Updated catalog of 132,684 galaxy clusters and evolution of brightest cluster galaxies

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Abstract. We identified 132,684 clusters in the redshift range of $0.05 < z < 0.8$ from SDSS DR8. The spectroscopic redshifts of 52,683 clusters have been included in the catalog using SDSS DR9 data. We found that BCGs are more luminous in richer clusters and at higher redshifts.

From the Sloan Digital Sky Survey Data Release 8 (SDSS DR8), we identified 132,684 clusters in the redshift range of $0.05 < z < 0.8$ (Wen *et al.* 2012). Using photometric redshifts of galaxies, we recognized a cluster when the richness $R_{L*} = L_{\text{total}}/L^* \geqslant 12$ and the number of member galaxy candidates within a photometric redshift gap of $z \pm 0.04(1 + z)$ and a radius of r_{200}, $N_{200} \geqslant 8$. Here, r_{200} is the radius within which the mean density of a cluster is 200 times of the critical density of the universe, L_{total} is the total luminosity of member galaxies, L^* is the characteristic luminosity. Monte Carlo simulations show that for rich clusters with a mass of $M_{200} > 1.0 \times 10^{14}$ $M_\odot$ in the redshift range of $0.05 \leqslant z < 0.42$, the sample has a purity of $> 95\%$ and a completeness of $> 95\%$. The spectroscopic redshifts of 52,683 clusters have been included in the catalog based on the spectra data of the SDSS DR9. The updated catalog of galaxy clusters is now available at http://zmtt.bao.ac.cn/galaxy_clusters/.

Brightest cluster galaxies (BCGs) are luminous elliptical galaxies located at the potential centers of galaxy clusters. Because of the dominant role inside clusters and their unusual properties, the formation and evolution of BCGs are very intriguing. The BCGs of the clusters in our catalog are recognized as the brightest member galaxies within a radius of 0.5 Mpc from the number density peaks. We found that BCGs are more luminous in richer clusters and at higher redshifts, in the form of

$$M_r = (-21.25 \pm 0.01) - (1.75 \pm 0.03)z - (1.10 \pm 0.03) \log R_{L*}.$$

The color evolution of BCGs was investigated using a higher redshift cluster sample identified from the Canada-France-Hawaii Telescope Deep Survey and the Cosmic Evolution Survey using photometric redshifts (Wen & Han 2011). There are 294 clusters in the redshift range of $0.5 < z < 1.6$. The colors $r' - z'$ and $r^+ - m_{3.6\mu m}$ of most BCGs are consistent with a stellar population synthesis model (Bruzual & Charlot 2003) in which the BCGs are formed at redshift $z_f > 2$ and are evolved passively.

We also checked if the BCGs are luminous red galaxies (LRGs). We found that 25% of LRGs are the BCGs of our clusters, and 36% of LRGs are cluster member galaxies. In our cluster sample, 63% of BCGs satisfy the SDSS LRGs selection criteria for magnitude of $r_{\text{petro}} < 19.5$.

References

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