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GALAXY FORMATION: MERGER VS GAS ACCRETION

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Abstract. According to the hierarchical model, small galaxies form first and merge together to form bigger objects. In parallel, galaxies assemble their mass through accretion from cosmic filaments. Recently, the increased spatial resolution of the cosmological simulations have emphasised that a large fraction of cold gas can be accreted by galaxies. In order to compare the role of both phenomena and the corresponding star formation history, one has to detect the structures in the numerical simulations and to follow them in time, by building a merger tree.

Keywords: galaxy: formation, galaxy: dark matter, galaxy: ISM

1 Introduction

Recent simulations (Kereš et al. (2005) for example) have emphasised the role of smooth cold accretion on galaxy formation. We aim at comparing the roles of mergers and gas accretion on galaxy growth by studying numerical simulations.

2 The simulations

We use a set of TreeSPH multizoom simulations (Semelin & Combes 2002, 2005), starting with a low resolution cosmological simulation, and resimulating regions of interest at higher resolution. The box radius is 8.30 Mpc (comoving), the mass resolution is $3 \times 10^7\ M_\odot$ for baryons and $1.4 \times 10^8\ M_\odot$ for DM particles, and the gravitational smoothing is $\varepsilon = 6.25$ kpc. There are 90 outputs spaced by 100 Myr from $z \sim 29$ to $z \sim 0.41$, which enables us to follow particles from one output to the other.

3 Structure detection and merger tree

We use AdaptaHOP (Aubert et al. 2004; Tweed et al. 2009) to detect the DM haloes and subhaloes hierarchy. We also use AdaptaHOP to detect the baryonic galaxies [*], with a better adapted set of parameters: we use for the density threshold above which structures are detected $\rho_{\rm T} = 1000$ (times the mean density of the simulation) instead of 81 for DM. We also check that the results do not vary too much with the choice of $\rho_{\rm T}$.

In the following, we are only interested in baryonic particles and structures. At each timestep, baryonic particles either belong to a structure (galaxy or satellite), or are diffuse and belong to the background. To compute the mass gained by the main galaxy at each timestep, we sum the mass of all the particles entering the structure, and we count as *smooth accretion* particles that belonged to the background at the previous timestep, and as *merger* particles that belong to another structure. Particles can also leave the main galaxy for another structure, generally for a satellite (*fragmentation*) or for the background (*evaporation*). We then have to substract *fragmentation* to *merger* and *evaporation* to *accretion*.

One of the main problems while building a merger tree is the so-called *flyby issue*: when structures are too close one to another, they are undistinguishable for the structure finder. Thus two structures can be separated at a given timestep, merged at the following, and separated again later. Such an example can be seen in figure 1,

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[*]Screenshots of the simulations and of the structures found by AdaptaHOP as well as an example of merger tree can be seen at `http://aramis.obspm.fr/~blhuill/research.html`

left: the red upper curve (satellites) grows, then decreases when the satellite flies away from the central galaxy, then the curve increases again when the satellite comes back.

Thus with our technique, when particles enter the main galaxy, they are counted positively, and negatively when they leave, which enables us to compute the total mass origin of the main galaxy (figure 1, right).

4 Results

We measure the smooth accretion and the merger fractions of several galaxies, as shown in figure 1, right and table 1.

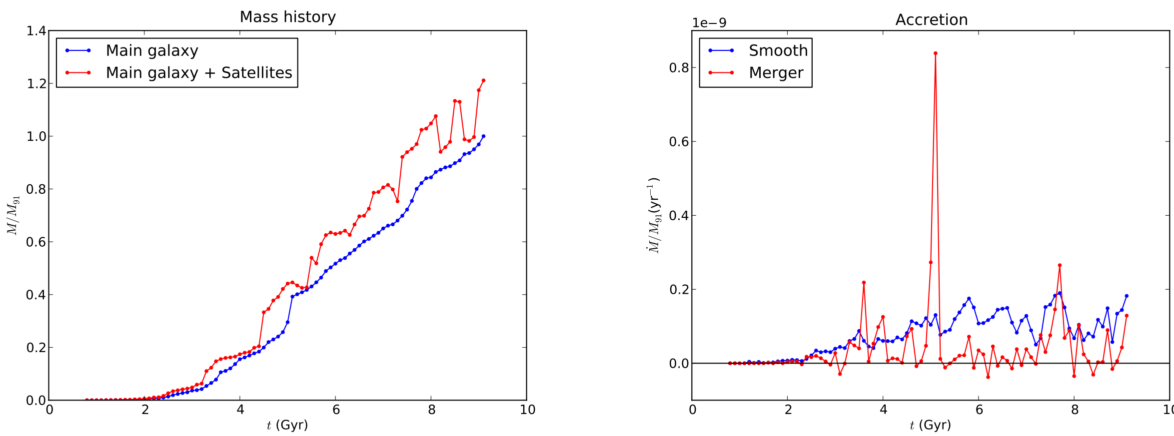

Fig. 1. *Left:* Baryonic mass evolution of a galaxy normalised by the galaxy mass at $t = 9.1$ Gyr. *Right:* Incoming mass by time unit. The blue curve shows mass smoothly accreted, the red curve shows the mass gained through mergers.

Table 1. Fraction of smooth accretion within the total assembled mass for different central galaxies. The first galaxy has $f_{\mathrm{acc}} > 1$, which means that the galaxy loses more mass during merger envents due to fragmentation that it gains.

galaxy	1	2	3	4	5	6
Mass ($10^{11} M_{\odot}$)	107.5	244.81	140.81	1.73	143.40	8.98
Accretion fraction	1.04*	0.65	0.67	0.52	0.95	0.71

5 Conclusions

The study of these simulations shows that baryonic mass assembly of galaxies seems to be dominated by smooth accretion, although we still have to perform further consistency tests. The next step is to perform statistical studies to confirm the preliminary results, then further physical exploitation can be made such as the role of the environment on the SFR.

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