

# Impact of the Milky Way bar on stellar streams: The case of Hyades

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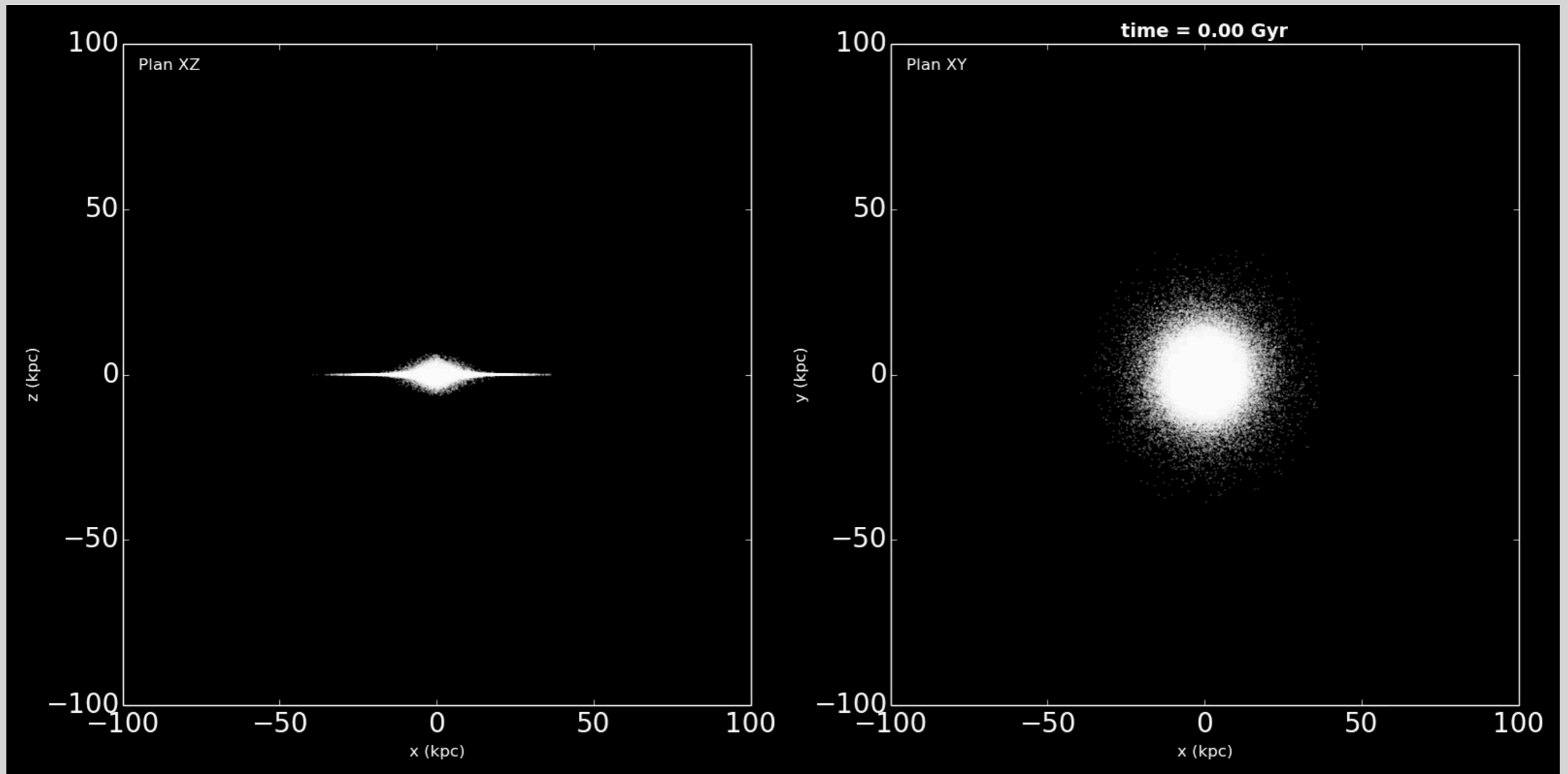
Submitted to A&A

*In collaboration with*

*B. Famaey, G. Monari, C. Laporte, R. Ibata, P. de Laverny, V. Hill and C. Boily*

# The stellar streams

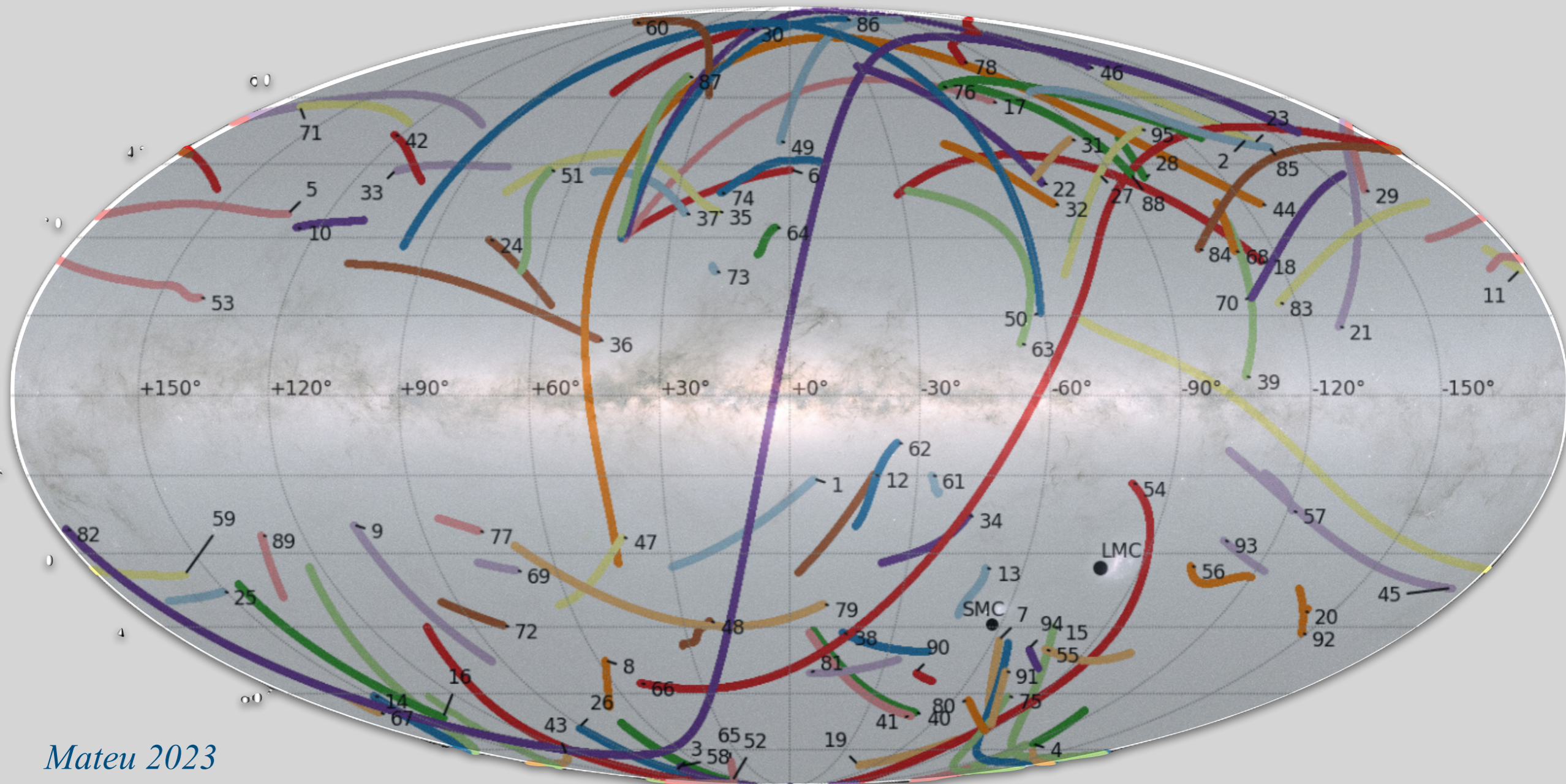
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- **~90 known around the Milky Way**





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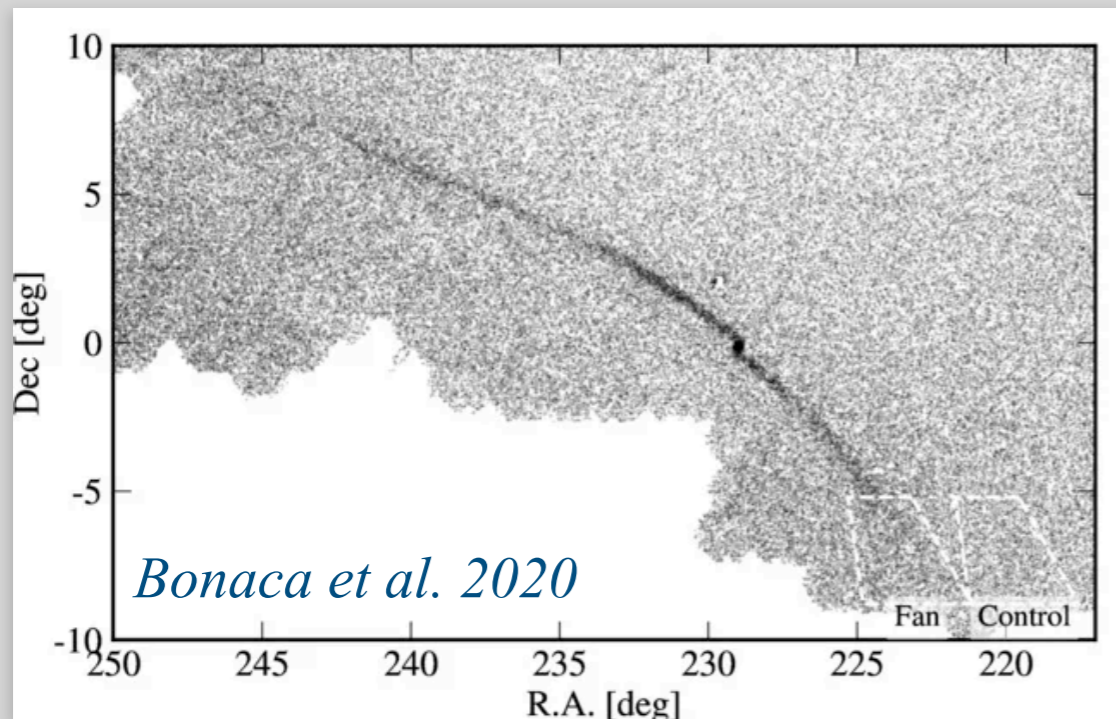
*Mateu 2023*



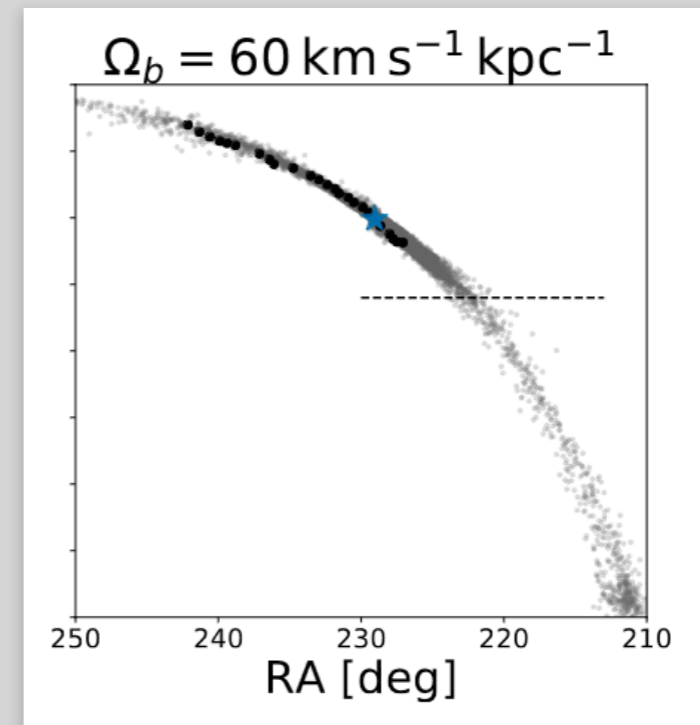
# The stellar streams

- Formed by the **disruption** of a dwarf galaxy or a **star cluster**
- **~90 known around the Milky Way**
- **Streams can be impacted by the galactic bar:**
  - ➔ The bar can explain the **short length** of some stream, ex: Ophiuchus (*Hattori et al. 2016*)
  - ➔ The bar might have impacted the **orbit of some progenitor**, ex: M92 (*Thomas et al. 2020*)
  - ➔ The bar might generate asymmetric streams, ex: Palomar 5 (*Pearson et al. 2017*)

Observations



Simulations





# The Hyades stream

- Formed by the **disruption** of the Hyades open cluster ( distant of 47 pc of the Sun) ~650 Myr old



Different than the Hyades moving group (called sometime Hyades stream)

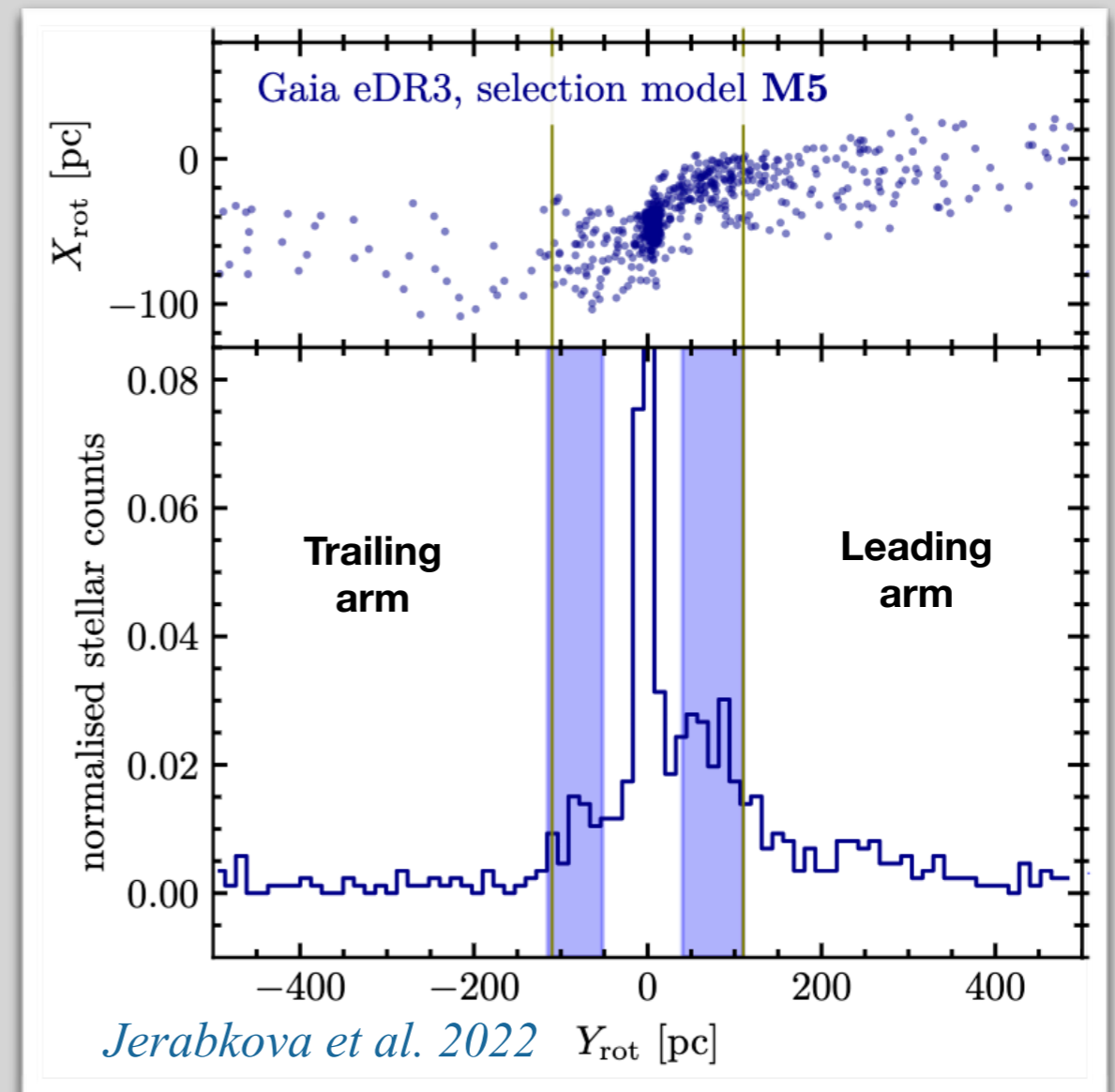
- Hyades stream is **800 pc** long
- Stream has a **density asymmetry**

$$Q = \frac{N_{lead}}{N_{trail}} = 2.53 \pm 0.37 \quad \text{Kroupa et al., 2022}$$

- ❖ This asymmetry can be signature of a **interaction** with a Galactic lump  
*Jerabkova et al. 2022*
- ❖ It can also be the signature of a departure of Newtonian gravity  
*Kroupa (incl. GT) et al. 2022*

Can the asymmetry be a consequence of the bar?

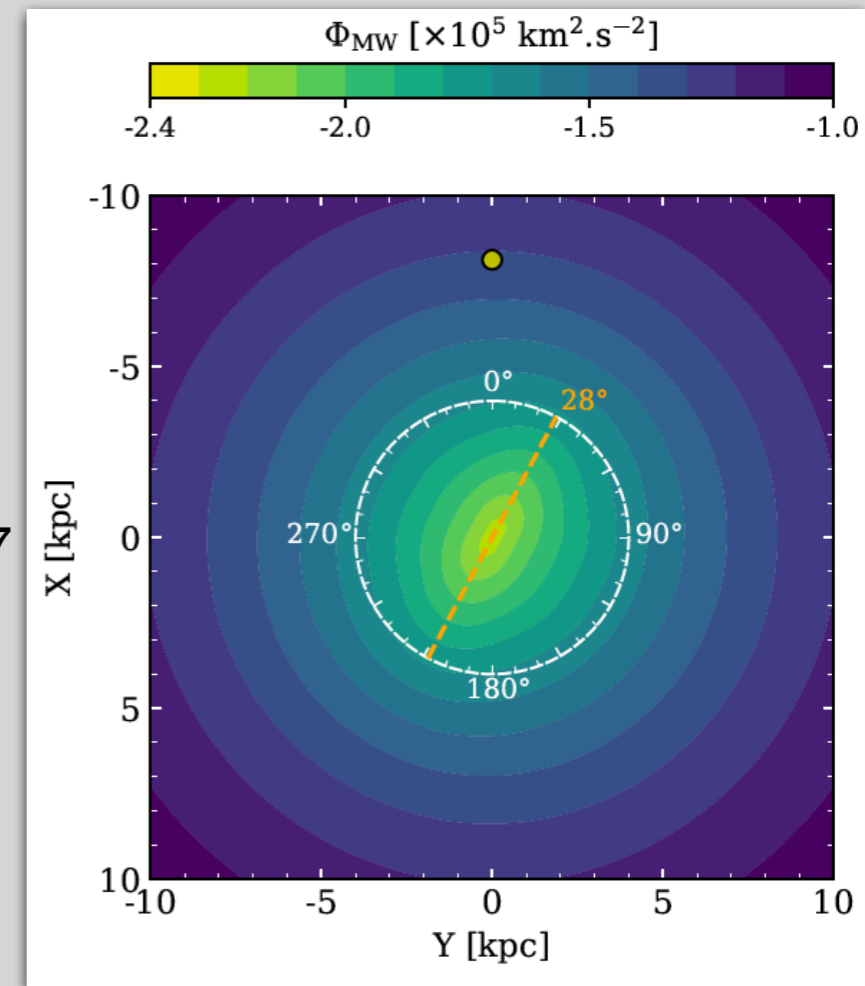
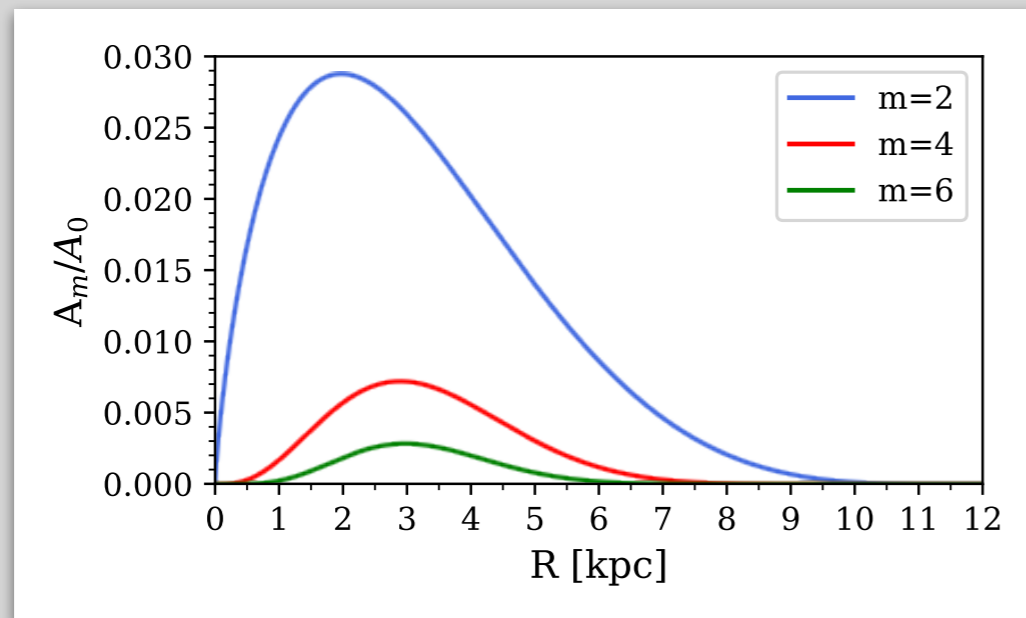
What is the impact of the bar of the stream?



# The Hyades stream & the bar

## The simulation set-up

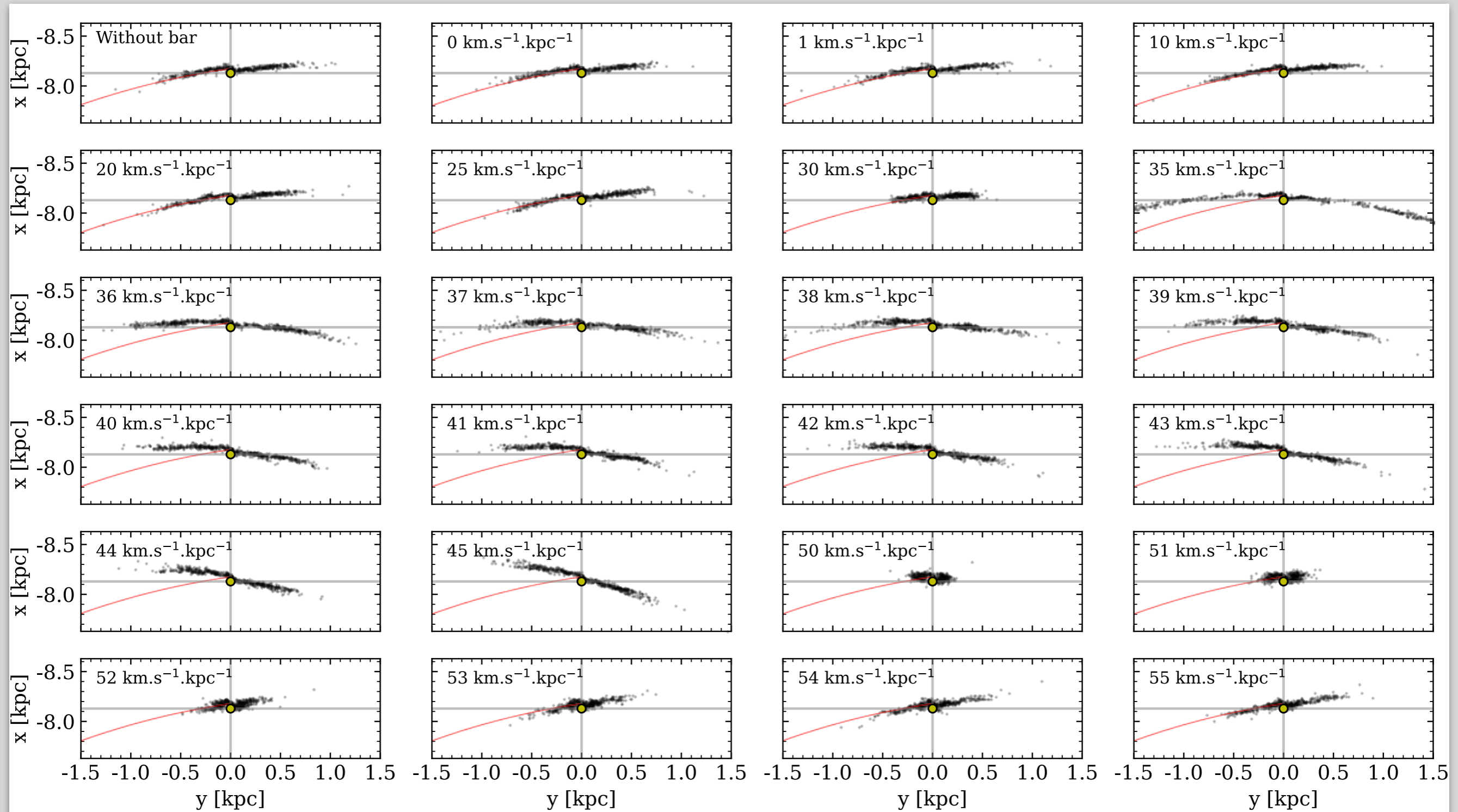
- Simulation made with *GyrfalcoN* over 655 Myr
- **Progenitor**: Plummer sphere of  $1230 M_{\odot}$  and  $r_s=2.62$  pc
- **Galaxy** modelled with the **GalBar** code (*a modification of GalPot*):
  - Axisymmetric mode similar to Dehnen & Binney 1998
  - Bar introduced using the amplitude ratio similar to Portail+2017 (*Mode  $m=2, 4, 6$* )



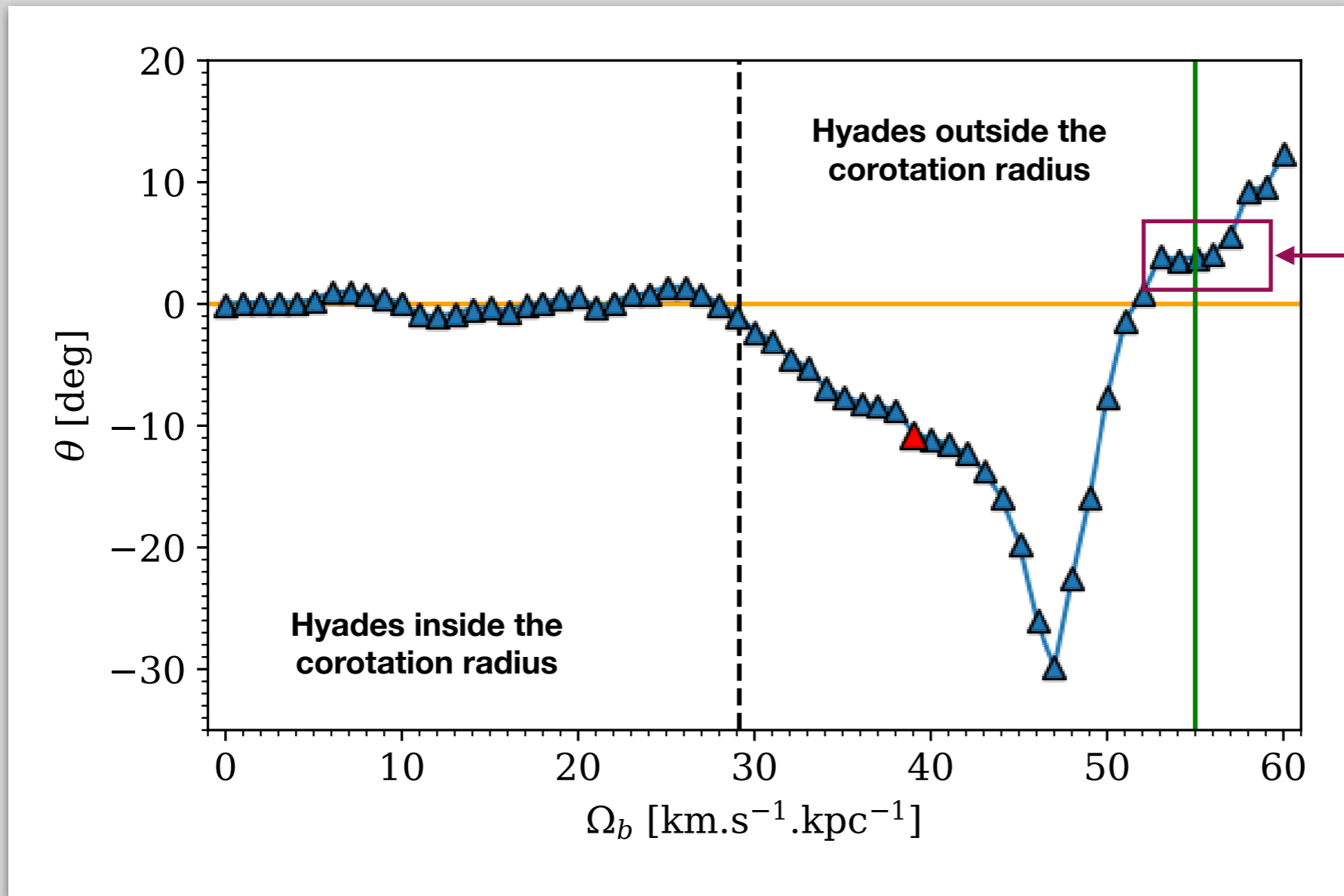
➔ We simulated the stream with different **the pattern speed of the bar**



# The Hyades stream & the bar



# The Hyades stream & the bar

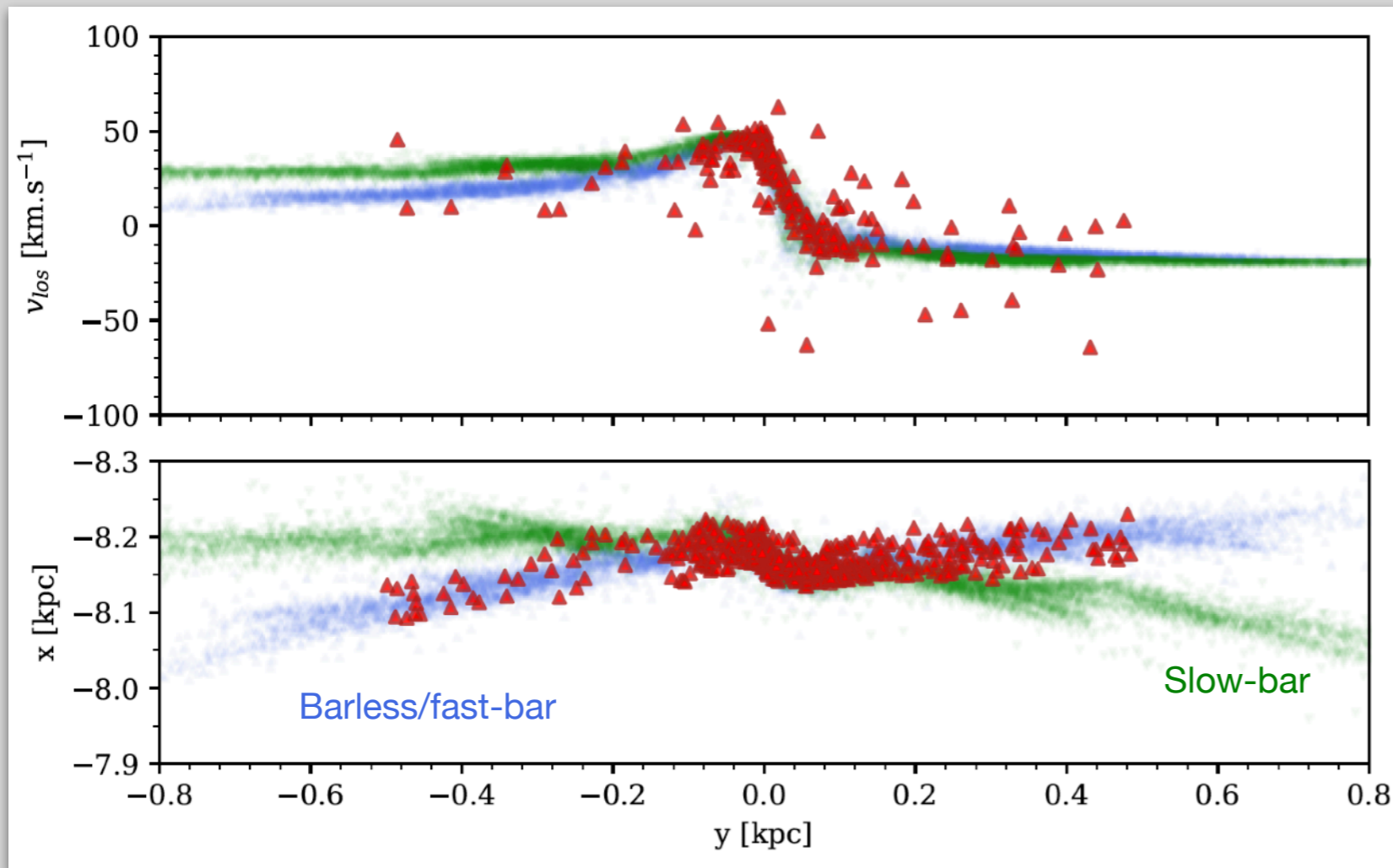


- ➔ The morphology and the track of the stream with a **fast bar** ( $\Omega_b = 55 \text{ km s}^{-1}$ ) is **similar** to the stream formed in an **axisymmetric** MW



# The Hyades stream & the bar

- We compared the simulation of a slow and without/fast bar to the observation of *Jerabkova et al. 2022*



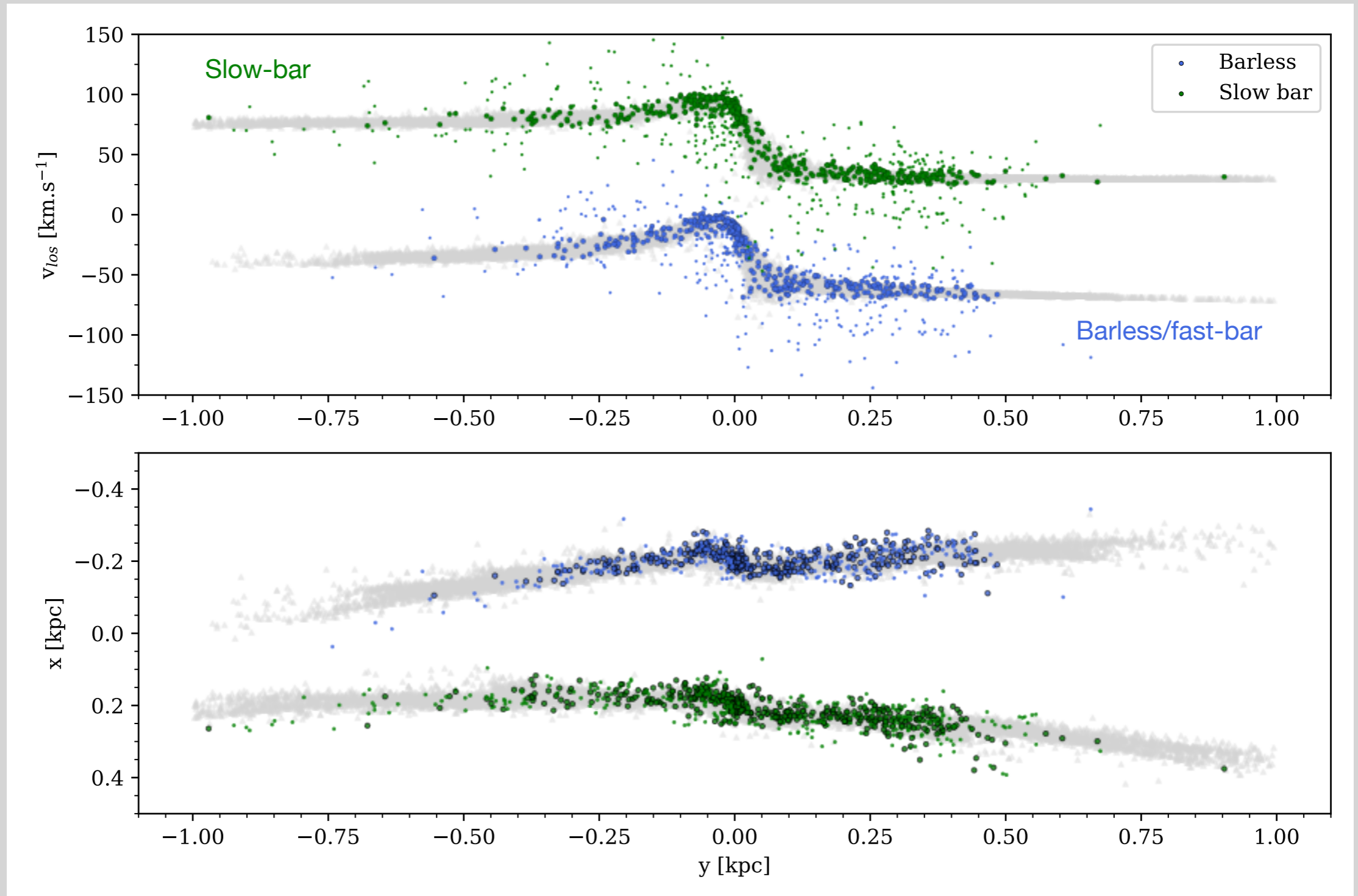
➔ **Observations favours a barless/fast-bar MW**

**But ...**

- Observations contain **~20% of contamination**
- **Observing sample selected based on a model made in an axisymmetric galaxy**

# Selecting the Hyades stream candidates

## Stars with Gaia RVS measurements



➡ It is currently not possible to said with model is the best (need High-res spectroscopy)



# A bar with a fluctuating pattern speed

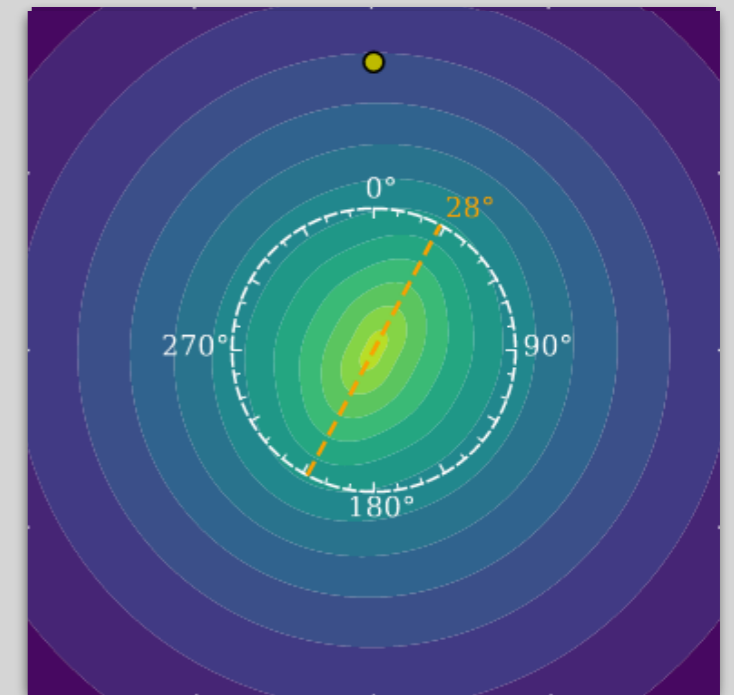
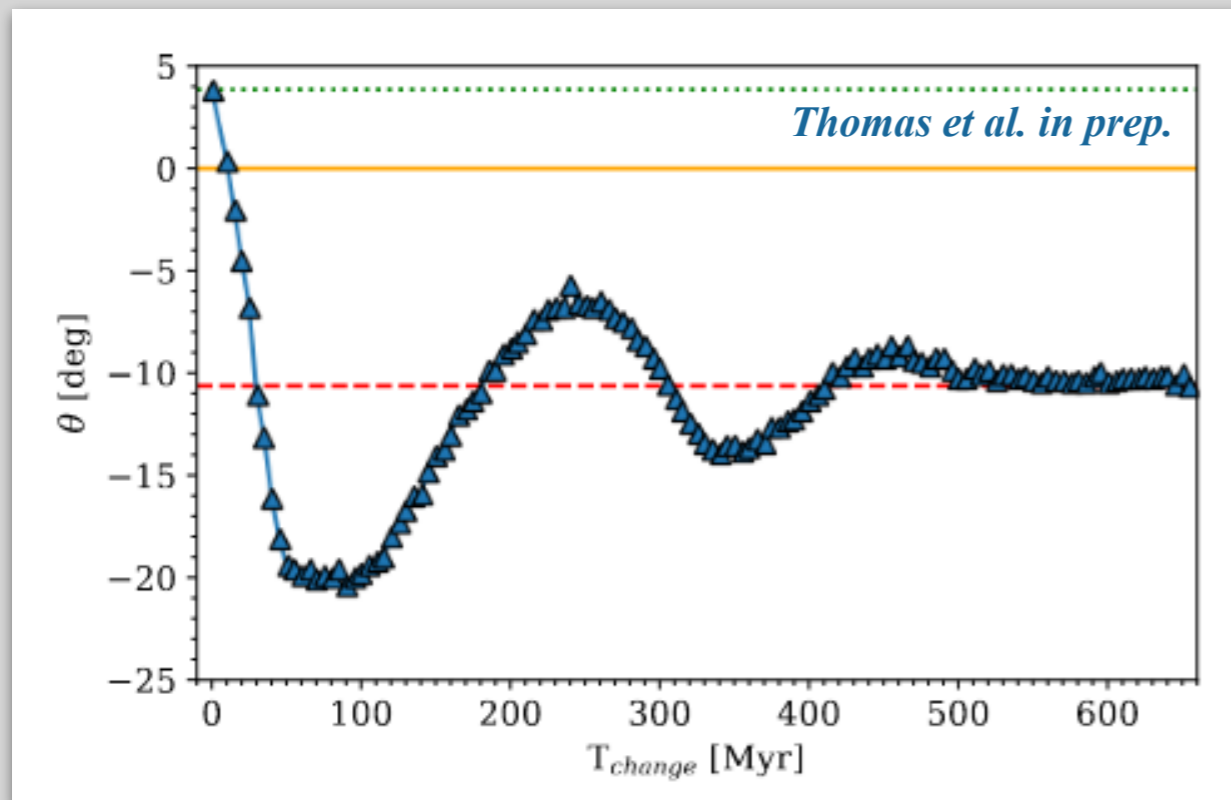
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- Let's assume that the model barless/fast-bar is the solution,  
how do we reconcile with the direct measurement of  $\Omega_b$  in the MW?

In prep.

# A bar with a fluctuating pattern speed

- Let's assume that the model barless/fast-bar is the solution, **how do we reconcile with the direct measurement of  $\Omega_b$  in the MW?**
- Brutal change of the pattern speed, based on the work of [Hilmi et al. 2020](#)



- ➔ Similar deflection than observed in [Jerabkova et al. 2022](#) with  $T_{change}=50$  Myr
  - ➔ Period of fluctuation of  $\Omega_b$  of 100 Myr, as found in [Hilmi et al 2020](#)

➔ **The streams might be used to measure the periodicity of the pattern speed fluctuations**

# Conclusions

- **The bar can change the spatial track**, and the length of **tidal streams**

- **For Hyades streams:**

- the bar does **not** create (strong) **asymmetry**
- Impact of the bar only if **outside the coronation radius**
- Hyades stream is **similar** in the case of a **fast bar** than in the **axisymmetric** case
- Observations from literature favour a fast bar

**But:** contain many contaminants, and made using an axisymmetric model

- We made a new method to select potential member of the stream
  - Gaia alone **cannot tell which model is the best**
  - need High Res spectroscopy

- **Galactic tidal tails might be useful to measure the fluctuation of the bar pattern speed**







# THE LOCAL GROUP as a benchmark for GALAXY EVOLUTION

8 - 15 November 2023  
Tenerife. Spain



Pre-registration until July 14th



<https://meetings.iac.es/winterschool/2023/>

