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MAGIC - A UNIQUE SURVEY TO PROBE THE ROLE OF ENVIRONMENT ON GALAXY MASS ASSEMBLY

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Abstract. The Muse gAlaxy Groups In Cosmos (MAGIC) survey was undertaken to invesitage the impact of environment on galaxy mass assembly at intermediate redshift. We present the MAGIC sample and a review of its core results about the impact of environment on scaling relations, as well as unexpected extended nebulae discovered in dense groups. We also provide links to publicly released data and catalogues.

Keywords: galaxies: evolution - galaxies: kinematics and dynamics - galaxies: ISM - galaxies: interactions - galaxies: groups: general - galaxies: clusters: general - galaxies: high-redshift - galaxies: fundamental parameters - galaxies: distances and redshift - catalogs

1 Introduction

The red sequence is predominant in groups and clusters in the local Universe. At intermediate redshift, when star formation was still high and groups or clusters recently began their mass assembly, environment is expected to start playing a role on the quenching of star-formation and on the build-up of the Hubble sequence. However, the detailed mechanisms associated to these transformations are not well constrained at this epoch.

Integral field spectroscopy has the capability to quantify the large-scale environment of galaxies, to infer the properties of these structures, as well as to study internal dynamics of galaxies, in one single shot down to low star-formation rates and stellar masses over a diversity of environments. Taking advantage of the large Multi-Unit Spectroscopic Explorer (MUSE, Bacon et al. 2010) field-of-view, the Muse gAlaxy Groups In Cosmos (MAGIC) survey was built to deepen our understanding of the impact of environment on galaxy evolution.

2 Survey and sample description

The MAGIC survey consists of 17 MUSE fields targeting 14 massive groups at intermediate redshift ($0.3 < z < 0.8$) in the COSMOS area (Scoville et al. 2007; Knobel et al. 2012), with a total on-source exposure of 67 h. We securely measured the redshifts for 1419 sources located either in the target groups or in their foreground and background, and identified 76 galaxy pairs and 67 groups of at least three members using a friends-of-friends algorithm. The environment of galaxies has been quantified from group properties, as well as from global and local density estimators.

The MAGIC survey has increased the number of objects with a secure spectroscopic redshift over its footprint by a factor of about 5 compared to previous extensive spectroscopic campaigns on the COSMOS field (Khostovan et al. 2025). These new redshifts are mostly galaxies with apparent magnitudes fainter than 22.5 in the z^{++} band. The spectroscopic redshift completeness is high, especially in the intermediate redshift range, where most of the groups are found, and down to masses as low as 10^8 to 10^9 $M_\odot$, from $z \sim 0.25$ to $z \sim 1.5$.

A morphological dichotomy is found between bulge-dominated quiescent and disk-dominated star-forming galaxies, and the fraction of quiescent galaxies in MAGIC increases with local density and with the time spent by galaxies in groups. More details on the sample and its properties are provided in Epinat et al. (2024).

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3 Scaling relations

The MAGIC sample was designed with the aim of studying the impact of environment on scaling relations such as the size/mass, star-formation rate/mass, velocity/mass (Tully-Fisher relation, TFR), and specific angular momentum/mass (Fall relation) relations at intermediate redshifts ([OII] emitters, $0.25 \leq z < 1.5$). The MUSE data coupled with high resolution HST data enabled us to probe spatially-resolved galaxy kinematics and morphology down to stellar masses as low as $\sim 10^8$ $M_\odot$. Our first analysis of the TFR (Abril-Melgarejo et al. 2021) showed a signifcant evolution of the zero point compared to previous similar studies that could be explained either by environmental or by methodological effects. In Mercier et al. (2022), we therefore studied the impact of environment on scaling relations using 146 galaxies from the MAGIC in a range of environments, ensuring homogeneous sample, dataset and methods used to measure galaxy properties such as kinematics, sizes, stellar masses, and star formation rates. We found no significant effect of environment on the TFR, stressing that the results obtained in Abril-Melgarejo et al. (2021) were mostly due to these residual biases. We also found that galaxies are 15% smaller in dense groups compared to those in low density regions, and that their star formation rate is reduced by a factor 1.5. Finally, we set up a careful angular momentum derivation in Mercier et al. (2023) and found a 2-σ significant depletion of the stellar specific angular momentum for low-mass galaxies located in groups with respect to the field. This might be induced by stripping or merging events.

4 Extended nebulae associated to dense environments

Thanks to deep exposures coupled with the wide field-of-view of MUSE, the MAGIC survey revealed four unexpected extended nebulae shinning through their emission lines, mostly [OII], but also [OIII] and Hβ for the brightest ones. These $\sim$ 100 kpc wide nebulae are all associated to dense and massive groups and are related to various physical processes able to remove gas from galaxies such as ram pressure gas stripping (RPS, first such event observed at $z \sim 0.7$ Boselli et al. 2019), active galaxy nucleus (AGN, Epinat et al. 2018) and quasar feedback (Epinat et al. 2024), as well as galaxy interactions (Epinat et al. 2024). A combination of AGN feedback, interactions and potentially RPS is observed in one group, where shocks may be responsible for some of the ionization, and where the gas expelled during those events seems to be reforming a disk around the central galaxy (Epinat et al. 2018). A systematic search may reveal more nebulae within the MAGIC dataset.

5 On-line material and conclusion

We provide here the links to the MAGIC data release described in the survey paper (Epinat et al. 2024). The reduced datacubes are publicly available as ESO phase 3 material*. The catalogs of galaxies and groups are on the CDS†. Finally, an extensive talk hosted at the Gemini North Observatory on May 2nd 2024 is available on the NOIRLab science website‡. We encourage the community to contact us and to use the MAGIC dataset.

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