The link between star formation activity and galaxy morphology through cosmic time

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Studies of the cosmic star formation rate density (CSFR; Madau & Dickinson 2015) reveals that the galaxies around 8-10 Gyr ago were forming stars at larger rates than galaxies today. A key step to explain such decline in the CSFR history (of almost one order of magnitude) is the understanding of the physical processes responsible for the regulation of the star formation rate in galaxies, and their evolution with redshift. At the same time, these processes have to explain the observed $z \sim 0$ relation between the morphology of galaxies and their star formation activity, with passive galaxies being mostly bulge-dominated, and star forming one being mostly disk dominated. A fundamental tool to study the drivers of star formation activity is the Main Sequence (MS; Noeske et al. 2007a, Speagle et al. 2014; Renzini & Peng 2015) of star forming galaxies: a correlation in place up to $z \sim 2$ between the stellar mass (M*) and the SFR of galaxies. Using a sample of low redshift galaxies drawn from SDSS, Morselli et al. (2017) showed that the MS corresponds, at every stellar mass, to the minimum of the B/T distribution; galaxies in the lower and upper envelopes of the MS have larger bulges than MS counterparts at fixed M*. At the same time, the analysis of the (g-r) colour and dust content of the individual bulges and disks, revealed that galaxies with the higher SFRs not only are more bulge dominated, but their bulges are consistent with being star forming, while MS bulges are mostly red and dead. On the other hand, the reddening of the disk components is responsible of the location of a galaxy in the lower envelop of the MS.

In Morselli et al. (in prep) we used galaxies in the Hubble Deep UV survey (HDUV; Oesch et al., sub) to extend at larger redshifts the study of the role of the central component in locating a galaxy around the MS. The HDUV survey consists of deep, high spatial resolution UV images of the central parts of the GOODS fields, obtained in F275W and F336W. We focus on galaxies that are in the range $0.2<z<1.2$ and with LogM*>9.5Mo. Using the MS of Karim et al. (2011) we located galaxies in the DeltaMS (distance from the MS) - M* plane, and divided our sample in 6 bins according to the distance from the MS. Fig. 1 shows the median sSFR profiles of galaxies in bins of stellar mass and redshift for the galaxies at a certain distance from the MS. The sSFR of the inner part of the galaxy (R<~1Re) drops significantly, up to 2-2.5 orders of magnitude, when going from the upper envelop of the MS to the passive region, while at larger radii, the maximum difference is lower than one order of magnitude.

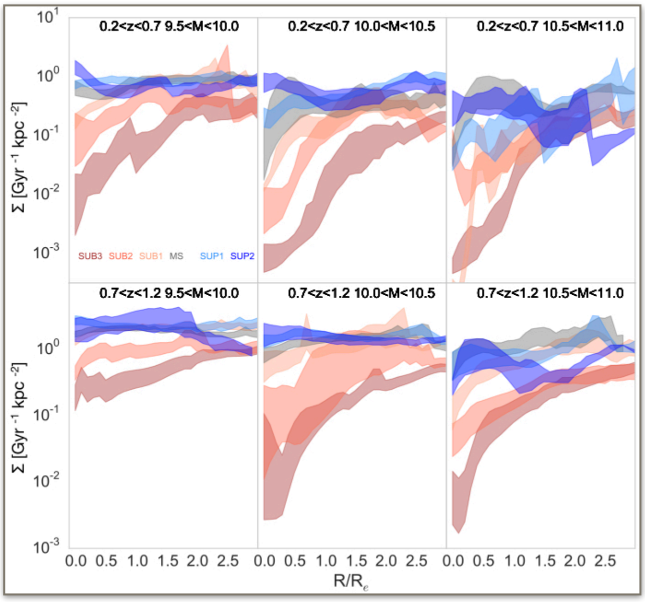

Fig.1: sSFR profiles of galaxies in bins of M and redshift, color coded as a function of the distance to the MS: from red (passive and lower MS envelop), to grey (MS), and blue (upper MS envelop).*

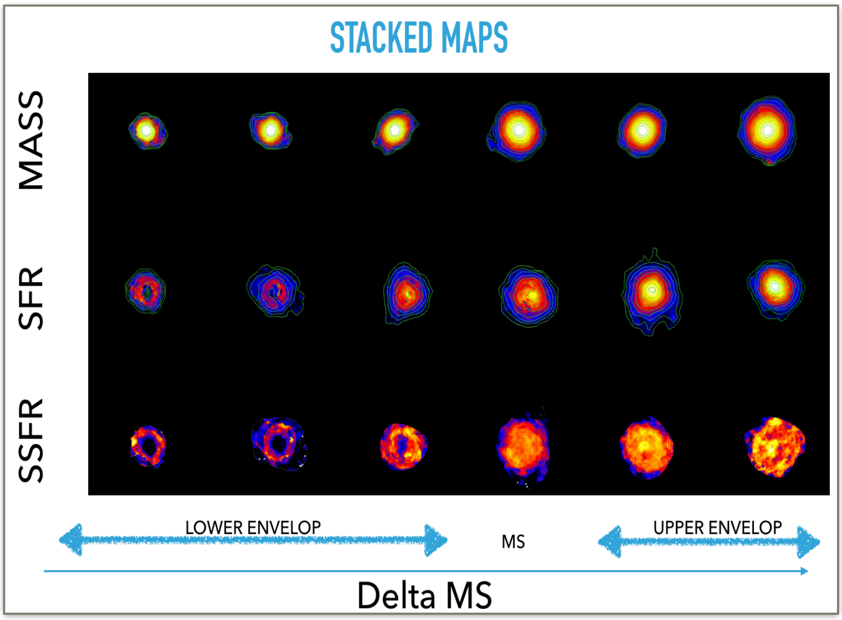

Fig.2: stacked maps of mass, SFR, and sSFR for galaxies as a function of their distance from the MS.

Such trends of the sSFR point towards a critical role of the star formation in the inner part of a galaxy in moving it from the MS to its lower envelop. On the other hand, the mass profiles reveal that galaxies in the upper and lower envelops of the MS do now show significant differences, contrary to what observed at low z. Fig. 2 shows the stacked maps of mass, SFR, and sSFR for galaxies in a narrow redshift range, as a function DeltaMS. Both the SFR and sSFR maps show how the SFR in the central part of galaxies increases significantly with increasing SFRs. Such behaviour is consistent with the inside out quenching picture.

References: Karim et al., ApJ, 2011; Madau & Dickinson, ARAA, 2015; Morselli et al., A&A, 2017; Noeske et al., ApJ, 2017; Renzini & Peng, APJ, 2015; Speagle et al., ApJS, 2014.