GASP. XX. From the loose spatially-resolved to the tight global SFR-Mass relation in local spiral galaxies

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ABSTRACT

Exploiting the sample of 30 local star-forming, undisturbed late-type galaxies in different environments drawn from the GAs Stripping Phenomena in galaxies with MUSE (GASP), we investigate the spatially resolved Star Formation Rate-Mass (Σ_{SFR}-Σ_*) relation. Our analysis includes also the galaxy outskirts (up to > 4 effective radii, r_e), a regime poorly explored by other Integral Field Spectrograph surveys. Our observational strategy allows us to detect Hα out to more than $2.7r_e$ for 75% of the sample. Considering all galaxies together, the correlation between the Σ_{SFR} and Σ_* is quite broad, with a scatter of 0.3 dex. It gets steeper and shifts to higher Σ_* values when external spaxels are excluded and moving from less to more massive galaxies. The broadness of the overall relation suggests galaxy-by-galaxy variations. Indeed, each object is characterized by a distinct Σ_{SFR}-Σ_* relation and in some cases the correlation is very loose. The scatter of the relation mainly arises from the existence of bright off-center star-forming knots whose Σ_{SFR}-Σ_* relation is systematically broader than that of the diffuse component. The Σ_{SFR}-$\Sigma_{tot\,gas}$ (total gas surface density) relation is as broad as the Σ_{SFR}-Σ_* relation, indicating that the surface gas density is not a primary driver of the relation. Even though a large galaxy-by-galaxy variation exists, mean Σ_{SFR} and Σ_* values vary of at most 0.7 dex across galaxies. We investigate the relationship between the local and global SFR-M_* relation, finding that the latter is driven by the existence of the size-mass relation.

銀河を空間分解した$\Sigma_{SFR} - \Sigma_*$関係が存在し、globalな関係との類似性などが議論されてきた。
⇒銀河をより裾野のほうまで見る & SF knotとdiffuse componentに分けて考えてみる。

[data]
MUSEのlarge programme GASPから30 local undisturbed late-type galaxies: 92020 star forming spaxels
GASP論文によると… 0.04 < z < 0.1, 空間分解能は~ 1kpc

[主な結果]
1. resolved SFMSの分散が大きく、外側のspaxelを除き大質量の銀河のみ考えると高Σ_*側で傾きが急になる。
   ⇒銀河ごとに関係が大きく違う。外側は違う性質を持つ？
2. 銀河個々に相関が違う(中には相関がないものもある)
   ⇒ユニバーサルな星形成関係は存在しない、globalな関係は様々なnomalizationの重ねあわせによるもの。
   ⇒ばらつきはSF knotによるもので、そのような星形成(Ha)の強い領域に銀河全体の測定値が影響を受けることを示唆。
3. それぞれの銀河で平均したΣ_*とΣ_{SFR}を求めると、よく似た値になる & サイズの大きい銀河ほどglobal SFMSで右上に来る。
   ⇒SFMSはsize-mass relationによって形成されている。

1

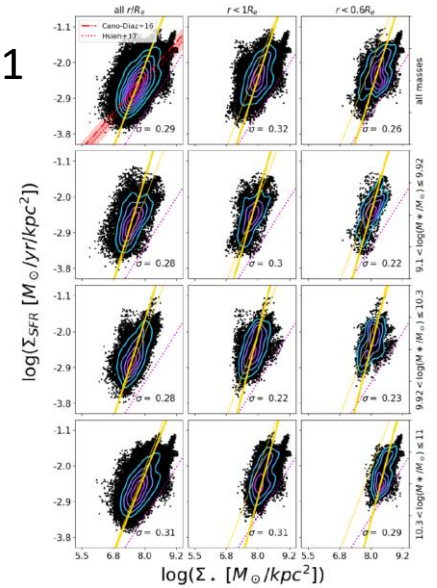

Figure 3. Spatially resolved SFR-M_* relation using all spaxels of all galaxies in the sample (left), the spaxels within $1r_e$ (central) and the spaxels within $0.6r_e$ (right), both for all galaxies together (upper row) and for galaxies in three different mass bins, as indicated in the left labels. Thick gold lines show the fit to the relation, the thin gold line shows the fit obtained in the first panel, for comparison. In the first panel, results from Cano-Díaz et al. (2016); Hsieh et al. (2017) are reported in red, for comparison, after converted to the same IMF. Contours identify regions characterised of similar density of points. The magenta dotted line represents the effective threshold in spatially resolved specific SFR entailed by the adopted cuts in S/N corresponds to $10^{-11.3}\,yr^{-1}\,kpc^{-2}$.

2

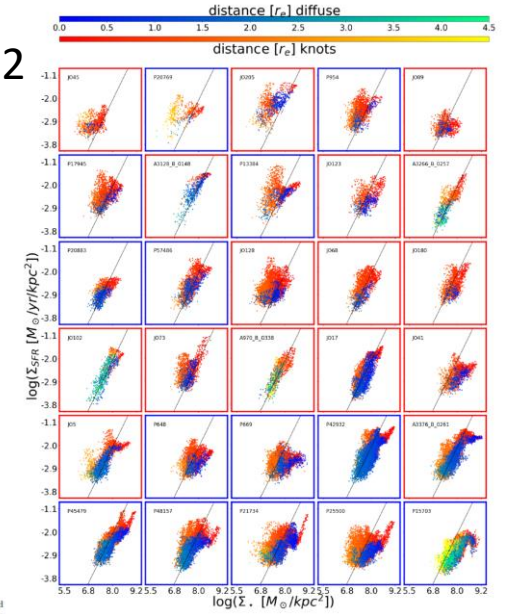

Figure 10. Σ_{SFR}-Σ_* relation for all galaxies in the sample, sorted by increasing stellar mass and colour coded by the distance, in unit of r_e. The diffuse component of the galaxies (removing the Hα knots) is plotted using a blue-green colour-scale, the knots are plotted using a red-yellow colour-scale. Galaxies surrounded by a red square belong to clusters, galaxies surrounded by a blue square belong to the field. The black line represents the fit to the whole sample, from Fig.3.

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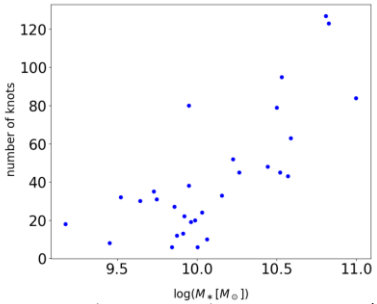
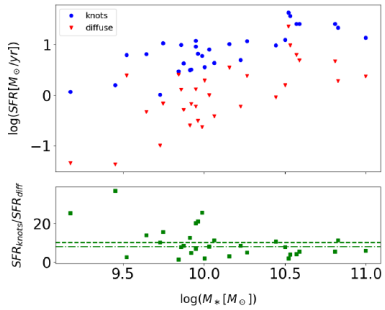


⇒大きい銀河ほどSF knotsが多い



3

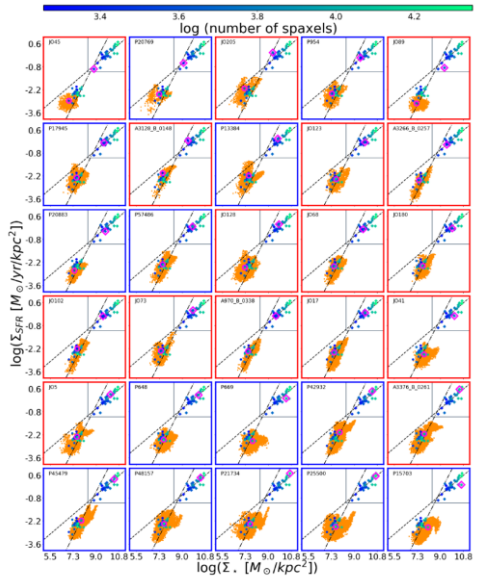


Figure 14. Comparison between the local and the global SFR-M_* relations. In each panel, the Σ_{SFR}-Σ_* relation of the galaxy listed in the upper corner is shown with orange dots. The mean Σ_{SFR} and Σ_* values of the same galaxy is shown with an empty magenta circle. Filled circles show the mean Σ_{SFR} and Σ_* values for all the galaxies. They are colour coded by the number of spaxels in each galaxy and are all the same in all the panels. The axis aligned sub-panels show the global relation, obtained by summing the values of all the spaxels in each galaxy. The x-axis shows the $\log(M_*[M_\odot])$, the y-axis shows the $\log(SFR[M_\odot\,yr^{-1}])$ Filled diamonds are colour coded by the number of spaxels in each galaxy, the empty magenta diamond indicates the position of the galaxy shown in that panel. In all the panels, the dash-dotted line shows the fit from the upper left panel of Fig.3, the dashed line shows the fit to the global SFR-Mass relation. Galaxies surrounded by a red square belong to clusters, galaxies surrounded by a blue square belong to the field.

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