The dependence of star formation activity of z<1 galaxies on stellar mass surface density and Sersic index

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Motivation and zCOSMOS sample

- What physical processes inside galaxies drive changes in the SFRs in individual galaxies that, taken together, produce the large decline in the global SFR density since z~2?
- Many studies at intermediate redshifts of the SFR or specific SFR (SSFR) have been made as a function of stellar mass, but not using information on the internal structural properties of galaxies
- Studies using the local SDSS sample (Brinchmann et al. 2004, MNRAS, 351, 1151) argued that the surface mass density (Ω_m) may be more important than stellar mass in regulating star formation
- Using zCOSMOS and SDSS: study the changes that have occurred in the SSFR - ΔM relation between redshift z~1 and the present epoch, selecting comparable mass-complete samples at 0.04<z<0.08 and 0.5<z<0.9
- zCOSMOS: large redshift survey covering 1.5 deg² of ACS COSMOS field (Lilly et al. 2007, ApJS, 172, 70)

zCOSMOS: stellar mass completeness

- Specific SFR versus stellar mass as a function of Sersic indices for ~3000 zCOSMOS galaxies at 0.5<z<0.9
- The inverse of the SSFR, T_{SSFR}, is the time required for the galaxy to form all its stellar mass at the current SFR
- The large magenta circles indicate the completeness limit of the sample → logM=10.4 for 0.5<z<0.7, and logM>10.7 for 0.7<z<0.9
- Galaxies with different Sersic indices have different star formation histories: T_{SSFR} - age of the universe (below magenta lines) for quiescent galaxies (higher SFR in the past) → mostly early-type n>2.5 galaxies

SDSS: SSFR – stellar mass density relation

- Specific SFR versus stellar mass surface density (Ω_m) as a function of Sersic indices for SDSS galaxies at 0.04<z<0.08 with logM>10.4
- The characteristic step-function dependence of the SSFR for the entire sample is due to the change-over from predominantly disk galaxies to predominantly spheroid galaxies at log Ω_m=8.5
- This change-over is clearly seen in Fig. 5: the fraction of n<1.5 SDSS objects shows a sharp increase at the point where the SSFR abruptly changes, i.e. at 2(Massive)=8.45 (dashed magenta vertical line in Fig.5)

SSFR – stellar mass density relation at z<1

- The characteristic step-function dependence of the median SSFR on Ω_m in SDSS, seen by Brinchmann et al. (2004), is due to the change-over from predominantly disk galaxies to predominantly spheroidal galaxies at the surface mass density logΩ_m=8.5 at which the SSFR is seen to drop (Fig. 3 and 5)
- zCOSMOS 0.5<z<0.9 galaxies show a similar shape for the median SSFR-Ω_m relation, but with median SSFR values that are about 5-6 times higher than for SDSS, across the whole range of Ω_m, and in galaxies with both high and low Sersic indices (Fig.4)
- Galaxies of all types are contributing, proportionally, to the global increase in star formation rate density in the Universe back to z~0.7 (Fig.4)
- The Ω_m step shifts to slightly higher values of Ω_m in zCOSMOS relative to SDSS, but this can be explained by a modest differential evolution in the size-mass relations of disk and spheroid galaxies (Fig.2)
- Low Sersic index galaxies have a SSFR that is almost independent of Ω_m, and the same is probably true of high Sersic index galaxies once obvious disk systems are excluded (Fig.4)

Conclusions

- Emission line fluxes and upper limits: derived using the Platefit_VIMOS automatic routine (Lamareille et al. 2008)
- SFRs for both zCOSMOS and SDSS from the [OII]3727 emission line at 0.5<z<0.9 using Moustakas et al. (2006, Apj), 642, 775 conversion
- Stellar masses from restframe U-V and B-V colors using the Lin et al. (2007, Apj, 660, 51) color-M/L conversion (which corrects for redshift evolution) for both zCOSMOS and SDSS to achieve internal consistency
- Sizes (half-light radii) and Sersic indices: for zCOSMOS from Sersic fits using GIM2D surface brightness fits (Sargent et al. 2007, Apj, 172, 434)

Stellar mass – size relation at z<1

- Semi-major half-light radius versus stellar mass for the mass-complete galaxy samples at 0.5<z<0.7 (zCOSMOS) and 0.04<z<0.08 (SDSS)
- For n<1.5 galaxies there is little change in the size – mass relation
- For n=2.5 there is modest evolution in the size-mass relation, with galaxies smaller by ~25% at z~0.7 compared to local SDSS galaxies
- The modest differential evolution in the size-mass relation of disk and spheroid galaxies can explain the shift in the ΔM_char step (see Fig. 4)

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