Formation and Evolution of Galaxy Bulges
Proceedings IAU Symposium No. 245, 2007
M. Bureau, E. Athanassoula & B. Barbuy, eds.

doi:10.1017/S1743921308018292

Finding galaxy clusters with spectro-photometric density in SDSS

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Abstract. We have attempted to overcome the incompleteness of spectroscopic survey and found galaxy clusters by measuring the spectro-photometric density of galaxies.

Keywords. catalogues, surveys, galaxies: clusters, galaxies: general

1. Measuring Local Density of Galaxies.

In order to measure local galaxy density, we adopt *Gaussian Filter* introduced by Schawinski *et al.* (2006). It first defines an ellipsoid arround a target galaxy and finds neighbouring galaxies. It also takes into account the "finger-of-god" effect due to the peculiar motion. The SDSS galaxy redshift survey tries to completely cover galaxies but it is hampered by fibre collisions. This effect is severe in dense clusters: spectroscopic coverage $f_{spec} \sim 65\%$ for rich clusters. In addition, von der Linden *et al.* (2006) reported that the spectroscopic survey missed 30% of brightest cluster galaxies. This incompleteness of spectroscopic survey results in a problem in the local density measurement. For the galaxies with spectroscopy we can easily determine cluster members and calculate the local density ρ with the Gaussian Filter. Among the galaxies missed by the spectroscopic survey, we use the colour-magnitude relation (CMR) to find cluster member candidates. The CMR is regarded as universal (Visvanathan & Sandage 1977: Hogg *et al.* 2004: López-Cruz *et al.* 2004). We assume that galaxies on the CMR have high likelyhood of being members of galaxy clusters. In our test of CMR efficiency, the method using the CMR shows 90% success rate of finding true members determined by the redshift. Galaxies with spectra are identified as members whether they reside in the ellipsoid and galaxies without spectra are determined by the CMR whether they belong to clusters. The ellipsoid has a radius of 1Mpc and it is elongated along the line-of-sight direction corresponding to the velocity dispersion of the clusters. We estimate the local density ρ with these member candidates by using 2-d Gaussian filter which weight closer galaxies (in projected distance) more. The member candidate selection by using the CMR does not provide 3-d information while the spectroscopy does. Hence, we use 2-d density rather than 3-d density but we have effectively improved the incompleteness problem of the spectroscopic survey.

2. Improvement by Photometric Members

Our spectro-photometric density shows 22% increasement with respect to the spectroscopic density only with member candidates selected by the spectroscopy. We

Table 1. The number of galaxy clusters found in our scheme matched to previous catalogues.

Cluster Catalogue	Number	Recovery(%)
Abell	181	61%
Zwicky	399	
C4	221	49%
NSC†	454	
Others	40	
Newly Found	161	
Total	915	

Note — The existing cluster catalogues are from the VizieR Catalogue Service and the newly found clusters are matched with the data from the NASA/IPAC Extragalactic Database. We choose Abell (when clusters have the redshift) and C4 clusters that exist in the SDSS area and our redshift range. Our scheme finds 61% and 48% among them, respectively.
† Northern Sky Optical Cluster Survey

try to strengthen the completeness of the spectroscopic survey by adding 2dF galaxies. The spectro-photometric density is in good agreement with the enhanced spectroscopic density with SDSS and 2dF. Moreover, we performed CTIO Hydra MOS observation to enhance the completeness up to 92% and this shows reliable consistency with our spectro-photometric density.

3. Cluster Catalogue

With SDSS data, we have found 915 robust galaxy cluster candidates in the redshift range between $0.05 < z < 0.1$. The threshold to define clusters is $\rho \geqslant 4.0$ corresponding to $200\,\mathrm{km}^{-1}$. We cross-match our finding to the existing catalogue and it is shown in Table 1. When we lower the threshold density, we could find more number of Abell, Zwicky, C4, and NSC clusters but it also causes to include false clusters into our catalogue. Therefore, we choose 4.0 to have robust cluster candidates. Among them, 161 clusters are new. Our density ρ provides a new richness parameter of galaxy clusters considering not only the number of members (N_{gal}) but also the distance to each member. We have also estimated various cluster properties such as virial radius, velocity dispersion, and richness.

Acknowledgements

This work was supported by grant No. R01-2006-000-10716-0 from the Basic Research Program of the Korea Science and Engineering Foundation and by the Global-5-5-10 Fund from Yonsei University to SKY.

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Figure 1. SOC member David Koo at high table during the symposium dinner.

Figure 2. Simon Driver and Matthew Colless discussing during a coffee break. Witold Maciejewski is in the left background, Adriana de Lorenzo-Cáceres and Inma Martinez-Valpuesta in the center.

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Figure 3. Russell Smith and Alessandra Beifiori during the symposium dinner.

Figure 4. John Lucey and Matthew Colless during the symposium dinner.

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Figure 5. SOC and LOC chair Martin Bureau during the after dinner speech. SOC member Sukyoung Yi is visible in the background on the left.

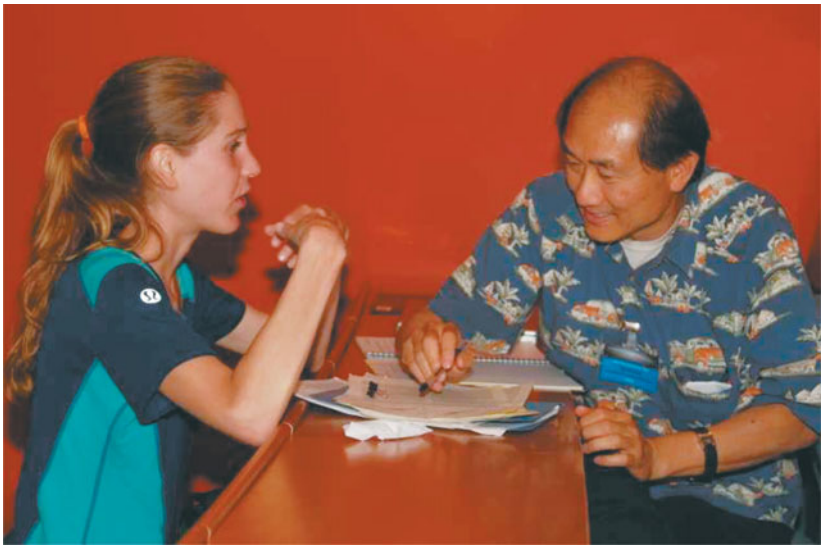

Figure 6. Lauren MacArthur and SOC member David Koo discussing in the lecture theatre.

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Figure 7. Katia Ganda, Marc Balcells and Reynier Peletier discussing in the lecture theatre.

Figure 8. John Kormendy and Michael Rich discussing during a coffee break.

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