# Are the *A* parameter and the *SFR* related for dwarf spiral galaxies?

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## Abstract

We study the relationship between the asymmetry parameter (*A*) and the star formation rate (*SFR*). We used images of dwarf galaxies (*dS*) in R and V Johnson filters for the *A* parameter and images in $H_\alpha$ to determine the *SFR*. As *dS* galaxies have not very clear spiral morphologies it is very interesting to check if the interactions have been the responsible of the SF in them.

## 2 Theory

The *A* parameter is an indicator of symmetry to the galaxy and is defined as

$$A \equiv \frac{|I-R|}{I} \propto \int_0^T \frac{t\left|\dot{M}_s(t)\right|}{TM_s(t)}dt \qquad (1)$$

where *I* is the original image and *R* is the image rotate an angle $\theta$ ( Conselice et al., 2000). In another hand, *A* is proportional to the change of the stellar mass with time.

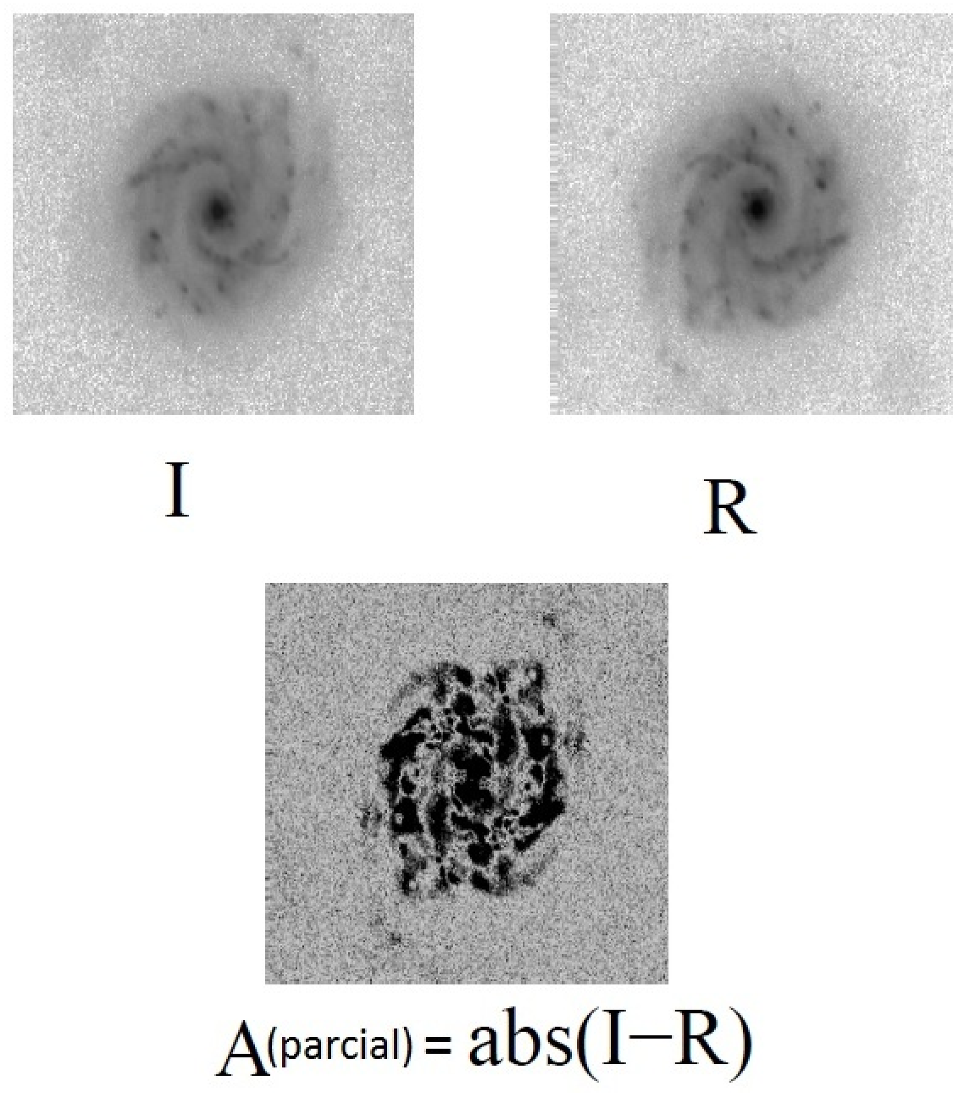


Figure: 3. *Parameter A*

The main caveat is to define where the galaxy is ended. To do that we used the Petrosian's radius which is defined as the solution of equation (2) when $\eta$ and *n* are fixed.

$$\eta(r) \equiv \frac{\langle I\rangle_r}{I(r)} = \frac{2n\gamma(2n,x)}{e^{-x}x^{2n}} \qquad (2)$$

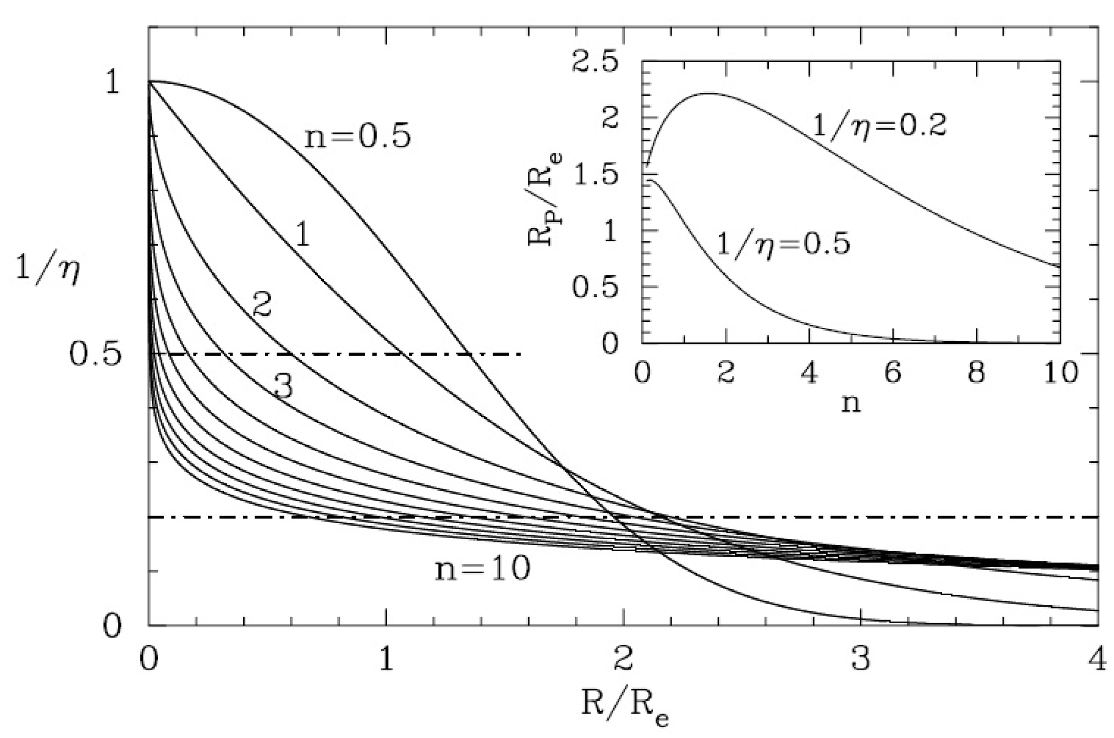


Figure: 4. Big plot $\frac{1}{\eta}$ vs. $\frac{R}{R_e}$, Small plot $R_P$ vs. Sérsic index *n* (Graham et al.2005).

Another morphological parameter is the so-called *S* (clumpiness) parameter. It is defined as

$$S \equiv \frac{I-B}{I} \propto \int_0^T \frac{t\alpha(t)M_G(t)}{TM_s(t)}dt \qquad (3)$$

where *I* is the original image and *B* is the image whit the filter $\sigma$. In another hand, *S* is sensitive to dust and inclination and also *S* is proportional to the variation of the gas mass, $M_G$, star mass, $M_s$, and the SFR, $\alpha$, (Kennicut Jr. and Kent, 1983). In particular when $\left|\dot{M}_S(t)\right|$, $M_G(t)$ and $\alpha(t)$ are constant, as in a closed box system, it can be related to A parameter as

$$S \propto \left(\frac{\alpha M_G}{\left|\dot{M}_S(t)\right|}\right) A \qquad (4)$$

Therefore, A and the SFR might be related somehow.
The star formation rate gives the total mass of stars formed per unit time. The $H_\alpha$ emission-line luminosity, $L(H_\alpha)$, can be used as an indicator of the currer star formation rate by the relationship (Kennicut, 1998)

$$SFR\left(M_\odot yr^{-1}\right) = 7.9\times10^{-42}L(H_\alpha) \qquad (5)$$

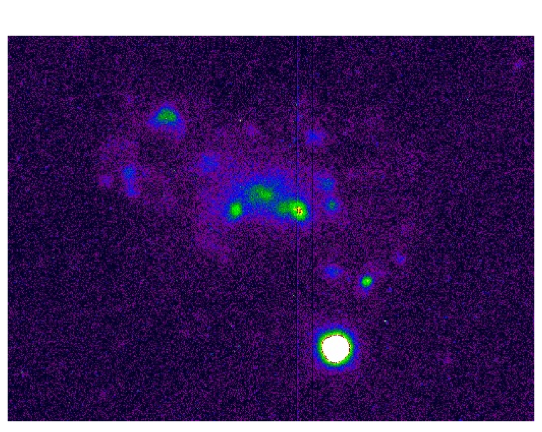

Figure: 5. *Image of UGC5242 in* $H_\alpha$

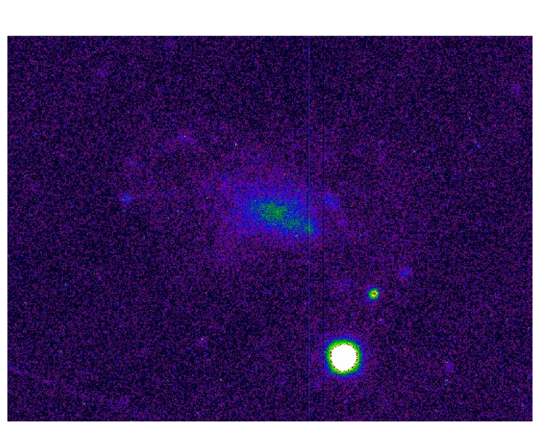

Figure: 6. *Image of UGC5242 in Continous*

## 1 Introduction

The dS are galaxies with radius $\lesssim 5Kpc$, $M_b \leq -18$ and they have spiral structure (Hidalgo-Gámez and Olofsson, 2004). The existence of arms in these galaxies is probably due to interactions so the arms might be really tidal structure instead of real of density waves. In order to study the interactions is interesting to use star formation rate and the *A* parameter of asymmetry (Abraham, 1996).

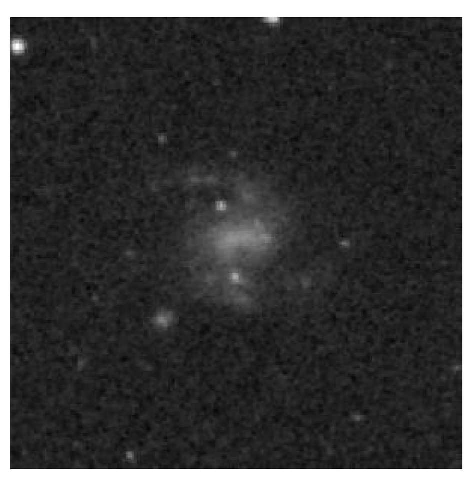

Figure: 1. *UGC6304 in V*

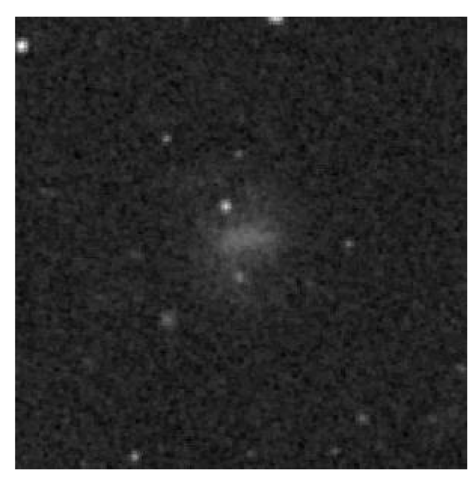

Figure: 2. *UGC6304 in R*

## 4 Conclusions

We can conclude that the *SFR* is related with the *A* parameter for *dS* galaxies which might be an indication that the most important mechanics triggering the star formation is not density waves but interactions. In the process, we have noticed that some of the *dS* galaxies do not show an expected value for the Sérsic index, which is quite interesting and it will be studied in the near future.

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## Acknowledgments

Acknowledges support from the CONACyT project 165584 and the SIP project SIP-20121135.

## 3 Development

In order to obtain the *A* parameter we fit a Sérsic law surface brightness profile for each galaxy and obtain *n*, so we can get the *A* parameter inside this radius (Table 1).

| Galaxia | Filtro | n | Err(n) | Rp [arcmin] |
|---|---|---|---|---|
| 11820 | V | 0.695 | 0.033 | 2.052 |
| | R | 0.773 | 0.068 | 2.089 |
| 12212 | V | 1.387 | 0.593 | 2.167 |
| | R | 1.160 | 0.085 | 2.165 |
| 3775 | V | 0.520 | 0.086 | 1.966 |
| | R | 0.549 | 0.054 | 1.988 |
| 5242 | V | 2.037 | 0.141 | 2.193 |
| | R | 2.107 | 0.401 | 2.186 |
| 5296 | V | 1.812 | 0.112 | 2.191 |
| | R | 1.795 | 0.113 | 2.189 |
| 6205 | V | 1.540 | 0.092 | 2.179 |
| | R | 1.656 | 0.084 | 2.187 |
| 6304 | V | 1.286 | 0.085 | 2.172 |
| | R | 1.267 | 0.082 | 2.170 |
| 891 | V | 0.566 | 0.050 | 1.989 |
| | R | 0.673 | 0.034 | 2.039 |
| 9570 | V | 1.542 | 0.082 | 2.182 |
| | R | 1.439 | 0.094 | 2.176 |

Table: 1. Sérsic index for each galaxy and the Petrosian ratio whit $\eta = 0.1$.

| Morphological Type | n |
|---|---|
| S y S0<br>Disc, Bulbs | $n \approx 1$, $n < 4$ |
| E | $n > 4$ |
| cD | $n \gtrsim 4$ |
| dI | $n \approx 1$ |
| dE | $n > 1$ |

Table: 2. Sérsic index for galaxies of different morphological type

In the next figures the *SFR* vs *A* in the two filters *V* and *R* for three rotation angle $45^o$, $90^o$ and $180^o$ are plotted

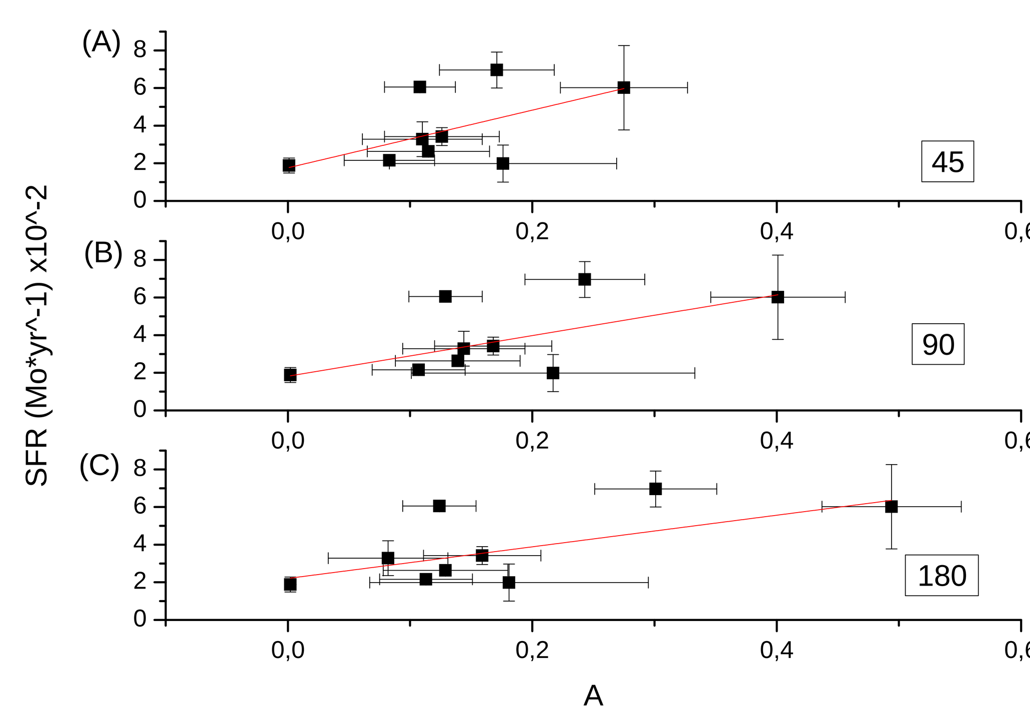


Figure: 7. *SFRvs.A in V filter*

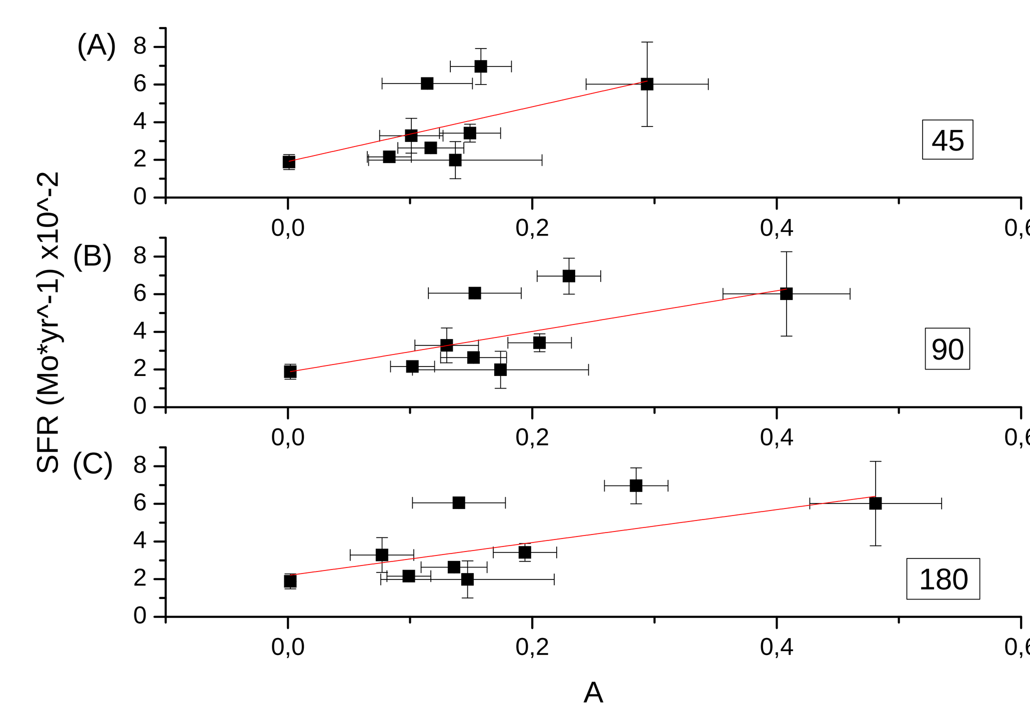


Figure: 8. *SFRvs.A in R filter*

The linear square fits for these plots are

| | Slope $\pm$ | Intercept $\pm$ | Regression coefficient |
|---|---|---|---|
| 45 | $15.322 \pm 6.861$ | $1.761 \pm 1.353$ | 0.644 |
| 90 | $10.794 \pm 4.229$ | $1.819 \pm 1.179$ | 0.694 |
| 180 | $8.398 \pm 2.629$ | $2.206 \pm 0.859$ | 0.770 |

Table: 3. Slop and Intercept for the figure 7

| | Slope $\pm$ | Intercept $\pm$ | Regression coefficient |
|---|---|---|---|
| 45 | $14.529 \pm 5.783$ | $1.914 \pm 1.162$ | 0.688 |
| 90 | $10.796 \pm 3.865$ | $1.865 \pm 1.072$ | 0.726 |
| 180 | $8.735 \pm 2.609$ | $2.199 \pm 0.825$ | 0.784 |

Table: 4. Slop and Intercept for the figure 8

We can conclude that the asymmetry and the *SFR* might be related for *dS* galaxies.