SFR-stellar mass correlation as a function of morphological type for 1000 galaxies at z~1

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Abstract:

We have investigated the relation between the morphology of a galaxy and its activity for a range of redshift around 1 in the GOODS-South field. Deep Spitzer+MIPS imaging at 24µm is used to measure galaxies SFRs. We find that spiral galaxies define a narrow sequence in the stellar mass/SFR plane, and that a cloud of elliptical galaxies with residual star formation lies under this sequence. This cloud might include galaxies recently transitioning out of the spiral sequence. Using the UV rest frame HST+ACS estimate of galaxies sizes we apply the Schmidt-Kennicutt law to predict molecular gas masses. This suggests that a tight correlation also exists between the gas mass and the stellar mass for the spirals, appearing to have a large fraction of gas. Future observations with IRAM PdBI can powerfully test this picture.

1. Sample and methods:

We have studied a sample of 1000 galaxies 24µm detected in the GOODS-SOUTH field and we have used the data from ACS camera (Hubble) and from MIPS camera (Spitzer).
The redshifts are mainly spectroscopic (61%) and range from 0.5 to 1.3.
With the 2D algorithm galfit (Peng et al 2002) we can determine the morphology of these galaxies fitting a Sérsic profile, and measure the effective radius.
We have distinguished between a spiral and an elliptical using the Sérsic index.
In Figure 1, we can see the number of ellipticals in red in function of the redshift and the spirals in blue. The sample contains 34% of ellipticals and 66% of spirals.

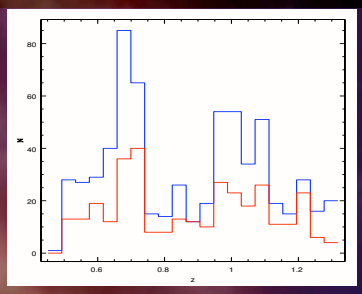

Figure 1. Histogram of the numbers of spirals (blue) and ellipticals (red) versus the redshift.

2. Correlation between the SFR and the stellar mass for the spirals.

In Figure 2, we see plots representing the SFR of the galaxies versus their stellar masses where plotting all the sample (left), all the sample and distinguishing between spirals in blue and ellipticals in red (middle) and plotting only the spirals (right). Without splitting between spirals and ellipticals, we do not see any clear correlation. But doing so, we see a narrow sequence of spirals and a cloud of ellipticals. This correlation between SFR and mass for spirals might emphasize the role of the mass in forming stars. Moreover the narrowness of this sequence (0.28dex) might reflect similar physical processing for spirals galaxies. Finally these 'cloud' galaxies detected at 24µm and therefore still star forming, might come from the transformation of spiral galaxies out of the sequence.

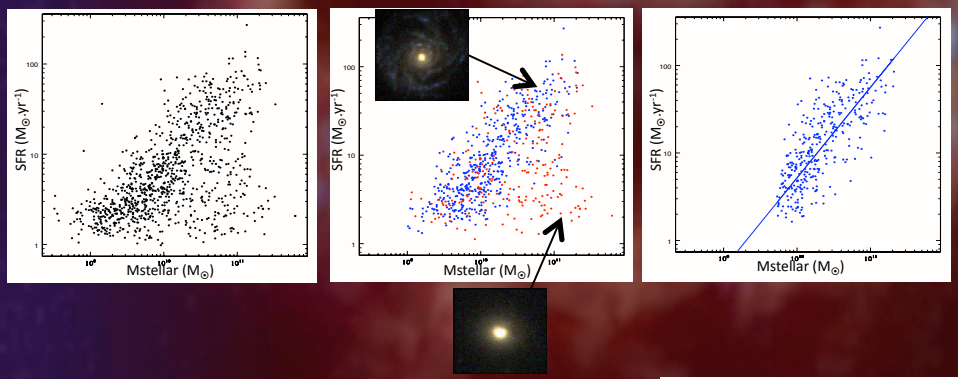

Figure 2. SFR versus stellar mass for all the sample (left), for all the sample with in blue the spirals and in red the ellipticals (middle), only the spirals (right). The line in the right panel fits the spirals galaxies with this equation:
$Log(SFR_{M_\odot yr^{-1}}) = 0.82 Log(M_{stellar\ M_\odot}) + 0{,}43z - 7{,}796$

3. Fraction of gas and relation between gas mass and stellar mass:

To form stars we necessarily need gas, we have thus tried to determinate the quantity of molecular gas in the spirals, using the Schmidt-Kennicutt law which connects the star formation rate surface density to the gas mass surface density. The UV sizes from Sérsic fits to the HST images were used for this purpose. This would suggest a tight correlation between the mass of gas and the mass in stars of the spirals, and generally large gas fractions.
If this picture is correct, the most massive spirals at z=0.5-1 might contain enough molecular gas to be detectable with the IRAM PdBI, as demonstrated by Daddi et al 2008 for z=1.5.

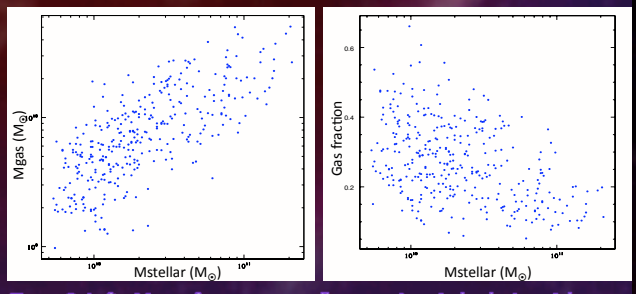

Figure 3. Left : Mass of gas versus stellar mass in spiral galaxies, right: the fraction of gas in these galaxies.