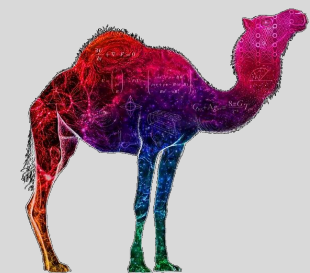


# *Robust field-level inference with galaxies*

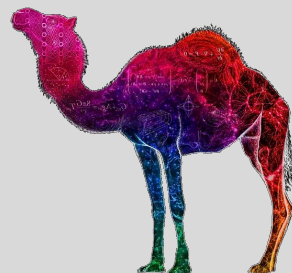
Natalí de Santi,  
Francisco Villaescusa-Navarro and Raul Abramo

Flatiron Institute/University of São Paulo  
FAPESP: 2022/03589-4

December 1st, 2022



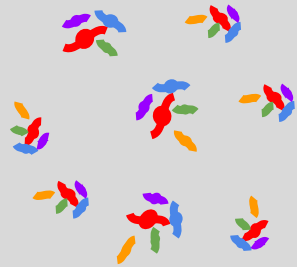
**CAMELS**  
WORKSHOP



**CAMELS**  
WORKSHOP

# The problem

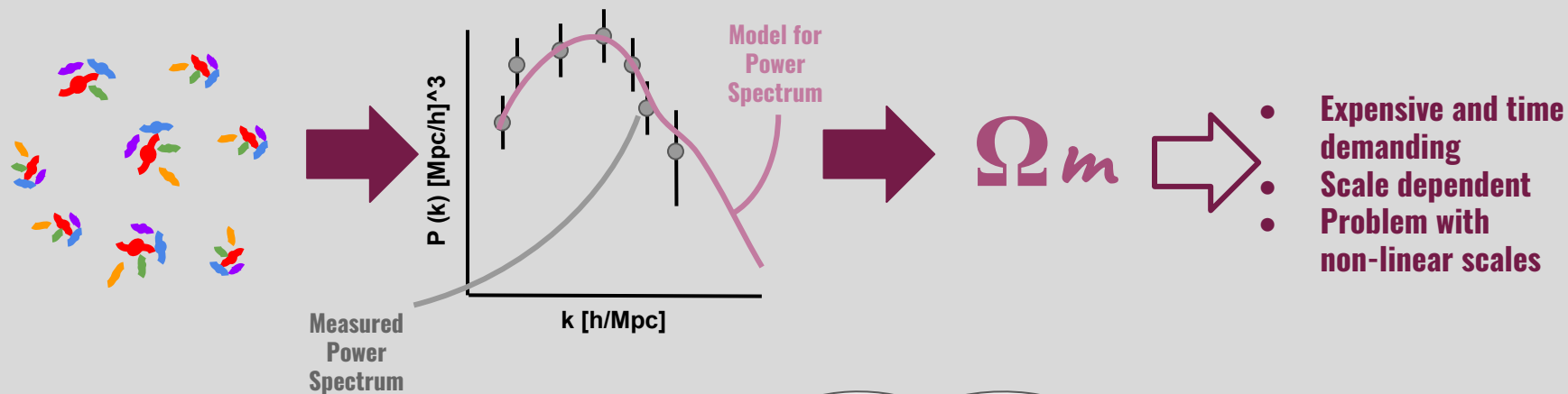
*The traditional way to infer cosmological parameters*



**SUMMARY  
STATISTICS**

# The problem

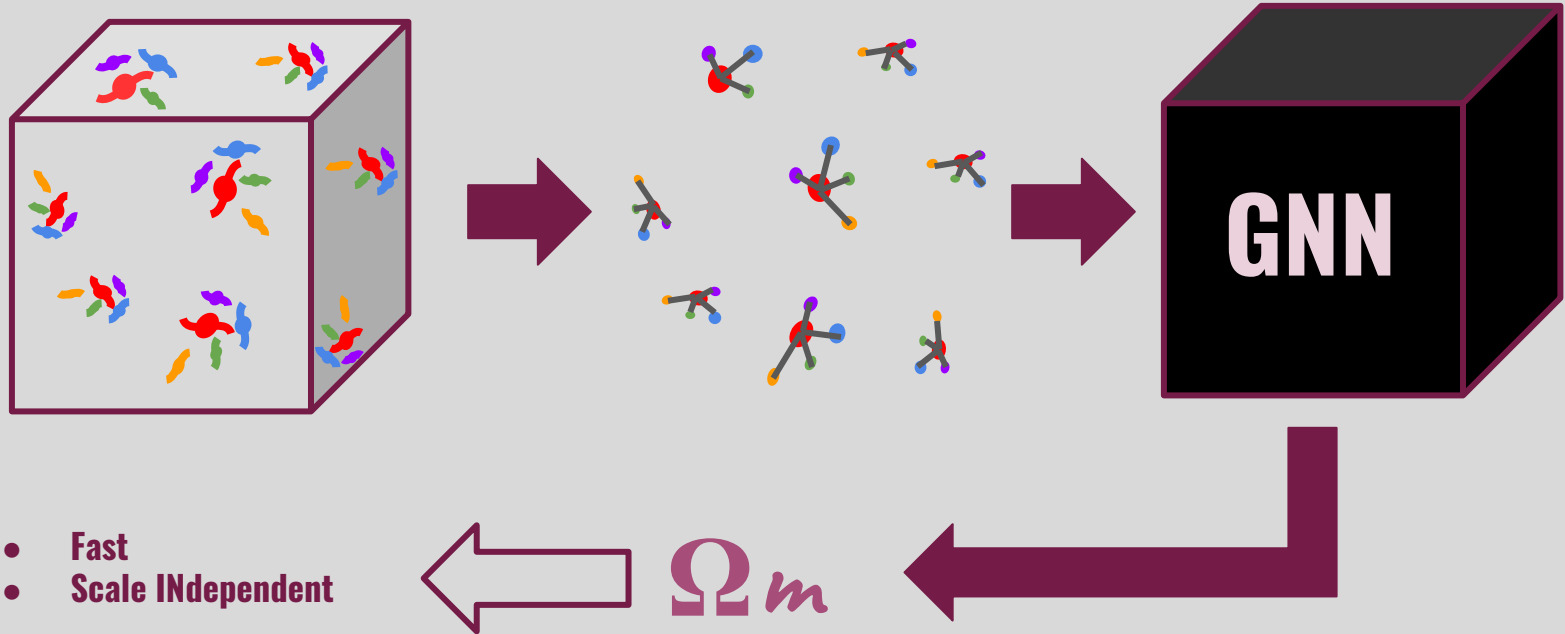
## The traditional way to infer cosmological parameters



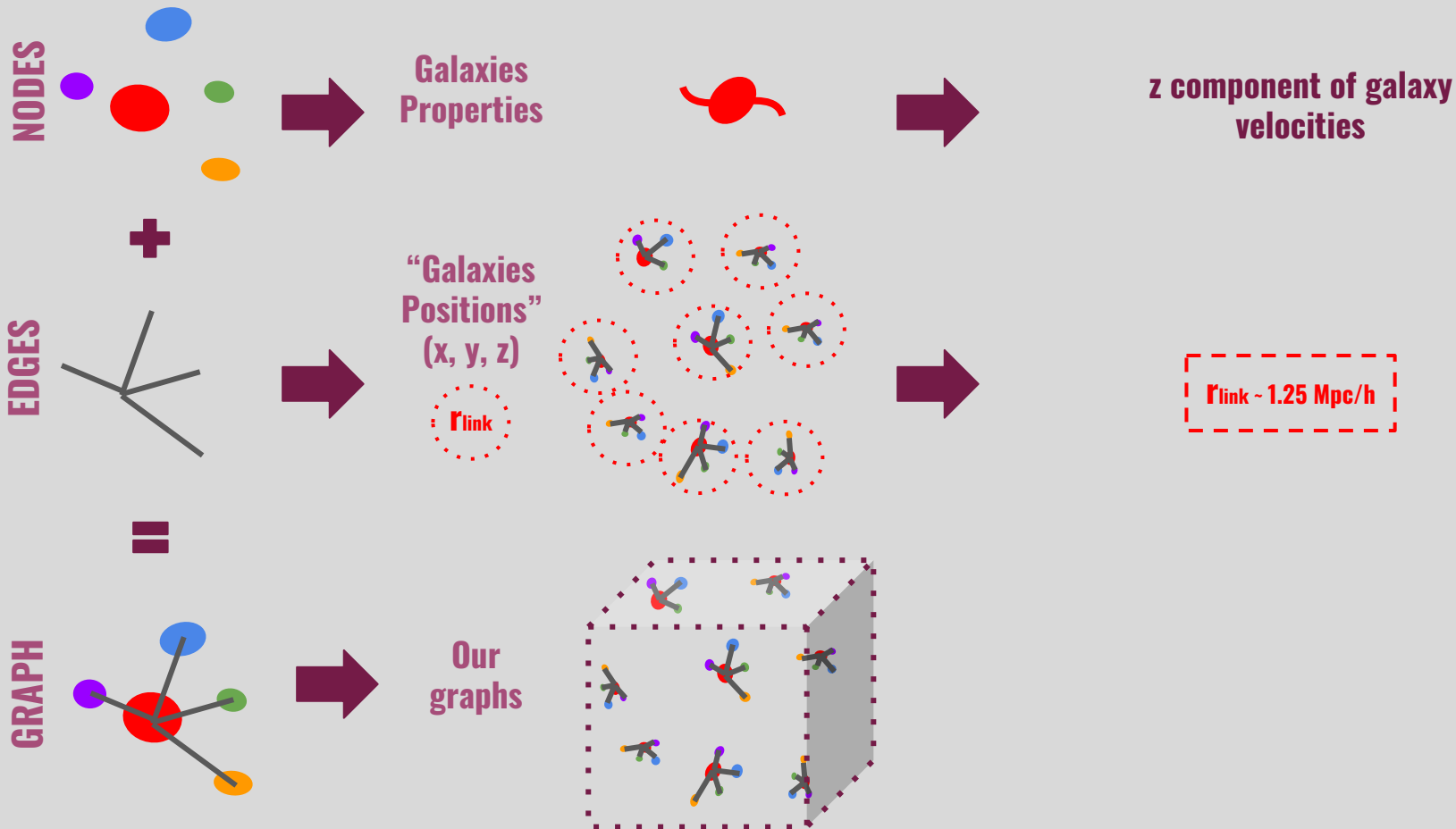
*Is there an optimal way to do parameter inference?*

# The brand new way to infer cosmological parameters

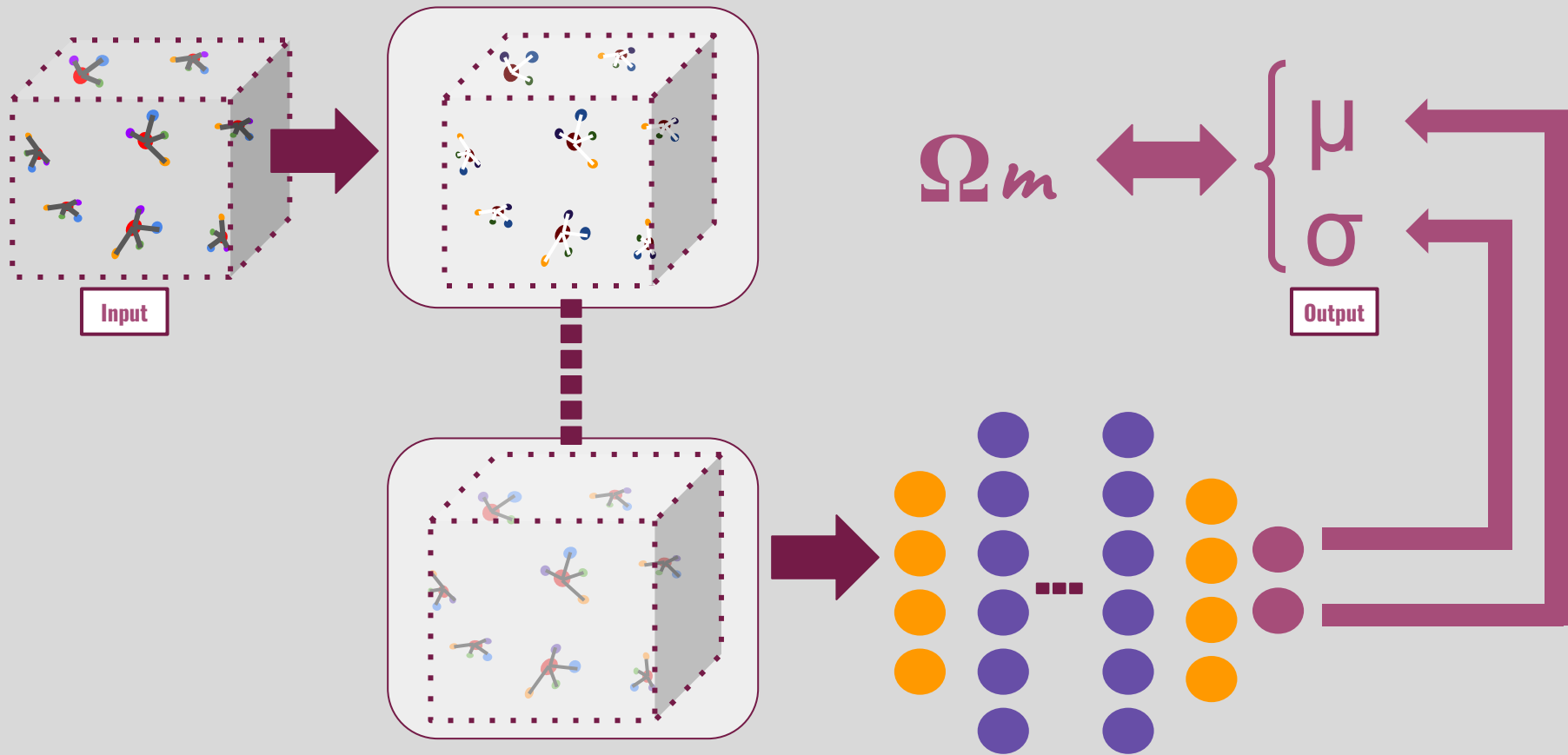
## Galaxy field-level likelihood-free inference



# GRAPHS

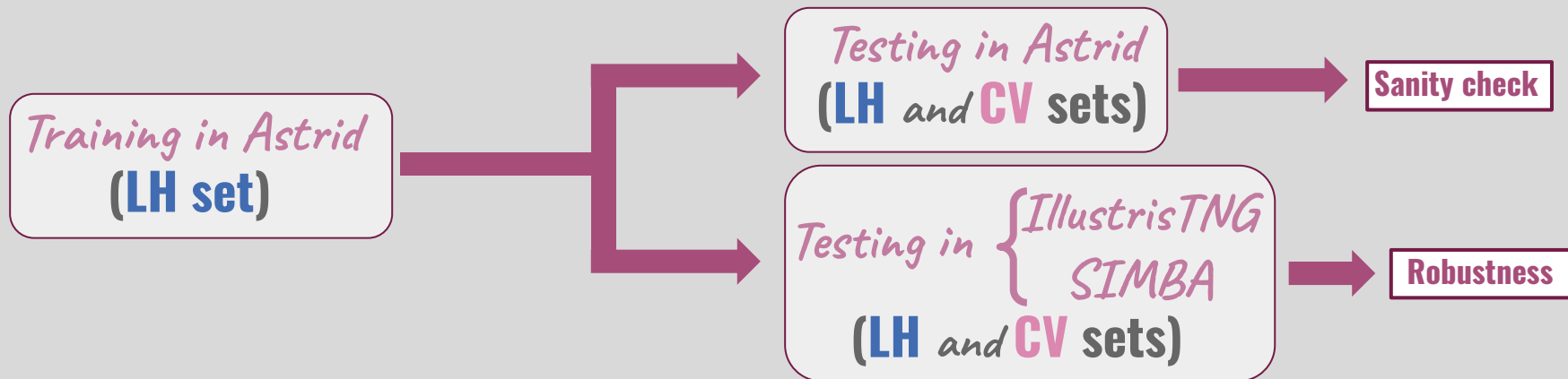


# Graph Neural Networks - GNNs



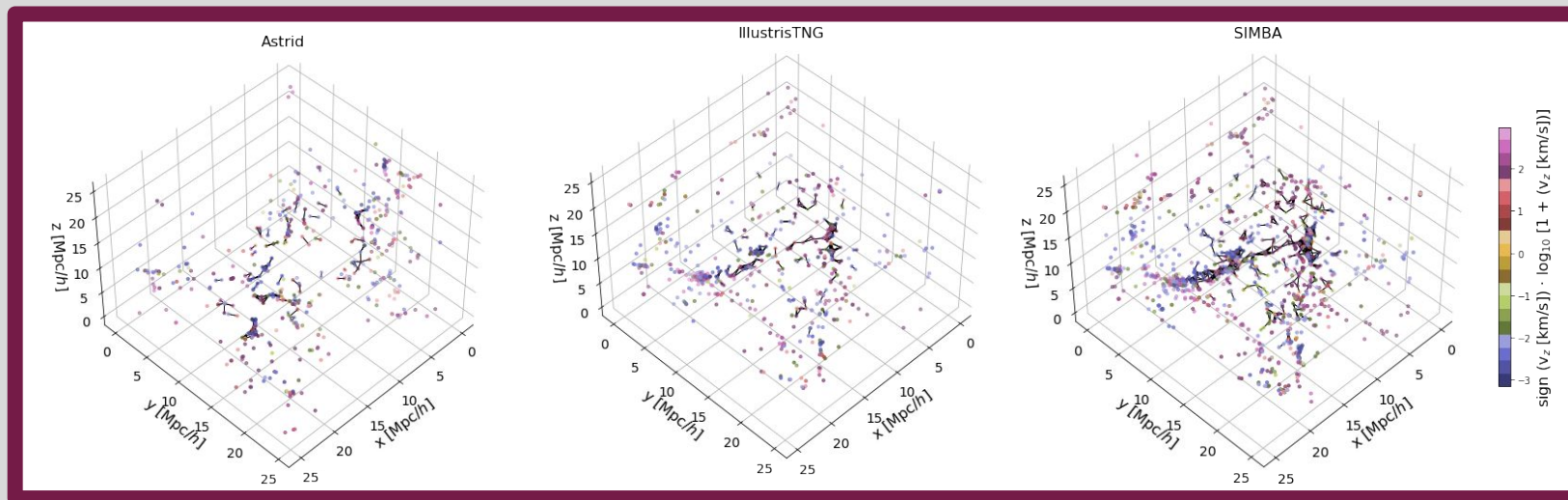
# Dataset

@franciscovillaescusa-navaro7383



# Dataset

@franciscovillaescusa-navar7383





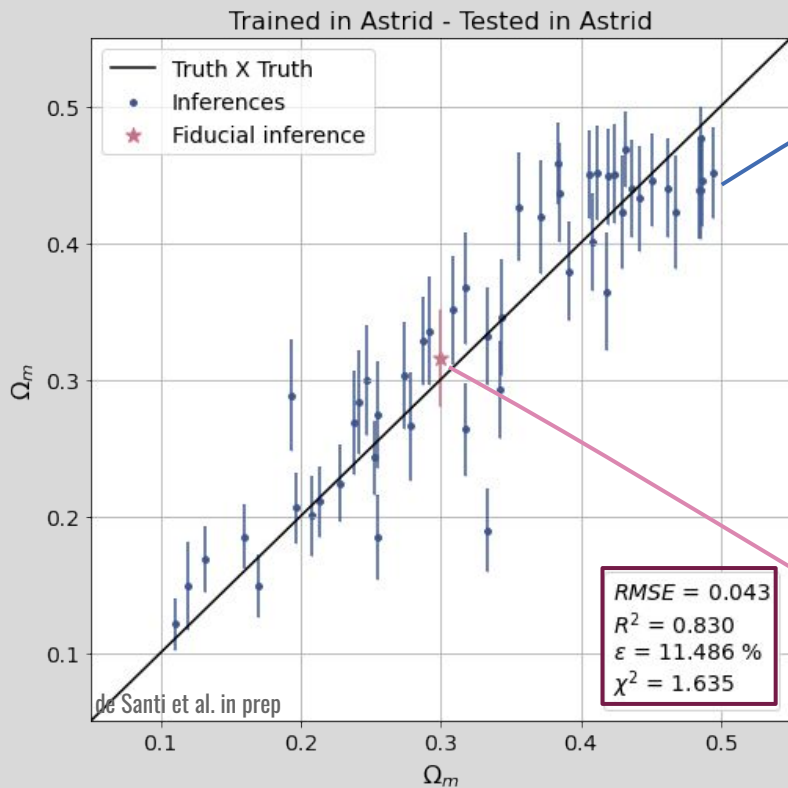
# The best model

Astrid



Positions  
Velocity in z direction

Sanity check



LH box

CV box

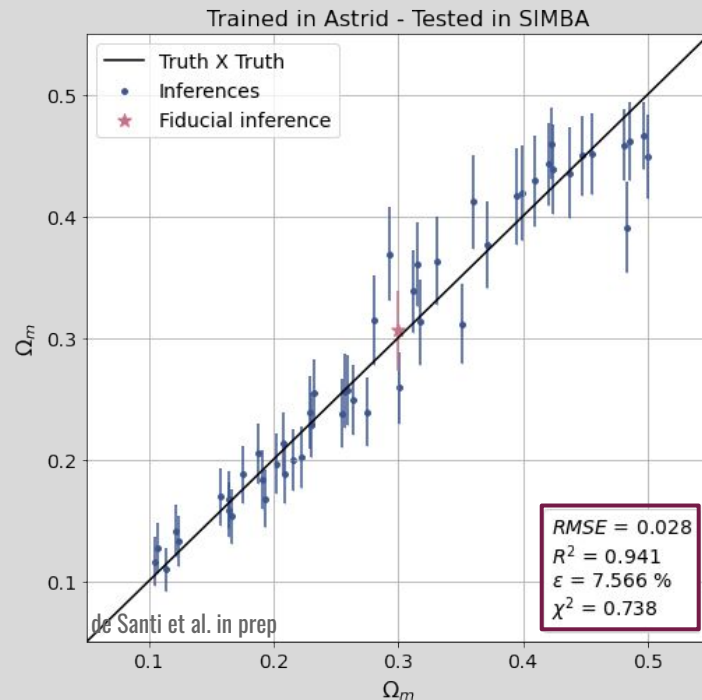
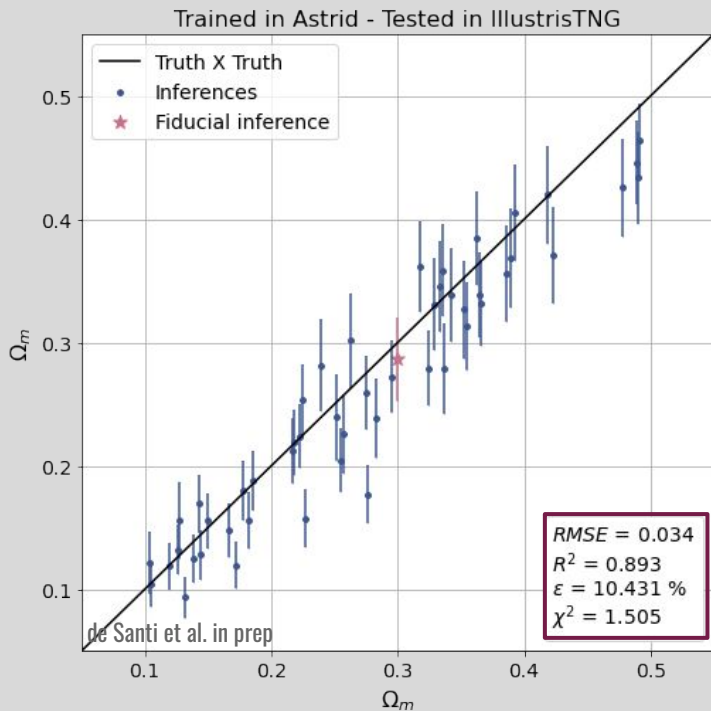
# The best model

Astrid



Positions  
Velocity in z direction

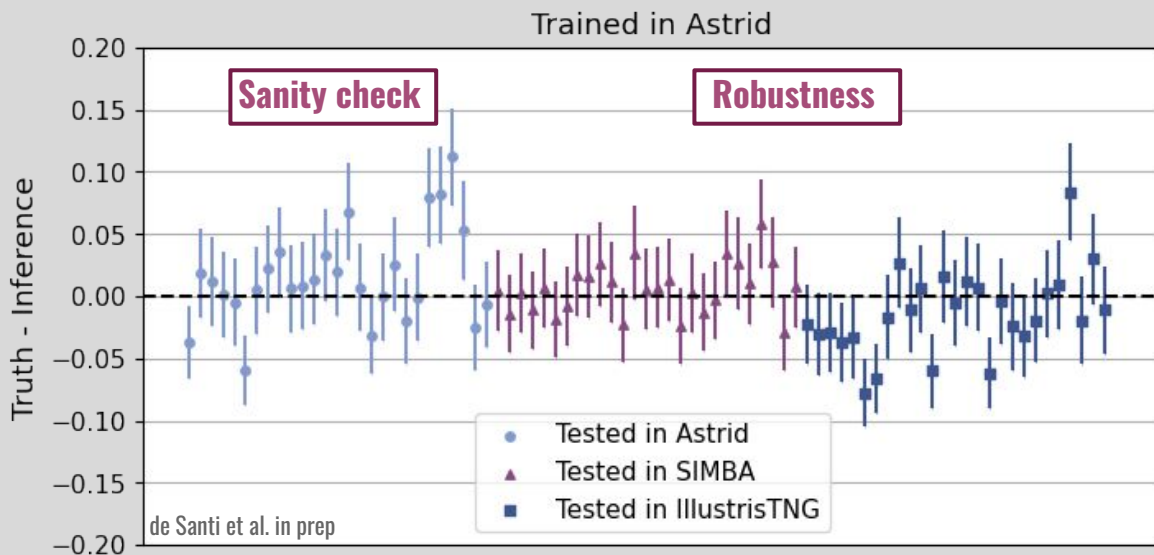
Robustness



# The best model



CV boxes



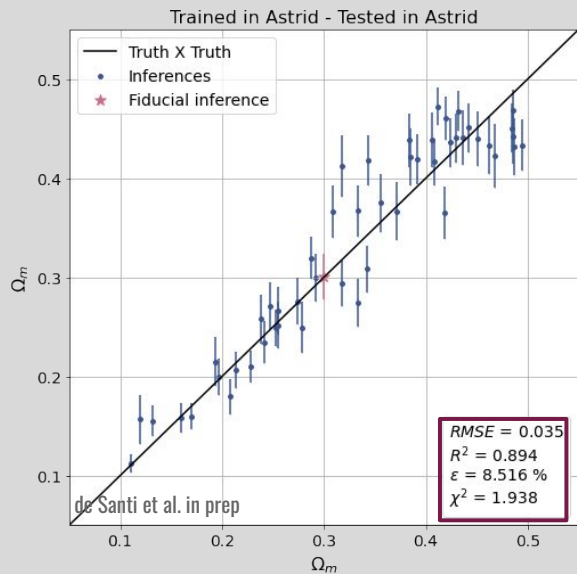
# Trying to improve the predictions

**Astrid**

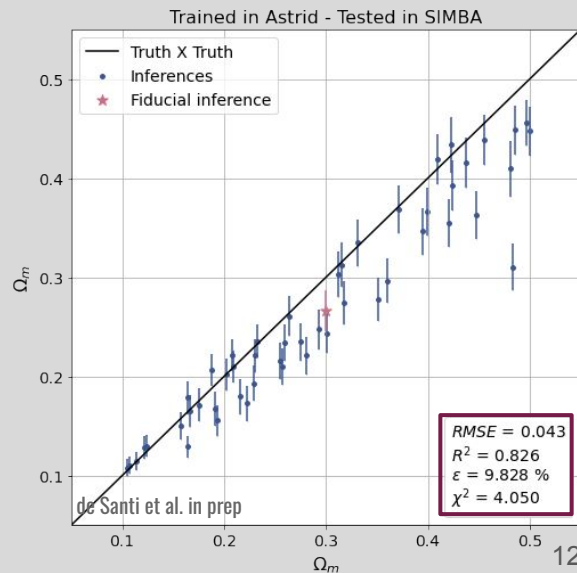
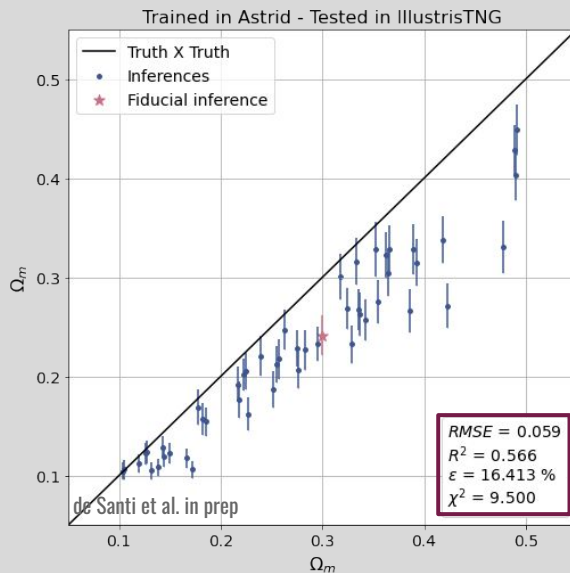


**Positions**  
**Velocity in z direction**  
**Stellar mass**

**Sanity check**



**Robustness**



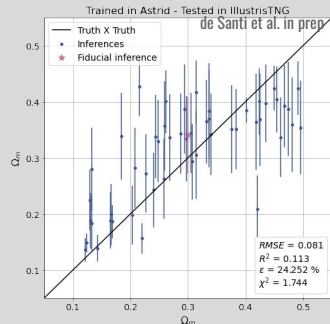
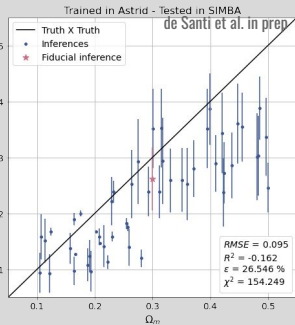
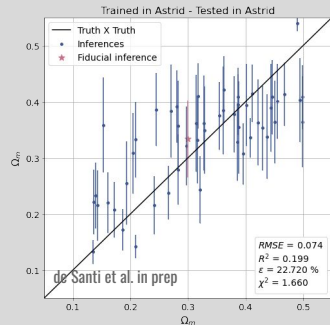
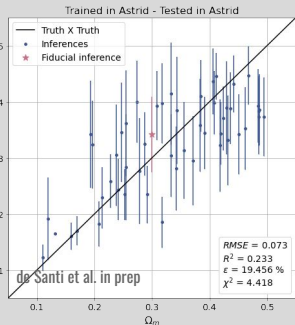
# Where does the information come from?



*We need both!*

**GNN without node information**

**Deep Set**



**Sanity check**

**Error bars increased**

**Robustness**

**Breaks down**

## Takeaway messages

- Galaxy field-level likelihood-free inference  $\Rightarrow$  a brand new way to do Cosmology;
- The model is **fast**, **accurate** and **robust**  $\Rightarrow$  good predictions in different hydrodynamical simulations;
- Information is coming from:
  - **galaxy positions** and **velocities**;
  - **small scales**;
- Possibility to apply this kind of model in **real observations**.

*Thank you for your attention!*