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Recovering the origin of the lenticular galaxy NGC3115 using multi-band photometry

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Abstract. We perform simultaneous multi-band fitting, using the routine GALFITM, of the galaxy NGC3115, in order to recover the stellar populations of its main components (a bulge, a thin disc and a thick disc). We model 11 bands, from ultraviolet to infrared, in order to take into account the galaxy younger stellar population and the presence of the Active Galactic Nuclei (AGN). We find that the majority of the galaxy baryonic mass belongs to the thick disc, which is also the oldest galaxy component, consistent with results from the literature. Differently from previous works, we find that the bulge has the bluest colour and it is younger than the thick disc, either as a result of recent star formation activity, or AGN feedback, or white dwarf emission in an old stellar population. Finally, we propose that NGC3115 was formed either through a two-phase formation scenario, or via an outside-in quenching of an isolated spiral galaxy, whose thick disc had been heated-up via minor mergers with dwarf satellites.

Keywords. galaxies: evolution, galaxies: formation, galaxies: elliptical and lenticular

1. Introduction

We try to answer the question of how the closest lenticular galaxy to the Milky Way, NGC3115, was formed. To perform this study, we use multi-band fitting techniques with data from ultraviolet to infrared, decomposing the galaxy into its main components to analyse their properties over a large wavelength range. In general, spectral data allows to precisely retrieve age and metallicity of a galaxy, but cover only a small wavelength range (usually the optical). Furthermore, spectroscopy is limited in aperture – even integral field units (IFU) data usually do not cover galaxies' outskirts. Spectral Energy Distributions (SEDs) obtained from broad-band photometry are far less restricted in spatial coverage. The ability of this technique to gather information from ultraviolet to infrared make up for the loss of detailed λ-by-λ constraints (Salim *et al.* 2014). Thus, multi-wavelength photometric SEDs are the right data sources to study the distribution of stellar populations from the inner parts to the outskirts of galaxies. By comparing the stellar population of the disk and the spheroid we can understand where the last formation episode occurred and from where the quenching has started, recovering the formation history of the galaxy.

2. Results

The final model created for NGC3115 using the routine GALFITM in 11 images, from ultraviolet (GALEX) to infrared (WISE), is shown in Fig. 1a and was constructed using

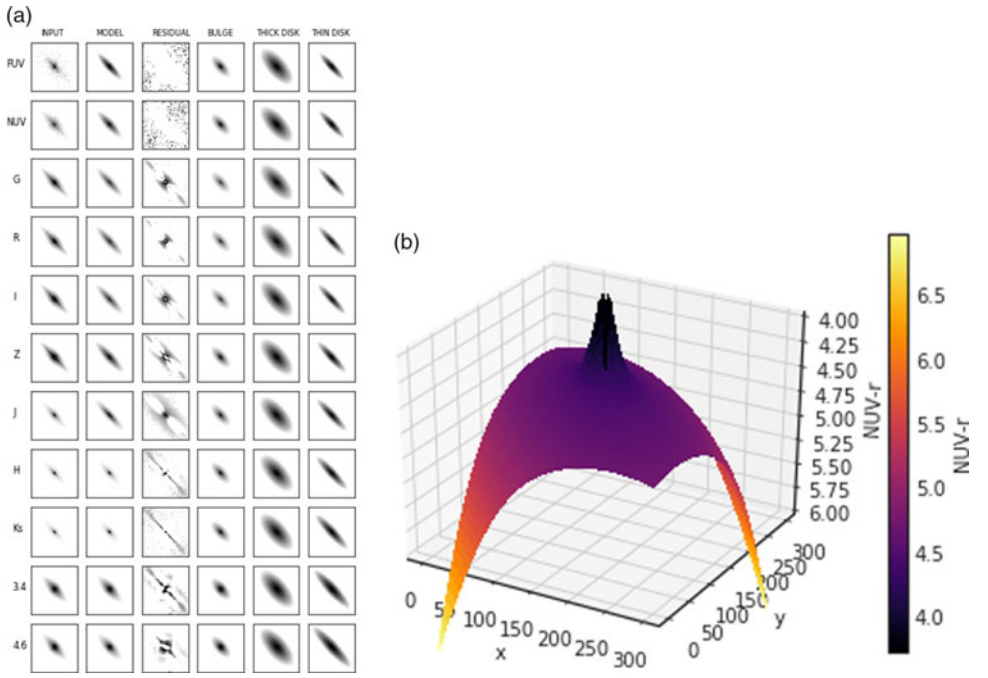

Figure 1. (a) Model of NGC3115 created using GALFITM with a bulge, a thick and a thin disc. (b) near-UV−r colour gradient of each pixel of the galaxy.

3 components: a bulge, a thick disc and a thin disc (also shown separately in the figure). With this model we are able to understand the stellar populations and ages of each component, deriving their SEDs and analysing the colour gradient across the galaxy. We have also calculated the near-UV (NUV)−r colour of each pixel, shown in Fig. 1b. From this figure, we identify a positive age gradient, i.e. a bulge bluer than the outskirts. The NUV−r colour of the bulge could be attributed to a young stellar population, the presence of the AGN (Wong *et al.* 2011) or the emission of white dwarf stars (Lisker *et al.* 2008). With these results and other properties retrieved from our model, we end up with two possible formation scenarios: the "two-phase scenario" or secular evolution (starvation induced by the AGN (Menezes *et al.* 2014)).

In the literature, the most likely formation scenario for NGC3115 is the so-called "two phase" scenario (Guérou *et al.* 2016), which consists in an in-situ formation at high redshift by dissipative gas collapse (creating the central stellar mass), followed by a significant merger event, responsible for the formation of the thick disc (or fast rotating oblate spheroid). Accretion of satellites or gas inflow would be responsible for the formation of the thin disc. Alternatively, NGC3115 could be a spiral galaxy whose thick disc has been heated up by several minor mergers. In a second moment, AGN and supernovae mechanical feedbacks would have been responsible for the quenching of the thick disc of the galaxy, and the continuing inflow of gas into the centre was capable of inducing star-formation events that rejuvenated the stellar population of the bulge. We reinforce, nevertheless, that all the components of this galaxy have, today, very low levels of star-formation and are all very old. Acquiring deeper images (surface brightness 28 mag/arcsec^2) would be a way to tell if the galaxy went through several accretions or not.

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