The global and local stellar mass assembly of galaxies from the MaNGA survey

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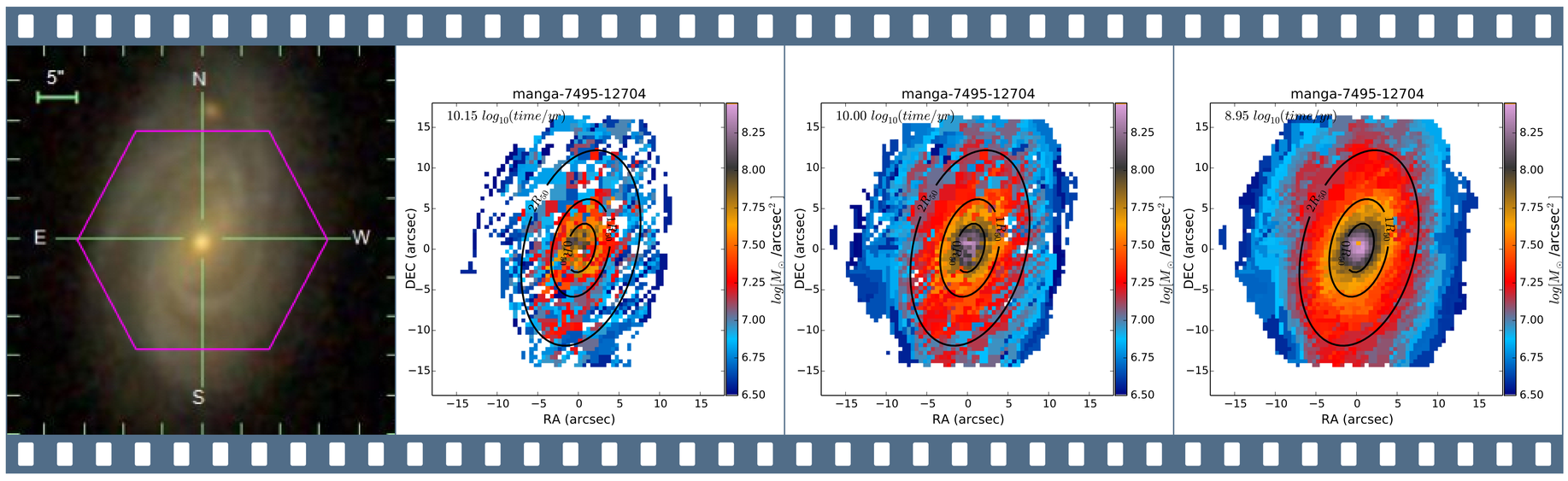
1.-Abstract

By means of the fossil record method implemented through Pipe3D we reconstruct the global and radial stellar mass growth histories (MGHs) of a large sample of galaxies in the mass range $10^{8.5}\mathcal{M}_{\odot}$–$10^{11.5}\mathcal{M}_{\odot}$ from the MaNGA survey. We find that: (1) The main driver of the global MGHs is mass, with more massive galaxies assembling their masses earlier (downsizing). (2) For most galaxies in their late evolutionary stages, the innermost regions formed earlier than the outermost ones (inside-out). This behaviour is stronger for blue/late-type galaxies.

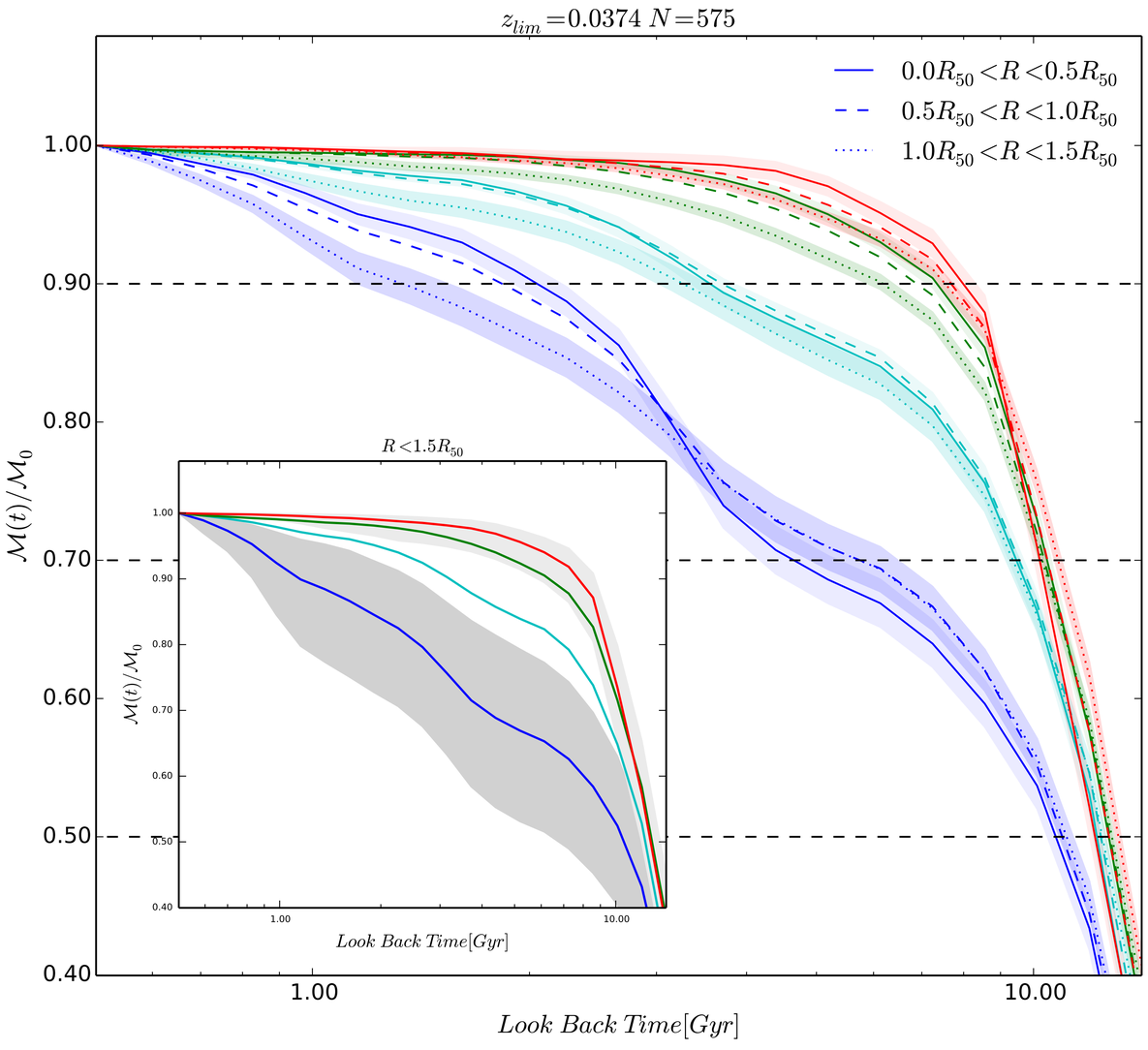
2.-Method



We can resolve multiple mass growth histories (MGHs) along the galaxy radial distribution. To quantify the MGH, we integrate the accumulative mass maps (as a function of the look backtime) at three radial regions ($R < 0.5R_{50}$, $0.5R_{50} < R < R_{50}$ and $R_{50} < R < 1.5R_{50}$). We obtain the stellar mass maps at different time steps by using the stellar population synthesis code Pipe3D (Sánchez et al. 2015a,b).

3.-Results

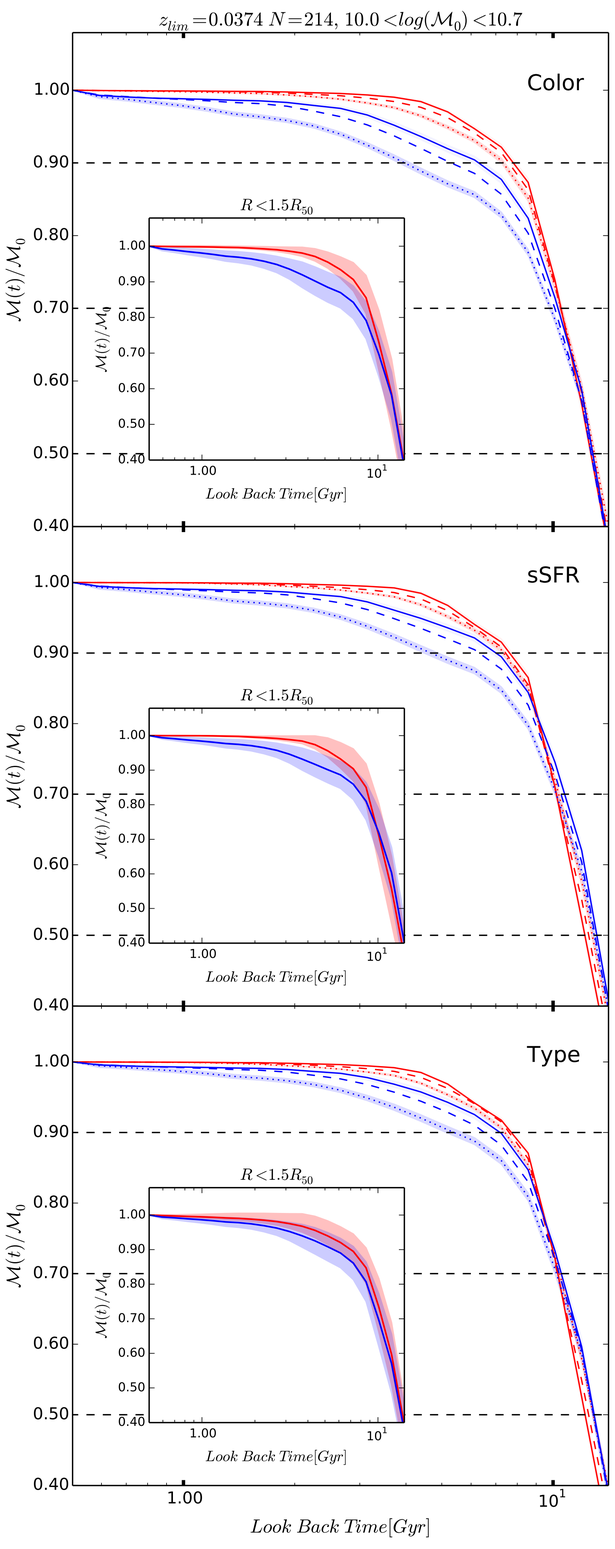
Mean MGHs in Stellar Mass Bins



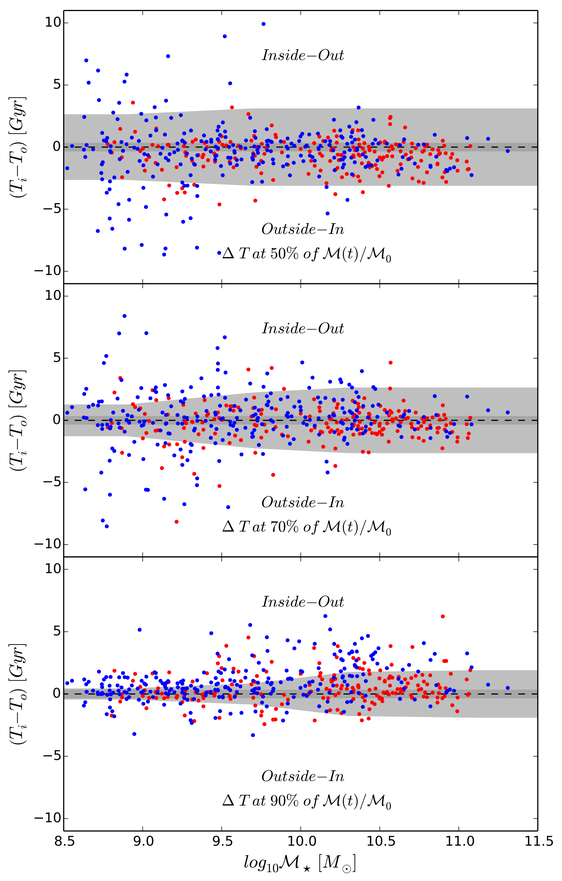
Upper panel Mean stellar MGHs obtained from the truncated method with $z_{\rm lim} = 0.037$. The main panel shows the stacked MGHs at three galaxy radial regions, and for four mass bins: $10^{8.5} < \mathcal{M}_0/\mathcal{M}_{\odot} < 10^{9.3}$ (blue colors), $10^{9.3} < \mathcal{M}_0/\mathcal{M}_{\odot} < 10^{10.0}$ (cyan colors), $10^{10.0} < \mathcal{M}_0/\mathcal{M}_{\odot} < 10^{10.7}$ (green colors), and $10^{10.7} < \mathcal{M}/\mathcal{M}_{\odot} < 10^{11.5}$ (red colors). The shaded areas represent the errors on the mean per each mass bin. The inset panel shows the global mean MGHs integrated within $R < 1.5R_{50}$ and the standard deviations (shaded regions; only for the lowest and highest mass bins). The color code is the same as in the main panel.

Right/Central panel Mean stellar MGHs segregated by color, sSFR, and morphology for galaxies in the $10^{10} - 10^{10.7}$ $\mathcal{M}_{\odot}$ mass bin. The line type code is the same as in the Upper panel. Red lines are for red/quiescent/early-type galaxies and blue lines for blue/star forming/late-type galaxies.

Dependence of the MGHs on galaxy properties



Individual mass assembly gradients



Upper panel Difference on the formation times for the inner and outer regions ($\Delta T_{\rm i-o} = T_i - T_o$) when the MGHs reaches their 50%, 70% and 90% of their total masses. For both panels, the blue points represent the selected blue galaxy sample whereas the red points represent the red galaxy sample. The light grey area represents the not resolved time region of the archaeological method. The dark grey region represents the galaxy mixed time (300 Myr).

4.-Conclusions

- The larger the final galaxy mass, the earlier on average was assembled most of this mass. On the other hand, in a given mass bin, red/quiescent/early-type galaxies assemble on average their masses earlier than blue/star forming/late-type ones. However, these differences are not so large as those among the different mass bins.
- Most of galaxies in all the mass bins show that in the late evolutionary stages (or high fractions of assembled mass) the innermost regions formed earlier than the outermost ones (inside-out formation mode). At earlier stages (lower assembled mass fractions), this trend tends to disappear.
- The way galaxies assemble their mass radially depends more on the galaxy color/type than on its mass: blue/star forming/late-type galaxies follow on average a more regular and significantly more pronounced inside-out formation mode than red/quiescent/early-type galaxies. For red/quiescent/early-type galaxies, the outermost MGHs present a large diversity of shapes, in many cases with signs of older stellar populations than in the innermost regions.
- The values of $\Delta T_{\rm i-o}$ present a large variation from galaxy to galaxy at early epochs, when the corresponding innermost/outermost mass fractions are 50-70%. The more massive the galaxy, the more common is the trend of transiting from outside-in/flat gradient mode to inside- out mode: from $\sim 40\%$ for dwarfs to $\sim 75\%$ for the most massive galaxies.