# Dissecting the Galactic bar using Gaia observables and statistical techniques

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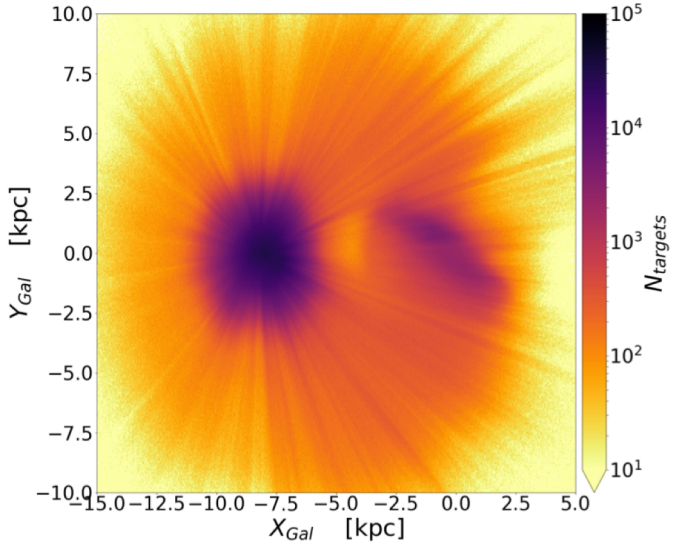
**Abstract:**
The main characteristics of the Galactic bar still remain a mistery. Being able to constrain the bar orientation angle or its pattern speed would provide information on the length of the Galactic bar, the position of resonances, and a plausible origin of the spiral arms. Recent works using GaiaDR2 combined with other photometric surveys or complementary on-ground spectroscopic surveys provide some insights of either the bar orientation or the bar pattern speed with still large uncertainties. Some of these works rely on the choice of a distance estimator from the GaiaDR2 parallax. The novel approach we use in this work is directly using Gaia astrometric observables and comparing them to a set of Gaia mock simulations obtained by varying the bar pattern speed and its orientation angle within the literature limits. We aim at constraining both free parameters simultaneously, by using statistical techniques such as Gaussian Mixture Models. This technique can favour a combination of both parameters that best matches the observed data.

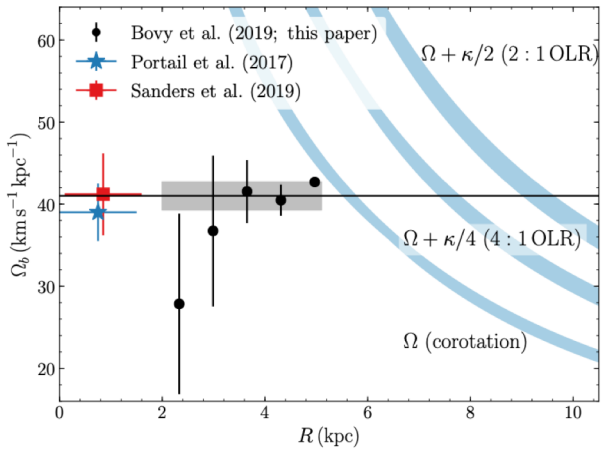
# Context

- The characteristics that define the Galactic bar: orientation angle, pattern speed, length, still have large uncertainties.
- Recent studies:
  - Using photo-astrometric distances (SH19) based on Pan-STARRS1, 2MASS and AllWISE. The bayesian distances depend on prior imposed. Favour a bar with 40deg orientation angle.
  - Using APOGEE (DR16) data and neural-network distance Bovy+19 favour a pattern speed of 41 km/s/kpc.
  - Using VIRAC & Gaia data proper motions of a Red Clump (RC) sample selected using 2MASS photometry, Clarke+19 favour a pattern speed of 37.5 km/s/kpc.

All these studies rely on derived distances, bayesian or neural networks or have a relatively small sample.



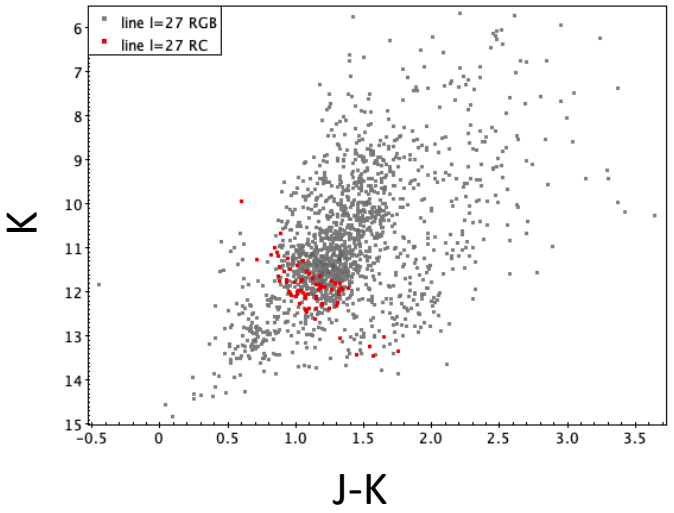

Anders+19

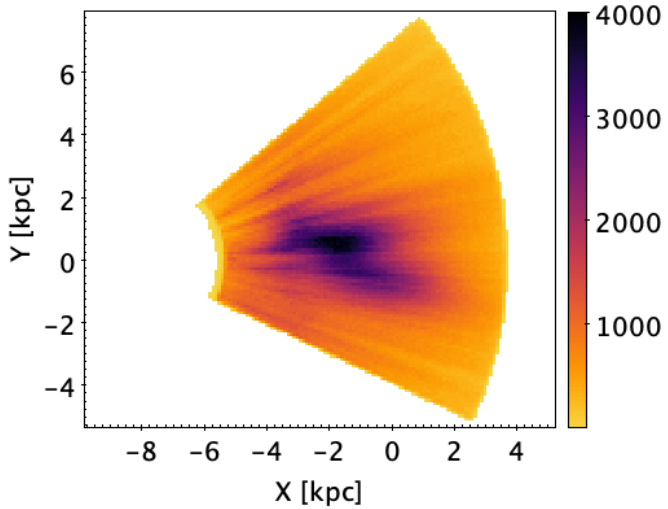


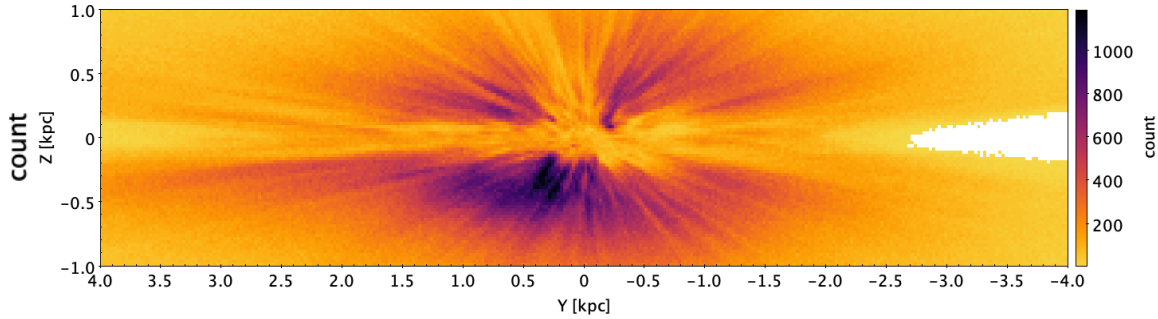

Bovy+19

# Description of the work and methodology

- The sample:
  - We use a RC sample selected from Gaia & 2MASS stars following the RC extinction line between |l|<40deg with a total of ~13.5M sources.
  - After removing dwarf and subgiants contamination and photometric distance >3 kpc: ~7.1M sources



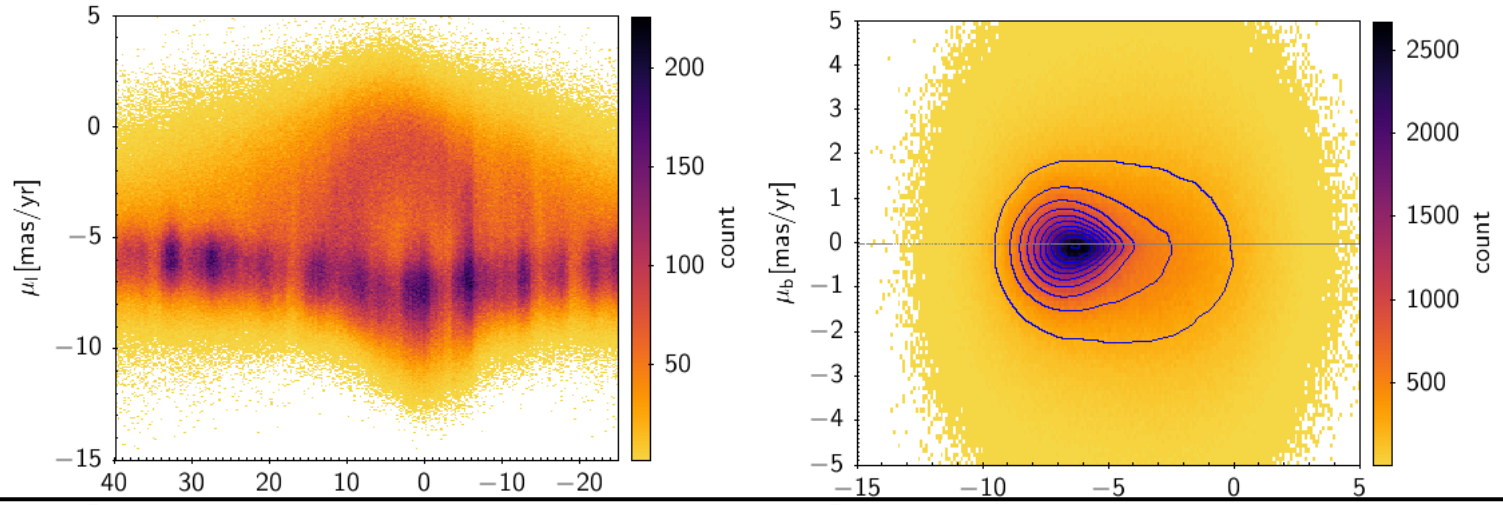



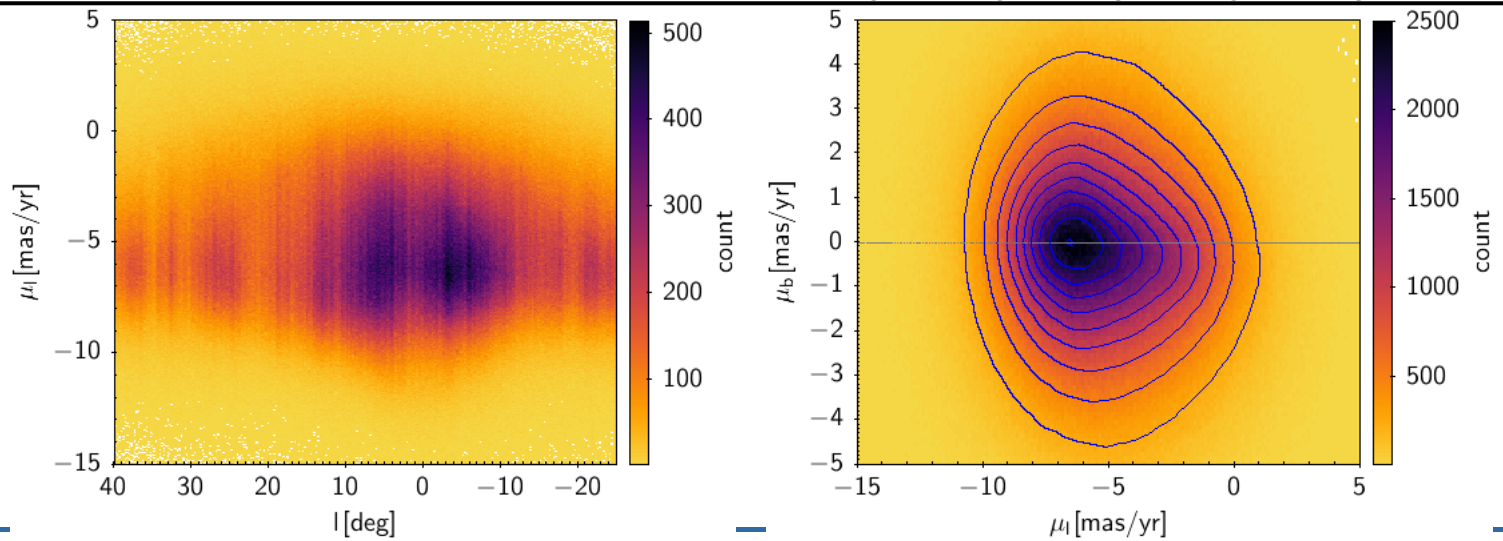

- Gaia mock catalogue:
  - We use test particle simulations (Romero-Gomez+15) with different pattern speeds and orientation angles
  - We generate the RC Gaia mock using the prescriptions in https://github.com/mromerog/Gaia-errors

# Results

- We examine the characteristics of the Galactic bar in the observable space.
- We make use of the RC Gaia mock catalogues to help interpreting the features in the observable space.




RC particles in bar orbits
$\Omega_b$ = 50 km/s/kpc and $\phi$=20º




Gaia RC selection

WORK IN PROGRESS

# Impact and prospects for the future

**Impact:**

- Having a good determination of the bar orientation angle and pattern speed has a big impact on the dynamics of the Galaxy, placing the starting point of the spiral arms, the effect of resonances to the stars, ridges, moving groups,…

**Future steps:**

- By using the grid of test particle simulations we plan to characterise the Galactic bar in the observable space, identifying the features created by the bar from the features natural from disc orbits.
- We plan to quantify differences between models and similarities with data using statistical techniques such as Gaussian Mixture Models.