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

doi:10.1017/S1743921308018401

Towards a robust estimate of the merger rate evolution using near-IR photometry

Abhishek Rawat[1,2] †, **Francois Hammer**[2], **Ajit K Kembhavi**[1] and **Hector Flores**[2]

[1] Inter University Centre for Astronomy and Astrophysics, Post Bag 4, Ganeshkhind, Pune 411007, India

[2]GEPI, l'Observatoire de Paris-Meudon, 92195 Meudon, France

Abstract. We use a combination of deep, high angular resolution imaging data from the HST/ACS GOODS survey and ground based near-IR K_s images to derive the evolution of the galaxy major merger rate in the redshift range $0.2 \leqslant z \leqslant 1.2$. We select galaxies on the sole basis of their J-band rest-frame, absolute magnitude, which is a good tracer of the stellar mass. We find steep evolution with redshift, with the merger rate $\propto (1+z)^{2.44\pm0.39}$ for optically selected pairs, and $\propto (1+z)^{2.07\pm0.74}$ for pairs selected in the near-IR. Our result is unlikely affected by luminosity evolution which is relatively modest when using a rest-frame J band selection. The major merger rate evolves by a factor $\sim$5 from the current epoch to $1.6 \times 10^{-3}\,\mathrm{Mpc}^{-3}\,\mathrm{Gyr}^{-1}$ at $z \sim 1.2$, suggesting that $58\% \times (0.5\,\mathrm{Gyr}/\tau)$ of all galaxies with $M_J \leqslant -19.5$ have undergone a major merger in the last $\sim 8\,\mathrm{Gyr}$ (where τ is the merger timescale). Interestingly, we find no effect on the derived major merger rate due to the presence of the large scale structure at $z = 0.735$ in the CDFS. We do find some evidence for increased star formation due to possible interactions between members of a pair using Spitzer MIPS 24μm fluxes to estimate the SFR.

Keywords. galaxies: evolution – galaxies: formation – galaxies: interactions – galaxies: statistics

1. Introduction

Galaxy mergers are believed to be the chief mechanism driving galaxy evolution within the hierarchical framework. Although mergers are rare at the current epoch, the hierarchical framework predicts that the merger rate must have been higher at earlier epochs. Despite its importance in understanding galaxy evolution, the quantification of the galaxy major merger rate and its evolution with redshift is still an ill constrained and hotly debated issue, with the reported evolution having a power law index of $0.0 \leqslant \alpha \leqslant 4.0$ (Patton *et al.* 1997, Le Fevre *et al.* 2000, Bundy *et al.* 2004, Lin *et al.* 2004, Lotz *et al.* 2006).

2. Sample selection and the pair statistics

We have used version v1.0 of the reduced, calibrated images of the Chandra Deep Field South (CDFS) acquired with HST/ACS as part of the GOODS survey (Giavalisco *et al.* 2004). Spectroscopic redshifts were taken from the redshift catalog of the VVDS (Le Fevre *et al.* 2004), GOODS/FORS2 redshift survey (Vanzella *et al.* 2005) and from the IMAGES survey (Ravikumar *et al.* 2007). The near-IR J & K_s band imaging data of the GOODS/CDFS region from the ESO GOODS/EIS Release Version 1.5 (Vandame *et al.*, in preparation) was used. We adopt a cosmology with $H_0 = 70\,\mathrm{km\,sec^{-1}\,Mpc^{-1}}$, $\Omega_\mathrm{M} = 0.3$ and $\Omega_\Lambda = 0.7$.

† email:rawat@iucaa.ernet.in

We cross-correlated the HST/ACS source catalog with the three redshift catalogs mentioned above to yield objects with spectroscopic redshifts in the range $0.2 \leqslant z \leqslant 1.2$. Galaxies with rest frame absolute magnitude brighter than $M_J(AB) = -19.5$ have been selected as the primary galaxies, leaving us with 695 galaxies.

We have used a simple prescription for finding major pairs of galaxies in the z and the Ks filter by identifying neighbours within a projected radius of $20h_{100}^{-1}$ kpc for each of the 695 main galaxies, such that the condition $-1.5 \leqslant \delta m \leqslant 1.5$ is satisfied in at least one of the two filters. This selection criterion yielded 162 and 226 major pair candidates in the K_s filter, and in the z filter, respectively. Since we do not have the redshift for the secondary member of a pair in most cases, some of them can simply be foreground/background superpositions. Such a contamination can be statistically corrected for by using number counts of objects in the field in the z or K_s filter. We then defined the major merger fraction as $f(z) = \frac{N_{pairs} - N_{proj.}}{N_{host}} \times 0.5$ where N_{host} is the number of primary galaxies in each redshift bin, N_{pairs} is the number of galaxies existing in *major* pairs in either of the two filters and $N_{proj.}$ is the number of *major* neighbours expected to be found by pure chance coincidence. The factor 0.5 is the fraction of close pairs that are likely to merge as estimated by Patton *et al.* 1997. The merger fraction f(z) is plotted in Fig. 1, with the low redshift points taken from Patton *et al.* 1997.

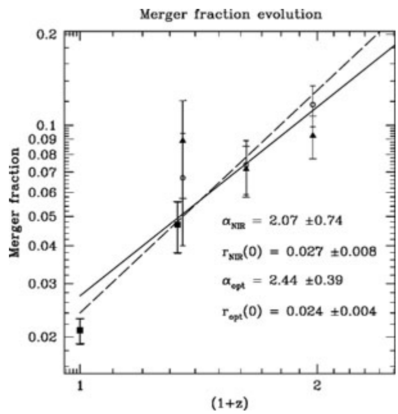

Figure 1. The merger fraction evolution with redshift in z filter (open circles) and K_s filter (filled triangles). The filled squares are from Patton *et al.* 1997.

Finally we notice that at least some of the discrepancies between results derived in this paper and those of other workers in the field can be attributed to different definitions of major merger.

References

Bundy, K., Fukugita, M., Ellis, R. S., *et al.* 2004, ApJL, 601, L123
Giavalisco, M., Ferguson, H. C., *et al.* 2004, ApJ, 600, L93
Le Fevre, O., Abraham, R., *et al.* 2000, MNRAS, 311, 565
Le Fevre, O., Vettolani, G., Paltani, S., *et al.* 2004, A&A, 428, 1043
Lin, L., Koo, D. C., Willmer, C. N. A., *et al.* 2004, ApJL, 617, L9
Lotz, J. M., Davis, M., Faber, S. M., *et al.* 2006, astro-ph/0602088
Patton, D. R., Pritchet, C. J., *et al.* 1997, ApJ, 475, 29
Ravikumar, C. D., Puech, M., *et al.* 2007, A&A, 465, 1099
Vandame, B., *et al.*, in preparation.
Vanzella, E., Cristiani, S., Dickinson, M., *et al.* 2005, A&A, 434, 53