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Dry minor mergers and the size evolution of high-z compact massive early-type galaxies

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1. Summary

Recent observations show evidence that high-z ($z \sim 2-3$) early-type galaxies (ETGs) are more compact than those with comparable mass at $z \sim 0$ (e.g. Trujillo *et al.* 2007; Buitrago *et al.* 2008). Such a size evolution is most likely explained by the 'dry merger scenario'. However, previous studies based on this scenario are not able to consistently explain both the properties of the high-z compact massive ETGs and the local ETGs (Nipoti *et al.* 2009). We investigate the effect of multiple sequential minor mergers on the size evolution of the compact massive ETGs. From an analysis of the Millennium Simulation Database (Springel *et al.* 2005; De Lucia & Blaizot 2007), we show that such minor (stellar mass ratio $M_2/M_1 < 1/4$) mergers are extremely common during hierarchical structure formation. We perform N-body simulations of sequential dry minor mergers with parabolic and head-on orbits, including a dark matter component and a stellar component. Typical mass ratios of the minor mergers are $1/20 < M_2/M_1 \leqq 1/10$.

We show that sequential dry minor mergers of compact satellite galaxies are the most efficient at promoting size growth and decreasing the velocity dispersion of the compact massive ETGs in our simulations. In particular, we show that the sequential minor mergers of the compact satellites have the most efficient size growth efficiency, $\alpha \simeq 2.7$ ($R_e \propto M_*^\alpha$). The change of stellar size, density, and stellar velocity dispersion of the merger remnants is consistent with recent observations (e.g. Bezanson *et al.* 2009).

Furthermore, we construct the merger histories of candidates for the high-z compact massive ETGs using the Millennium Simulation Database, and estimate the size growth of the galaxies in the dry minor merger scenario. We can reproduce the mean size growth of the galaxies between $z = 2$ and $z = 0$, assuming the efficient size growth, $\alpha \gtrsim 2.3$, obtained during sequential dry minor mergers in our simulations. However, we note that our numerical result is only valid for merger histories with typical mass ratios between 1/20 and 1/10 with parabolic and head-on orbits, and that our most efficient size growth efficiency is likely to serve as an upper limit. In future studies, we will investigate various mass ratios and merger orbits for a more robust prediction.

References

Bezanson, R., *et al.* 2009, *ApJ*, 697, 1290
Buitrago, F., *et al.* 2008, *ApJ*, 687, L61
De Lucia, G. & Blaizot, J. 2005, *MNRAS*, 375, 2
Nipoti, C., *et al.* 2009, *ApJ*, 706, L86
Springel, V., *et al.* 2005, *Nature*, 435, 629
Trujillo, I., *et al.* 2007, *MNRAS*, 382, 109