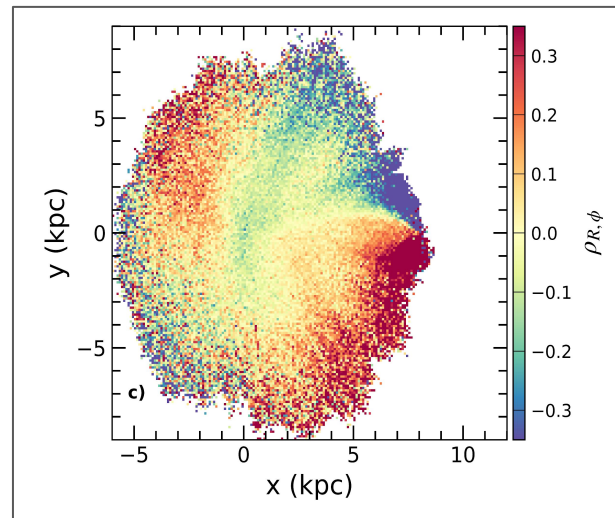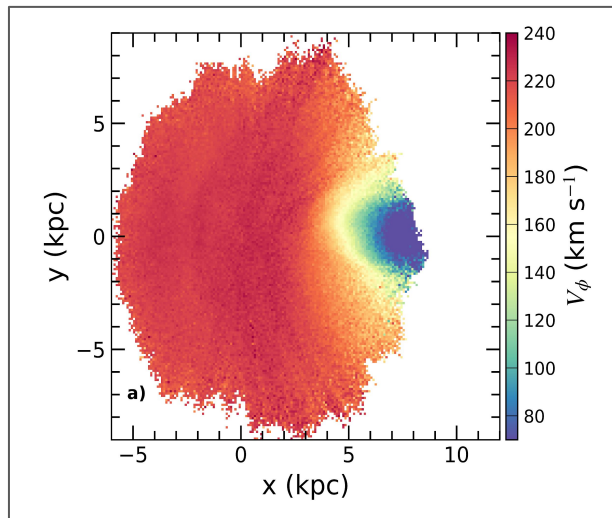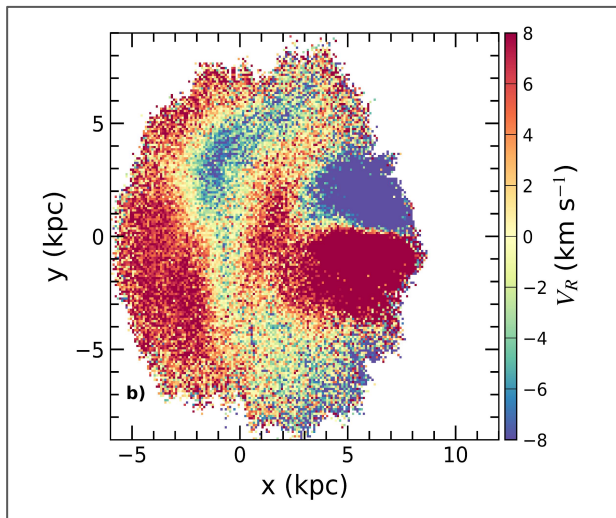


Romero-Gómez, Chemin, Hunt+ (2023, in preparation)

# In the present study

- Alternatively to the experimental method used in the Gaia Collaboration, Drimmel+2023 paper, we use the Tremaine-Weinberg version of the code in Bovy+2019 to estimate the pattern speed of the Galactic bar from this new dataset. Results of the corotation radius and bar pattern speed are consistent with the ones found in the Gaia Collaboration paper.

# Preliminary results
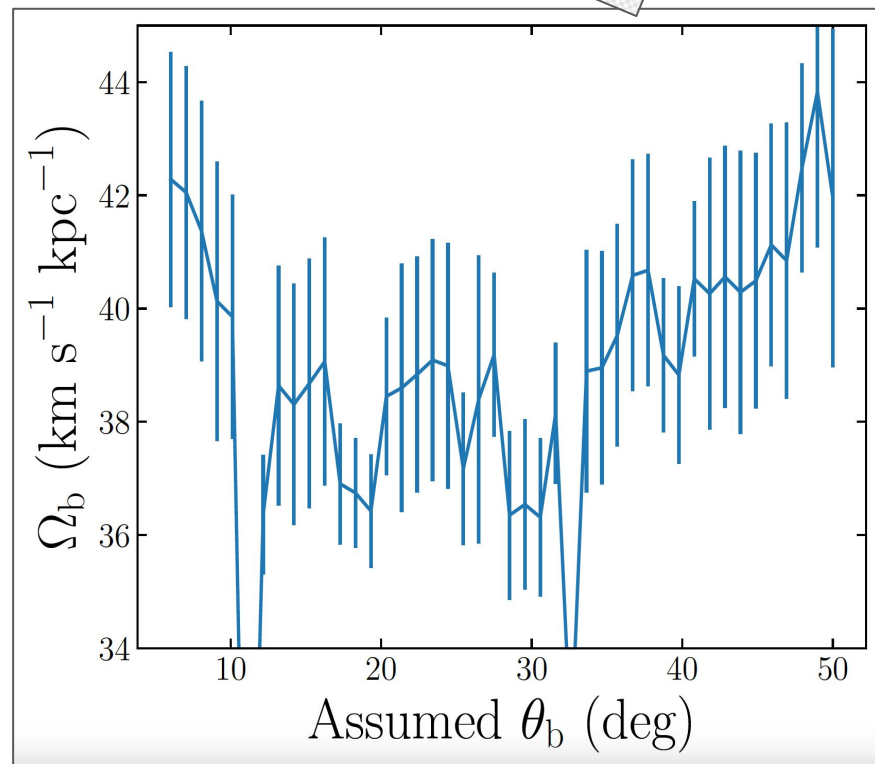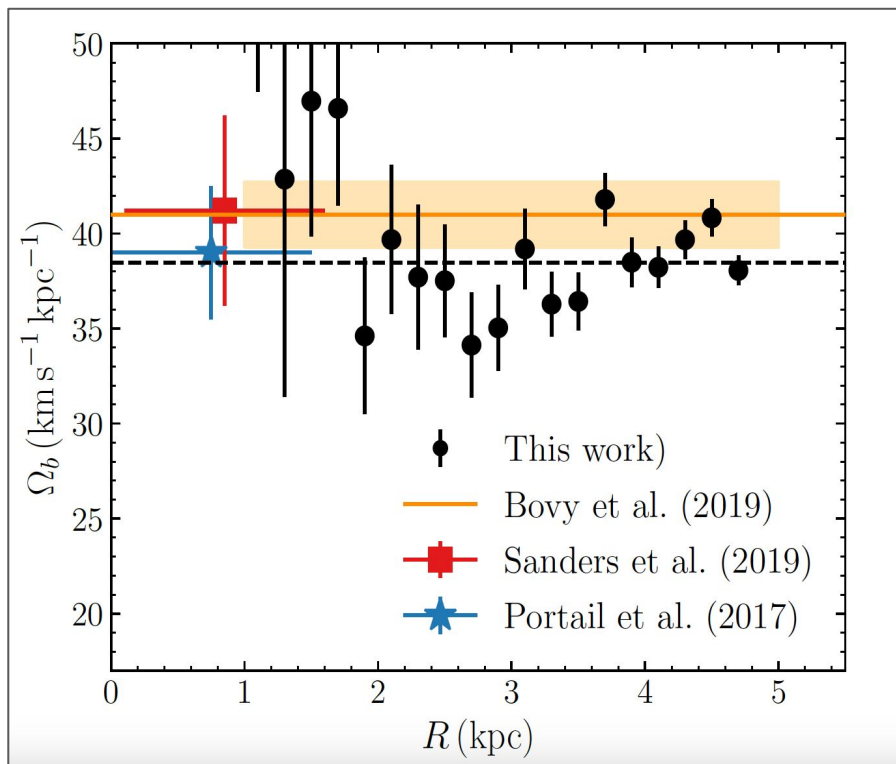
# Currently

- Testing and evaluating the capabilities of the method with test particle simulations taking into account the Gaia Selection function and the astrometric and spectroscopic uncertainties
- Same test particle simulation as in Appendix of Gaia Collaboration, Drimmel, Romero-Gómez+2023, with **Omega_b = 45 km/s/kpc** (R_CR = 4.7kpc) and bar orientation angle = 20 deg.
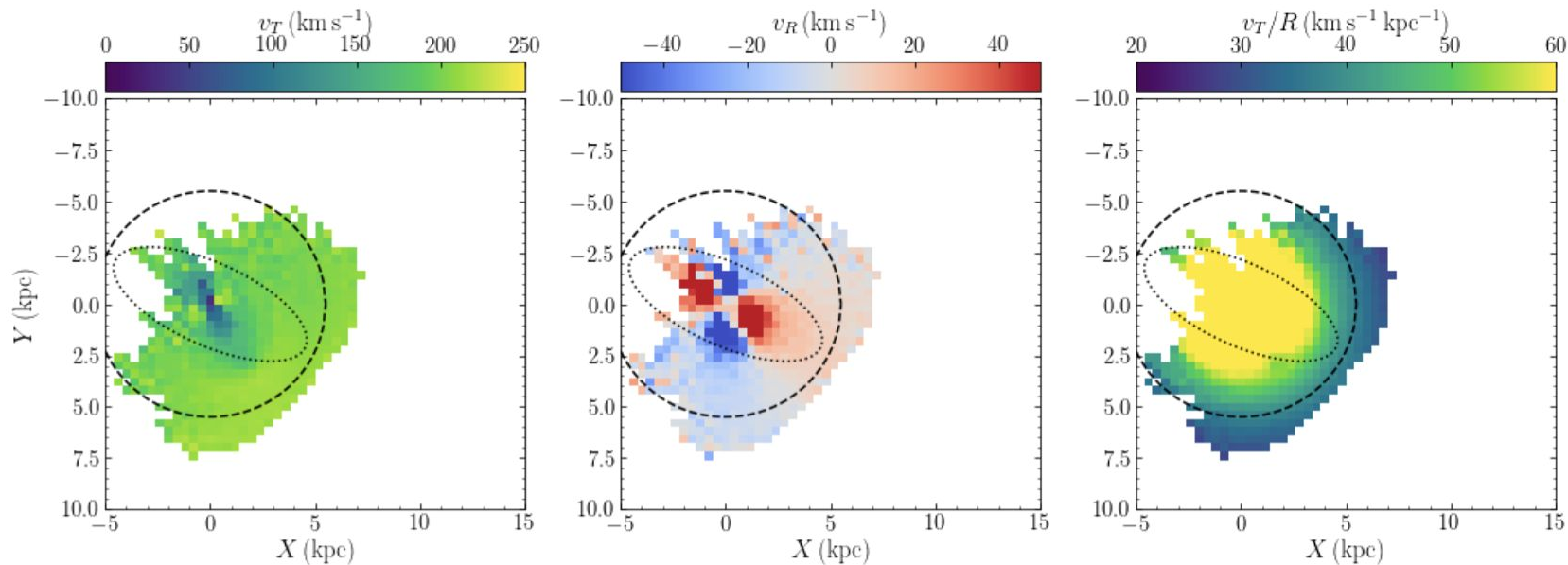
# No cut in G, no errors
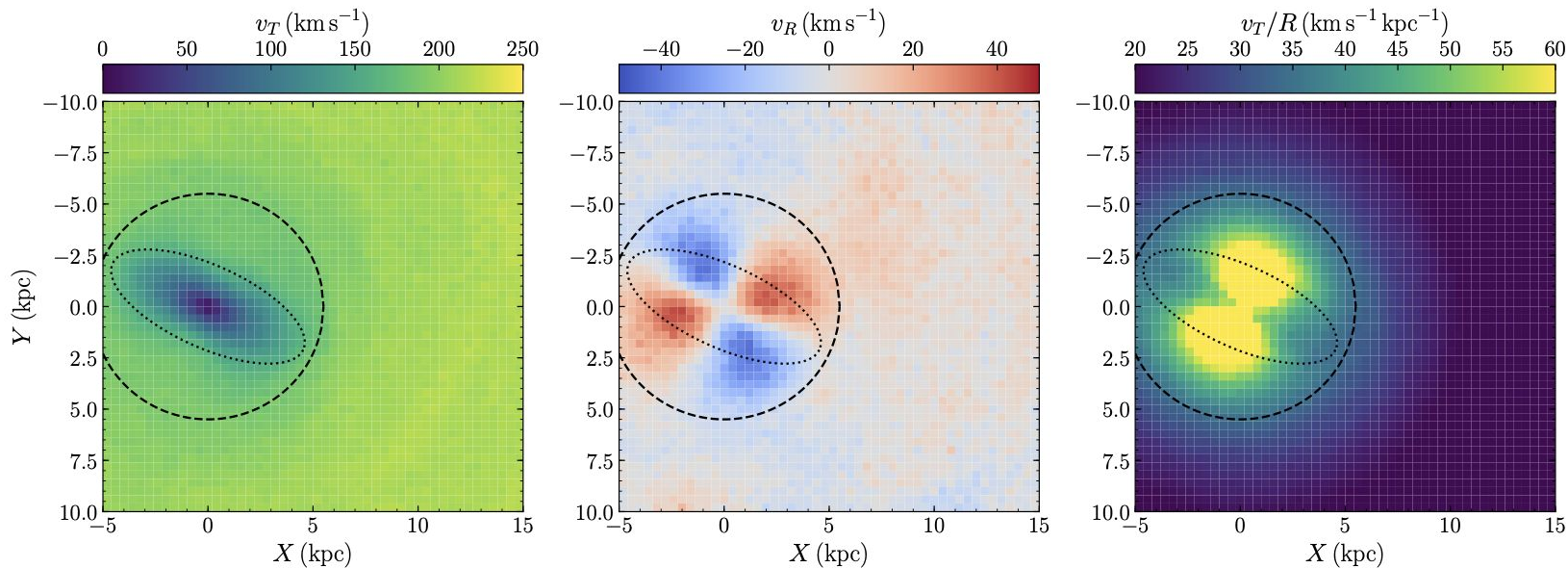
Bar pattern speed: 46.20 +/- 0.62 km/s/kpc based on 163 bins (scatter 7.90)
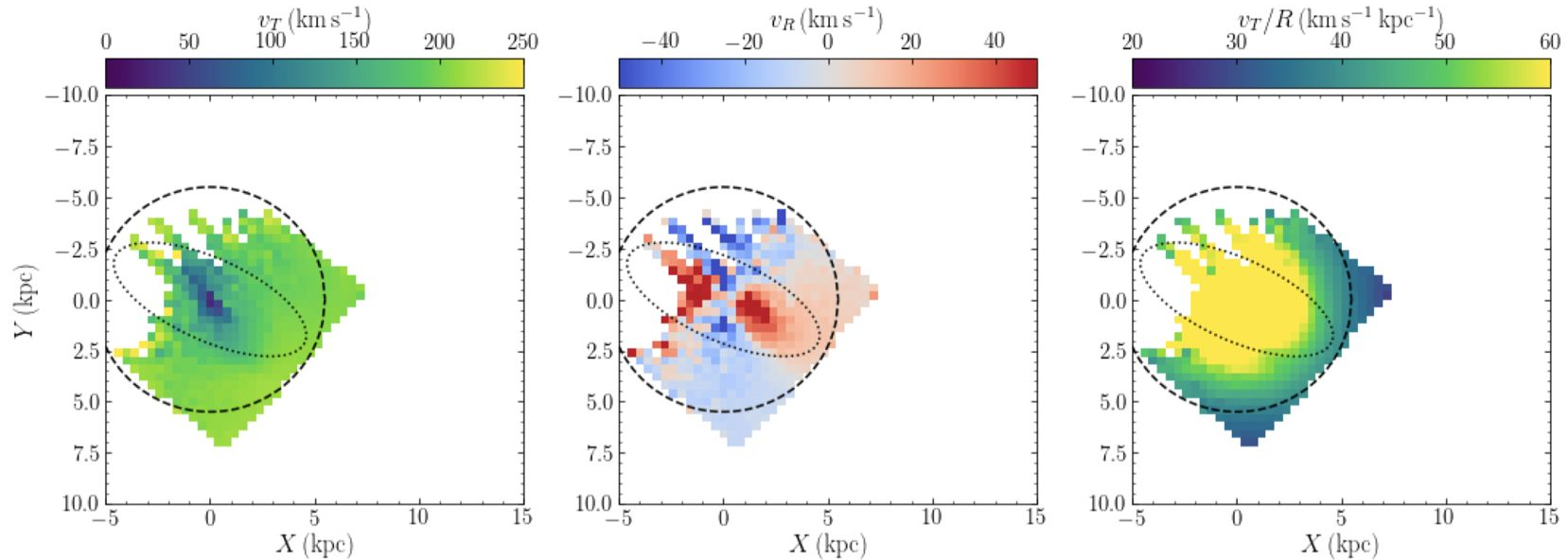
# Cut in G, no errors

Bar pattern speed: 48.86 +/- 1.24 km/s/kpc based on 138 bins (scatter 14.61)

# Cut in G, with errors

Bar pattern speed: 49.10 +/- 1.27 km/s/kpc based on 137 bins (scatter 14.83)

# Conclusions

- New data set used with 12M RGB stars using XBoost (Andrae+2023)
- New correlation maps
- Tremaine & Weinberg method applied to the new data set with results compatible with previous studies