

## ***Gaia* Data Release 2: Mapping the Milky Way disc kinematics**

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Non-axisymmetric structures (bar, spiral arms... secular evolutionary processes) and external perturbers (several accretion events) are expected to disturb the MW velocity field.

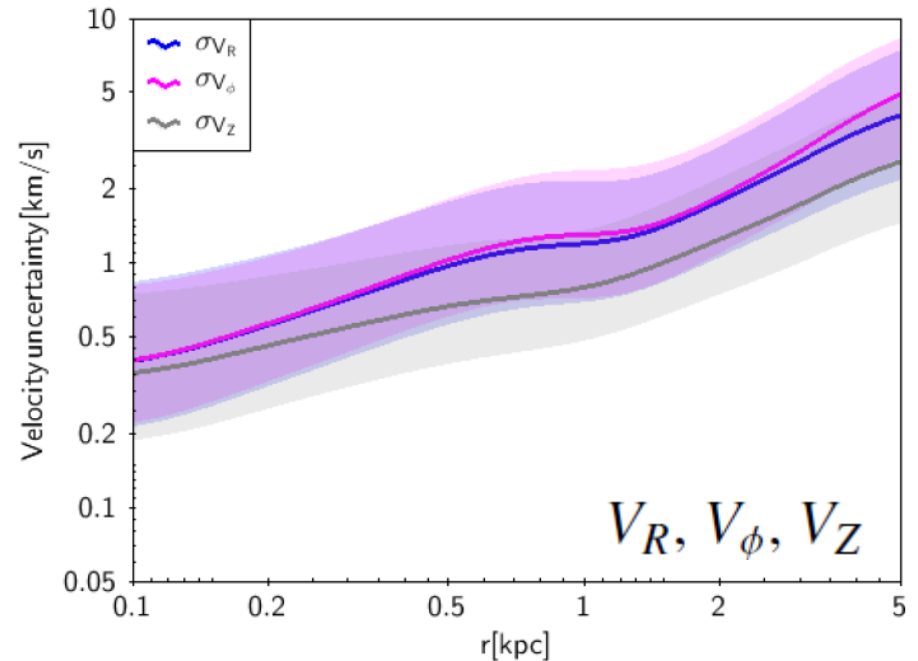
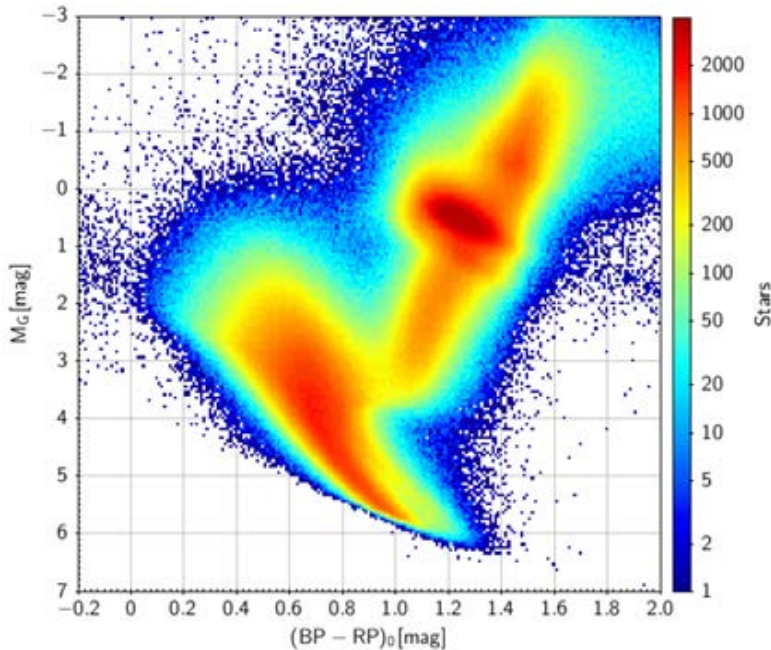
- To what extent can be represented as a system in dynamical equilibrium?
- Can we recover from 6D phase space the nature /accretion time of the perturber?

**Events are imprinted in the kinematics-age and kinematics-abundance relations**

**This paper is ONLY a first kinematic exploration**

# The Main Sample (6.3M)

- stars with  $\omega/\Delta\omega > 5$ , distance estimate ( $1/\omega$ ), overestimation of  $\sim 17\%$  at 3 kpc.
- Radial Velocities from Gaia Spectrometer, only stars with  $T_{\text{eff}} = [3550; 6900]$  K
- Extinction: DR2+2MASS photometry (helps to break the  $T_{\text{eff}}$ -extinction degeneracy)
- Median uncertainties in velocities: (1.4, 1.4, 0.9) km/s, 20% with all components  $< 1$  km/s



Supersedes any previous full 6D phase space sample:

- Quantity: 12 times larger in number than a sample made from UCAC + RAVE
- Precision: Galactocentric cylindrical velocities are roughly 5-7 times better

we have mapped in 3D the velocity field of the galaxy over a large portion of the disc:  $5 < R < 13$  kpc,  $|\phi| < 30^\circ$ ,  $|Z| < 2$  kpc

**Giant Sample:**

- 3 153 160 stars, 78% located within 3 kpc of the Sun.
- Median velocity uncertainties of (1.6, 1.7, 1.2) km/s
- 13% of stars having uncertainties smaller than 1 km/s (all comp)

**The OB sample:**

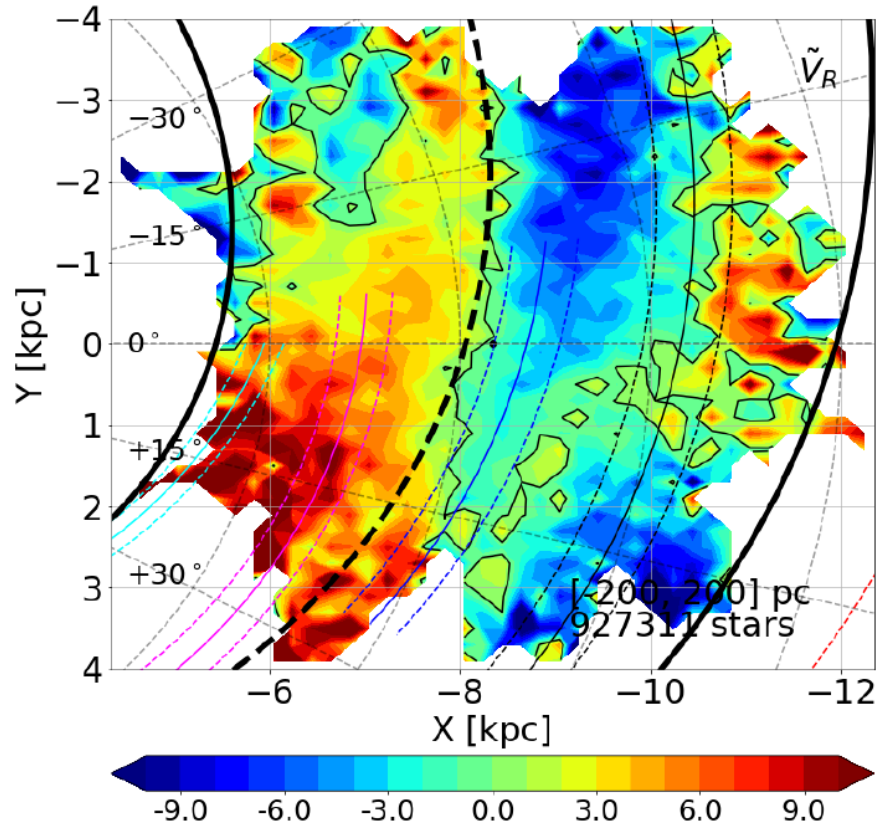
- 285 699 stars, 2MASS/Gaia colours and astrometry consistent with being OB stars (Gaia DR2 extinction, degenerated for large values)

**Solar Neighbourhood Sample:**

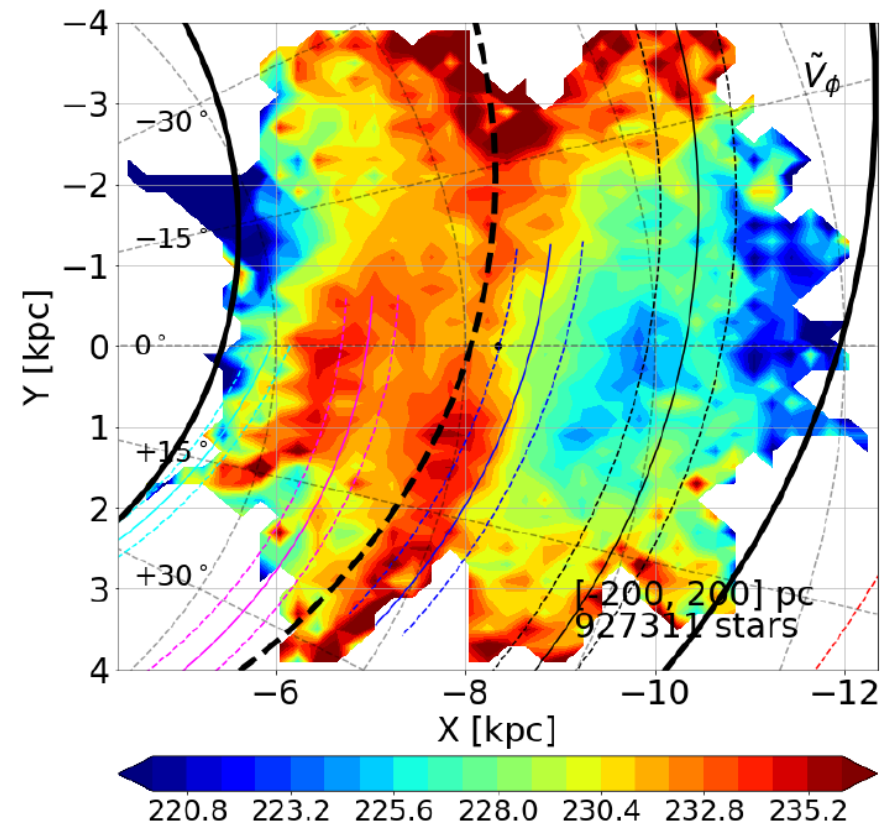
- 366 182 stars located within 200 pc of the Sun
- Median velocity uncertainties of ( 0.4, 0.4, 0.4 ) km/s
- 78% of stars having uncertainties smaller than 1 km/s (all comp)

$(R, \phi, Z, V_R, V_\phi, V_Z)$

## RADIAL



## AZIMUTHAL

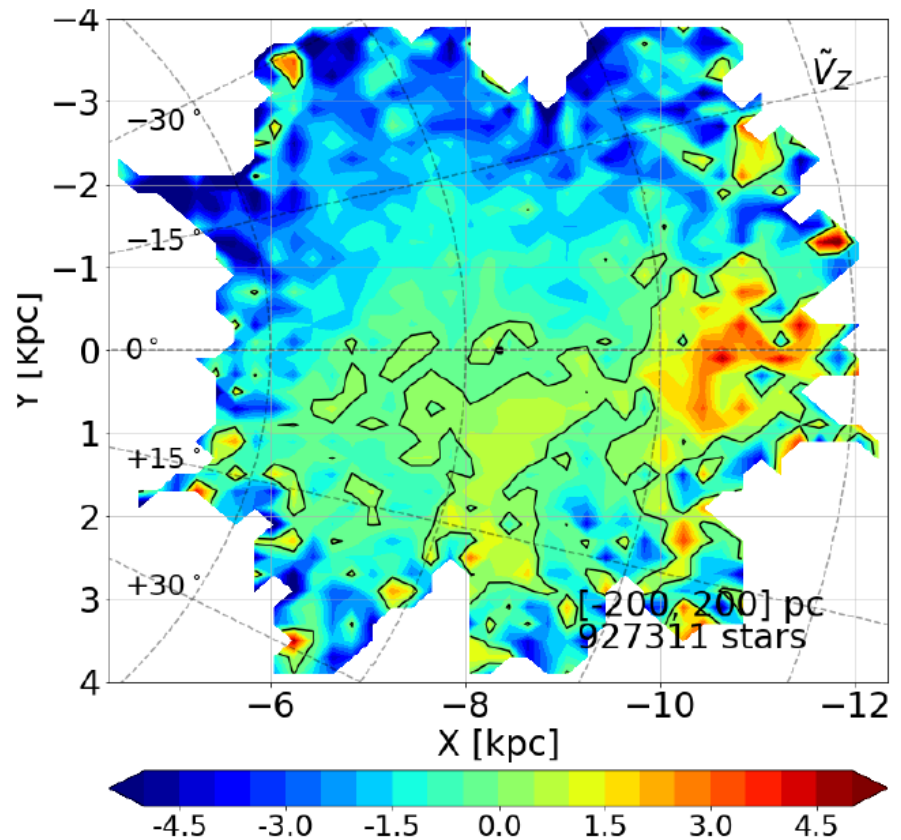
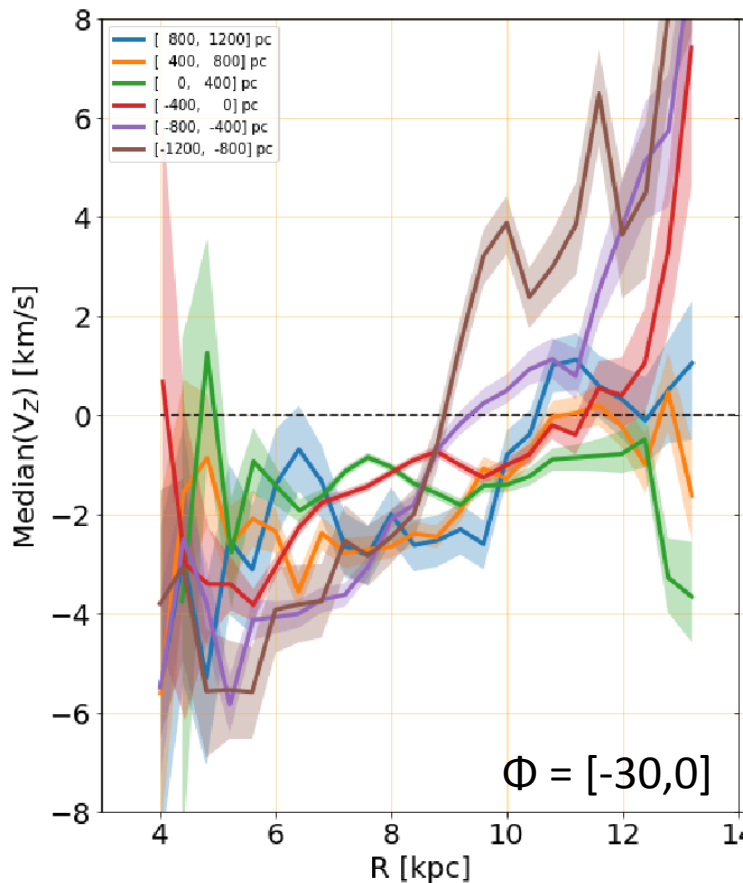


- Rotation curve: gradient in the potential? thin vs thick?
- Radial velocity field: has a U-shape
- local arm: coincidence with the ridge of negative median  $V_R$  (fortuitous?)
- infra-red arms (low density): matches boundary between  $V_R$  (+ vs -)

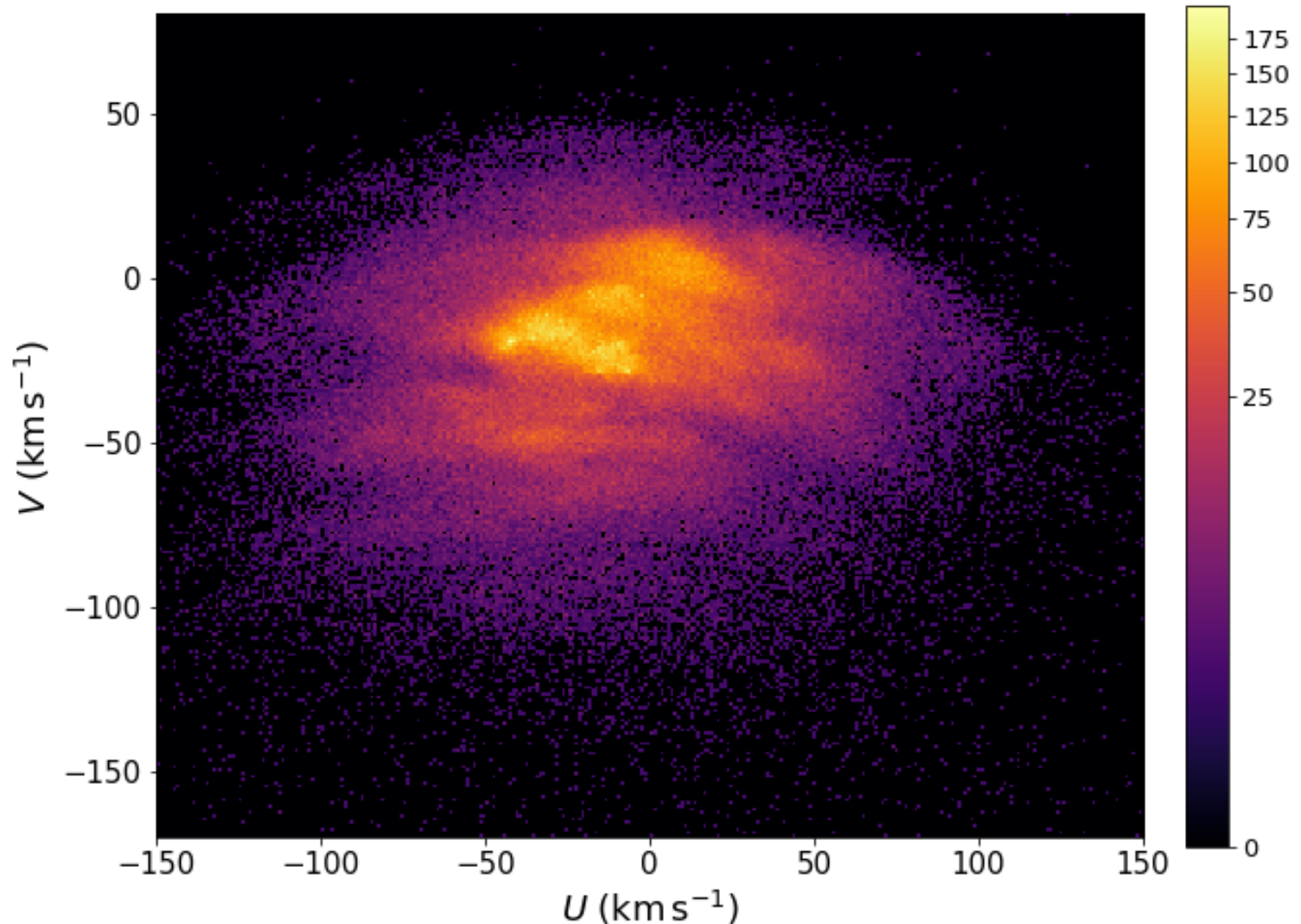
# The vertical velocity field is complex

(inner vs outer with radial, azimuthal and vertical dependences)

**Definitively, it cannot be described by a single bending, breathing or higher mode. We likely witness a superposition of modes, possibly of several different origins.**



Many nearly horizontal arched-like structures never seen before



Enough velocity precision and statistics to resolve the small scales of the  $UV$  plane  
Wavelet transform (SN and distant regions) Pau and Teresa's talk (arXiv:1805.09790)

# The Galactic warp:

- Generated by the interaction with LMC or Sagittarius?
- Generated by a dark matter halo distribution offcentered or tilted wrt baryonic?
- Due to bending instabilities in the disc?
- Due to misaligned infall of material?

Romero-Gómez et al., (in preparation)

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## Warped kinematics of the Milky Way revealed by *Gaia*

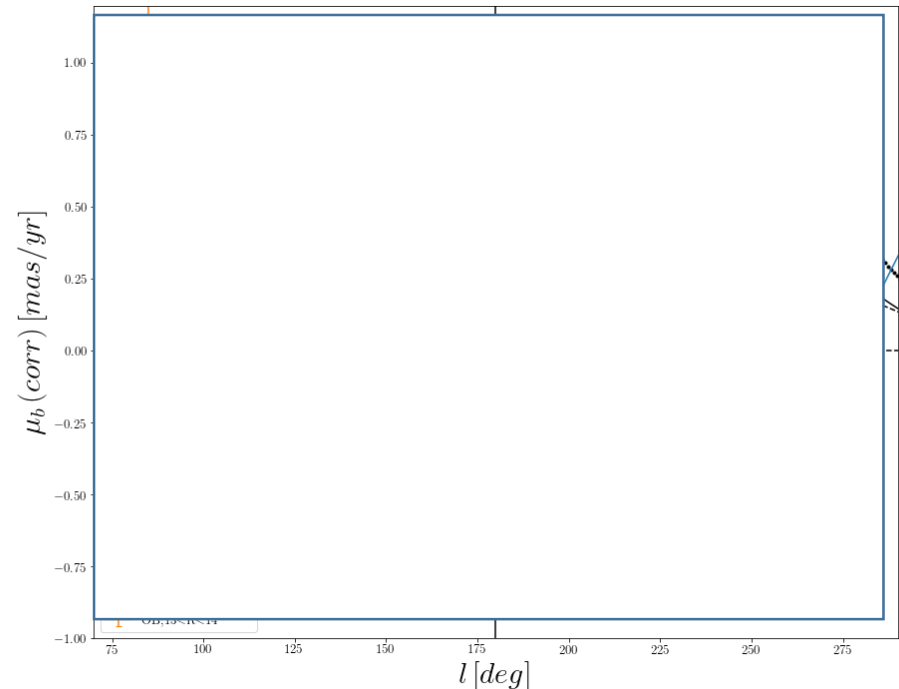
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**ABSTRACT**  
 Using 2MASS photometry of *Gaia* DR2 sources, we present a technique for selecting upper main sequence stars and giants without the need for individual extinction estimates, to a distance of 7 kpc from the Sun. The spatial distribution of the upper main sequence stars clearly shows the nearest spiral arms, while the large-scale kinematics of the two populations perpendicular to the Galactic plane both show for the first time a clear signature of the warp of the Milky Way.

[astro-ph.GA] 9 May 2018



$$\psi_{SI}(\theta) = \begin{cases} \psi_{up} \sin^2(\theta) & 0 \leq \theta < \pi \\ \psi_{down} \sin^2(\theta) & \pi \leq \theta < 2\pi, \end{cases}$$