that the high-mass end of the $GSMF$ was in place since high z (e.g., Fontana et al. 2004, 2006; Drory et al. 2005; Cimatti et al. 2006; Marchesini et al. 2009; Perez-Gonzalez et al. 2008), and evidence a decrease with cosmic time of the characteristic mass at which the SFR is quenched or at which the $GSMF$s of early- and late-type galaxies cross, i.e., less and less massive migrate with time to the red sequence (e.g., Bundy et al. 2006; Borch et al 2006; Bell et al. 2007; Hopkins et al. 2007; Drory & Alvarez 2008; Vergani et al. 2008; Pozzetti et al. 2010). This is in line with 'archaeological' inferences for local galaxies that evidence an early and coheval mass assembly for massive ellipticals (e.g., Thomas et al. 2005).

(B) Less massive galaxies, which are on average blue and star-forming. Although the observations of less luminous galaxies suffer incompleteness as z increases due to the flux limits, at least up to $z \sim 1-2$, most of observational studies have found that the specific SFR (SSFR = SFR/$M_{\rm s}$) of galaxies with $M_{\rm s} \lesssim 3\times10^{10}\ M_{\odot}$, which are mostly late-type, star-forming galaxies, is surprisingly high even at $z \sim 0$ (late mass assembly) and, on average, the lower the mass, the higher the SSFR ('downsizing in SSFR'; e.g., Baldry et al. 2004; Bauer et al. 2005; Zheng et al. 2007; Noeske et al. 2007; Bell et al. 2007; Elbaz et al. 2007; Salim et al. 2007; Chen et al. 2009; Damen et al. 2009; Santini et al. 2009; Oliver et al. 2010; Kajisawa et al. 2010; Rodighiero et al. 2010; Karim et al. 2011; Gilbank et al. 2011).

By combining the evolution of the $GSMF$ with the measured SFR-$M_{\rm s}$ relations at different z, the contribution of local SF and galaxy accretion (mergers) to the stellar mass build up can be constrained (Bell et al. 2007; Drory & Alvarez 2008; Pozzetti et al. 2010). These and some direct –but yet limited– observational determinations of the merging rate (e.g., Lotz et al. 2008; Bundy et al. 2009) show that the former channel completely dominates in low- and intermedium-mass galaxies at all epochs, while (dry) mergers may play a moderate role for massive ($M_{\rm s} \gtrsim 10^{11} M_{\odot}$, mainly red) galaxies at later epochs ($z \lesssim 1$).

Although important efforts have been made in order to constrain the dynamical evolution of galaxies (e.g., from observational studies at high z of the Tully-Fisher and Faber-Jackson relations, galaxy-galaxy weak lensing, etc.), direct constraints of the galaxy-halo connection as a function of mass are yet very limited. This kind of observations together with those regarding the gas mass of galaxies at high z are necessary to complete the whole picture of galaxy stellar, baryonic, and dark mass assembly. In the meantime, semi-empirical methods were introduced in order to get the whole evolutionary connection in the context of the ΛCDM scenario and constrain in this way the average *individual* trends of the galaxy evolution process as a function of mass (e.g., Conroy & Wechsler 2009; Hopkins et al. 2009; Firmani & Avila-Reese 2010).

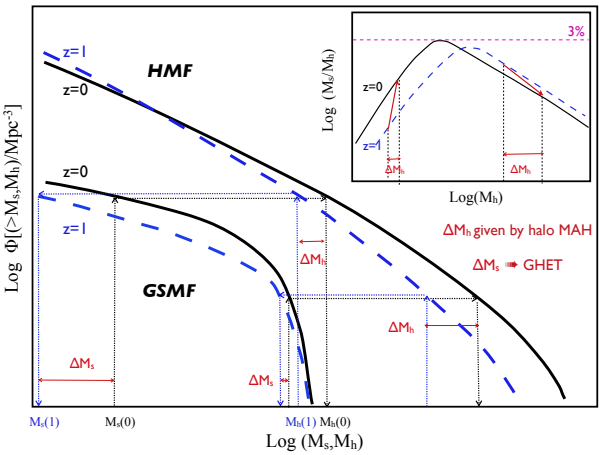

Fig. 1. Halo and galaxy stellar mass cumulative functions at $z = 0$ (solid black curves). Given a $M_{\rm s}$, its corresponding $M_{\rm h}$ is found by matching the mass functions (the dotted black arrows show this for two masses). A relation between $M_{\rm s}$ (or $M_{\rm s}/M_{\rm h}$) and $M_{\rm h}$ is constructed this way (solid black curve in the inset). The same exercise can be repeated at other redshifts (e.g., $z = 1$, dashed blue curves). Given the halo average MAH, the mass at $z = 1$, $M_{\rm h}(1)$, that had a halo of a given mass at $z = 0$, $M_{\rm h}(0)$, can be calculated ($\Delta M_{\rm h}$). Then, by using again the AMT, the $M_{\rm s}(1)$ corresponding to $M_{\rm h}(1)$ is obtained (the dotted blue arrows show this for two masses), and $\Delta M_{\rm s} = M_{\rm s}(0) - M_{\rm s}(1)$ gives the *individual* average $M_{\rm s}$ track (GHET; the red arrows in the inset show two GHET-based tracks in the $M_{\rm s}/M_{\rm h}$–$M_{\rm h}$ diagram).

3. CONNECTING GALAXIES TO DARK HALOS

In the semi-empirical approach, the information provided by direct observations at different epochs is combined in a statistical way with predicted properties for the ΛCDM halos in order: (1) to attain a connection between galaxies and halos, and (2) to infer *individual* galaxy 'hybrid' evolutionary tracks (GHETs). An schematic idea of the approach is shown in Figure 1 and explained below:

(1) Global galaxy-halo connection.- Given the measured cumulative $GSMF$ and the cumulative halo mass function, HMF (both at the same epoch e.g., $z = 0$, black solid curves), and assuming a one-to-one correspondence between $M_{\rm s}$ and $M_{\rm h}$, both