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The Globular Cluster System of the Auriga Simulations

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ABSTRACT
We investigate whether the galaxy formation model used for the Auriga simulations can produce a realistic globular cluster population at redshift zero. We compare properties of the simulated star particles in the Auriga haloes with catalogues of observations of the Milky Way globular cluster population available in the literature. We find that the Auriga simulations produce sufficient mass at radii and metallicities that are typical for the MW GCS, although we observe a varying mass-excess for the different $R_{\rm GC}$-[Fe/H] bins. This implies different values for the combined product of the bound cluster formation efficiency and the globular cluster disruption rate. We investigate wether these differences could result from formation insitu vs. accreted star particles. We find ...

Key words: methods: numerical – galaxies: formation – galaxies: star clusters: general.

1 INTRODUCTION

1.1 GC form under special circumstances in high-z Universe

Renaud et al. (2017)
GCs are among the oldest astrophysical objects. They form in the early Universe in highest density peaks (e.g. Diemand et al. 2005; Boley et al. 2009)

Diemand et al. (2005)
The radial profile of the stellar halo and metal-poor globular clusters of the Milky Way suggest that these components formed in rare early peaks above 2.5σ at redshift above 10.

Diemand et al. (2005)
The clustering properties of metal-poor globular clusters contain clues on their formation sites and the epoch when star formation was suppressed by feedback processes (e.g. reionization, supernova- driven winds) in low-mass haloes. In the Milky Way metal-poor globular clusters follow the same radial profile as halo stars, sug- gesting within the framework of our model a common origin within early 2.5σ peak progenitors at $z \approx 12$. Observations of the distri- bution of globular clusters within present-day haloes of different masses could provide information on feedback effects as a function of environment (Moore et al. 2005). The suppression of globular cluster formation at some early epoch may also explain the bimodal- ity observed in cluster metallicities (e.g. Strader et al. 2005). The widely used assumption that globular cluster formation is a fair tracer of star formation, combined with the suppression of the for- mation of metal-poor globulars after reionization, imply that the amount of high-σ material in a halo is proportional to the number of metal-poor globular clusters. From the results in Section 3.4 it fol- lows then that a simple universal reionization epoch would lead to a constant abundance of metal-poor globular clusters per virial mass. Deviations from this simplest case may provide information about the local reionization epoch, and whether regions with more (less) metal-poor

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> globulars per virial mass were reionized later (earlier) (see Moore et al. 2005).

1.2 YMC and GC formation governed by same physics; differences due to nearly a Hubble time of evolution

"The widely used assumption that globular cluster formation is a fair tracer of star formation" → disputed?!

1.3 Understand GC formation & evolution → understand MW formation & evolution

This seems to shift the problem from 'why care about GC formation and evolution' to 'why care about MW formation and evolution'. People seems to accept this form of what-about-ism / diversion of focus. Actually, this is expansion of focus so probably people accept this as the bigger picture that we're all after.

> **Renaud et al. (2017)**
> Hence, they witness most of the formation and evolution processes of galaxies, and can be used to probe them (Brodie & Strader 2006)

1.4 Colour bimodality

> **Renaud et al. (2017)**
> colour bimodality, blue and red clusters (e.g. Zinn 1985; Gebhardt & Kissler-Patig 1999; Larsen et al. 2001; Peng et al. 2006)

> **Renaud et al. (2017)**
> blue metal-poor (with distribution peaking at [Fe/H] ≈ -1.5 for the Milky Way), no sign of rotation as a population (..) more metal-rich (peak at [Fe/H] ≈ -0.5 in the Milky Way) more spatially concentrated and rotating with the galaxy. (Harris 1996)

REFERENCES

Boley A. C., Lake G., Read J., Teyssier R., 2009, ApJ, 706, L192
Brodie J. P., Strader J., 2006, ARA&A, 44, 193
Diemand J., Madau P., Moore B., 2005, MNRAS, 364, 367
Gebhardt K., Kissler-Patig M., 1999, AJ, 118, 1526
Harris W. E., 1996, AJ, 112, 1487
Larsen S. S., Brodie J. P., Huchra J. P., Forbes D. A., Grillmair C. J., 2001, AJ, 121, 2974
Peng E. W., et al., 2006, ApJ, 639, 95
Renaud F., Agertz O., Gieles M., 2017, MNRAS, 465, 3622
Zinn R., 1985, ApJ, 293, 424