SDSS-IVMaNGA: Effects of Morphology in the global and local Star Formation Main Sequences

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Cano-Diaz et al. 2019, arXiv:1907.04386

ABSTRACT

We study the global star-formation rate (SFR) vs. stellar mass (M_*) correlation, and the spatially-resolved SFR surface density (Σ_{SFR}) vs. stellar mass surface density (Σ_*) correlation, in a sample of ~ 2,000 galaxies from the MaNGA MPL-5 survey. We classify galaxies and spatially-resolved areas into star-forming and retired according to their ionization processes. We confirm the existence of a Star-Forming Main Sequence (SFMS) for galaxies and spatially-resolved areas, and show that they have the same nature, with the global as a consequence of the local one. The latter presents a bend below a limit Σ_*value, $\approx 3\times10^7$ $M_\odot kpc^{-2}$, which is not physical. Using only star-forming areas (SFAs) above this limit, a slope and a scatter of $\approx$ 1 and $\approx$ 0.27 dex are determined. The retired galaxies/areas strongly segregate from their respective SFMS's, by ~ −1.5 dex on average. We explore how the global/local SFMS's depend on galaxy morphology, finding that for star-forming galaxies and SFAs, there is a trend to lower values of star-formation activity with earlier morphological types, which is more pronounced for the local SFMS. The morphology not only affects the global SFR due to the diminish of SFAs with earlier types, but also affects the local SF process. Our results suggest that the local SF at all radii is established by some universal mechanism partially modulated by morphology. Morphology seems to be connected to the slow aging and sharp decline of the SF process, and on its own it may depend on other properties as the environment.

銀河の重要な物理量であるSFR, M*と形態の関係
SFMSはlate-typeメインでpassive sequenceはearly typeメイン
global, localに考えることでquenching の物理などに迫れるかも

MaNGAから1754の銀河
inclination <60deg
2,126,380のresolved area
ionization processで分類

class	EW(Hα)	BPT
AGN	> 6AA	AGN
SF (SFG/SFA)	> 6AA	SF
Passive (RG/RA)	< 3AA	-
unclassified	3-6 AA	-

[global] (table1)
MorphologyごとにSFMS
earlyなものの方が
- 低めのSFR
- shallowなslope

⇒ SFHの違い(主にはgas fraction?SFE?)

[resolved] (table2)
globalでのSFMSのmorphologyによる違いはlocalでもあるか(もしないならglobalな違いはSFAの割合の違い)
- normalizationがlate→earlyで単調減少

⇒ morphology(and/or それに関わる何かしら物理量)はlocalな星形成にも影響を及ぼす(主にはgas fraction?SFE?)

[memo]
SFAはほぼSFG(98.7%)
RAは様々
(SFG12.8% RG85.7% AGN1.5%)
RAを含むSFGはquenchの最中？

[memo]
Late-typeにRetired Galxies (RG)はいない(0.2%)
Early-typeにはそれなりにSFGがいる(18.2%)
AGN, unclassifiedは中間位置

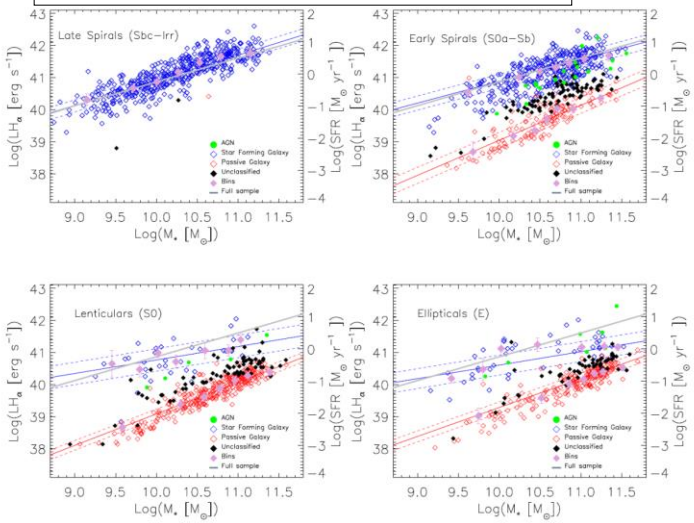

Figure 8. Global SFR-M_* diagram for sub-samples segregated by morphology: late types on the top and early types at the bottom. The nomenclature adopted in the different panels is the same as in Figure 5.

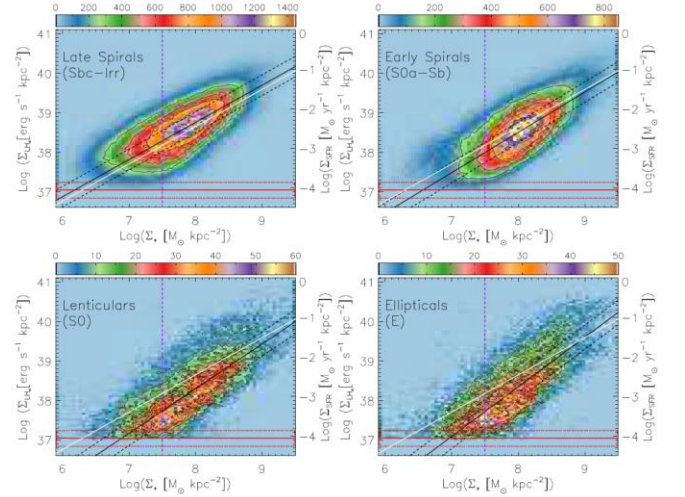

Figure 9. Local $\Sigma_{SFR}-\Sigma_*$ diagram for SFAs of the different galaxies segregated by morphology: Late types at the top, and early types at the bottom. The contours and color-image represent the density of points, following the same nomenclature used in Fig. 6. The best fitted linear regression is represented as a black solid line, and its dispersion with dashed black lines; the average detection limit is represented with horizontal red solid line, enclosed by the region that represents its 2-σ scatter. As a comparison, we show the fit to the full sample of areas with the white solid line, which is the one plotted in Figure 7 with black color. Finally the cut in Σ_* used for the fits is represented with the vertical dashed line.

table 2 Local relation for SFA

$\Sigma_{SFR}-\Sigma_*$ SFGs/SFAs Relations	Pearson Correlation Coeff. (ρ)	Confidence Interval ρ 99%	Slope	$\log(\Sigma_{SFR})_{8M_\odot Kpc^{-2}}{}^*$ ($M_\odot$ yr^{-1} Kpc^{-2})	Standard Deviation (σ)
SFGs Global	0.60	(0.55, 0.66)	0.66±0.10	-2.34±0.86	0.23
SFAs Full sample	0.62	(0.62, 0.62)	0.94±0.08	-2.48±0.69	0.27
SFAs E	0.71	(0.70, 0.72)	1.26±0.07	-2.73±0.63	0.31
SFAs S0	0.72	(0.71, 0.73)	1.13±0.06	-2.80±0.56	0.31
SFAs S0a-Sb	0.68	(0.68,0.68)	1.02±0.07	-2.60±0.61	0.26
SFAs Sbc-Irr	0.62	(0.62,0.62)	0.94±0.08	-2.36±0.70	0.26
SFAs CALIFA†	0.63	(0.62, 0.63)	0.72±0.04	-2.19±0.33	0.16

減少

table 1 Global relation

SFMS	Pearson Correlation Coeff. (ρ)	Confidence Interval ρ 99%	Slope	$\log(SFR)^*_{10.5M_\odot}$ $\log(M_\odot\ yr^{-1})$	Standard Deviation (σ)	No. of galaxies in the relation
Full Sample	0.76	(0.72, 0.80)	0.74±0.01	0.13±0.05	0.23	892
E	0.67	(0.39, 0.83)	0.42±0.01	-0.29±0.14	0.31	45
S0	0.57	(0.19, 0.81)	0.42±0.02	-0.13±0.22	0.35	34
S0a-Sb	0.73	(0.66, 0.79)	0.68±0.01	0.12±0.07	0.22	357
Sbc-Irr	0.85	(0.81, 0.88)	0.79±0.01	0.20±0.06	0.19	456
CALIFA†	0.84	(0.76, 0.89)	0.81±0.02	0.16±0.21	0.20	
RP15††	-	-	0.76±0.01	0.34±0.03	-	

減少

RGs Relation	Pearson Correlation Coeff. (ρ)	Confidence Interval ρ 99%	Slope	$\log(SFR)^*_{10.5M_\odot}$ $\log(M_\odot\ yr^{-1})$	Standard Deviation (σ)	No. of galaxies in the relation
Full Sample	0.89	(0.87, 0.91)	1.09±0.01	-1.55±0.06	0.18	616
E	0.90	(0.86, 0.93)	0.90±0.01	-1.37±0.10	0.17	196
S0	0.92	(0.89, 0.94)	0.98±0.01	-1.53±0.08	0.15	290
S0a-Sb	0.82	(0.72, 0.88)	1.09±0.01	-1.51±0.13	0.25	129
Sbc-Irr	-	-	-	-	-	1
CALIFA†	0.85	(0.77, 0.90)	0.86±0.02	-1.29±0.26	0.22	