HUNTING FOR GLOBULAR CLUSTERS IN THE EARLY UNIVERSE

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TMOCS
Theoretical Modeling of Cosmic Structures

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BACKGROUND AND MOTIVATION

MOTIVATION

Globular clusters (GCs) are among the most ancient gravitationally bound star clusters and can be found around any type of galaxy from dwarf to elliptical. Understanding GC formation and evolution can aid in constraining galaxy formation models.

OUTLINE

We explore a suite of high-resolution cosmological simulations at high redshift to investigate theoretical scenarios concerning the formation of old, low-mass stellar systems with a particular focus on GCs

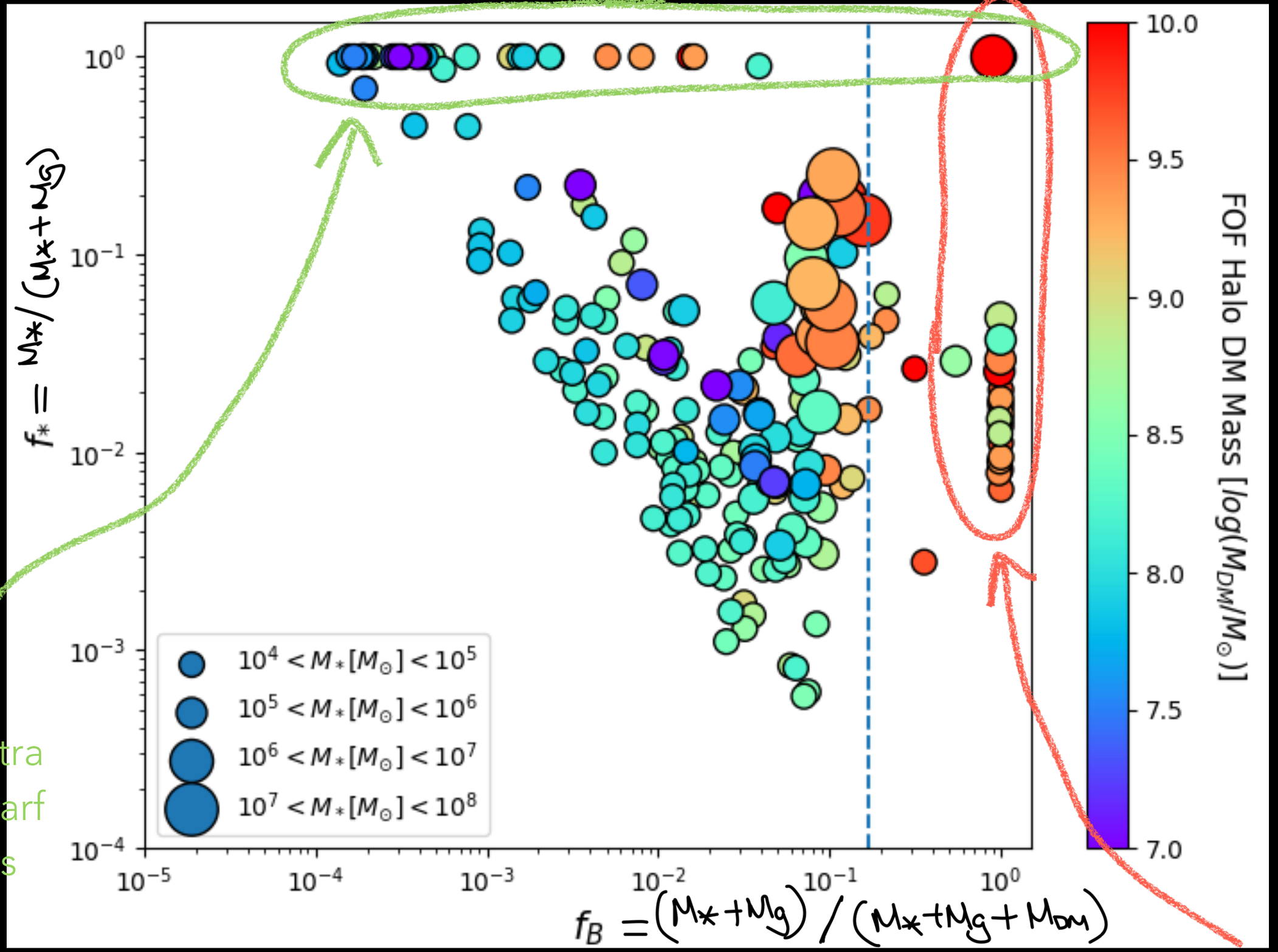
OUR NUMERICAL SET-UP

In this work, a simulated box of volume (4 cMpc)^3 with 684^3 particles per type was used. The mass resolution for particles is: 1250 $M_\odot$ and 6160 $M_\odot$ for SPH and dark matter particles respectively.

FIBY SIMULATIONS

The First Billion Years (FiBY) project is a set of high-resolution, physics rich, cosmological SPH simulations. The simulations track metal pollution for 9 elements and include prescriptions for SN feedback and formation of both Pop II and III stars

IDENTIFYING CANDIDATES

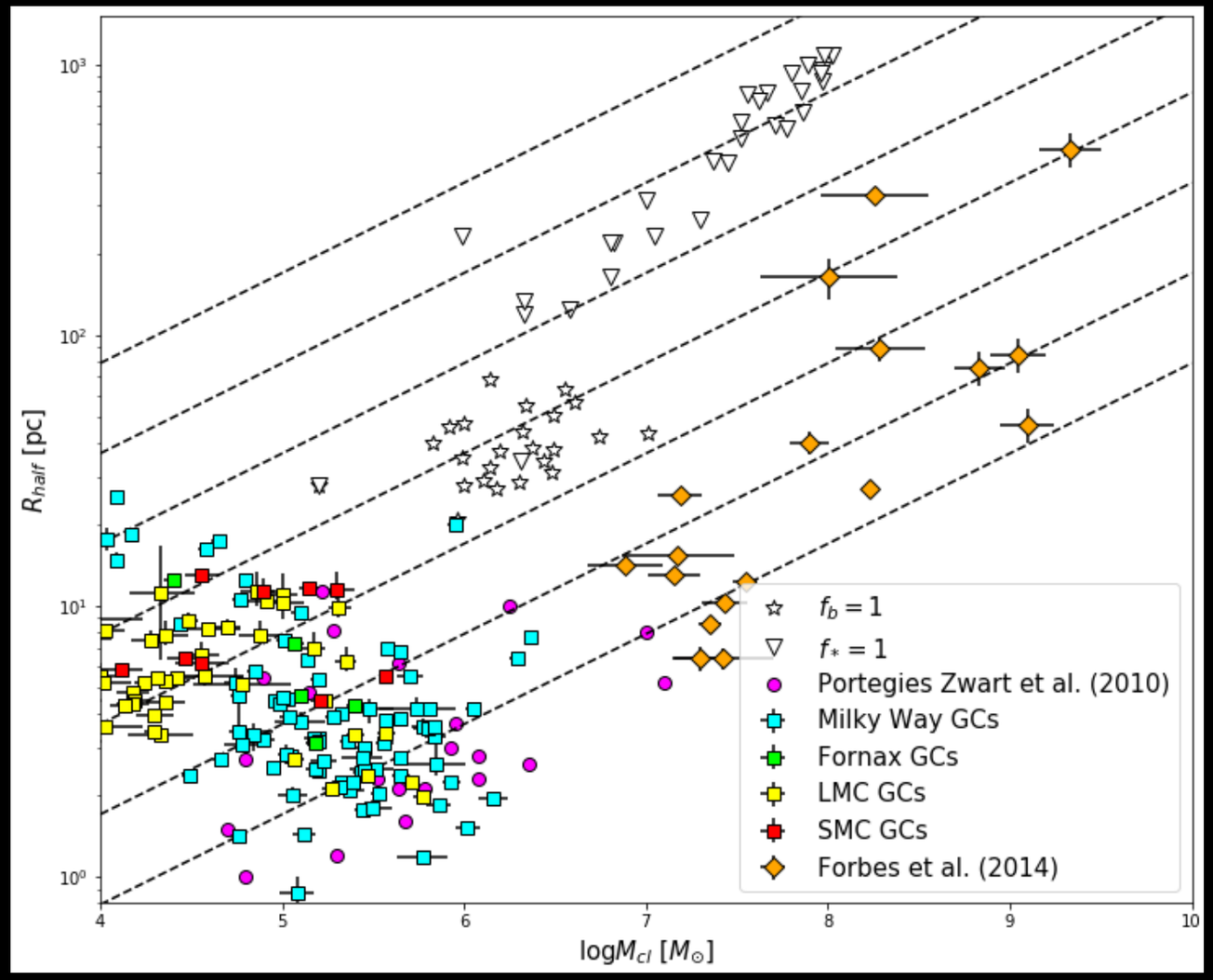


Proto ultra faint dwarf objects

Infant GC candidates

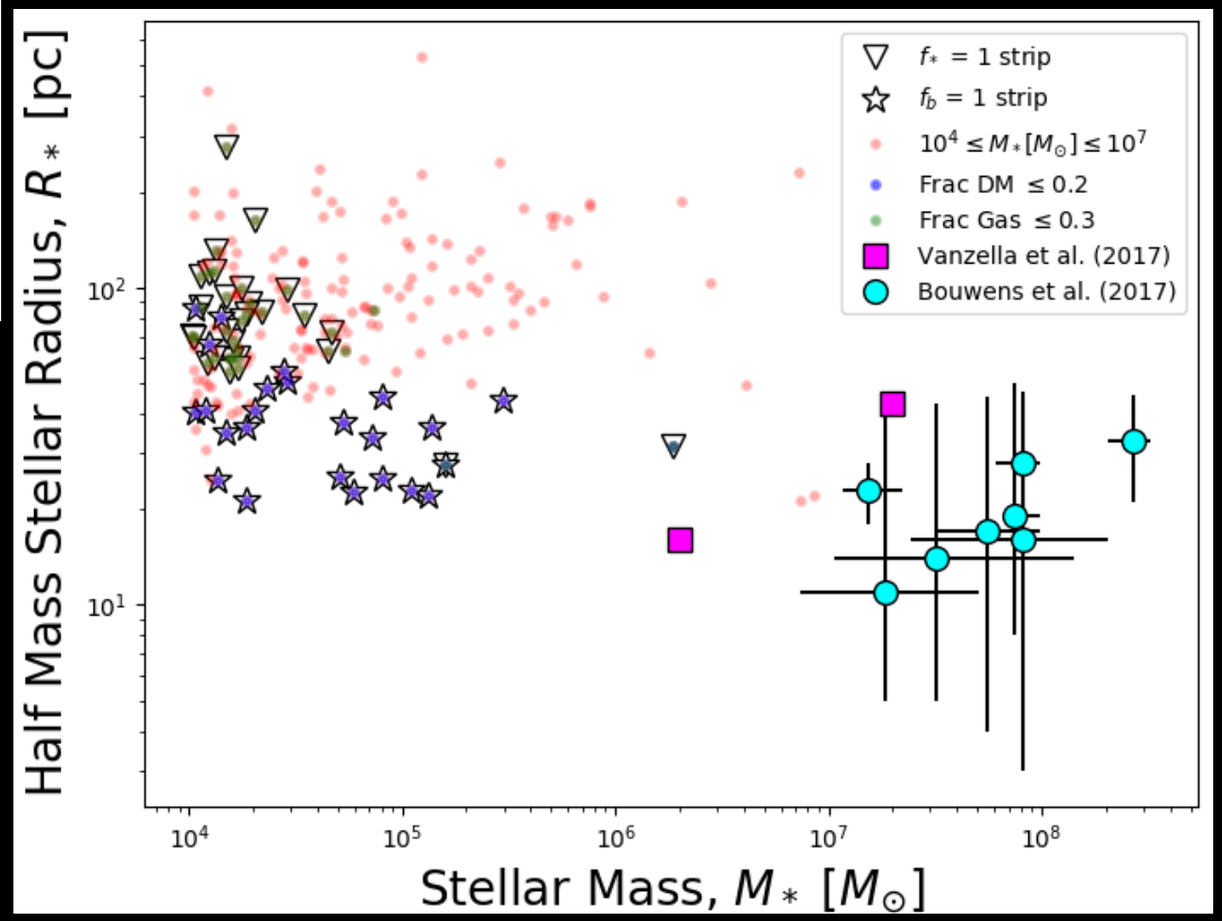
Phipps et al. (2020) | A&A, vol. 641, id. A132 | arXiv:1910.09924

GLOBAL PROPERTIES OF CANDIDATES



Left: Comparison to local Universe data for GCs, young massive clusters and ultra-compact dwarfs.

Below: Comparison to preliminary high redshift observations of proto-GCs



Also investigated stellar density, velocity dispersions and metallicity of infant GCs as well as number density of candidates

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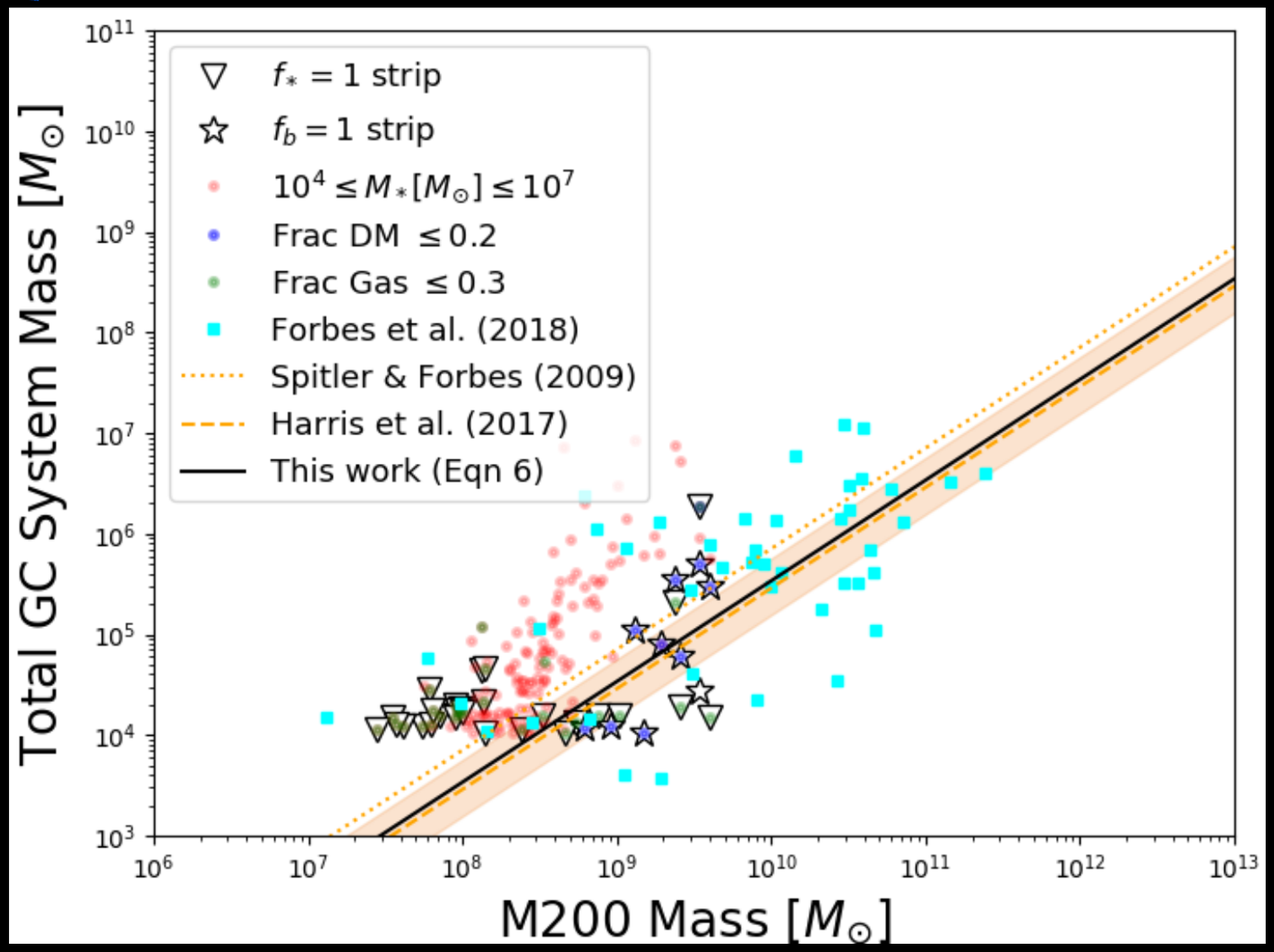
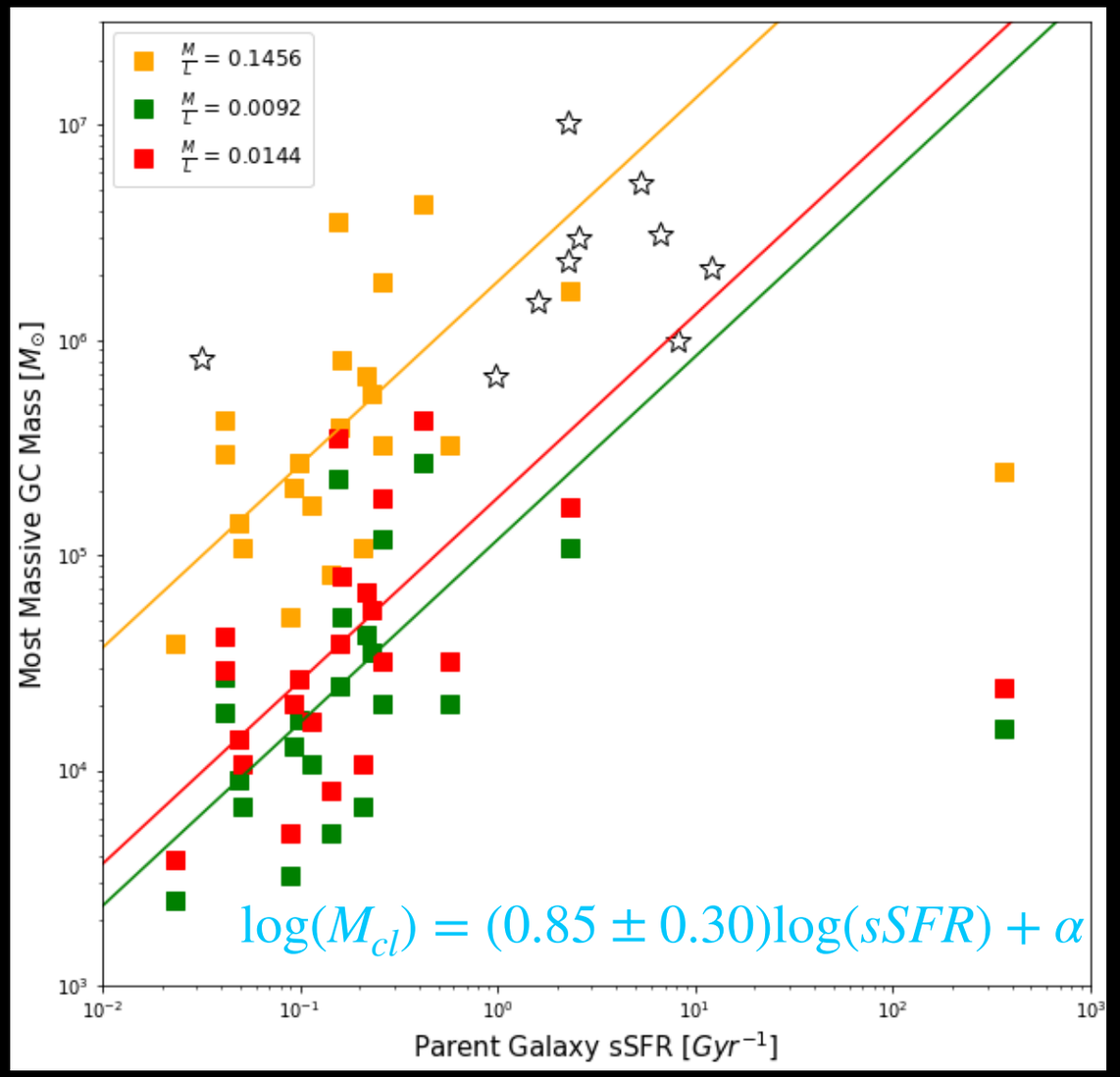
HIGH AND LOW REDSHIFT RELATIONS

Right: most massive GC in a system versus host galaxy sSFR

Below: GC system mass versus host halo mass

For the simulated data and a selection of local Universe observations



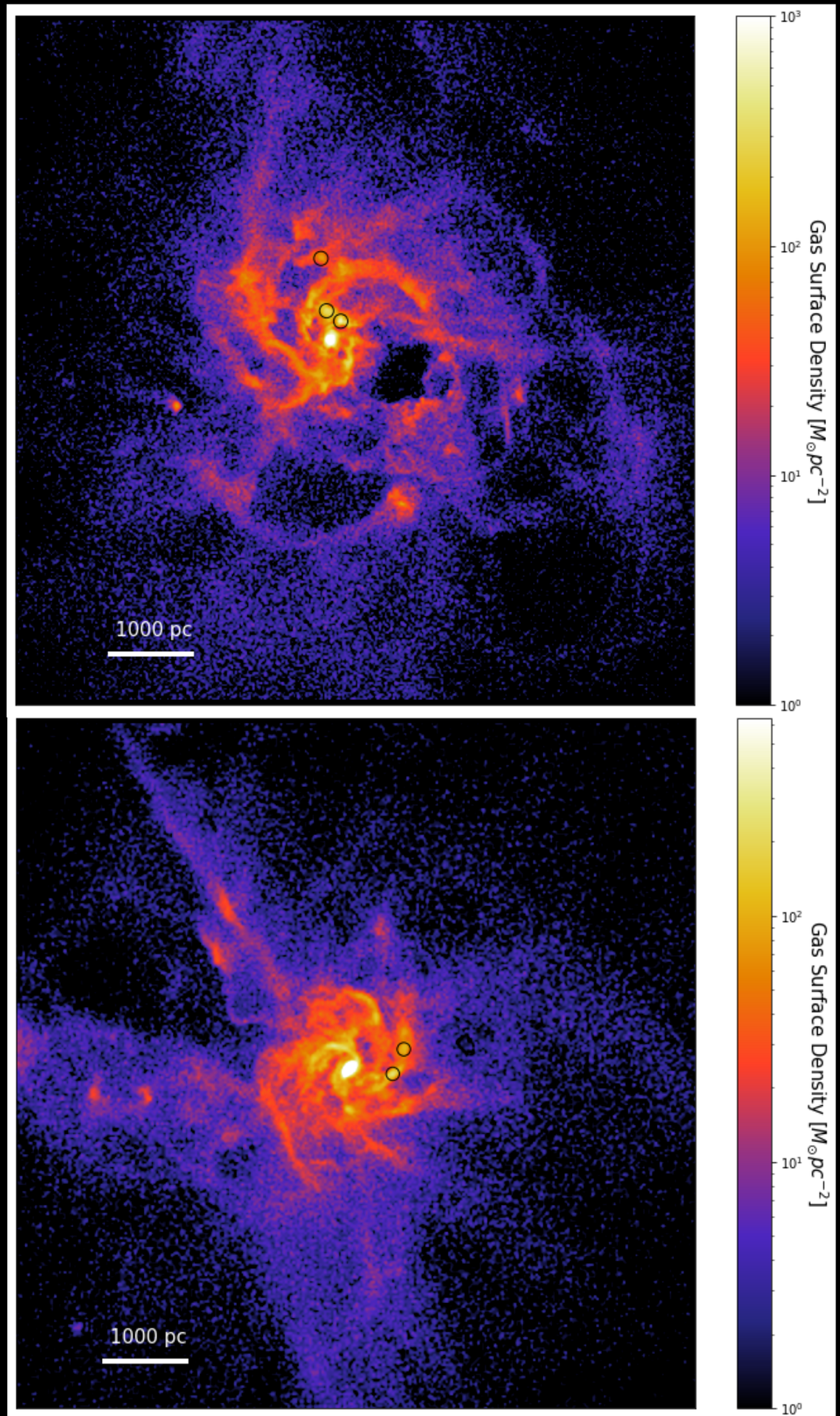


Low redshift relations that hold at z=6 imply that such relations are set during the formation process

Phipps et al. (2020) | A&A, vol. 641, id. A132 | arXiv:1910.09924

THINGS TO LOOK FORWARD TO

We are now studying the detailed formation processes of our infant GC candidates at earlier redshifts. Thanks to the high resolution and large volume of the FiBY simulations, we are exploring the detailed physical properties of stellar systems on the small-scale, whilst still preserving a realistic cosmological context. Expect to see our paper on this analysis soon!



CONCLUSIONS AND OPEN QUESTIONS

- We identified a group of objects in the FiBY simulations that are likely infant GC candidates
- Their properties are similar to those of the local Universe GCs although they have much more gas
- The redshift-zero GC system mass - halo mass relation fits well to the z=6 simulated data
- We presented a novel relation between the sSFR of galaxies and their most massive GC which holds across redshift

Q: What happens to the gas over the next 12 billion years?

Q: What is the formation channel of GCs and how is it linked to the formation of the host galaxy?

Q: What is the physical origin of this relation?

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