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GLOBAL CLUSTERS IN MASSIVE GALAXIES

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INTRODUCTION

One current major goal of Astronomy is the understanding of Galaxy Formation. Massive galaxies can aid us in the comprehension of galaxy assembly as they have started forming at the earliest epochs of cosmic history. As such, they have witnessed the earliest major star formation episodes that could have originated globular clusters (GCs). GCs are long lived tracers of galaxy assembly and are ubiquitous and found in large numbers in massive galaxies. In such way, they are key to support our understanding of the formation and evolution of their host galaxies. In this poster, we present Gemini/GMOS (g, i) and HST/WFC3 (J) image processing of four elliptical galaxies from the MASSIVE Survey (Chung-Pei Ma et. al. 2014): NGC5322, NGC5353, NGC5557 and NGC7619.

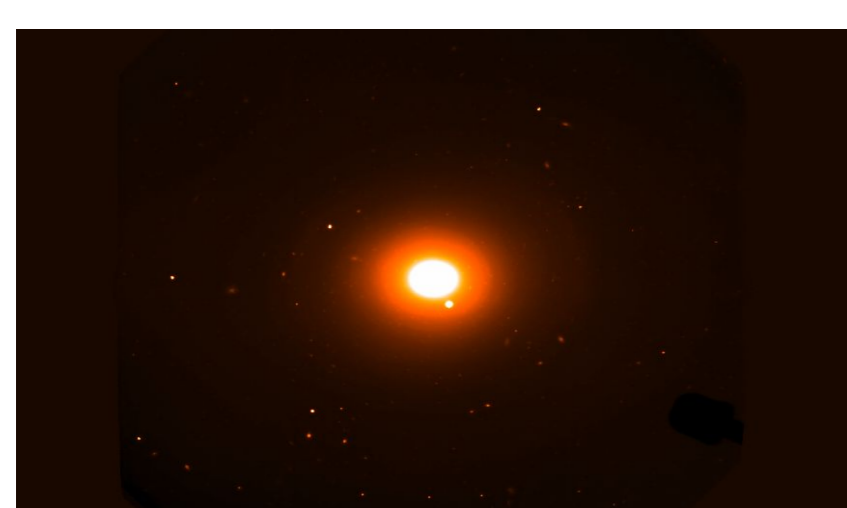
THE MASSIVE SURVEY

MASSIVE [1] is a volume-limited, multi-wavelength, integral-field spectroscopic (IFS) and photometric survey of the structure and dynamics of the ~100 most massive early-type galaxies within a distance of 108 Mpc. Here we have the images of the four galaxies that were studied.

NGC5322: 23.216 Mpc, E3 type



NGC5557: 36.079 Mpc, E1 type



NGC5353: 29.088 Mpc, S0 type



NGC7619: 50.527 Mpc, E1 type



DATA REDUCTION

For data reduction we followed the steps from ast.noao.edu/sites/default/files/GMOS_Cookbook/Processing/index.html#processing-tutorials. To remove the center of the galaxies, we used the tasks *ellipse* and *bmodel* from IRAF.

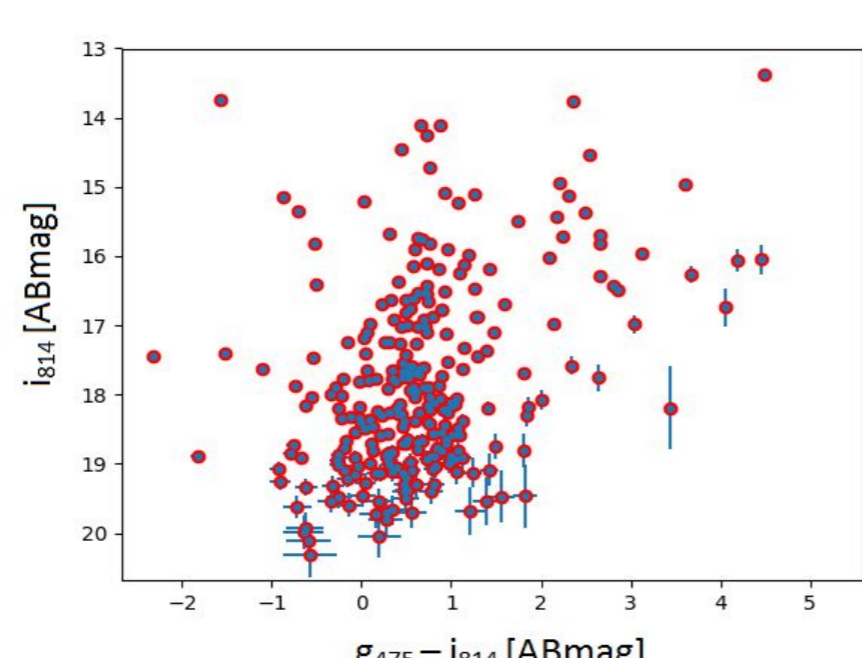
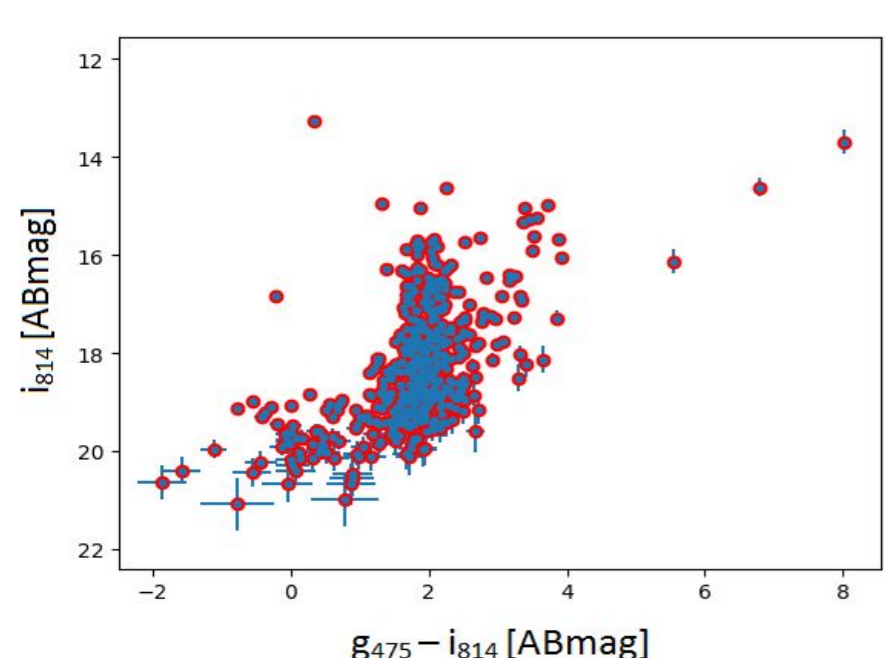
PHOTOMETRY AND CMDs

We have modeled and subtracted the galaxy light and ran SExtractor to do the photometry and detect globular cluster candidates. This software generates a catalogue with information, such as magnitude, error, right ascension, declination, FWHM, etc, of each object in the image. This allows us to make several optical and near-infrared color-magnitude diagrams (CMDs) of the globular clusters found in each image, with g, i and j (data provided by John Blakeslee) bands. The diagrams below show the candidates GC in all four galaxies, in optical ($g_{475} - i_{814}$) and give information on the color-metallicity and mass-metallicity relations of these MASSIVE GC systems.

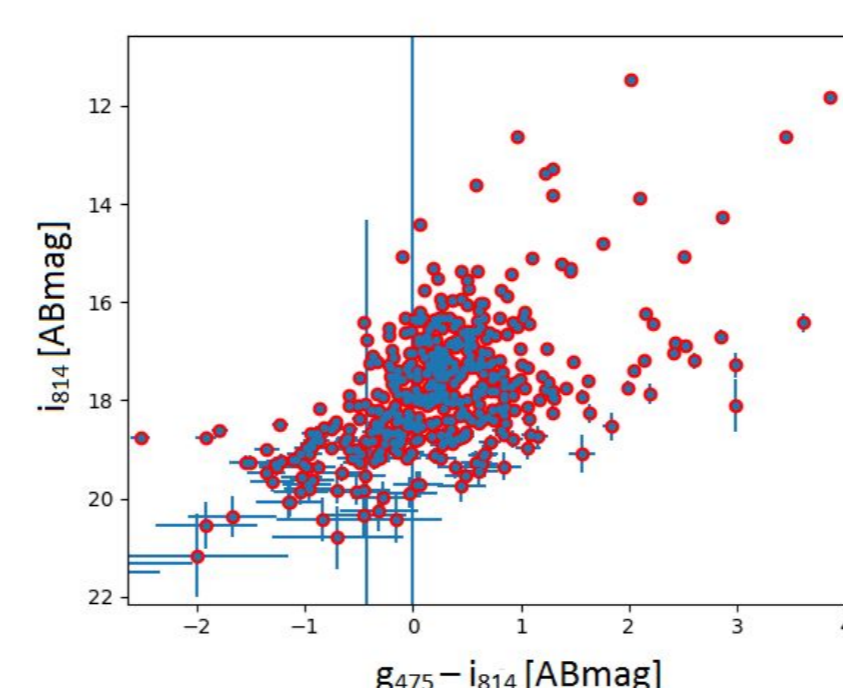
CMD for GC candidates with error bars, ($g_{475} - i_{814}$) versus i_{814}

NGC5322

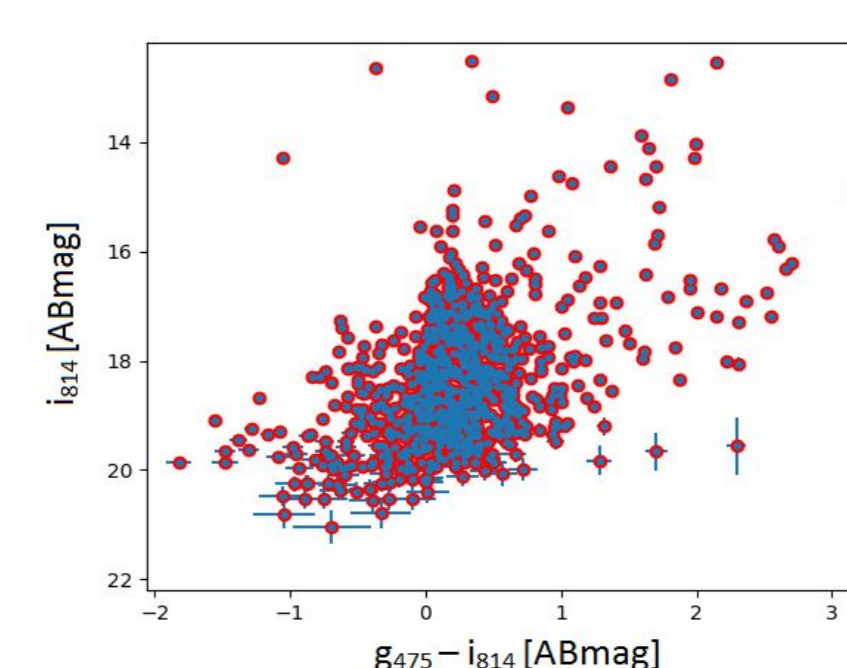
NGC5353



NGC5557

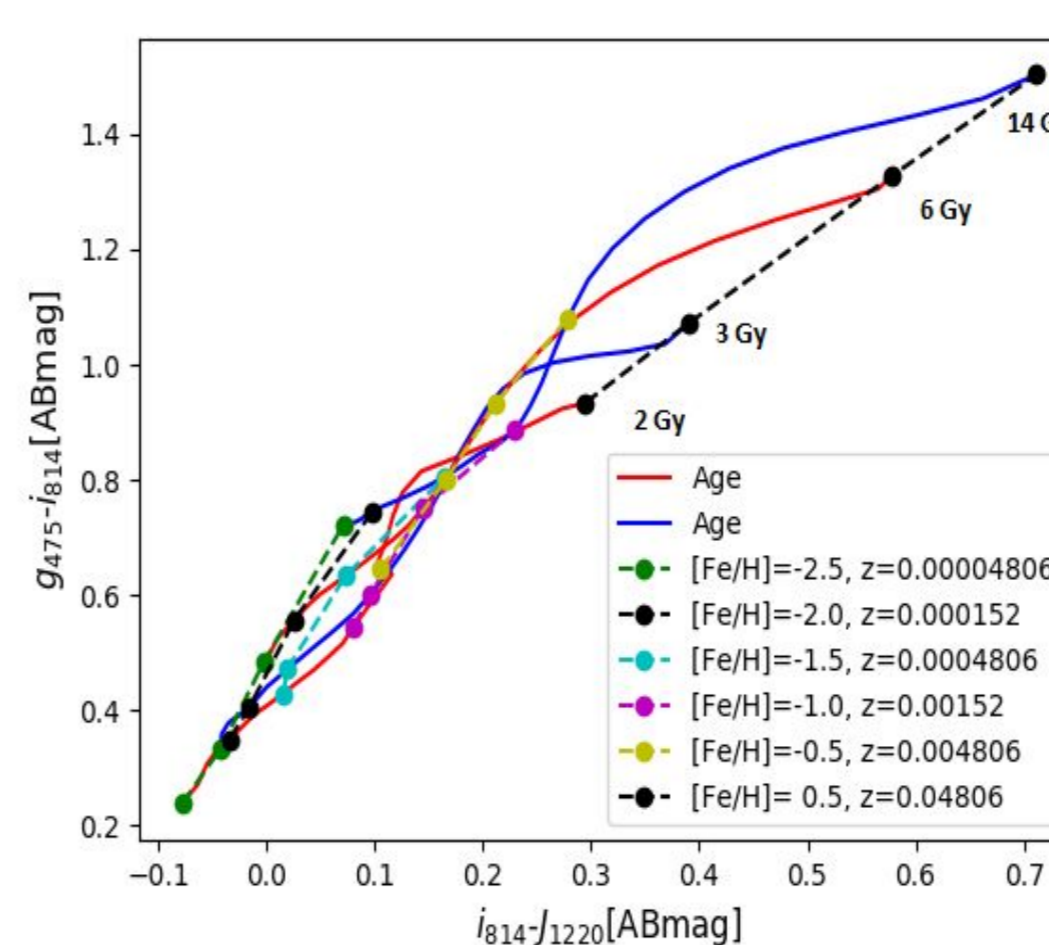


NGC7619

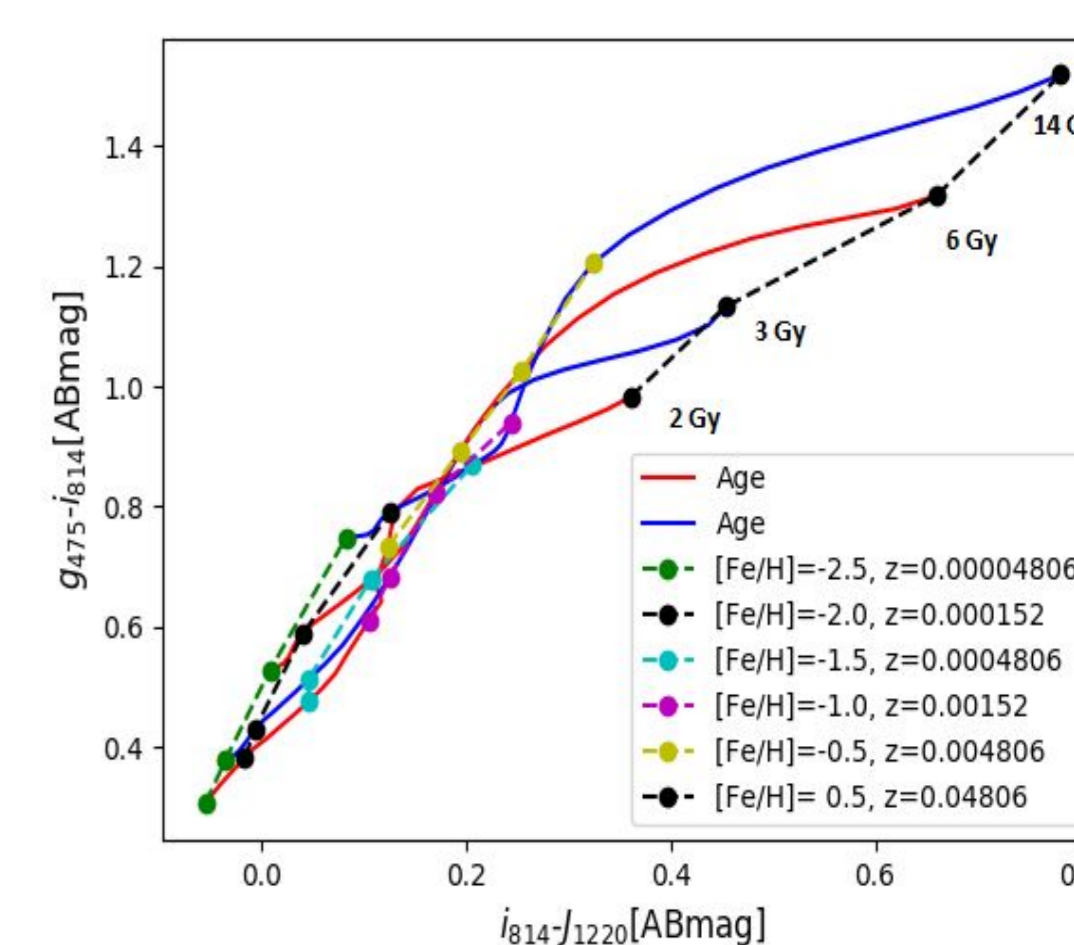


POPULATION MODELS

The Yonsei Evolutionary Population Synthesis (YEPS) Models provide models for simple stellar populations as functions of stellar parameters, such as metallicity, age and α -element mixture. They incorporate systematic contributions from horizontal-branch stars, which are very important to explain the bimodality found in index distributions of GCs in massive galaxies. The following diagrams show models for the bands (HST/ACS) ($g_{475nm} - i_{814nm}$) versus ($i_{814nm} - J_{1220nm}$).



YEPS photometric evolution model for simple stellar populations 0.0 (-2.5 < [Fe/H] < 0.5 by 0.1 dex)

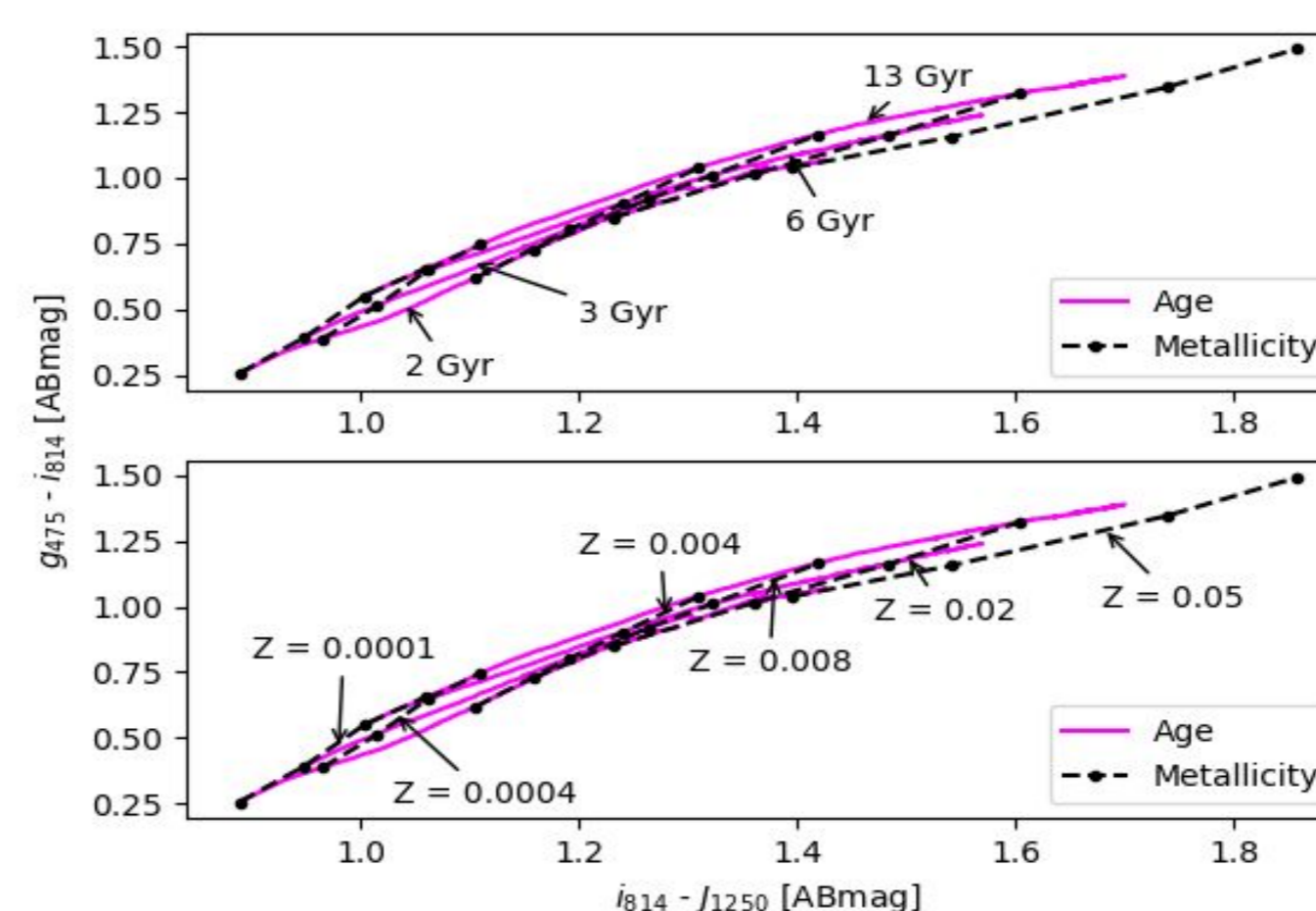


YEPS photometric evolution model for simple stellar populations 0.3 (-2.5 < [Fe/H] < 0.5 by 0.1 dex)

PS: The YEPS models do not have J_{1250} HST/WFC3 band available, so we used the closest band, Johnson J_{1220} , instead.

CONVERSION:
 $Z = Z_{\odot} * 10^{-[Fe/H]}$
 $Z_{\odot} = 0.0152$

We also made some of the same diagrams using Padova population models, in order to compare them.



Padova evolution models for stellar populations. In the upper panel, we present ages between 2 Gy and 13 Gy. In the bottom panel, the range of the metallicity is $0.0001 < z < 0.05$

NEXT STEPS

The next steps of the project will be to eliminate those candidates with error > 0.3 that are probably not GCs, and plot color-color diagrams in comparison with the YEPS and Padova population models in order to determine the age and metallicity distributions of the clusters.

REFERENCES

- [1] CHUNG-Pei Ma, Jenny E. Greene, Nicholas McConnell, Ryan Janish, John P. Blakeslee, Jens Thomas, Jeremy D. Murphy *The MASSIVE Survey - I. A Volume-Limited Integral-Field Spectroscopic Study of the Most Massive Early-Type Galaxies within 108 Mpc*, 13 de Outubro de 2014, astro-ph.GA
- [2] HYEJEON Cho, John P. Blakeslee, Ana L. Chies-Santos, M. James Jee, Joseph B. Jensen, Eric W. Peng, Young-Wook Lee *The Globular Cluster System of the Coma cD Galaxy NGC4874 from Hubble Space Telescope ACS and WFC3/IR Imaging*, 6 de Abril de 2016.