mains even at $z \sim 1-1.5$, though less drastic; (2) the $M_{\rm s}/M_{\rm h}$ ratios are $\sim 5-10$ times larger than the latter at $z \approx 0$ and this difference increases at higher $z$.

Unless the current observational inferences of $M_{\rm s}$, SFR, and their distributions at different $z$ are dominated by strong systematic effects and selection biases (see for discussions BCW10; Firmani et al. 2010; Avila-Reese et al. 2011), *the problems highlighted above pose a sharp challenge to current* $\Lambda$*CDM-based models and simulations of low-mass galaxies*. Its solution requires that galaxies smaller than $M_{\rm s}(z=0) \sim 2\times10^{10}\ M_\odot$ should have significantly delayed their $M_{\rm s}$ assembly with respect to the assembly of their corresponding $\Lambda$CDM halos, besides the smaller the galaxy, the longer should be such a delay. This is in line with the staged galaxy formation picture proposed in Noeske et al. (2007).

### 4.2. *Why the more massive the galaxy, the earlier assembled most of its* $M_{\rm s}$*?*

Though at first glance contradictory to the $\Lambda$CDM picture, this manifestation of downsizing has, at least partially, its natural roots namely in the hierarchical clustering assembly of halos and their progenitors distributions (Neistein et al. 2006, see also Guo & White 2008; Li, Mo, & Gao 2008; Kereš et al. 2009). Besides, red massive galaxies are expected to have been formed in early collapsed massive halos – associated to high peaks, therefore highly clustered– that afterwards become part of groups and clusters of galaxies, leaving truncated therefore the early efficient mass growth of the galaxies associated to these halos. The measured correlation function of luminous red galaxies is indeed very high (e.g., Li et al. 2006). On the other hand, massive galaxies typically hosted in the past AGNs. The strong feedback of the AGN may help to stop gas accretion, truncating further the galaxy stellar growth and giving rise to shorter formation time-scales for the massive galaxies (Bower et al. 2006; Croton et al. 2006; De Lucia et al. 2006). Although all these effects may explain the archeological downsizing, several questions remain yet open and subject to observational testing, among them, whether AGN-feedback is as efficient as required for quenching galaxies.

### 4.3. *Why galaxies transit from active to passive* $M_{\rm s}$ *growth regimes, the more massive earlier than the less massive ones? What does quench the SFR of galaxies?*

These questions are related to the previous one but make emphasis on the continuous and monotonic decreasing of $M_{\rm migr}$ with time. An important question to take into account is the possible link between SFR quenching and morphological transformation; after all, active (blue) and passive (red) galaxies use to be identified with disk- and spheroid-dominated systems, respectively. As numerical simulations show, the main driver of morphological evolution seem to be mergers (e.g., Scannapieco & Tissera 2003; Cox et al. 2006, and more references therein). Mergers can also quench SF through the associated explosive quasar or starburst phase that heats or drive out cold gas in the spheroidal merger remnant. Thus, the scenario where $\Lambda$CDM-based mergers drive the formation and quenching of red, early-type galaxies passing by a quasar and/or starburst phase looks promising (Kauffmann & Haehnelt 2000; Hopkins et al. 2008, and more references therein). The connection showed in § 3.1 between $M_{\rm migr}(z)$ and the characteristic luminosity of the quasar luminosity function at each $z$ supports this scenario, at least for the formation of red galaxies more massive than $M_{\rm migr}$ ($M_{\rm migr} \approx 2\times10^{10}\ M_\odot$ at $z=0$).

However, recent observations suggest that the situation could be more complicated, specially for the origin of passive (red) galaxies of smaller masses: nearly 50% of the red-sequence COSMOS galaxies ($z \lesssim 1$) have disk-like morphologies, being bulge-dominated (Bundy et al. 2010), though above $\sim 10^{11}$ $M_\odot$, this fraction is smaller and decreases with time. The authors suggest that passive (red) disks may be a common phase of galaxies transitioning onto the red sequence, and once formed, their transformation into spheroidals is moderately fast (1–3 Gyr), driven likely by minor mergers.

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