

A PANCHROMATIC DEFINITION OF THE KPC-SCALE RELATION  
BETWEEN STELLAR MASS AND STAR FORMATION  
IN LOCAL GRAND-DESIGN SPIRALS FROM DUSTPEDIA



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APP Poster Whatever, Milan



# WHAT'S THAAAAAA-AAAAAT?

DustPedia

Exploits the legacy of Herschel & Planck

Sample of 875  
Herschel-observed  
galaxies (within 3000  
 $\text{km s}^{-1}$  or 41 Mpc)  
observed in different  
bands (from GALEX  
to Planck)

Best case scenario,  
42 multiwavelength  
data from UV to  
microwave.

DustPedia

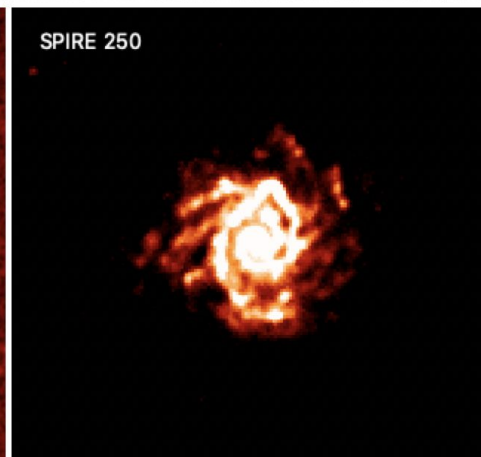
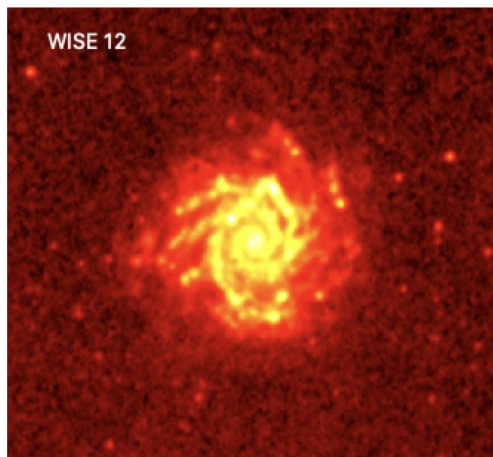
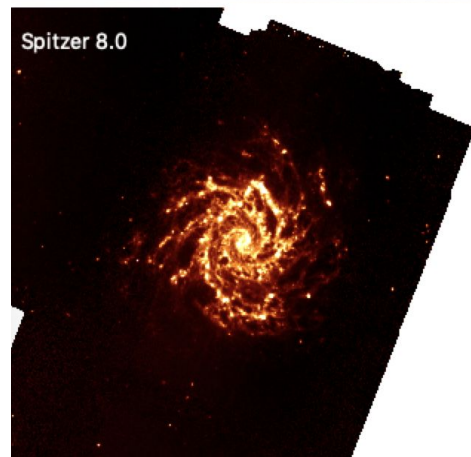
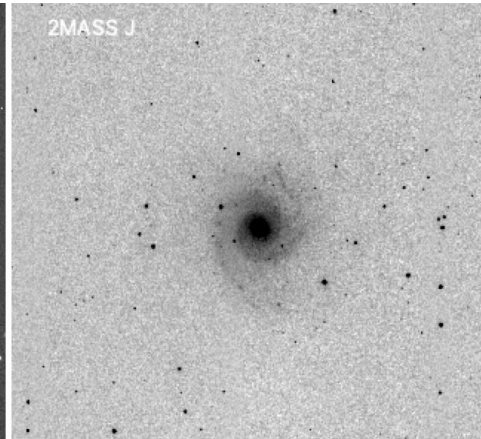
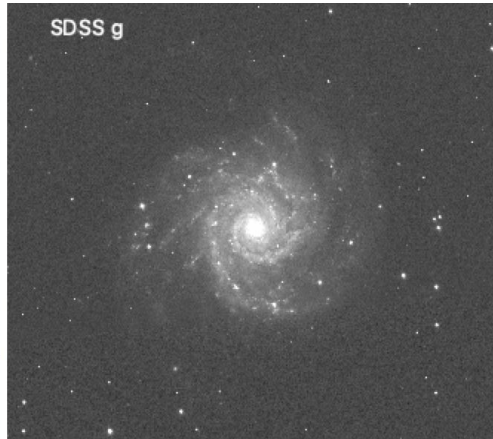
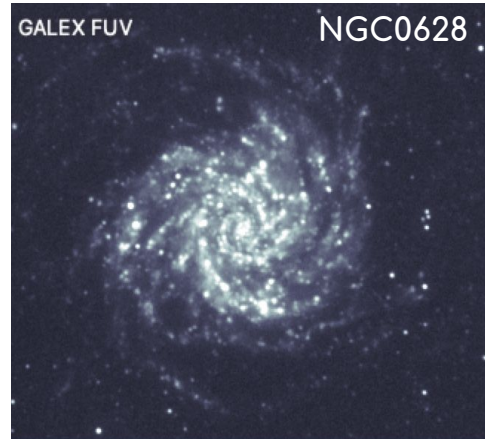


These are all 844 galaxies within 140 million light-years of us (that have angular sizes over  $1''$  a degree) that were observed by the Herschel Space Observatory's SPIRE camera. These images show how these galaxies appear at a wavelength of 250  $\mu\text{m}$  (2000 times longer than what our eyes see). At this wavelength, we observe the thermal glow of the cosmic dust that floats between stars, and cocoons star-formation. In galaxies with no dust, we only see the even more distant galaxies behind.



# AND SO? WHY IS THAT USEFUL TO ME?

The bulk of previous works dedicated to the study of the spatially resolved MS are (mainly) based on emission lines (i.e. H $\alpha$ ) or UV-to-optical tracers to constrain the SFR (see Sanchez+2019 for a review), which is nice but doesn't tell the full story.

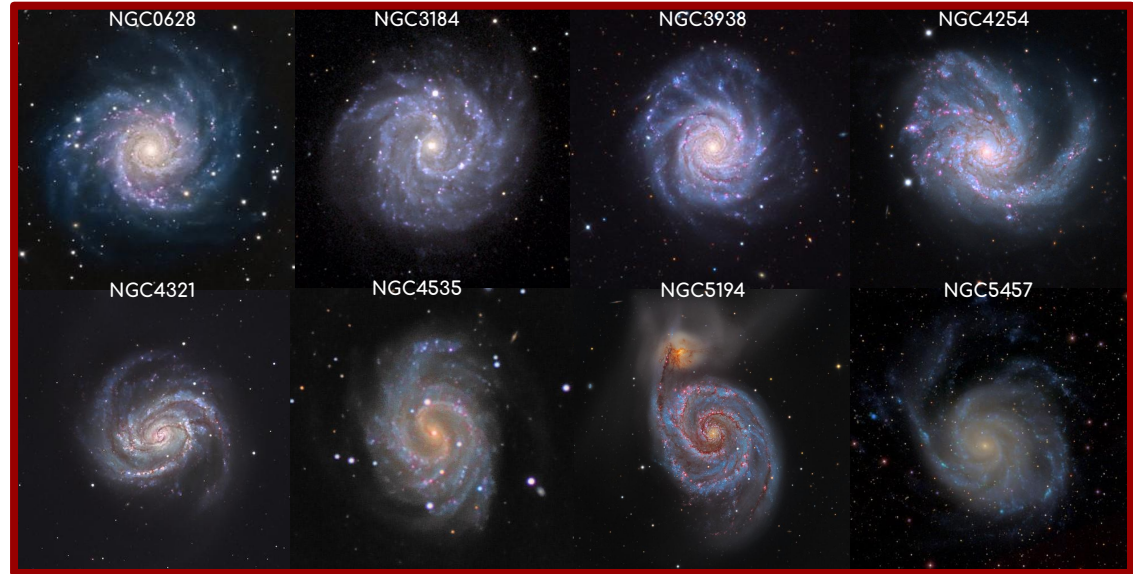


With DustPedia, we can exploit the power of a complete multiwavelength photometric coverage, extending from the far-UV up to the sub-mm, providing an highly reliable measure of the total SFR, accounting for both the observed and obscured component.

# THE SAMPLE

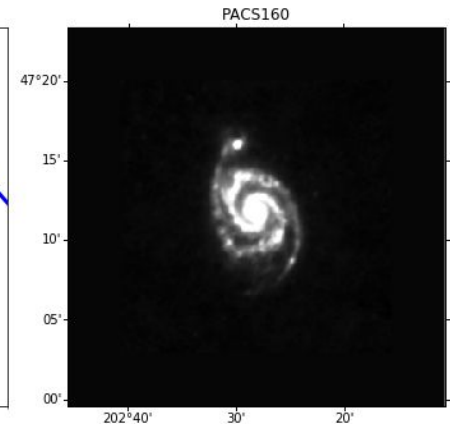
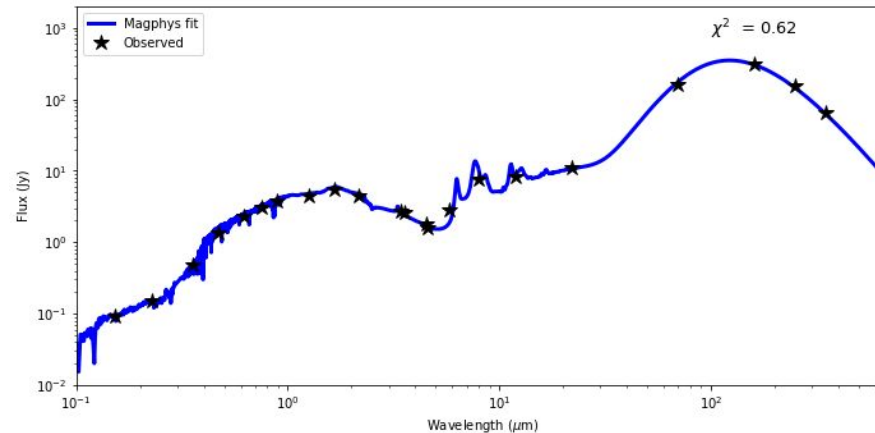
Aim: obtain resolved physical properties of grand design spirals with panchromatic SED fitting.

Conservative sample of nearby face-on spirals, in order to firstly characterize the final products of pure secular evolution processes, i.e. unperturbed disks.



DustPedia sample selection:

- uniform  $\lambda$  coverage
- Late-Type fitting the grand-design definition (more or less)
- since inclination is a pain, zero to moderate  $i < 40^\circ$





## Panchromatic SED modelling of spatially resolved galaxies

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### ABSTRACT

We test the efficacy of the energy-balance spectral energy distribution (SED) fitting code MAGPHYS for recovering the spatially resolved properties of a simulated isolated disc galaxy, for which it was not designed. We perform 226 950 MAGPHYS SED fits to regions between 0.2 and 25 kpc in size across the galaxy’s disc, viewed from three different sight-lines, to probe how well MAGPHYS can recover key galaxy properties based on 21 bands of UV–far-infrared model photometry. MAGPHYS yields statistically acceptable fits to >99 per cent of the pixels within the *r*-band effective radius and between 59 and 77 percent of pixels within 20 kpc of the nucleus. MAGPHYS is able to recover the distribution of stellar mass, star formation rate (SFR), specific SFR, dust luminosity, dust mass, and *V*-band attenuation reasonably well, especially when the pixel size is  $\gtrsim 1$  kpc, whereas non-standard outputs (stellar metallicity and mass-weighted age) are recovered less well. Accurate recovery is more challenging in the smallest sub-regions of the disc (pixel scale  $\lesssim 1$  kpc), where the energy balance criterion becomes increasingly incorrect. Estimating integrated galaxy properties by summing the recovered pixel values, the true integrated values of all parameters considered except metallicity and age are well recovered at all spatial resolutions, ranging from 0.2 kpc to integrating across the disc, albeit with some evidence for resolution-dependent biases. These results must be considered when attempting to analyse the structure of real galaxies with actual observational data, for which the ‘ground truth’ is unknown.

SED fitting performed with MAGPHYS.

Nice work from Smith & Hayward, 2018 on a simulated face-on disk galaxy, showing how well MAGPHYS is able to recover galaxy properties

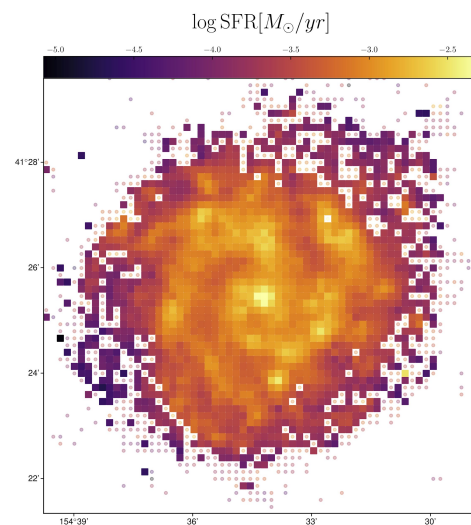
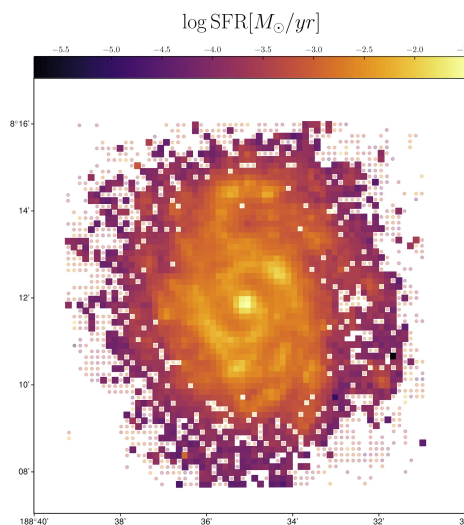
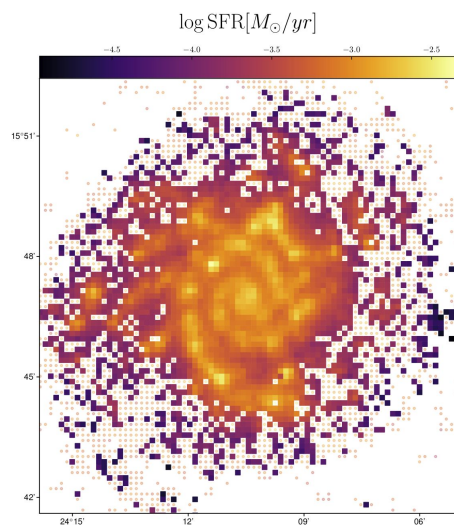
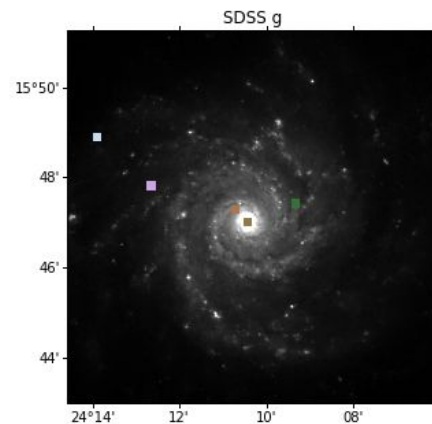
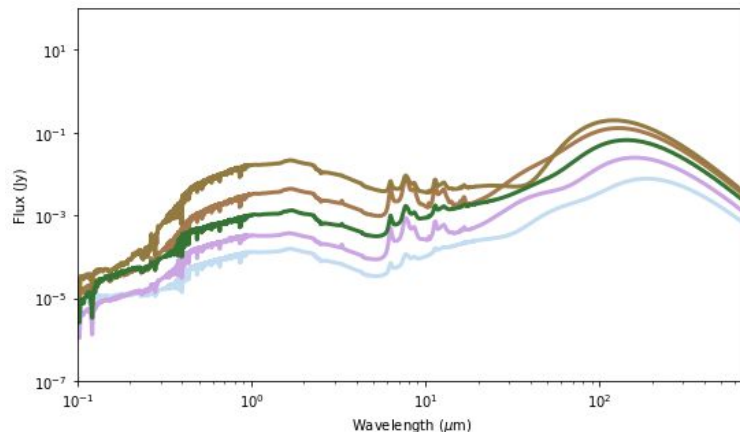


# SED FITTING

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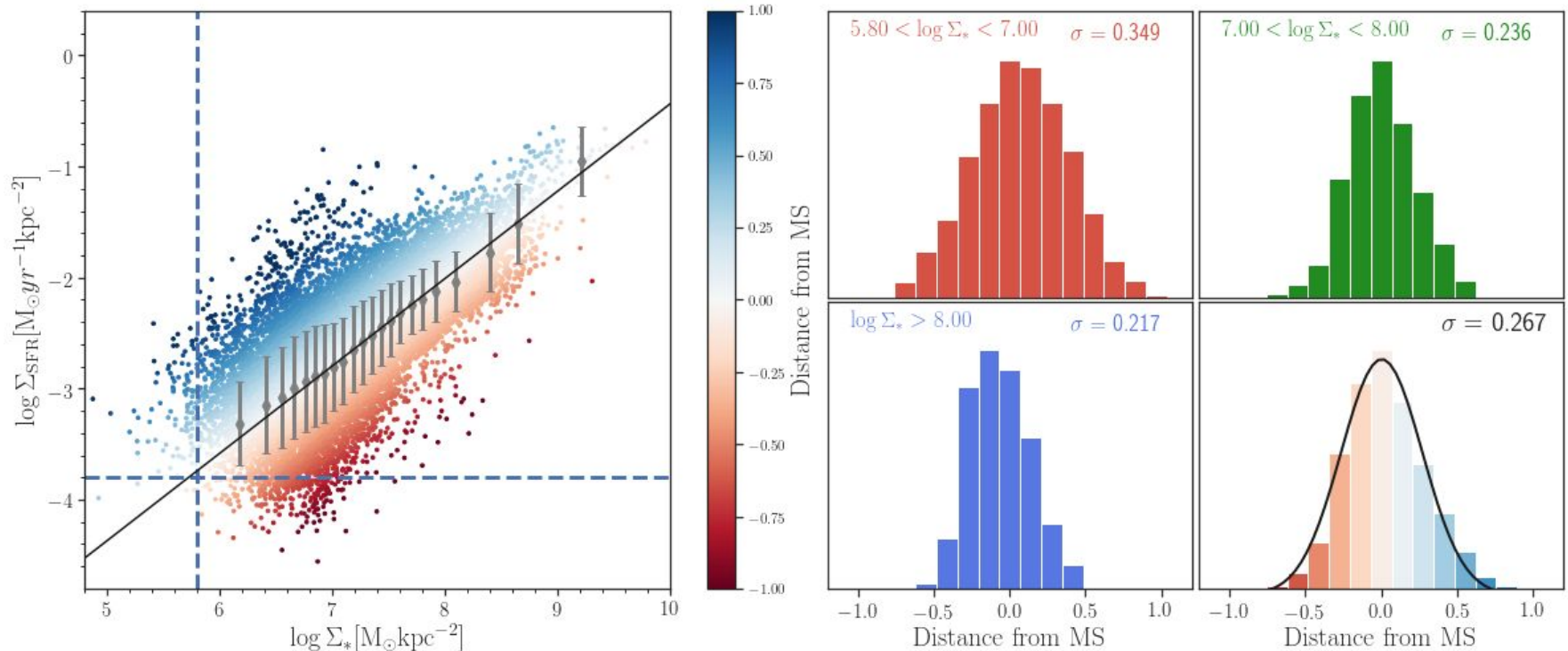
$M_{\text{star}}$  from standard MAGPHYS output, SFRs evaluated from scaling relations on the best-fit SED.



# THE MS

When plotted in the  $\Sigma_{\text{star}}-\Sigma_{\text{SFR}}$  plane, we observe the SFMS. We fit the data (binned in mass, gray points) with a linear relation, obtaining a slope of 0.86 and intercept -8.96. The total distribution of points has a scatter of 0.27 dex, in agreement with previous findings, e.g. Cano-Diaz, et al. (2016, 2019), Abdurro'uf & Akiyama (2017), Hsieh et al. (2017), Hall et al. (2018).

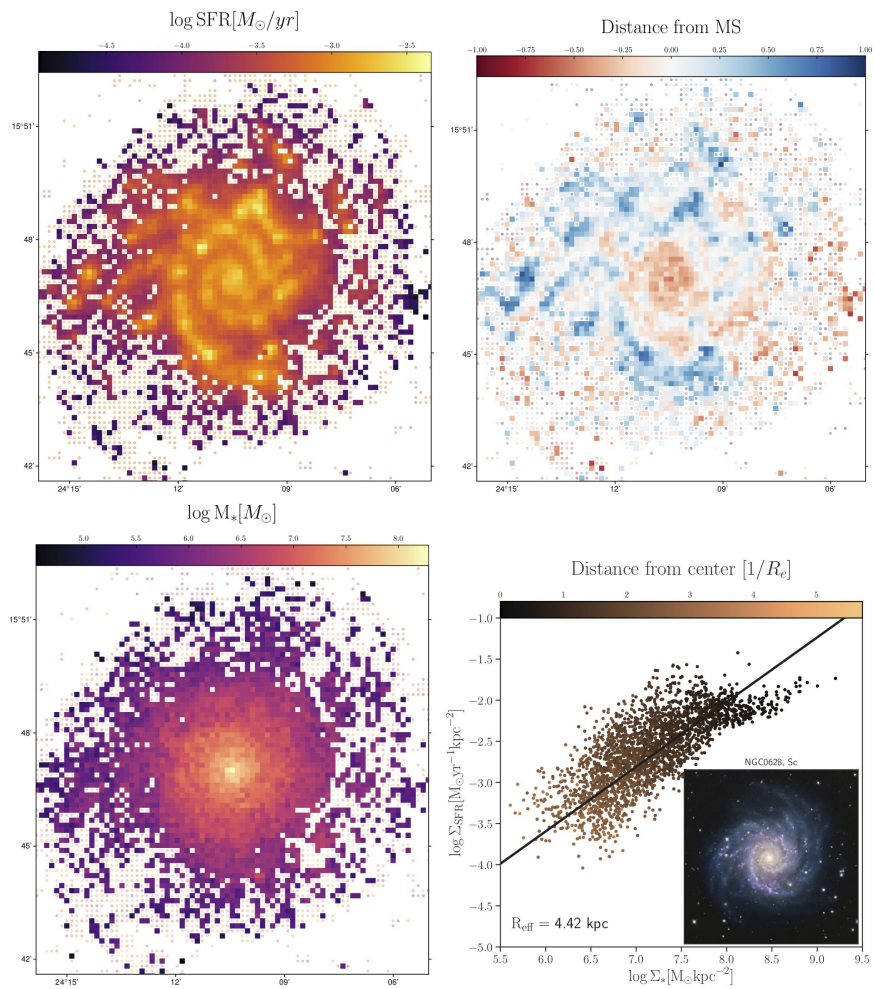
We also checked how the slope changes in three different mass bins (low, intermediate and high mass)



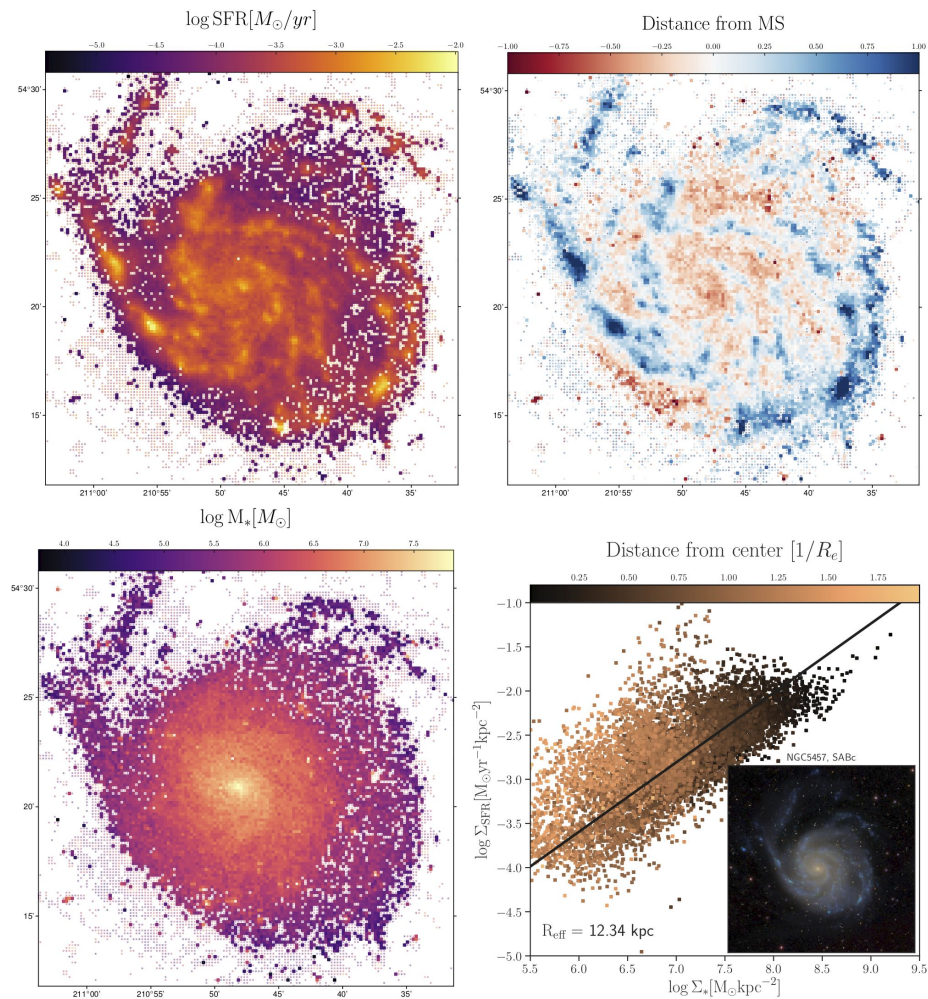
Enia et al., hopefully soon to be submitted

# A COUPLE OF EXAMPLES

NGC0628

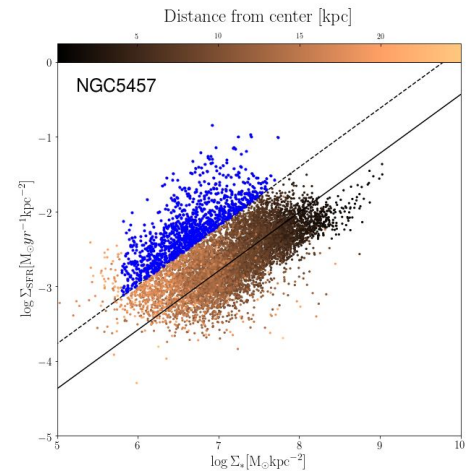
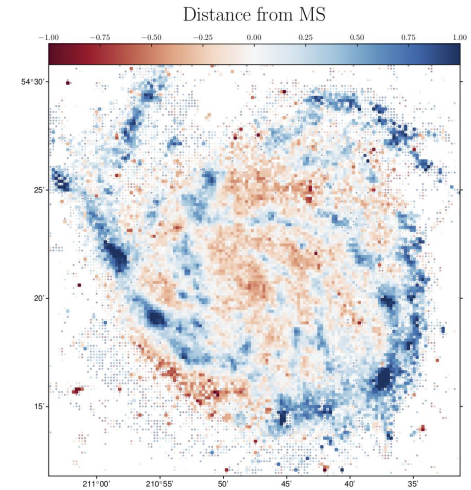


NGC5457

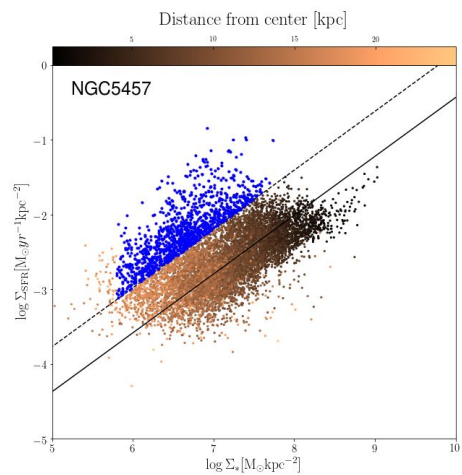
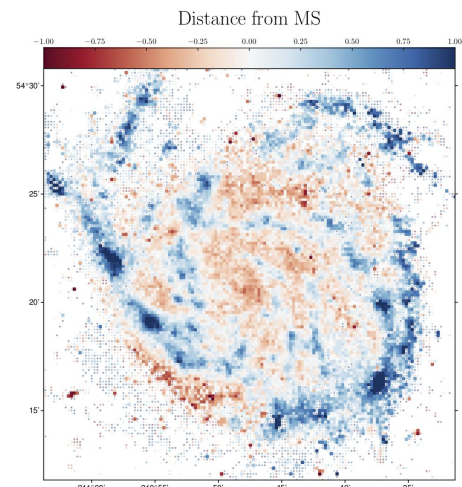
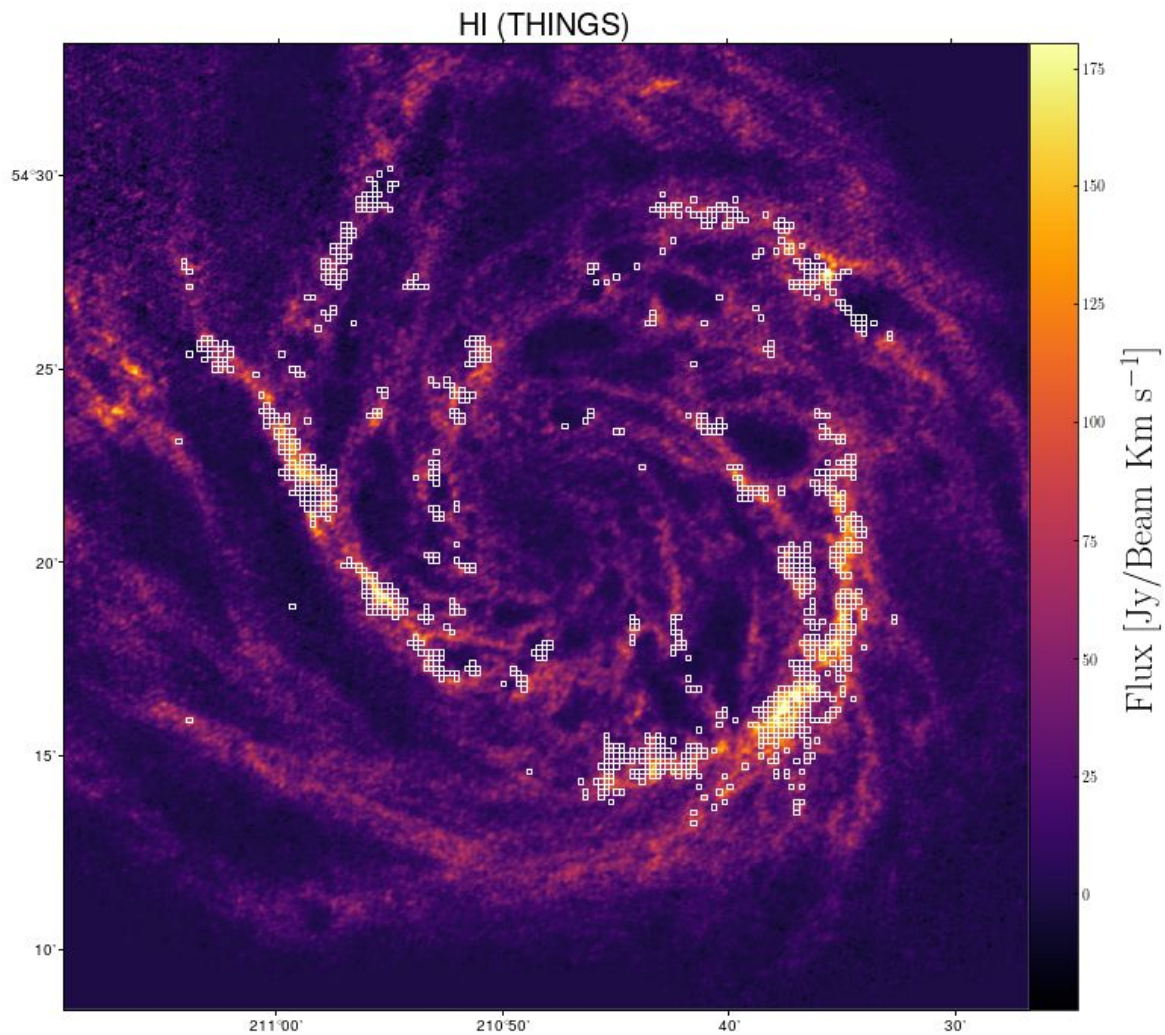




# LINKING EVERYTHING WITH GAS OBSERVATIONS



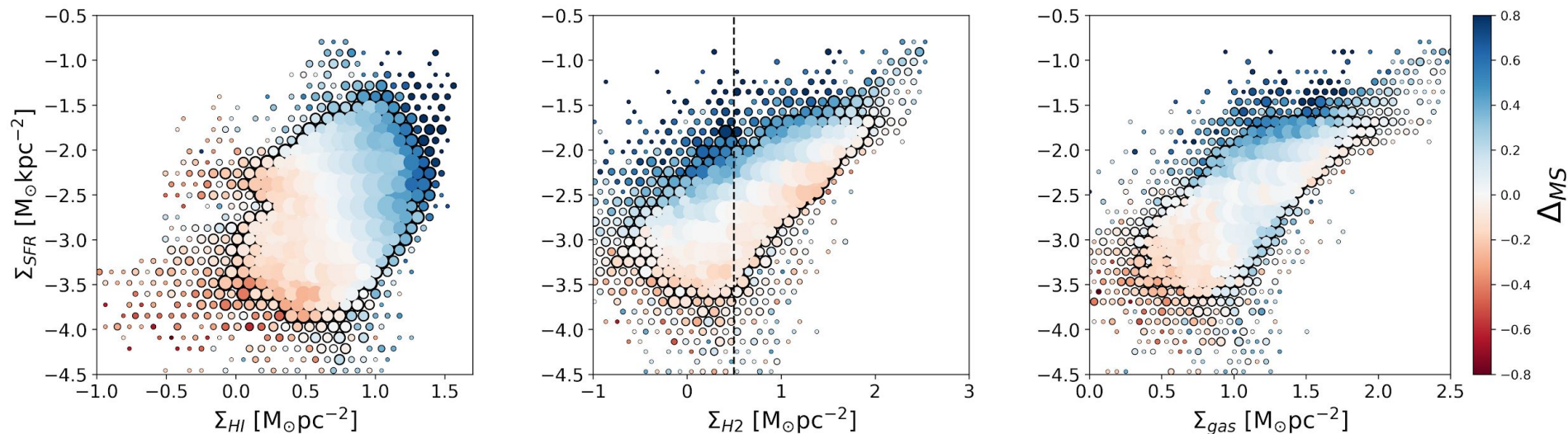
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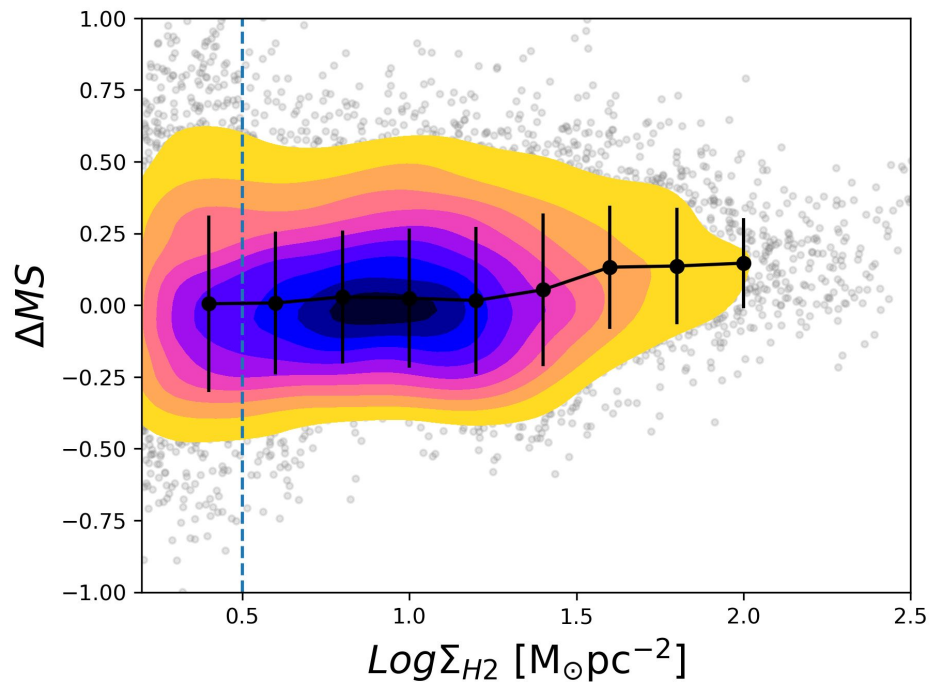
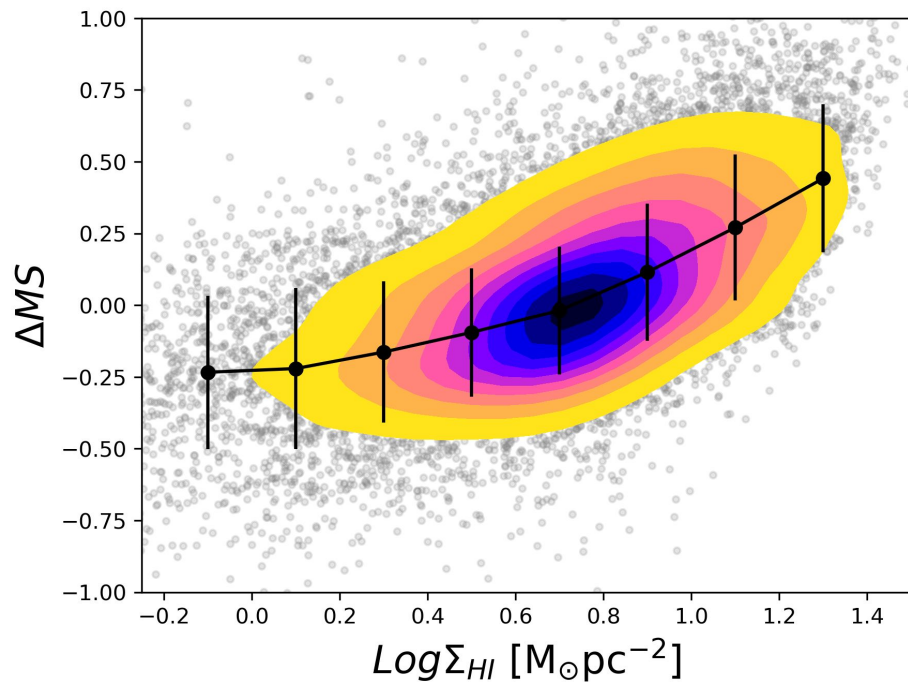
# GAS RESULTS

As expected, we find the Kennicutt-Schmidt relation, and results similar to Bigiel et al., 2008. However, we also observe a strong correlation between  $\Sigma_{\text{HI}}$  and the sSFR (or  $\Delta_{\text{MS}}$ ). Starbursting pixels are found in correspondence to the largest  $\Sigma_{\text{HI}}$ , while they span the full range of  $\Sigma_{\text{H2}}$ .



# GAS RESULTS

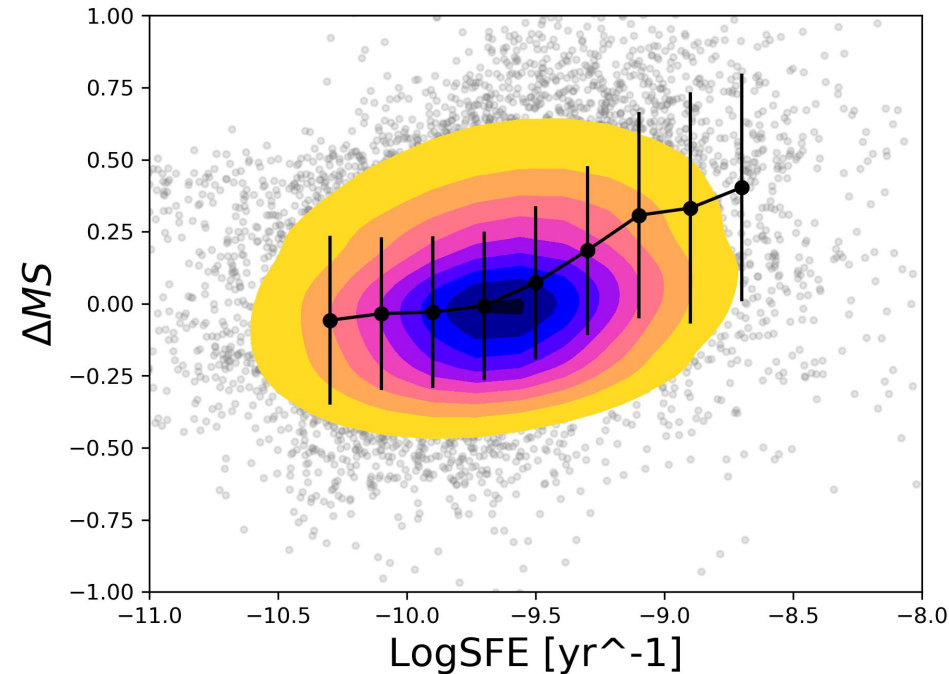
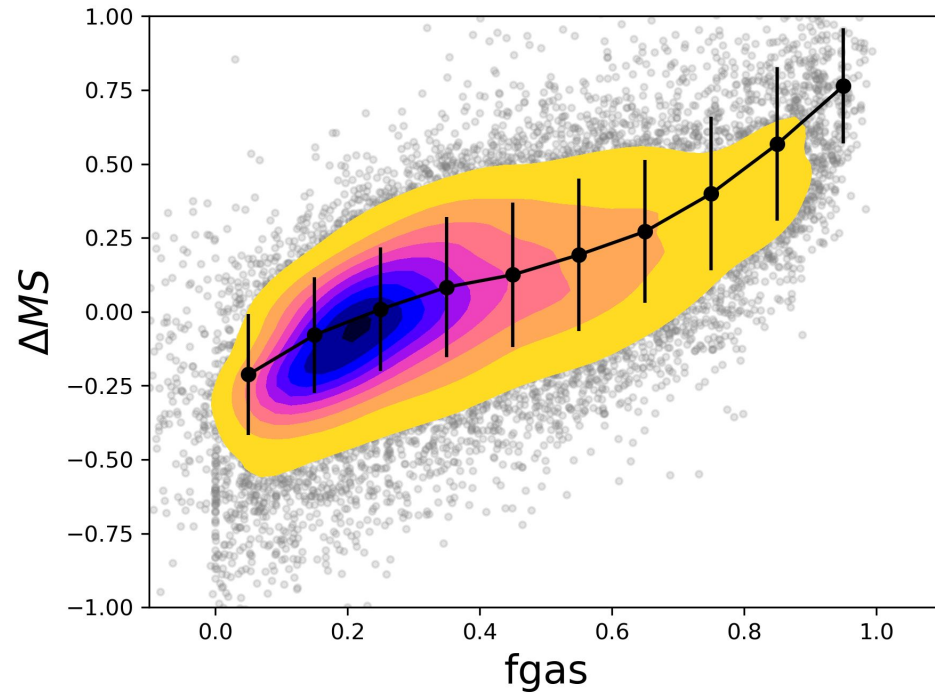
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# GAS RESULTS

We also observe a correlation between the total gas fraction ( $M_{H1} + M_{H2}/(M_{H1}+M_{H2}+M_{\text{star}})$ ) and the distance from the MS, and a extremely weak and highly scattered pseudo correlation with the star formation efficiency.



# CONCLUSIONS

We exploited the vast amount of multiwavelength data in the [DustPedia](#) archive to perform resolved SED fitting of a small sample of 8 local face-on grand-design spirals. DustPedia panchromaticity extends the SED fitting from [far-UV](#) to [sub-mm](#), keeping track of both unobscured and obscured star formation processes (and more).

SED fitting performed with MAGPHYS, following Smith & Hayward 2018 example on a (simulated) face-on disk galaxy. Stellar masses are from the standard MAGPHYS output, SFRs are evaluated from scaling relations ( $\text{SFR}_{\text{UV}} + \text{SFR}_{\text{IR}}$ ) applied to the best-fit SED.

We observe the MS in a  $\Sigma_{\text{star}} - \Sigma_{\text{SFR}}$  plane for the resolved results (also for global ones, i.e. non divided per  $\text{kpc}^2$ , not showed here), with a slope of 0.86 and a scatter of 0.27 dex.

We extended the analysis to the available gas observations of the sample ([HI](#) from VIVA and THINGS, [CO](#) from Heracles, if you know others let me know, see the mail below), recovering a strong correlation between  $\Sigma\text{HI}$  and the  $\Delta\text{MS}$ , while there is none with  $\Sigma\text{H}_2$ . Moreover, there's a clear correlation between the gas fraction and  $\Delta\text{MS}$ , while the one between SFR and  $\Delta\text{MS}$  is less clear and highly scattered.

Future plans: extend the analysis to other morphological types. Use different SED fitting codes (i.e. CIGALE) and compare the results. Have fun with the data.