



UNIVERSITAT DE
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Building the largest sample of open cluster masses with Gaia DR3



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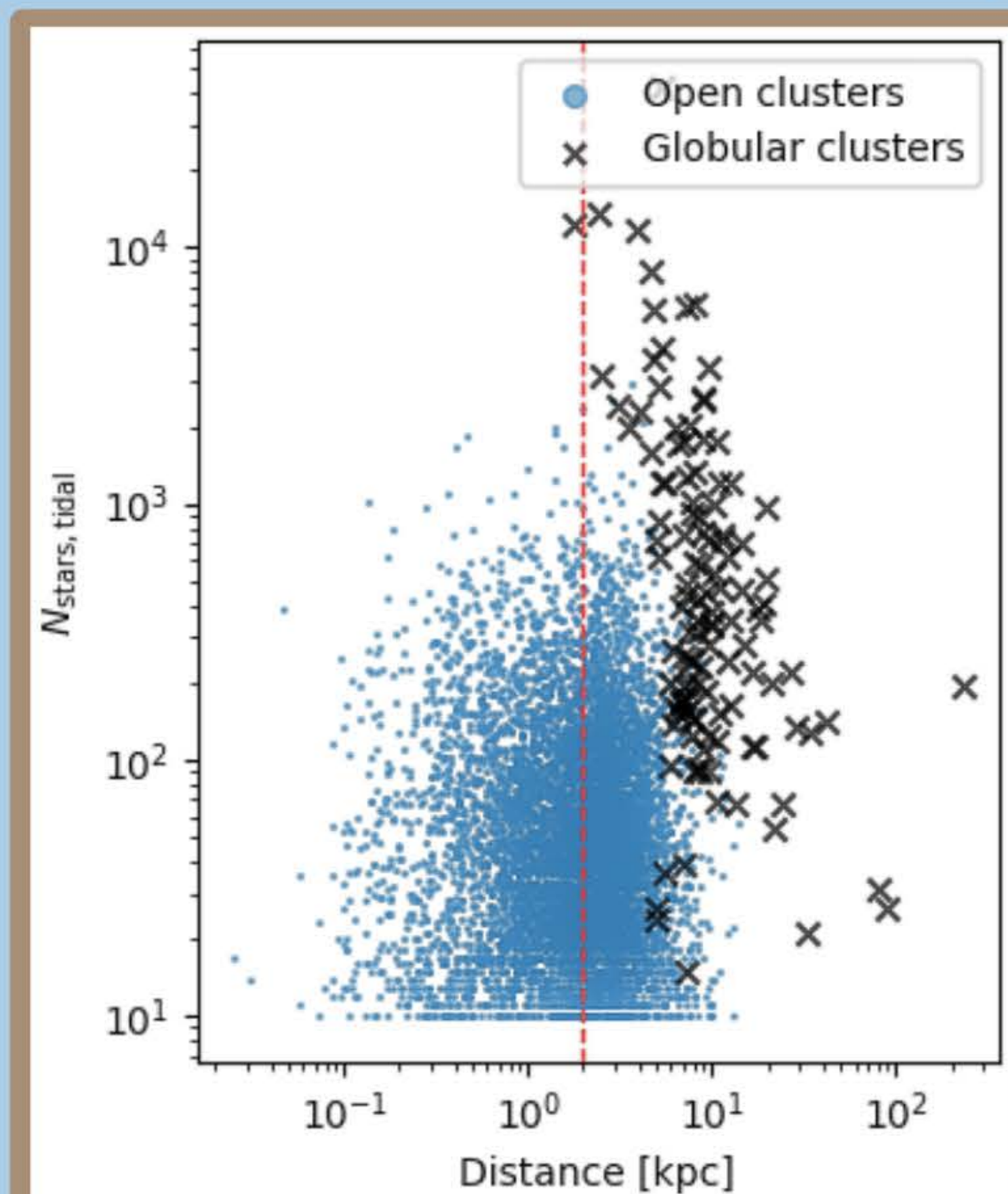
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1. Introduction

- **Open clusters (OCs)**
 - Gravitationally bound star clusters whose stars share traits due to their common origins from the same molecular cloud
 - Vital for studying star formation, evolution, and the Galaxy's structure
- **ESA's Gaia mission**
 - Advancing our understanding of OCs by providing data with unprecedented accuracy
- **This research**
 - Build the largest collection of estimated OC tidal masses to date using recent Gaia data by calculating the tidal mass of nearly 3000 OCs

2. Data Description and Preprocessing

- **OC catalogue by Hunt and Reffert (2023)**
 - Based on the latest Gaia data
- **Distance cutoff of 2 kpc**
 - Address potential biases related to distance
 - Ensure representation across a range of OC sizes and magnitudes
 - 2899 OCs remaining
- **Adjust CMD data for extinction**
 - Gaia DR3 extinction law
- **Select the main sequence**
- **Calibrate ages**
 - Bias in the age estimates in the Hunt and Reffert catalogue for OCs older than 2 Gyr due to blue stragglers
 - Calibrate using Cantat-Gaudin et al. (2020) dataset



3. Mass Estimation Methodology

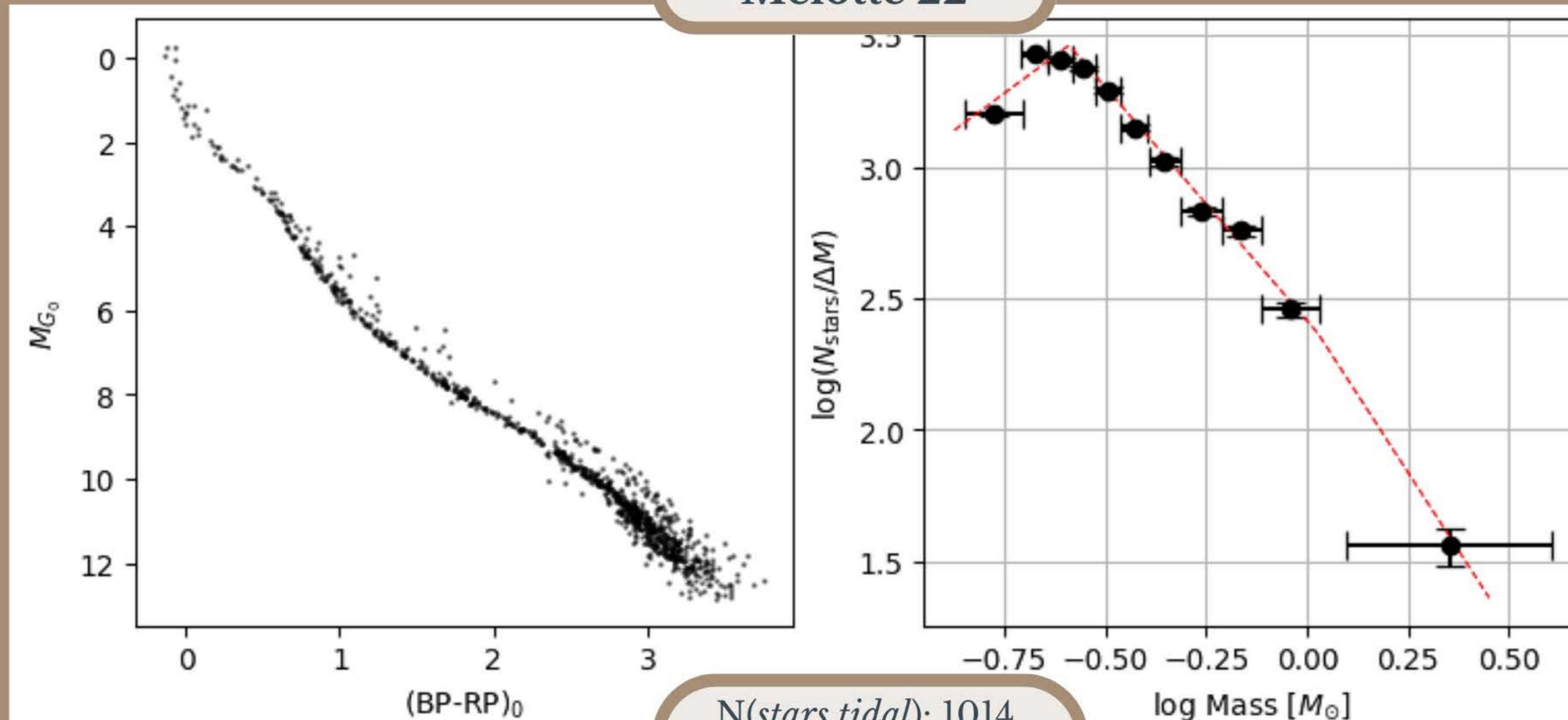
For OCs with 100 stars or more

- **753 OCs**
- **Convert stellar magnitudes to masses**
 - Magnitude-mass relation from PARSEC isochrones
- **Build a mass function (MF) histogram and fit it with a log broken power law**
 - OCs within 500 pc: power law with two breaks,
 - OCs farther than 500 pc: power law with a single break
- **Estimate tidal mass**
 - Integrate under the curve, also accounting for white dwarf masses.
- **Mass uncertainty**
 - Repeat the above process with varying bin sizes to create different histogram versions and fit them with a log broken power law

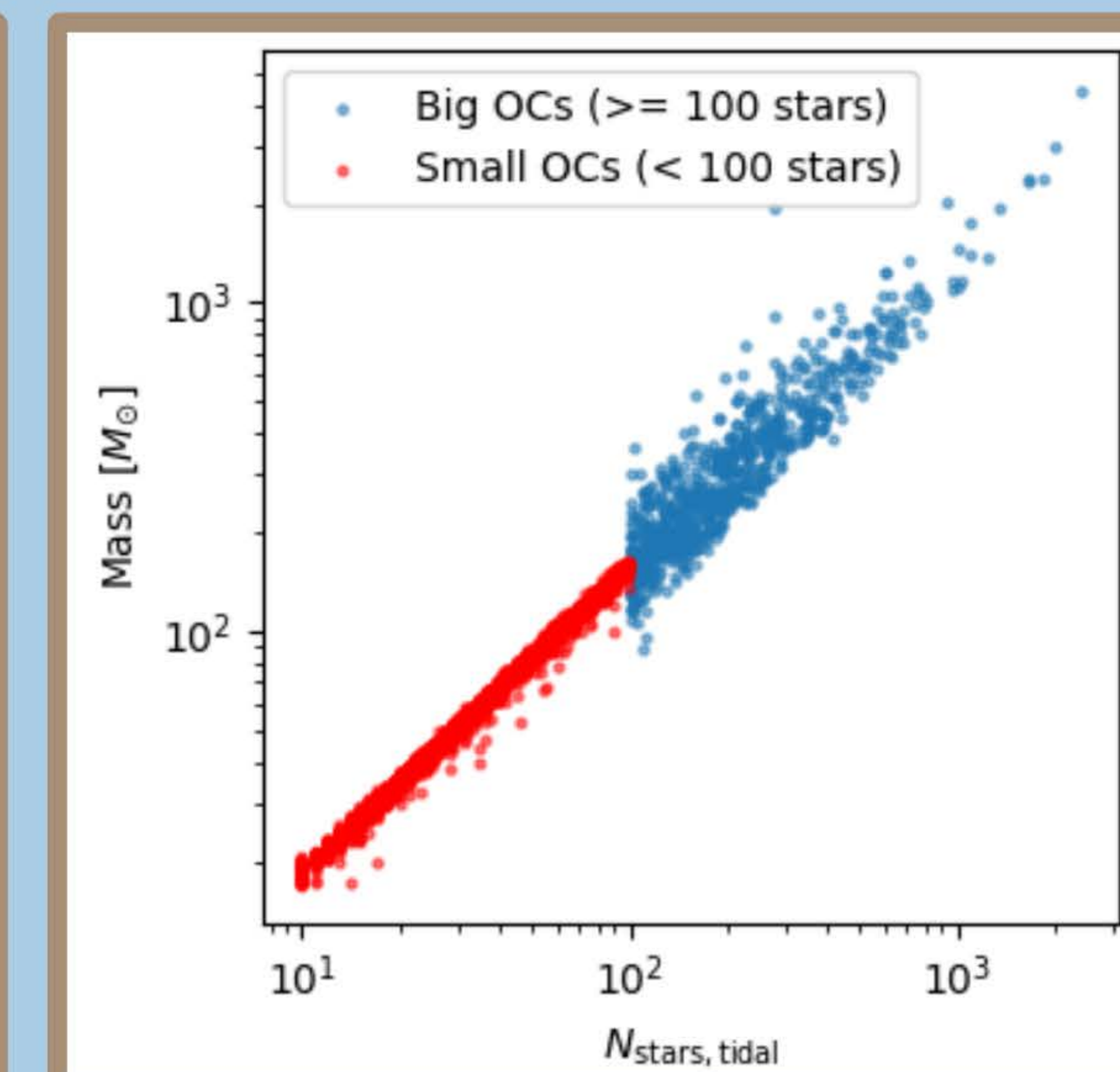
For OCs with less than 100 stars

- **2143 OCs**
- **Cannot construct a meaningful MF to estimate the mass.**
 - Insufficient number of stars
- **Use machine learning to estimate masses**
 - Bayesian ridge regression model
 - Trained on 753 OCs with estimated masses
 - **Features:** OC parameters such as the number of stars within the tidal radius of the OC and the OC radius
 - **Target:** Tidal mass

Melotte 22



$N(\text{stars}, \text{tidal}): 1014$
 $\text{Mass}: 1120 \pm 25 M_{\odot}$





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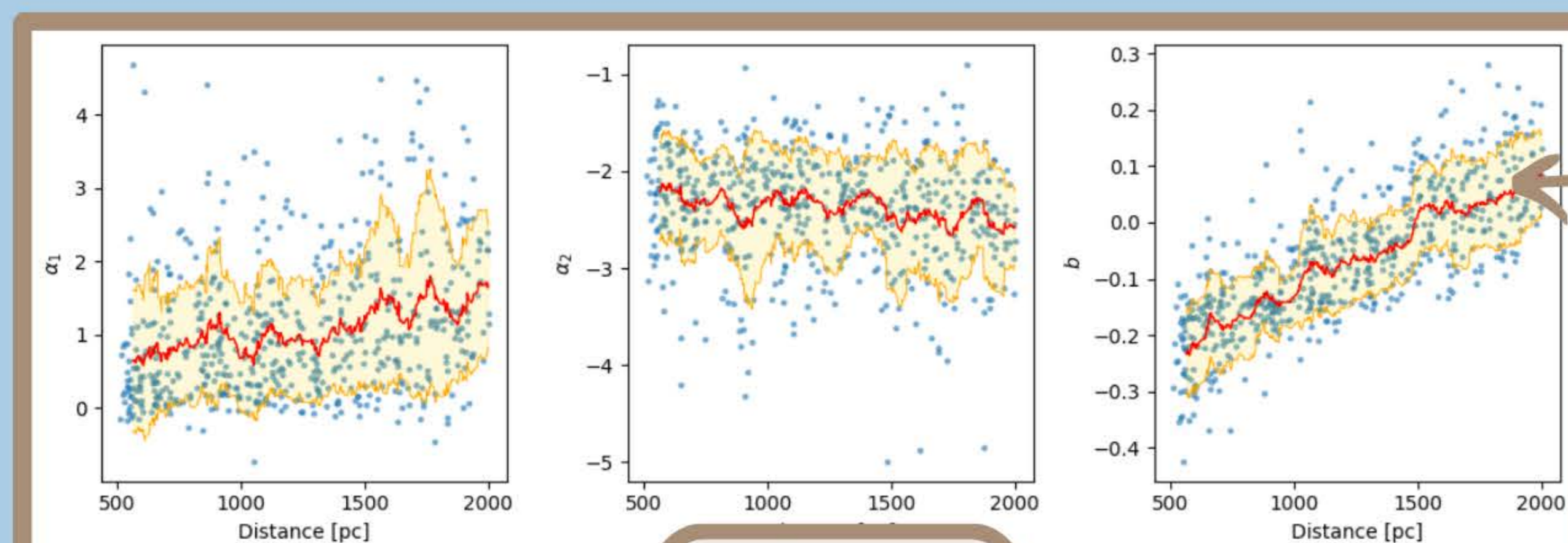
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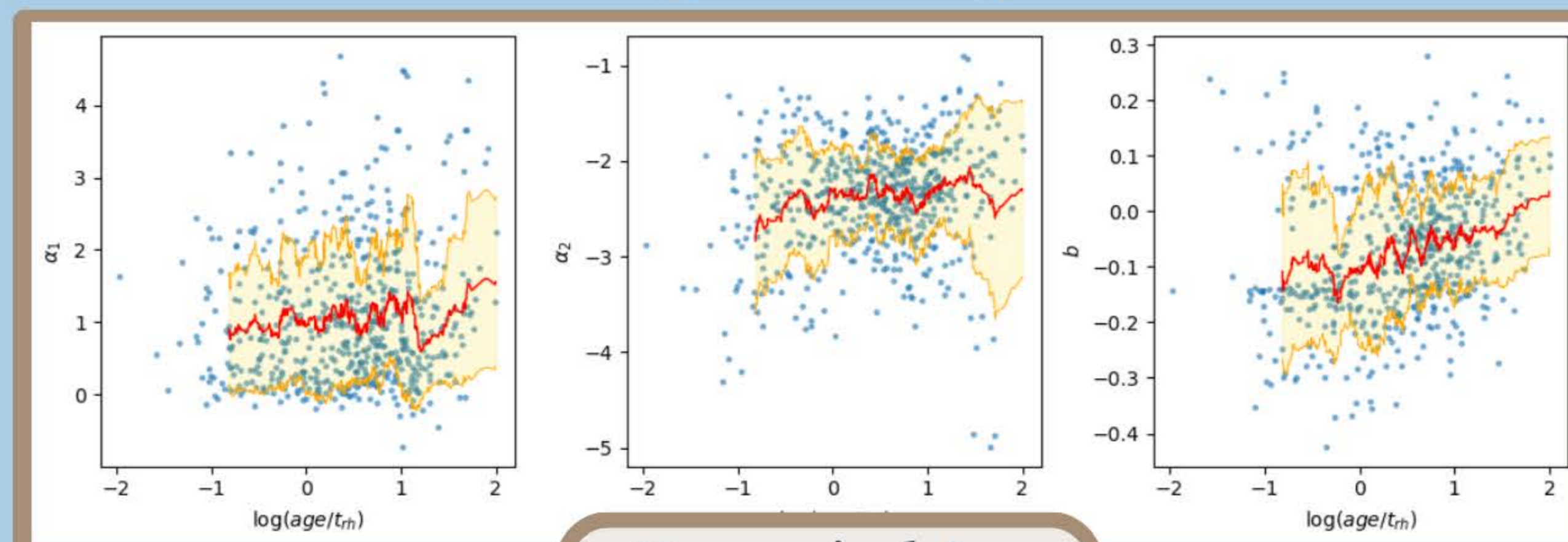
4. Results and Analysis

Trends in the MF parameters

α_1 0.9 ± 0.9 α_2 -2.3 ± 0.6 b -0.08 ± 0.1

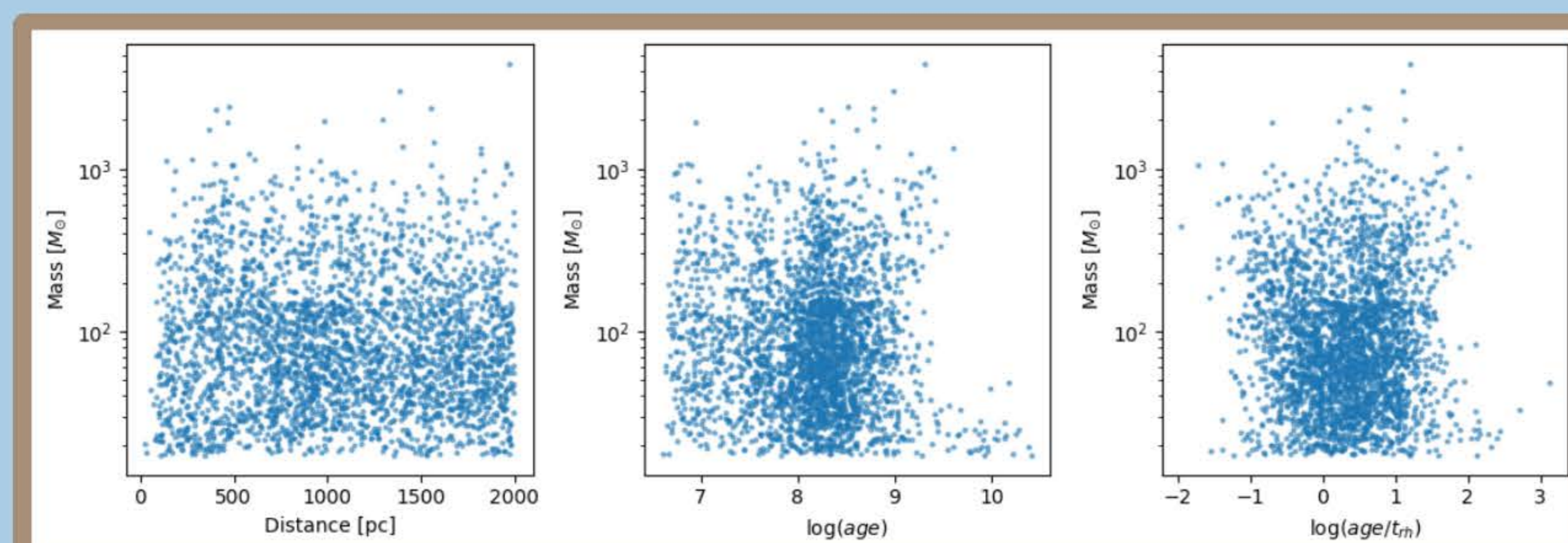


Distance



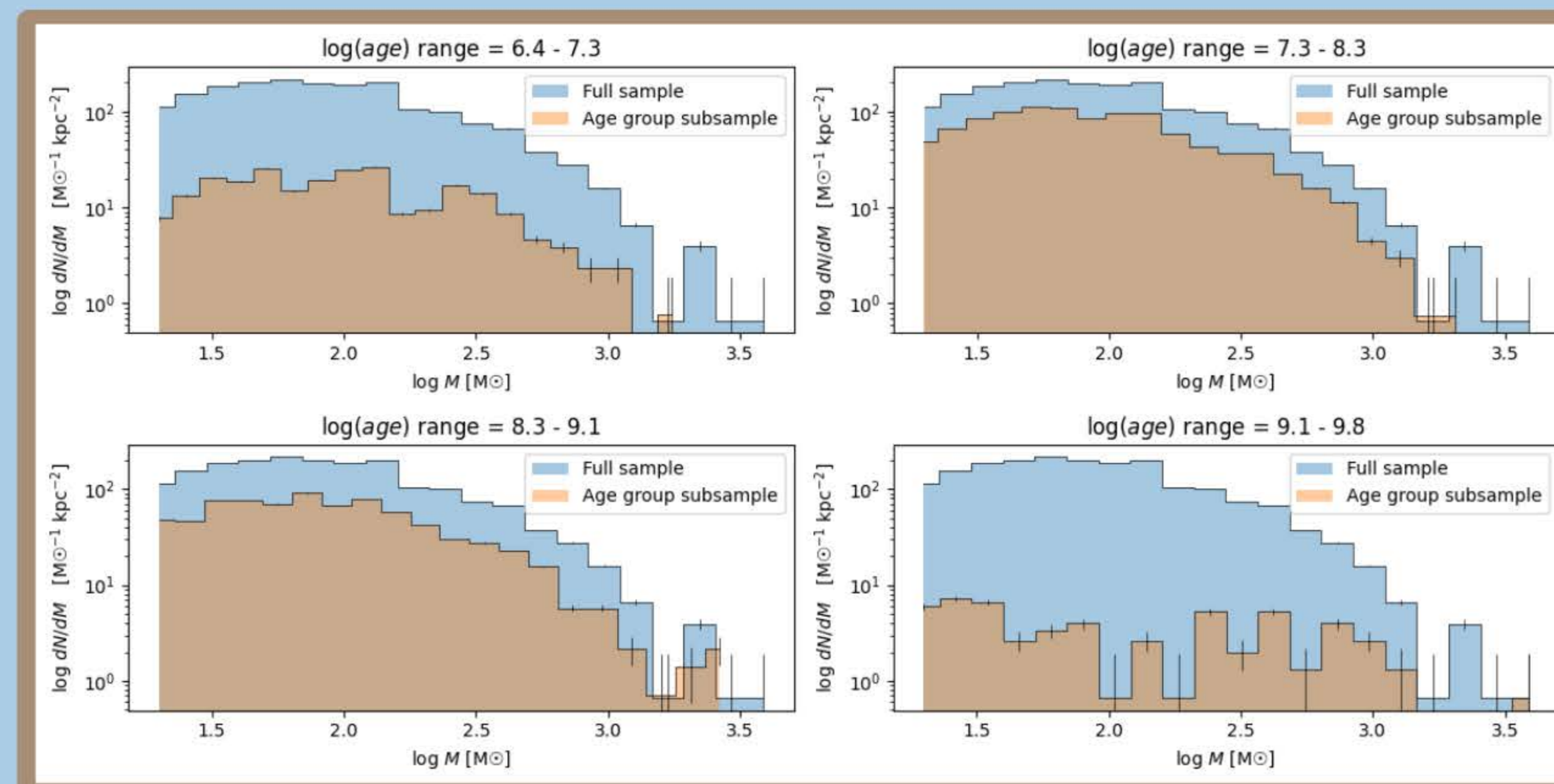
Dynamical Age

The mass - age relationship I

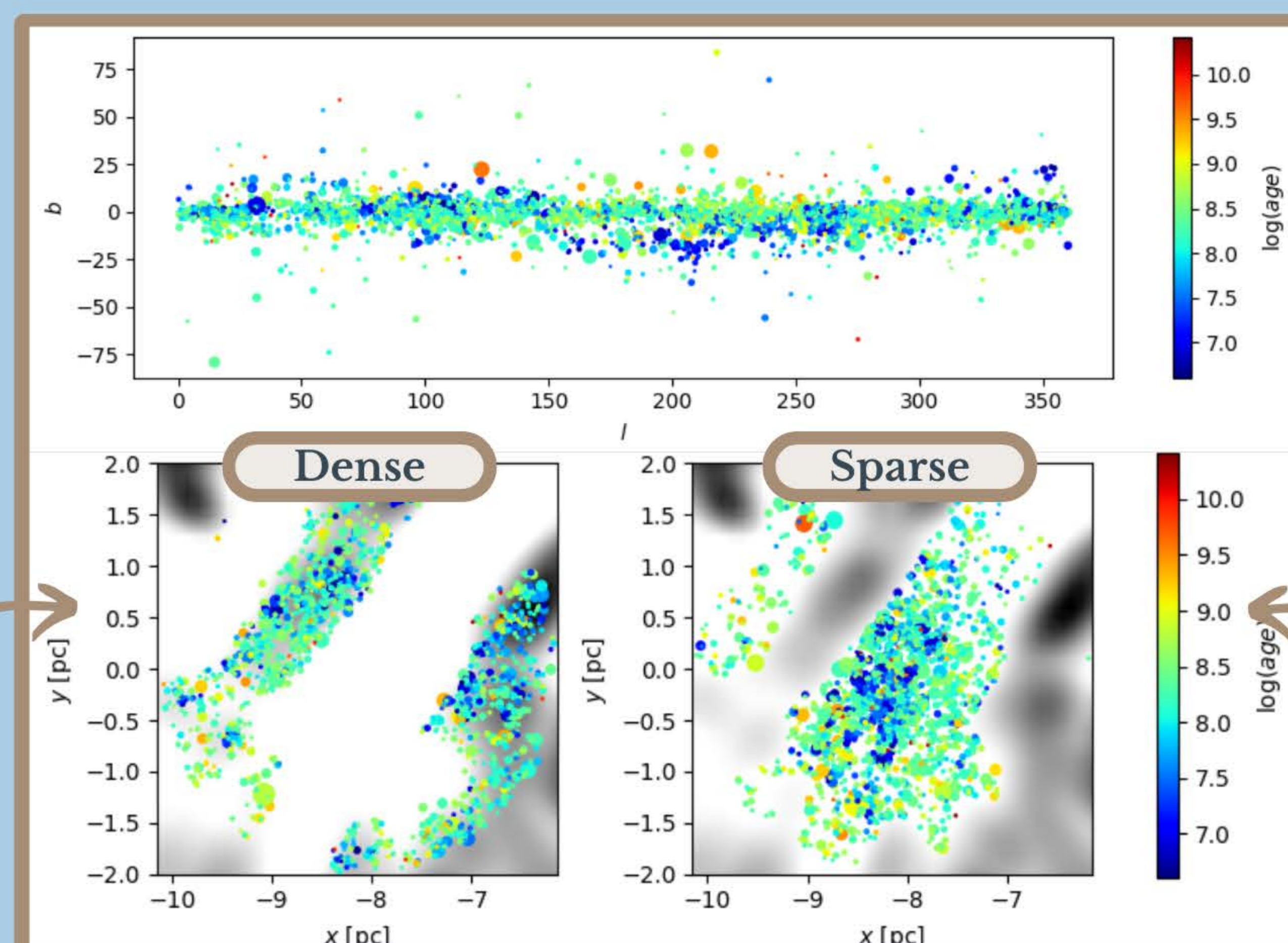


Mean mass:
154 M \odot
Median age:
0.17 Gyr

The mass - age relationship II

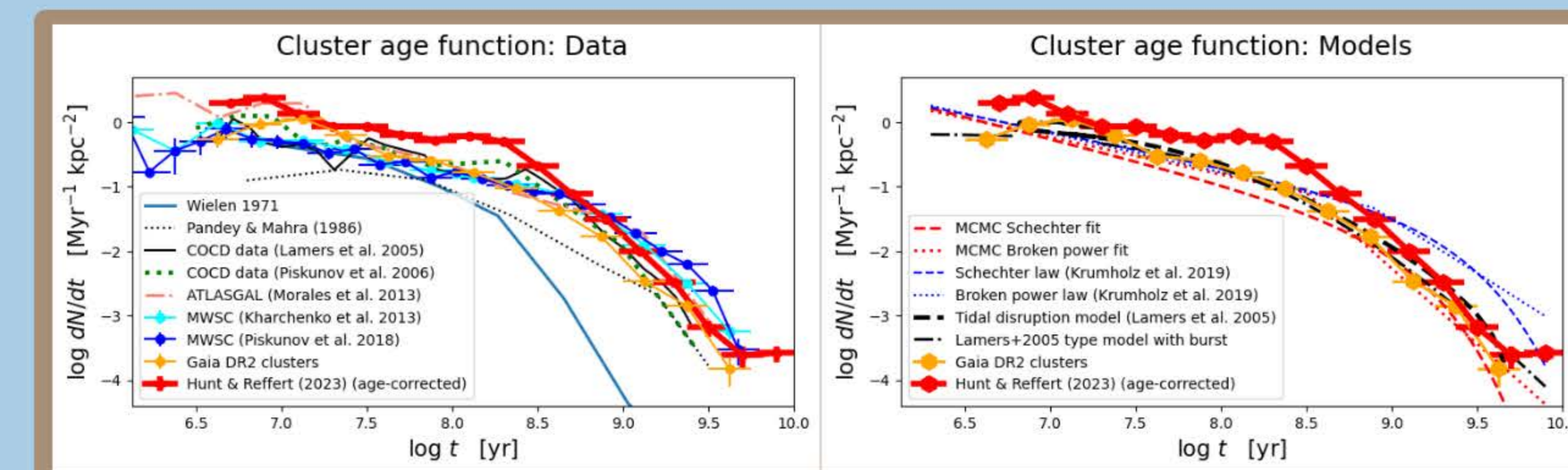


Spatial distribution

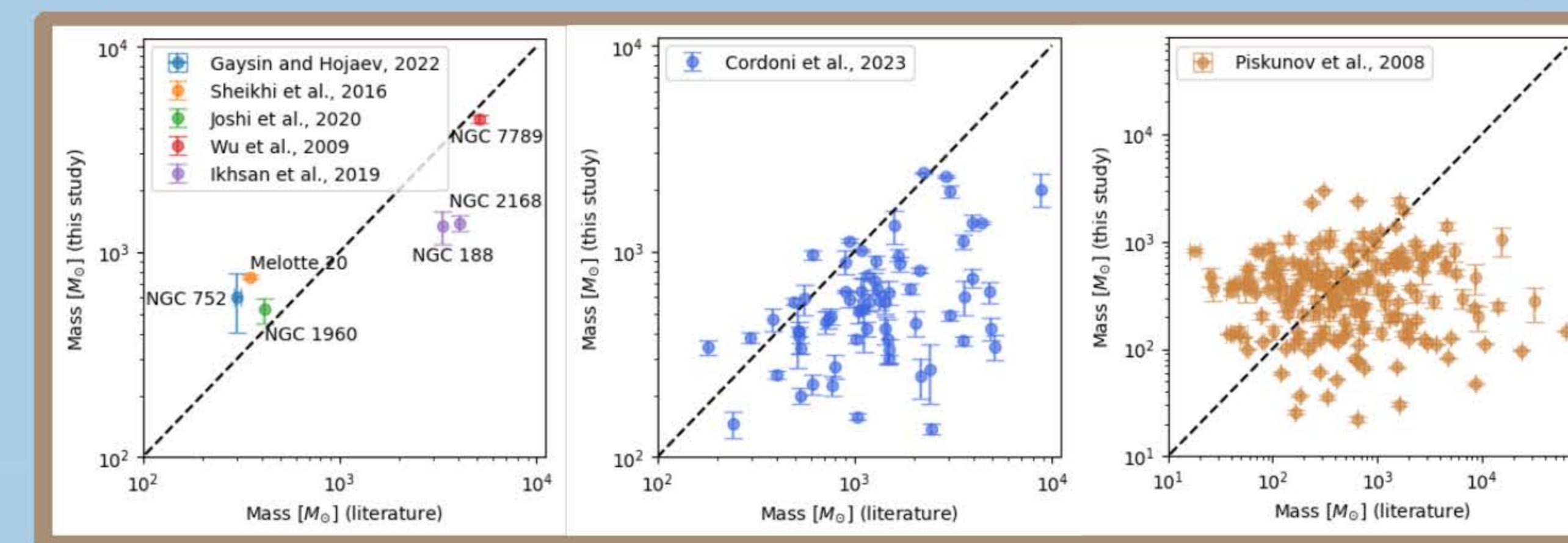


Mean mass:
130 M \odot
Median age:
0.15 Gyr

Cluster age function



Comparison with literature



5. Future Work

- Incorporate completeness-corrected Gaia data
- Consider the binary fraction of stars in the cluster
- Account for other stellar remnants
 - Black holes and neutron stars
- Employ a more complex function to fit the MF
 - Chabrier (2003) study
- Implement OC disruption models
 - Lamers model (Lamers et al., 2005)
 - Gieles model (Gieles et al., 2006)