SIZE EVOLUTION OF MASSIVE GALAXIES

Javier Navarro-González[1], Vicent Quilis[1] , Ignacio Trujillo[2], Javier Cenarro[3].

[1]DAA, Universitat de València, Spain; [2]IAC, La Laguna (Tenerife), Spain; [3]CEFCA, Teruel, Spain.
contact: nagonja@uv.es

Abstract

We present the preliminary results of cosmological simulation focused on the study of the size and velocity dispersion time evolution. We have study the main morphological features of a sample of more that 200 galaxies having masses between $5\cdot10^{10}M_\odot$ and $5\cdot10^{11}M_\odot$. We compared the results obtained from the analysis of the simulated sample with the observational data. The time evolution of size and velocity dispersion of simulated galaxies seems to go in the right direction, pointing observational results, leading to the conclusion that the cause of such morphological evolution could be due to the minor merger events and the smooth accretion of stars from the environment.

Introduction

* At present the exact physical mechanism behind the dramatic size evolution (Daddi et al. 2005; Trujillo et al. 2006) that massive galaxies have suffered since z ~3 is under discussion. It has been observed a moderate velocity dispersion evolution since z ~ 2 for objects with masses between $5\cdot10^{10}M_\odot$ and $5\cdot10^{11}M_\odot$ (Cenarro & Trujillo 2009; Cappellari et al. 2009)
* It has been suggested that the increase in size could be due to minor mergers on parabolic orbits that add stars in the outer part of the galaxies (Naab et al. 2009; Hopkins et al. 2009).
* Naab et al. (2009) conducted a pioneer work on exploring the minor merging effect on a cosmologically motivated evolution of a massive galaxy since z ~3. Their study supported the idea that minor merging can explain simultaneously the size and velocity dispersion evolution. However, the main limitation of that work was that their conclusions were based on a single object.
* In the present work we want to explore the evolution of the size and velocity dispersion of a larger sample of massive galaxies in a cosmological simulation. Adding more galaxies will allow us for the first time to explore whether the growth in size and the moderate evolution in velocity dispersion is a general effect for all the galaxies. Moreover, we will quantify the median evolution of the above quantities at a fixed stellar mass at every redshift, allowing us a direct comparison with the published data in the literature.

Observations

* Cenarro & Trujillo (2009), by comparing spheroid-like massive ($M_* \sim 10^{11}M_\odot$) galaxies of similar stellar mass, find the evidence for a mild evolution in velocity dispersion, contrasting with change in size found for these type of objects.

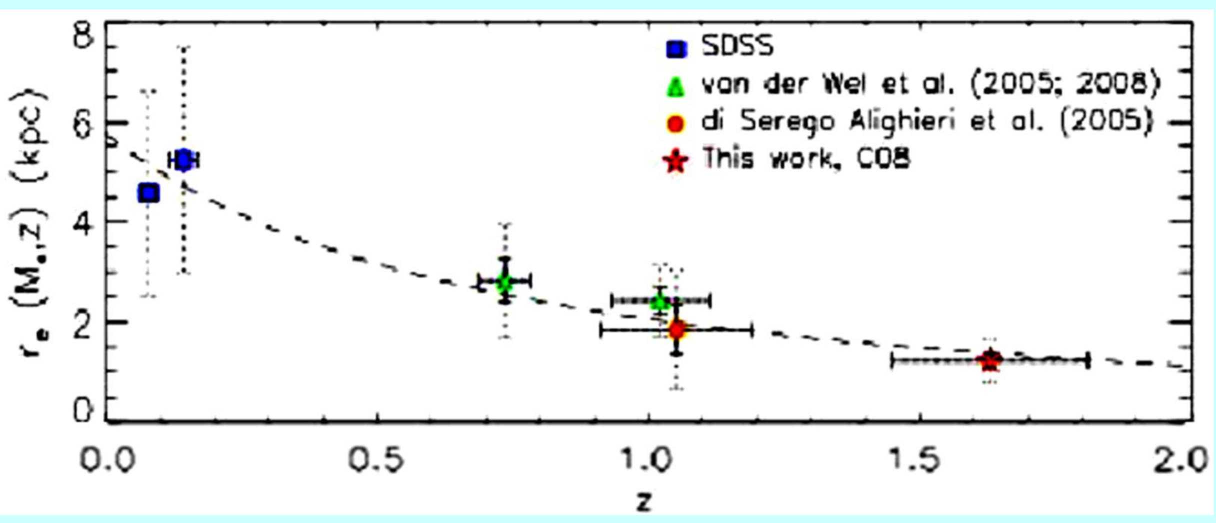

Fig. 1: Size evolution of spheroid-like massive ($M^* \sim 10^{11}M_\odot$) galaxies. The dashed line represent the observed evolution of sizes $r_e \sim (1+z)^{-1.48}$

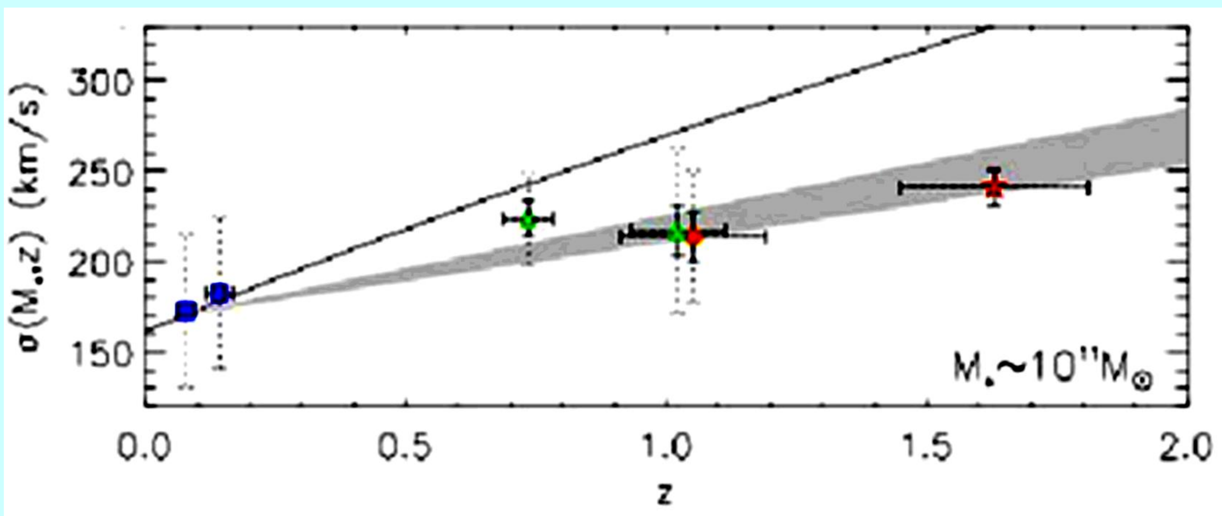

Fig. 2: Velocity dispersion evolution for the spheroid-like massive ($M^* \sim 10^{11}M_\odot$) galaxies as function of redshift.

Simulation

* The simulation described in this poster was performed with the cosmological code MASCLET (Quilis 2004). The initial conditions were set up at z = 50, using a CDM transfer function, for a cube of comoving side length 64Mpc. The computational domain was discretised with 512^3 cubical cells, using a maximum of six levels of refinement, which gives a peak spatial resolution of 4kpc at z = 0. The star formation is introduced in the MASCLET code following the ideas of Yepes et al. (1997) and Springel & Hernquist (2003).

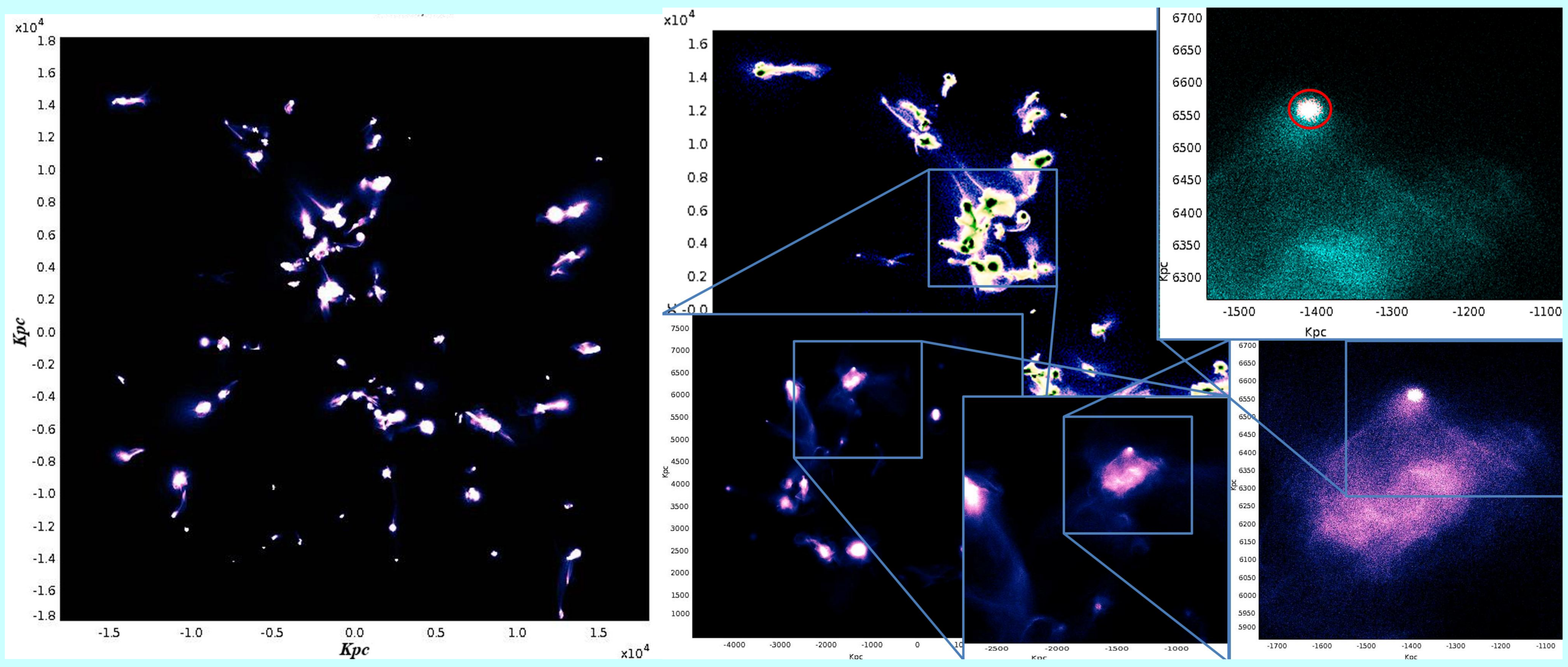

Fig. 3: Projected stellar density from a output of MASCLET at z ~3 and zoom of the area till we find a good candidate to be a spheroid-like massive galaxy (mount of stars in the red circle) . From this galaxies we take the spheroid-like massive ($M^* \sim 10^{11}M_\odot$) sample.

Results

* We use the sample of galaxies generated in our simulation to study the morphological changes suffered by compact massive galaxies.
* The velocity dispersions, σ, are computed in the common statistical manner adding up the deviations of the individual stellar particle velocities from the mean velocity. For the size, we defined the half mass radius, R_e, as the radius enclosing half of the stellar mass of the object when binning from the centre.

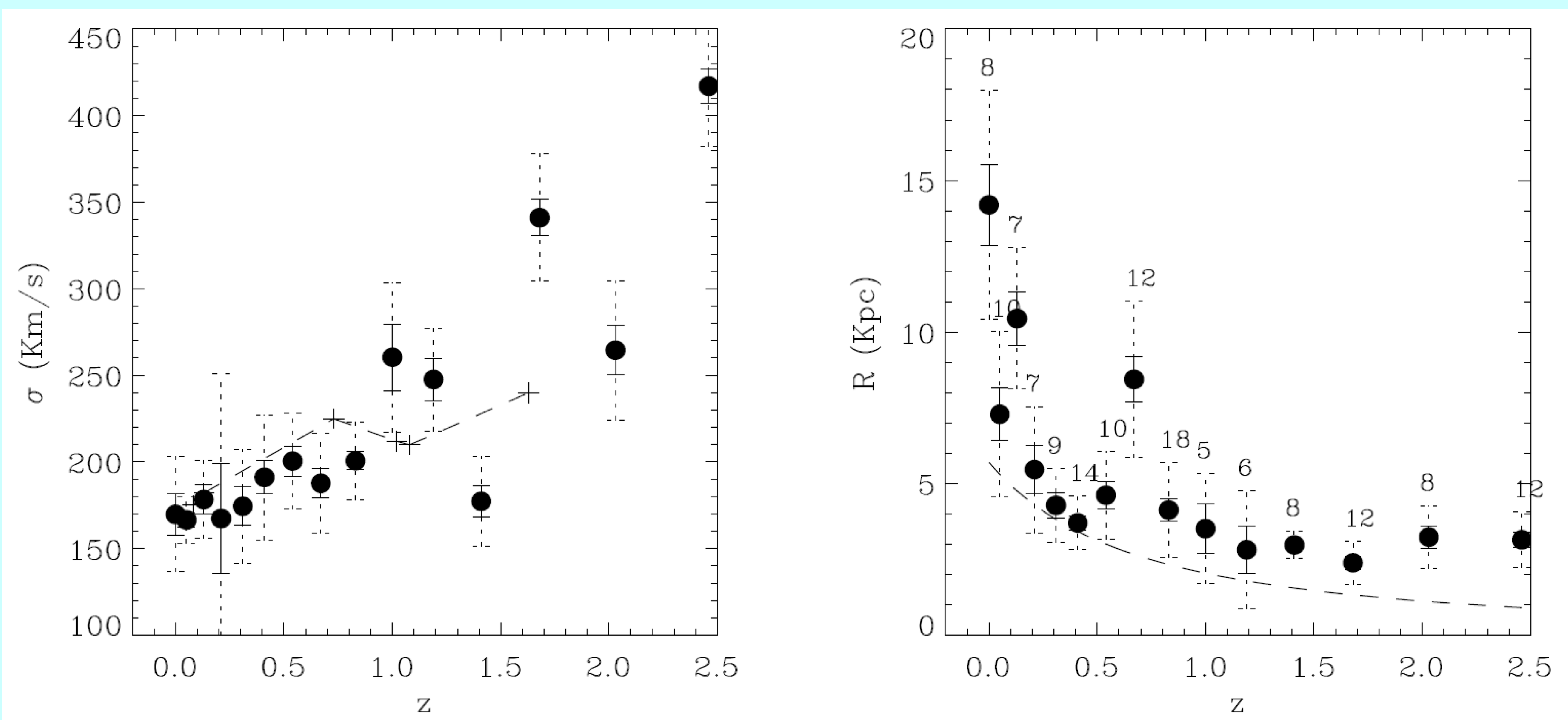

Fig. 4: Time evolution of the median of σ and R in the left and right, respectively, for galaxies with mass ($M^* \sim 10^{11}M_\odot$), excluding galaxies with major mergers . The bars draw with a continuous and discontinuous lines correspond to the mean quadratic error and one standard deviation, respectively. On the top of each error bar on the right column, there is a number showing the number of galaxies of the sample at this particular time. The dashed line at the left represents the observational velocity dispersion evolution and at the right, the observed evolution of sizes $r_e \sim (1+z)^{-1.48}$

References:

Quilis V., 2004, MNRAS, 325, 1426.
A. Javier Cenarro & Ignacio Trujillo, 2009, ApJ, 696, L43
Cappellari, Michele; di Serego Alighieri, S.; Cimatti, A.; Daddi, E.; Renzini, A.; Kurk, J. D.; Cassata, P.; Dickinson, M.; Franceschini, A.; Mignoli, M.; Pozzetti, L.; Rodighiero, G.; Rosati, P.; Zamorani, G., 2009, ApJ, 704, L34-L39.
Daddi, E.; Renzini, A.; Pirzkal, N.; Cimatti, A.; Malhotra, S.; Stiavelli, M.; Xu, C.; Pasquali, A.; Rhoads, J. E.; Brusa, M.; di Serego Alighieri, S.; Ferguson, H. C.; Koekemoer, A. M.; Moustakas, L. A.; Panagia, N.; Windhorst, R. A., 2005, ApJ, 626, 680-697.
Naab, Thorsten; Johansson, Peter H.; Ostriker, Jeremiah P., 2009, ApJ, 699,L178.
Springel V., Hernquist L., 2003,MNRAS,399,289.
Trujillo, Ignacio; Förster Schreiber, Natascha M.; Rudnick, Gregory; Barden, Marco; Franx, Marijn; Rix, Hans-Walter; Caldwell, J. A. R.; McIntosh, Daniel H.; Toft, Sune; Häussler, Boris; Zirm, Andrew; van Dokkum, Pieter G.; Labbé, Ivo; Moorwood, Alan; Röttgering, Huub; van der Wel, Arjen; van der Werf, Paul; van Starkenburg, Lottie,2006, ApJ, 650,18-41.
Yepes G., Kates R, Khokhlov A. Klypin A., MNRAS,284,235.

Conclusions

* The results of the simulations presented in this poster, summarised in Fig. 4, seem to go in the same direction of the observational results. The study of the sample of galaxies with masses ranging from $5\cdot10^{10}M_\odot$ and $5\cdot10^{11}M_\odot$, qualitatively seems to reproduce the time evolution of the velocity dispersion and size of such objects.
* Minor merging and smooth accretion of surrounding stars could explain the evolution of both, size and velocity dispersion.