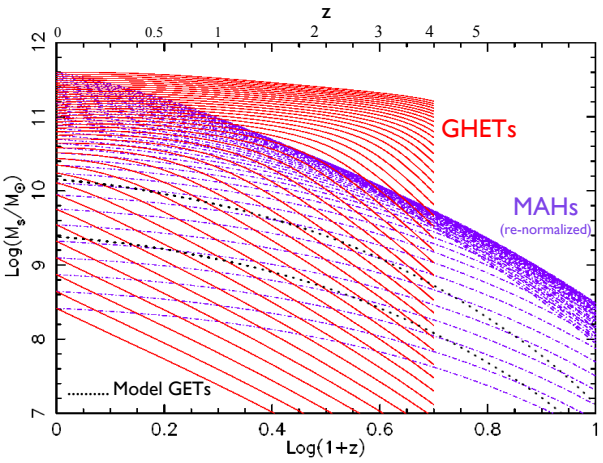

Fig. 3. Average $M_{\rm s}$ growth tracks (GHETs) as a function of z (solid red curves) and their corresponding halo MAHs (dot-dashed purpure curves) shifted vertically in order $M_{\rm s}(z=0)$=$M_{\rm h}(z=0)$. Galaxies and halos assemble their masses in a very different way. Adapted from FA10.

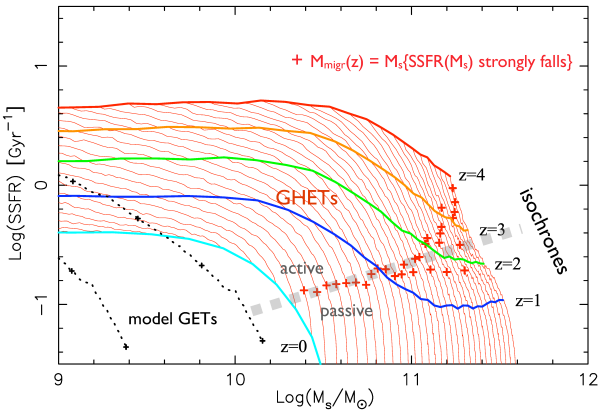

Fig. 4. Predicted average SSFR-$M_{\rm s}$ tracks (assuming negligible $M_{\rm s}$ growth by mergers; solid thin red curves, from FA10). The thick solid curves connect the individual tracks at a given z (isochrones). The crosses show when a given track strongly falls – the galaxy becomes passive. The mass $M_{\rm s}$ at this epoch is called $M_{\rm migr}$.

$M_{\rm s}(z) < 3\times10^{10}\ M_\odot$, their halo MAHs at later epochs grow slightly slower as smaller is the mass, while their stellar GHETs grow much faster. For $M_{\rm s}(z=0) > 3\times10^{10}\ M_\odot$, as the system is more massive, the stellar assembly of the galaxy occurs earlier in time with respect to the corresponding halo.

3.1. *Predictions*

SSFR histories.- By using the GHETs, the specific $M_{\rm s}$ growth rate histories, $\dot{M}_{\rm s}(z)/M_{\rm s}(z)$, can be calculated. If as a working hypothesis one assumes that the $M_{\rm s}$ growth of a given galaxy is only due to local SF, then its SSFR history is $\dot{M}_{\rm s}(z)/M_{\rm s}(z)$ divided by $(1-R)$, where $R\approx0.4$ is the gas recycling factor due to stellar mass loss. In Figure 4 we reproduce the individual average SSFR tracks in the SSFR vs $M_{\rm s}$ diagram as obtained in FA10 (thin red solid lines): the SSFR of low-mass galaxies decreases with time slowly, their late $M_{\rm s}$ growth being very fast, while for large galaxies, the SSFR decreases very fast and their $M_{\rm s}$ growth practically stops at late epochs.

The thick solid lines correspond to isochrones at $z=0,1,2,3$ and 4, from bottom to top, respectively. These isochrones are the SSFR-$M_{\rm s}$ relations at the given z and can be compared with the direct determinations mentioned in § 2.3. Within the current large uncertainties and sample selection effects, the GHET-based and directly determined average SSFR-$M_{\rm s}$ relations out to $z\sim2$ are in reasonable agreement. If any, the former are shallower than the latter at the low-mass side; at low z, the predicted SSFRs for intermediate masses ($M_{\rm s}\sim0.7-2\times10^{10}\ M_\odot$) are slightly larger than the averages of those directly measured. It is important to note that the fast decreasing in the SSFR-$M_{\rm s}$ relations (isochrones) seen at the high-mass side is associated to passive (red) galaxies. Most of the SSFR-$M_{\rm s}$ relations presented in the literature refer to only star-forming (blue) galaxies; for masses lower than $M_{\rm s}\approx2-3\times10^{10}M_\odot$, blue galaxies by far dominate in number, but at high masses passive (red) galaxies become dominant (e.g., Bell et al. 2003; Salim et al. 2007; Pozzetti et al. 2010). In the works where the samples were partitioned by color, the SSFR-$M_{\rm s}$ relation of the red galaxies is inferred indeed very steep (e.g., Bell et al. 2007; Karim et al. 2011).

Downsizing of the migration (quenching) mass.- The GHET-based SSFRs can be used to calculate the z at which the SSFR as a function of $M_{\rm s}$ for a given track decreases dramatically (the galaxy migrates to the passive sequence). The crosses in Figure 4 show, for each track, the $M_{\rm s}$ attained by the galaxy at this epoch, i.e., at each epoch there is a mass $M_{\rm migr}$ at which galaxies on average came to be passive (Figure 5). The solid line in Figure 5 is a by-eye linear fit to the data: $\log(M_{\rm migr}/M_\odot) = 10.30+0.55z$, i.e., the population migration progresses from massive systems at high z to less massive systems at lower z ('population downsizing'). Is there evidence from direct observations of a migration mass to the passive population as a function of z? As mentioned in § 2.3, observations allow now