The Evolution of Luminous Red Galaxies

Luca Beale[1,†], Nicholas Mondrik[2], Dr. Casey Papovich[2], Dr. Ryan Quadri[2]

[1]*Department of Physics and Astronomy, SUNY Geneseo*
[2]*Department of Physics and Astronomy, Texas A&M University*
[†]*lpb3@geneseo.edu*

Abstract

Tracking the evolution of massive galaxies and galaxies in clusters provides insight into the assembly of dark matter structures and how they form large scale structure in the universe. Here, we study the color and mass evolution of luminous red galaxies (LRGs) in clusters to measure their formation history. Using data from the Dark Energy Survey, we use a large sample of LRGs (~550000) with photometric redshifts spanning $0.1 < z < 1$. We measure apparent and rest-frame color indices, and estimate stellar masses for each galaxy. We track the evolution of galaxies at different redshifts simply by linking the progenitors of present-day galaxies at higher redshifts by their comoving number density. The evolution of the massive galaxies over the redshift range $0.1 < z < 1$ is consistent with a passive scenario, where most of their growth occurred at earlier times. Future work will apply the technique to an even larger sample.

Motivation

Massive galaxies are important in the ongoing study of the formation of the universe, and have many unique properties:

- Tracers of dark matter (especially in clusters)
- Abundant in the very early universe
- Influential in the formation of large scale structure

Luminous red galaxies (LRGs) are also indicators of overdense regions in space, highlighting the centers of groups and clusters.

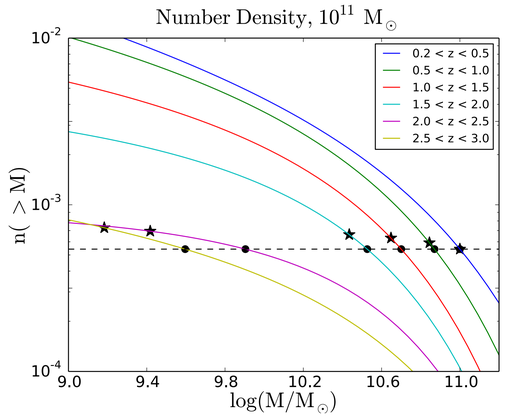
The evolution of these massive galaxies is a good marker for the evolution of the dark matter and filamentary structure in the universe.

We study two important aspects of LRGs:

- How has the intrinsic color of the galaxy changed over time?
- How has the stellar mass content changed over time?

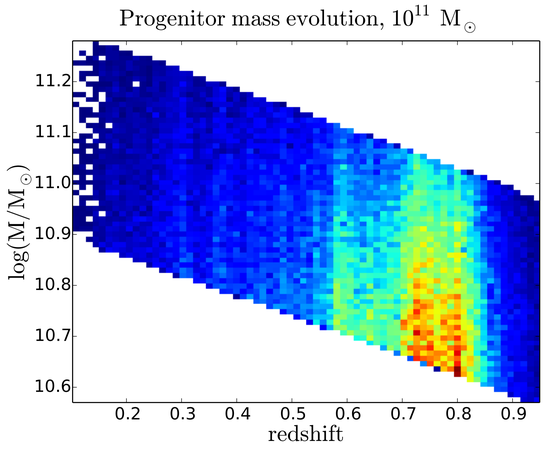
Method

- Measure rest frame color indices
- Estimate stellar masses (mass of stars in the galaxy)
- Connect galaxies to progenitors via comoving number density
- Trace progenitor masses and colors across redshift



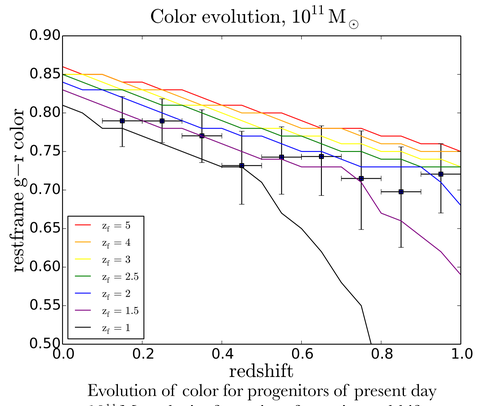
Comparison of mass evolution using fixed number density (circles) and cumulative number density (stars)

Mass Evolution



Evolution of stellar mass for progenitors of present day 10^{11} $M_\odot$ galaxies – redder colors indicate more data points

Color Evolution



Evolution of color for progenitors of present day 10^{11} $M_\odot$ galaxies for various formation redshifts

Conclusion

The relatively constant increase in stellar mass across redshift, combined with the flat slope in color evolution, indicates that LRGs have not had any significant star formation activity in the range $0.1 < z < 1$. Present day 10^{11} $M_\odot$ galaxies at a formation redshift of $z \sim 1.5$ have followed a passive evolution scenario. Future work can elucidate the reasons for the lack of formation.

Acknowledgements

We wish to thank the following people: Eli Rykoff, Gabriel Brammer, Mariska Kriek, and Texas A&M Department of Physics and Astronomy, especially Dr. Jennifer Marshall, without whom this would not be possible. This work was supported by NSF grant AST-1263034, "REU Site: Astronomical Research and Instrumentation at Texas A&M University."

References

Behroozi, P. S., Marchesini, D., et al. 2013a, ApJ, 777, L10
Brammer, G., van Dokkum, P. G., & Coppi, P. 2008, ApJ, 686, 1503
Kriek, M., van Dokkum, P. G., et al. 2009, ApJ, 700, 221
Muzzin A., Marchesini, D., et al., 2013, ApJ, 777, 18