

# Examining Bar–Environment Connections in Disc Galaxies with MaNGA Observations

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## Abstract

Bars represent a common structural feature in disc galaxies, yet their contribution to galaxy evolution remains only partially understood. In this work, we examine how the presence of a bar influences the environmental dependence of various properties of disc galaxies. Our analysis uses a volume-limited sample from the Mapping Nearby Galaxies at APO (MaNGA) survey. Barred and unbarred disc galaxy samples are selected through classifications from the Galaxy Zoo 2 project and subsequently divided into isolated and non-isolated sub-samples.

The comparison reveals a close correspondence between the properties of isolated and non-isolated galaxies, although unbarred galaxies exhibit a pronounced environmental sensitivity. Relations such as stellar mass versus star formation rate,  $g-r$  colour versus concentration index, and stellar mass versus gas-phase metallicity show strong environmental dependence for unbarred discs, whereas the same trends for barred galaxies display only weak environmental variation. These results indicate that the presence of a bar reduces how strongly the examined properties and their interrelations depend on the surrounding environment.

## Introduction

- In addition to internal processes, the external environment is expected to play an important role in the formation and evolution of galaxies.
- This study examines whether the presence of a bar alters the environmental dependence of disc galaxy properties using a volume-limited sample from the Mapping Nearby Galaxies at APO (MaNGA) survey.

## Data and Analysis

- From MaNGA survey barred and unbarred galaxies' samples were selected using the following criteria:

$$P_{\text{features/disc}} > 0.430, \quad (1)$$

$$P_{\text{notedgeon}} > 0.715, \quad (2)$$

$$N_{\text{notedgeon}} > 20, \quad (3)$$

$$P_{\text{bar}} > 0.8, \quad (4)$$

$$P_{\text{bar}} < 0.2 \quad (5)$$

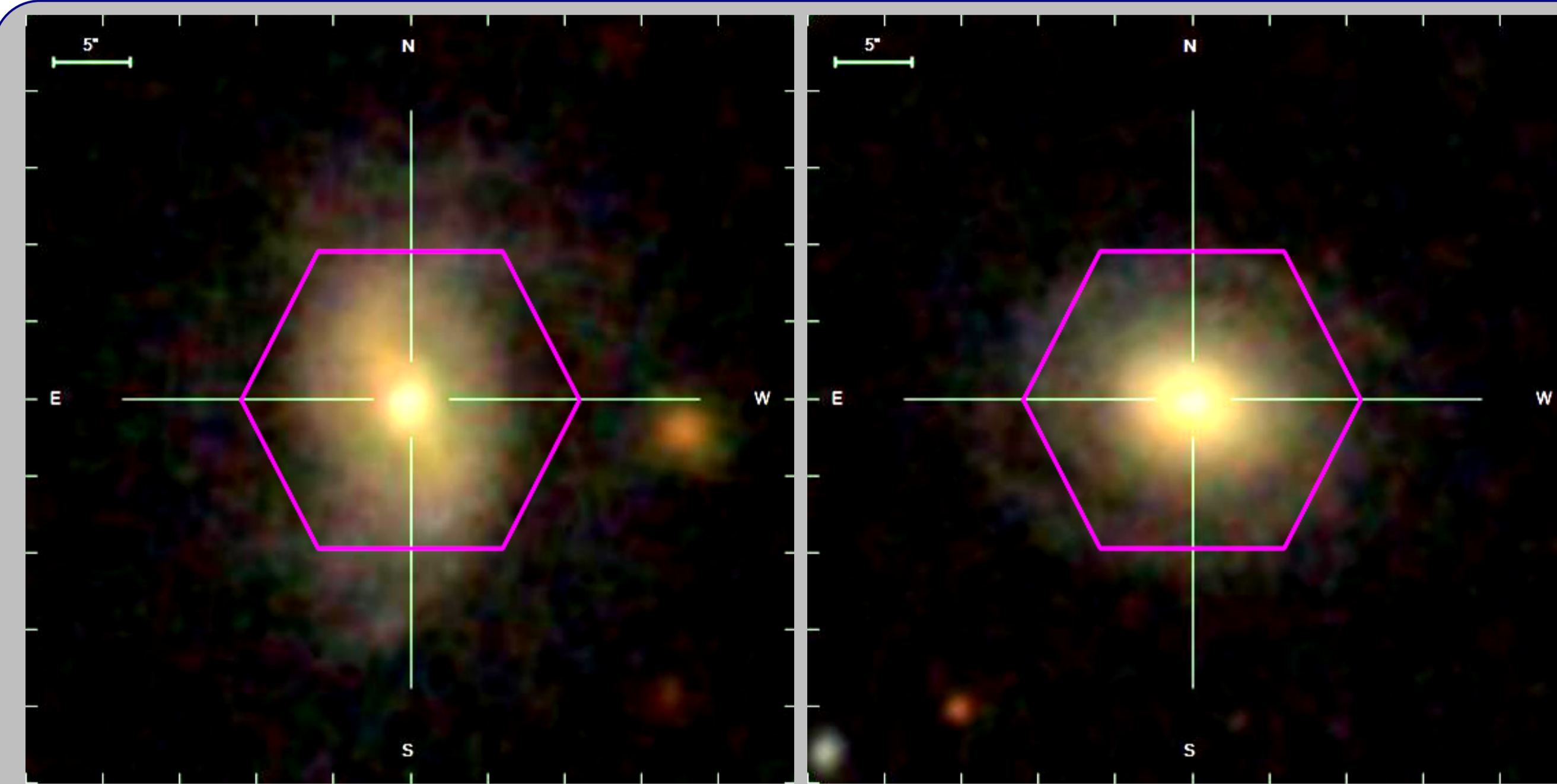


Figure 1: Barred and Unbarred galaxies denoted by their MaNGA plate and IFU, 10222 – 6103 (left panel) and 9890 – 6102 (right panel).

- Galaxies with group size (GS) = 1 are defined as isolated, while those with  $GS \geq 2$  are defined as non-isolated.
- The distributions of major properties were compared across environments and their relations.

## Results and Discussions

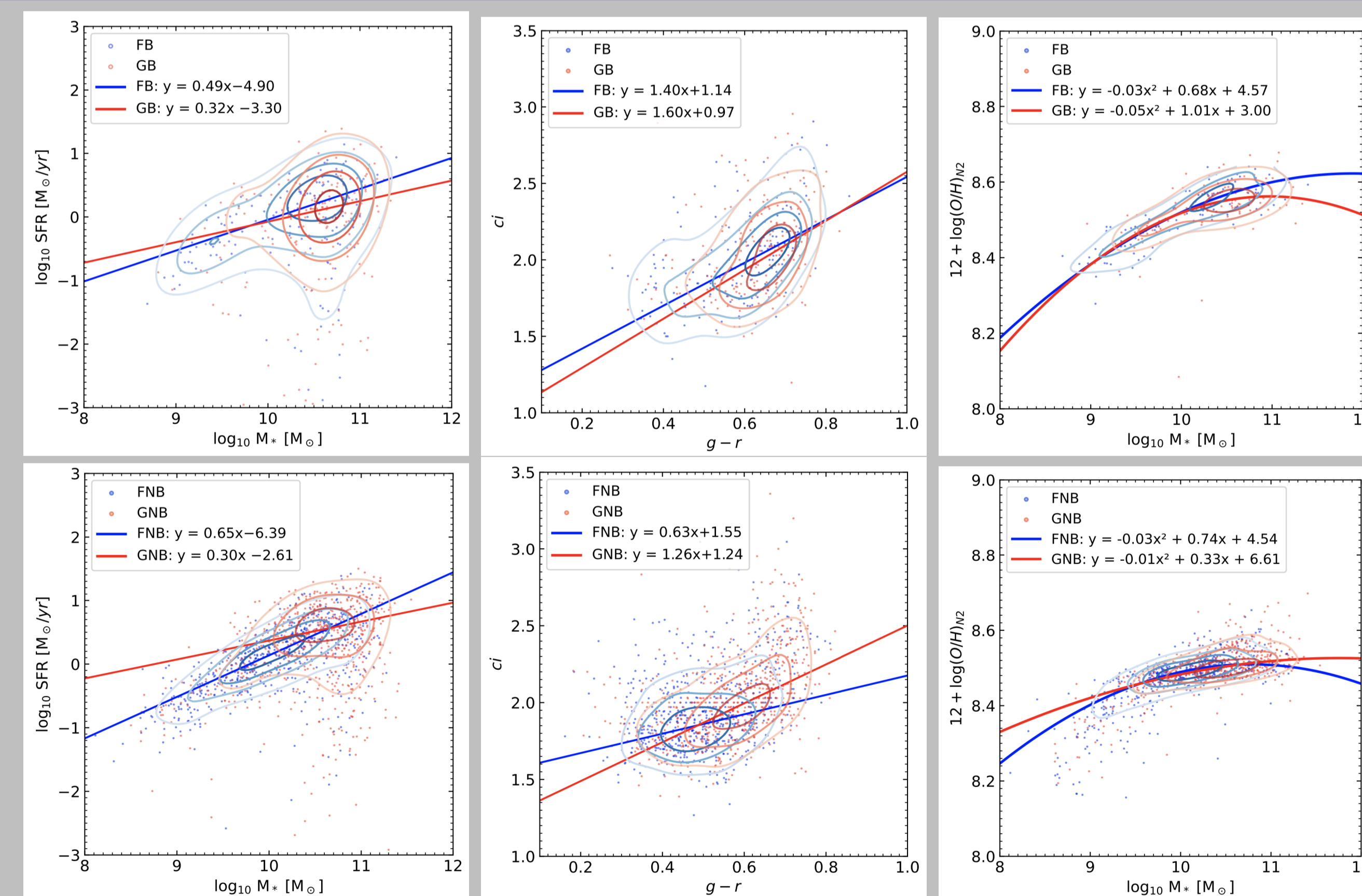


Figure 2: Variation of  $M_*$  against SFR (left panels),  $g-r$  colour against concentration index ( $c_i$ ) (middle panes) and gas phase metallicity against  $M_*$  (right panel) for barred (top panels) and unbarred (bottom panels) galaxies.

- SFR– $M_*$ : Barred galaxies show small slope/intercept differences (0.17, 1.60 dex) with comparable errors (0.16, 1.71) and insignificant  $p$ -values (0.403, 0.431), while unbarred galaxies show larger differences (0.35, 3.78 dex) with smaller errors and highly significant  $p$ -values ( $2.027 \times 10^{-9}$ ,  $6.424 \times 10^{-10}$ ).
- $C_i-g-r$ : Barred galaxies show weak environmental variation (differences 0.20, 0.17 dex;  $p \sim 0.48, 0.34$ ), whereas unbarred galaxies show stronger differences (0.63, 0.31 dex) with high significance ( $p = 5.176 \times 10^{-7}$ ,  $9.255 \times 10^{-6}$ ).
- Gas-phase metallicity– $M_*$ : Barred galaxies show small curvature/slope/intercept differences ( $\sim 0.02, \sim 0.33, \sim 1.57$  dex) with insignificant  $p \sim 0.32-0.39$ , while unbarred galaxies show stronger environmental dependence ( $\sim 0.02, \sim 0.41, \sim 2.07$  dex) with significant  $p \sim 10^{-3}$ .

## Conclusions

- For unbarred galaxies, the SFR,  $g-r$  colour,  $c_i$  and gas phase metallicity exhibit a strong correlation with the environment while these same properties for barred galaxies display a notably weaker environmental dependence.
- The slope and intercept of  $M_*$  against SFR and  $g-r$  colour against  $c_i$  relations of barred galaxies are weakly dependent on the environment while for unbarred there is a strong dependence.
- The insignificant difference in curvatures, slopes and intercepts of  $M_*$  against gas phase metallicity when isolated and non-isolated barred galaxies are compared were observed while for unbarred galaxies the differences are significant.

## References

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