The first 62 AGN observed with MaNGA: spatially resolved stellar populations

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Introduction

A breakthrough in understanding the relation between the AGN and the surrounding stellar population can be reached by a simple, but thorough, investigation of whether young or intermediate age stars are present within few hundred pc of the AGN. If the youngest stellar types are present, AGN fueling is coeval with star formation; if instead intermediate age stars dominate the stellar population, fueling would be driven by a post-starburst and, thus the AGN phase would follow the starburst phase; finding only old stars would imply that gas inflow to the AGN is not necessarily linked to star formation.

Aimed at investigating the relation between the nuclear activity and the hosts' star formation history (SFH), we use the MaNGA datacubes of the first 62 observed AGNs and compared them with a matched sample of inactive galaxies.

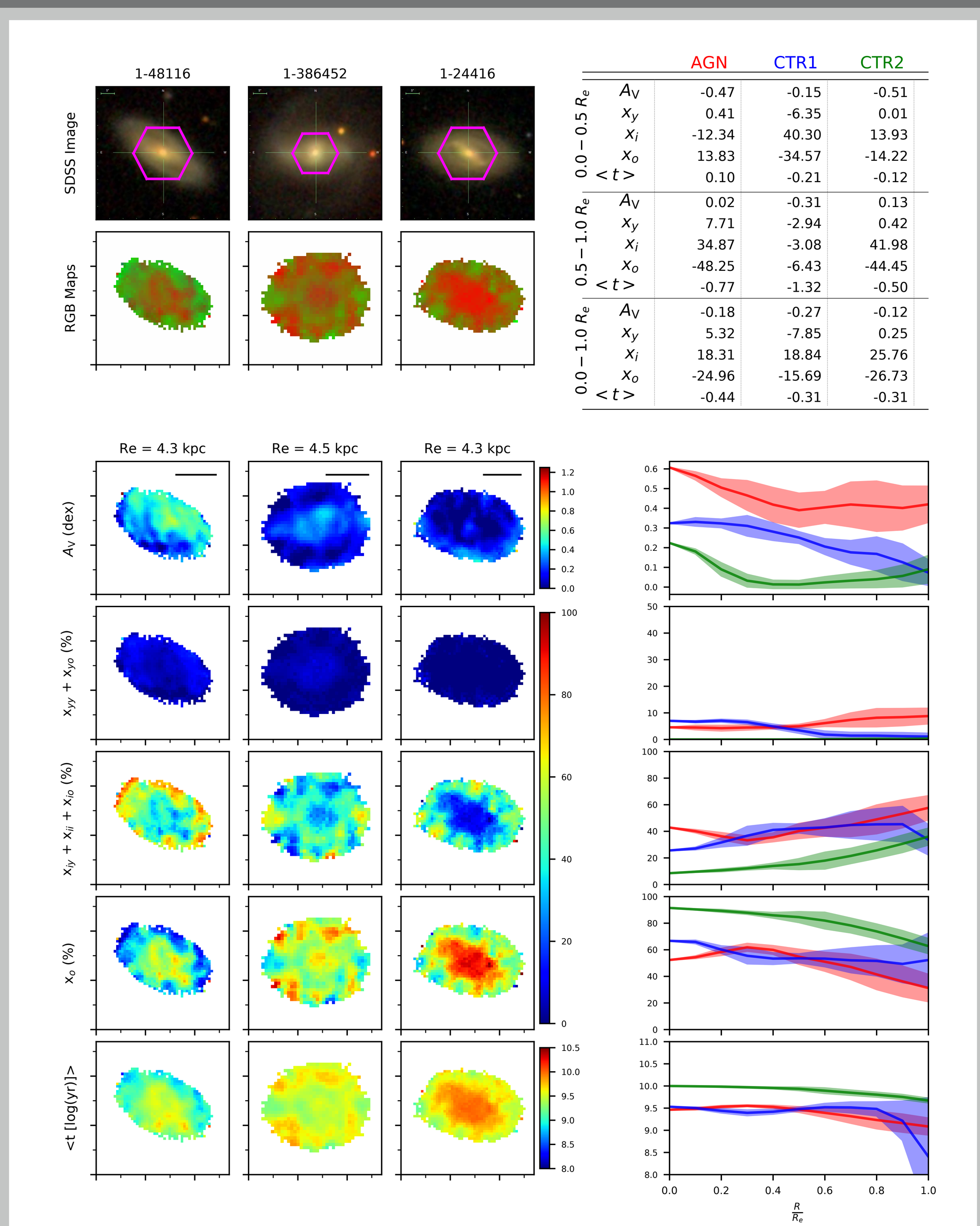
Stellar population synthesis

To disentangle the contribution of each stellar population to the integrated spectra of each spaxel in the datacubes we employed the STARLIGHT code together with the Bruzual & Charlot (2003) models. STARLIGHT combines the $N_\star$ template spectra $b_{j,\lambda}$ in order to reproduce the observed spectra O_λ. To generate the modeled spectra M_λ, the SSPs are normalized at an arbitrary λ_0 wavelength, reddened by the term $r_\lambda = 10^{-0.4(A_\lambda - A_{\lambda_0})}$, weighted by the population vector x_j, and convoluted with a Gaussian distribution $G(v_\star, \sigma_\star)$ to account for the effects of velocity shifts in the central velocity $v_\star$ and velocity dispersion $\sigma_\star$. The model spectrum can be expressed as:

$$M_\lambda = M_{\lambda_0}\left[\sum_{n=1}^{N_\star} x_j\, b_{j,\lambda}\, r_\lambda\right] \otimes G(v_\star, \sigma_\star) \qquad (1)$$

where M_{λ_0} is the synthetic flux at the wavelength λ_0. The best fit is found through a χ^2 minimization procedure.
To improve the management of STARLIGHT inputs and outputs, the compilation of the results and the analysis, we developed a modular software called MEGACUBE (Mallmann+18, astro-ph:1805.08655).

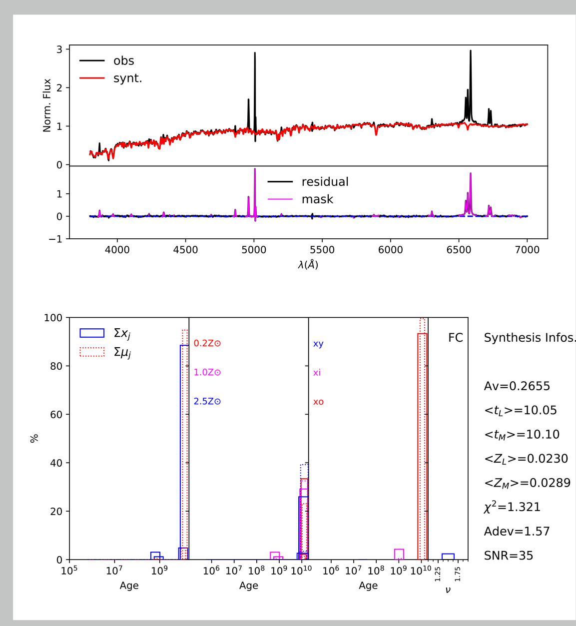
Comparison between an AGN and its control galaxies.



		AGN	CTR1	CTR2
$0.0-0.5\,R_e$	A_V	-0.47	-0.15	-0.51
	x_y	0.41	-6.35	0.01
	x_i	-12.34	40.30	13.93
	x_o	13.83	-34.57	-14.22
	$<t>$	0.10	-0.21	-0.12
$0.5-1.0\,R_e$	A_V	0.02	-0.31	0.13
	x_y	7.71	-2.94	0.42
	x_i	34.87	-3.08	41.98
	x_o	-48.25	-6.43	-44.45
	$<t>$	-0.77	-1.32	-0.50
$0.0-1.0\,R_e$	A_V	-0.18	-0.27	-0.12
	x_y	5.32	-7.85	0.25
	x_i	18.31	18.84	25.76
	x_o	-24.96	-15.69	-26.73
	$<t>$	-0.44	-0.31	-0.31

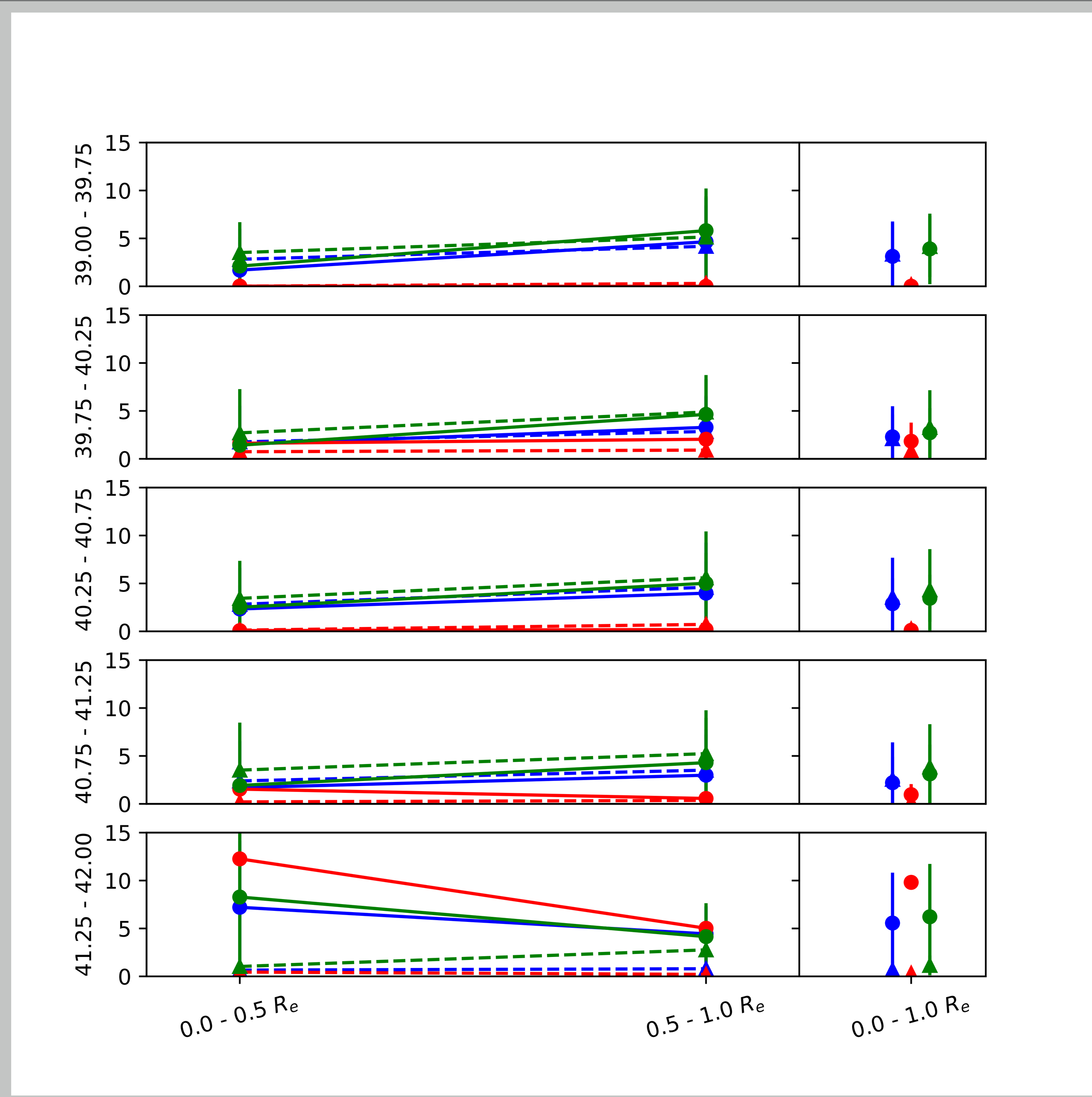
Left side panels - *Top set of panels:* SDSS image (the MaNGA field is indicated in magenta). Second row: composed RGB image using the binned population vectors [blue: young (X_Y: t$\lesssim$40 Myr); green: intermediate age (X_I: $40 < t \leq 2.5$ *Gyr*); red: old (X_O: $t > 2.5$ *Gyr*)]. *Bottom set of panels:* From top to bottom: visual extinction (A_V), X_Y, X_I, X_O and mean age ($< t >$) maps. For display purposes we used tick marks separated by 5''. The solid horizontal line in the A_V maps represent 1 R_e.
Right side panels - *Top:* summary table with the mean gradient values for each property in 3 different R_e ranges. *Bottom:* average radial profiles, up to 1 R_e, for AGN (red color) and control (blue and green colors). Shaded area represents $1\,\sigma$ standard deviation.

Individual spaxel fit example



Top panel: Observed (black) and synthetic (red) spectra.
Middle panel: Observed spectrum free from the stellar absorption features (residual) and regions not used in the fit (mask).
Bottom panels - *left panels:* Mass (μ_j) and light (x_j) contributions of each population vector, grouped in ages (left) and in ages and metallicities (left center). *Right panels:* age binned population vectors (right center) and featureless continuum contribution.

Young stellar populations $\times$ AGN luminosity



Young stellar population x_y contribution for five different bins of luminosity (log(L([O III]39-39.75, 39.75-40.25, 40.25-40.75, 40.75-41.25, 41.25-42), calculated for three different regions (0.0-0.5 R_e, 0.5-1.0 R_e, 0.0-1.0 R_e). Each color represents a different AGN grouping: green for the late-type AGN, red for the early-type AGN, and blue for all the AGN sample. Solid lines correspond to the active galaxies and dashed lines to the control galaxies.

Conclusion

⋆ We found that the fraction of the young stellar population ($t \lesssim 40$ Myr) is related with the AGN luminosity. For high-luminosity AGN ($L_{[OIII]} \gtrsim 10^{41.25}$ ergs/s) it increases in the inner ($R \leq 0.5 R_e$) regions when compared with control sample objects. In the case of the low-luminosity AGN, both AGN hosts and control sources, present very similar fractions of young stars. This result indicates that the inflow of material, besides feeding the nuclear engine, is being used to form new stars, thus rejuvenating the stellar content of the nuclear region of the AGN hosts. In addition, this very young starburst could also be enhanced by a positive AGN feedback produced by the high-luminosity AGN.

⋆ The fraction of the intermediate age, X_I (40 Myr $< t \leq 2.6$ Gyr), SP of the AGN hosts slightly increase outwards, with a clear enhancement over the entire galaxy when compared with the control sample. In addition, our results show that the inner region of the galaxies are dominated by an old SP, whose fraction decreases outwards.

⋆ We also investigated for differences on the SFHs between the different Hubble types. No significant differences were found between early and late-type hosts galaxies.

⋆ From our results we suggest that an outside in scenario better describes the recent star formation in the AGN hosts, while an inside out scenario represents better the older generations of stars.

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for full paper: arxiv.org/abs/1805.08655
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