Galaxies at High Redshift and Their Evolution Over Cosmic Time
Proceedings IAU Symposium No. 319, 2015
S. Kaviraj, ed.

doi:10.1017/S1743921315009904

Environmental Effects on LRGs as Cosmic Chronometers

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Abstract. Massive luminous red galaxies (LRGs) are believed to be evolving passively and can be used as cosmic chronometers to estimate the Hubble constant (the differential age method). However, different LRGs may be located in different environments. We investigate the environmental and mass dependence of the formation of 'quiescent' LRGs by using the population synthesis software STARLIGHT. We derive the stellar populations in each LRG, and obtain the mean age distribution and the mean star formation history (SFH) of those LRGs. We find that there is no apparent dependence of the mean age and the SFH of quiescent LRGs on their environment, while the ages of these quiescent LRGs depend weakly on their mass. We also evaluate the possible uncertainties in estimating the Hubble constant by the differential age method when using LRGs as cosmic chronometers.

Keywords. cosmological parameters – cosmology:evolution – galaxies:stellar content

1. Sample and Results

We select 2,718 bright cluster galaxies (BCGs), 1,075 member galaxies (MGs), and 4,089 field galaxies (FGs) from SDSS DR8 by cross-matching the LRG sample with the cluster catalog. Using the population synthesis software STARLIGHT, we derive the stellar populations in each LRG through the full spectrum fitting and obtain the mean age distribution and the mean star formation history (SFH) of those LRGs. We find that there is no apparent dependence of the mean age and the SFH of quiescent LRGs on their environment, while the ages of those quiescent LRGs depend weakly on their mass. We compare the SFHs of the SDSS LRGs with those obtained from a semi-analytical galaxy formation model and find that they are roughly consistent with each other if we consider the errors in the STARLIGHT-derived ages (~ 0.1 dex). We find that a small fraction of later star formation in LRGs leads to a systematical overestimation ($\sim 28\%$) of the Hubble constant by the differential age method, and the systematical errors in the STARLIGHT-derived ages may lead to an underestimation ($\sim 16\%$) of the Hubble constant. However, these errors can be corrected by a detailed study of the mean SFH of those LRGs and by calibrating the STARLIGHT-derived ages with those obtained independently by other methods. We conclude that the environmental effects do not play a significant role in the age estimates of quiescent LRGs; and the quiescent LRGs as a population can be used securely as cosmic chronometers, and the Hubble constant can be measured with high precision by using the differential age method once the systematical error in the age estimations and the effect of the late star formation are corrected and removed. For more details, we refer to the paper at http://arxiv.org/abs/1509.08046.