Structural analysis of massive galaxies using Hubble Space Telescope deep imaging at $z < 0.5$

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Using HST CANDELS data to analyze the lowest redshift ($z < 0.5$) massive galaxies

The most massive (Mstellar ≥ 10^{11} $M_\odot$) early-type galaxies in the local Universe appear to arise from a population of large disk-like galaxies at high-redshift ($z > 1$). If this scenario is true, then the local massive galaxies are expected to contain remnants of their high-redshift massive progenitors.

We present a detailed bulge+disk decomposition of our sample of 17 massive galaxies at low-redshift ($z < 0.5$), in the H and I-bands, in order to disentangle its main components with the goal of detecting and studying faint non-axis-symmetric features.

Methodology

We use state-of-the-art surface photometry software, namely SExtractor and GALFIT, performing single and double-Sérsic analysis for the 17 galaxies from our sample. We obtain their surface brightness profiles, along with their color profiles. We also derive multi-component effective radii that help us understanding their place in the local mass-size relation.

Results

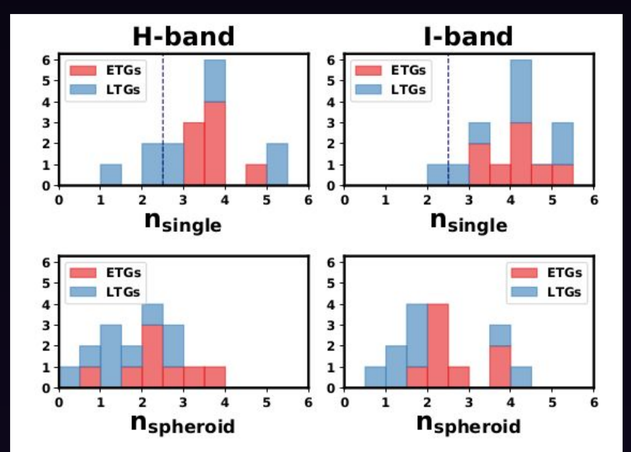
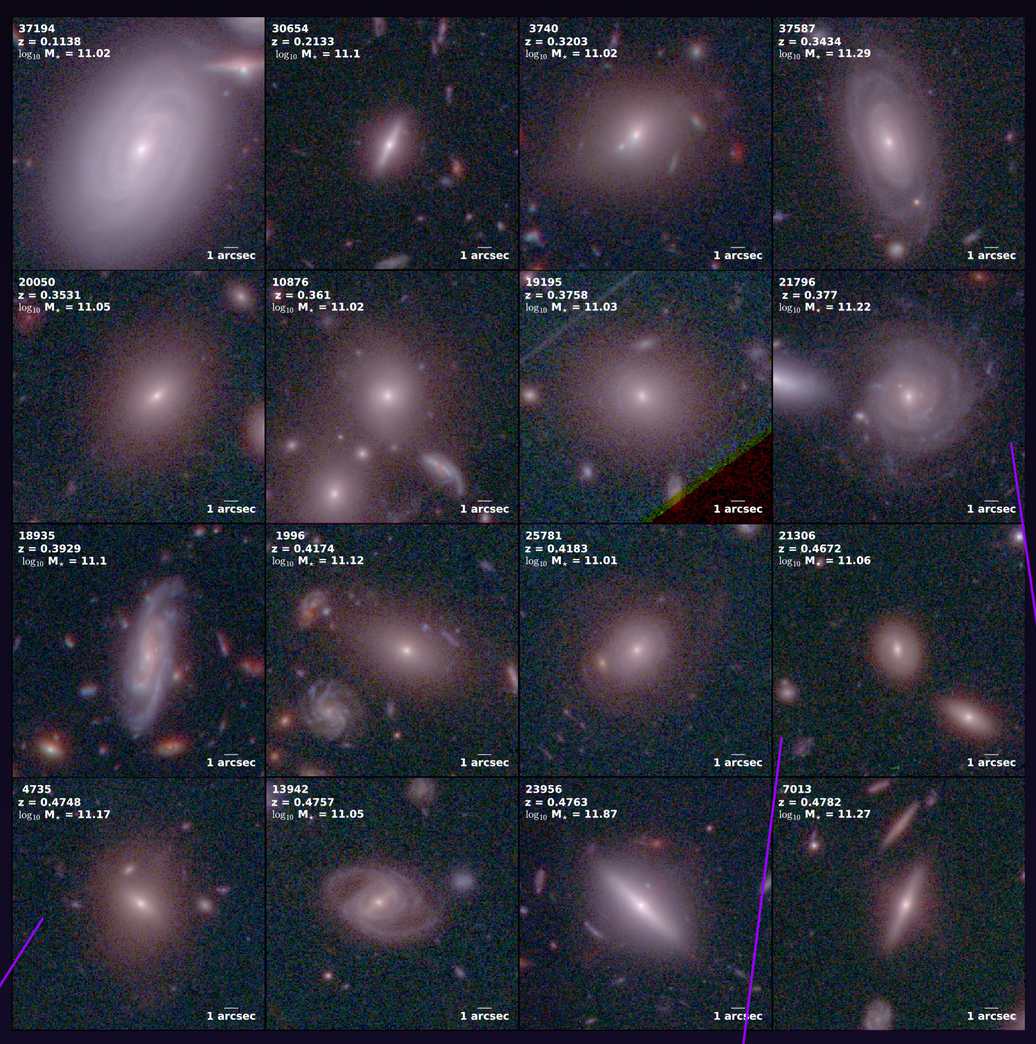


Fig. 6: Sérsic index histograms for single Sérsic fits values (top panels) and for the spheroid component (bottom panels) in the B+D decomposition, both for the H- (left panels) and the I-band (right panels). The dashed grey line represents the division line between disk-like ($n < 2.5$) and spheroid-like ($n > 2.5$) objects. It is remarkable that in the H-band our sample contains nine visually classified LTGs, but using single Sérsic fits only three objects would be classified as disk-like galaxies. For the bottom histograms, it is also remarkable that the majority of our sample contains low spheroid Sérsic indices ($n_{\rm spheroid} < 3$) in both bands, pointing to profiles with flux not very centrally concentrated.



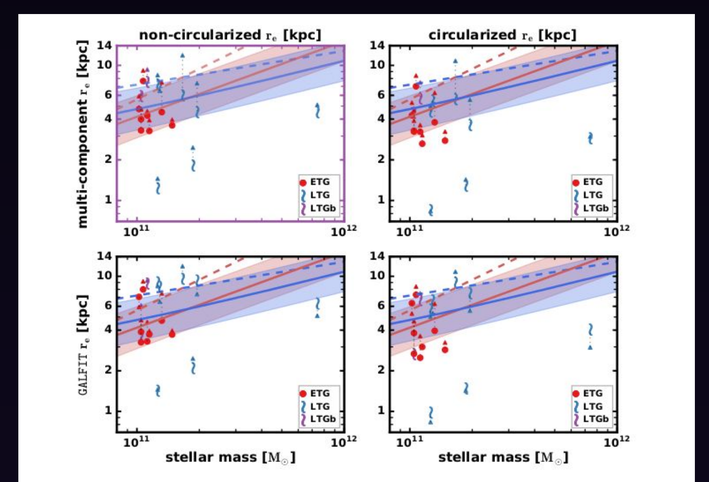
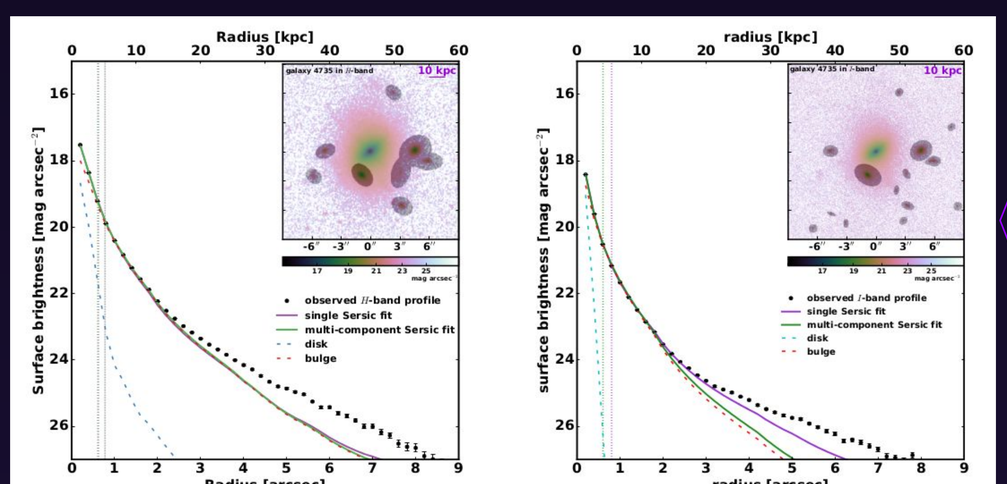
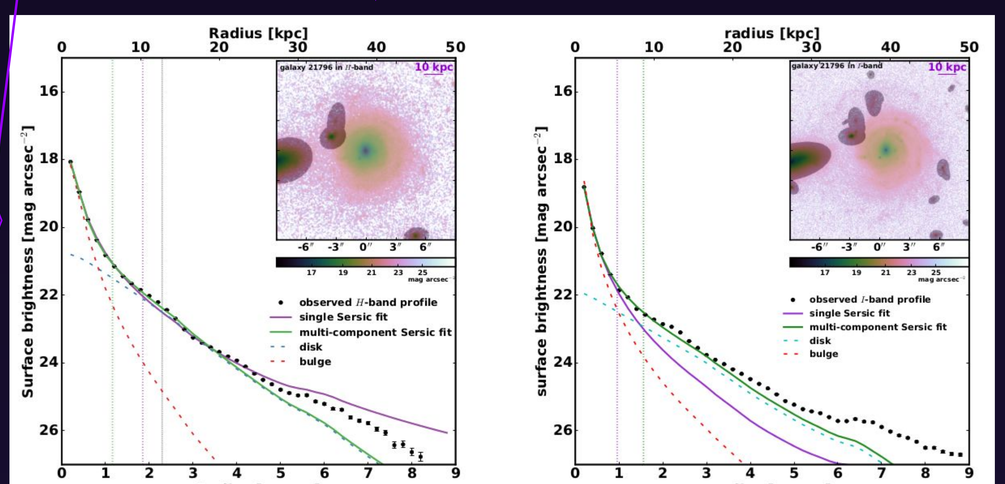
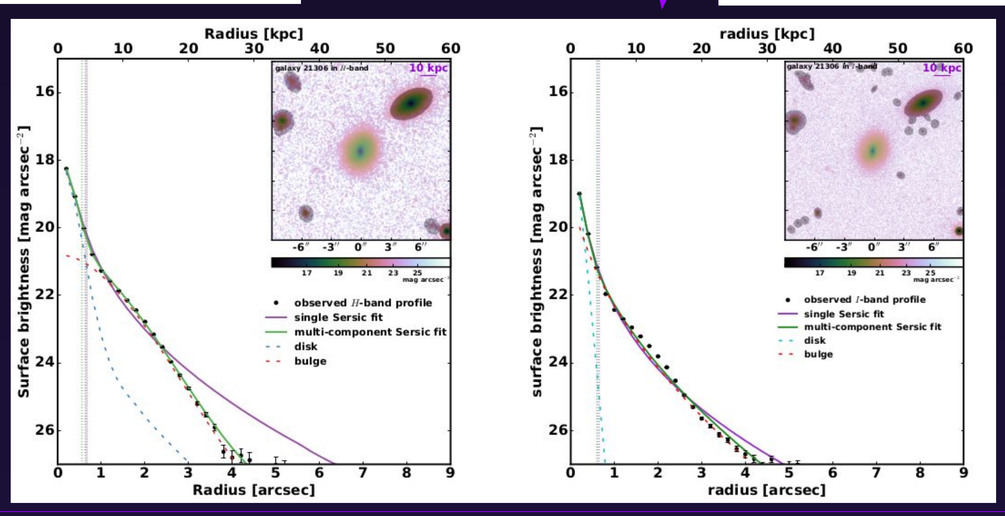


Fig. 10: Size-stellar mass distribution of our H-band data, linked to van der Wel et al. (2014) results represented by triangles. Left panels show non-circularized effective radius, while in the right panels are displayed the circularized ones ($r_{e,circ}$). Top panels correspond to our computed multi-component effective radii, whereas bottom panels show the GALFIT single Sérsic effective radii. Shen et al. (2003) local relation for ETGs and LTGs is represented by the solid red and blue lines, respectively, with the corresponded scatter being the shaded red and blue regions. The colored dashed lines correspond to van der Wel et al. (2014) mass-size relations at $z = 0.25$ which are also not circularized. Our results lay on the scatter of the local relation. However, there are two disk-like galaxies significantly smaller (by $\sim 2\sigma$) than the rest of objects. We choose to highlight with purple color the axis of our preferred plot, since it shows the values of the most representative effective radius (multi-component r_e) without circularization (as in the works that we are comparing our results with).



SBPs in H-band (left panels) and I-band (right panels).
Black points represent the observed luminosity profile.
Solid lines show the models convolved with the PSF (violet line for single-Sérsic fit, green line to B+D decomposition).
Galaxy stamp in units of surface brightness with shadowed areas matching the masks used to obtain the observed profile.





All galaxies in our sample are more luminous in the H-band. For most of the cases, when performing B+D decompositions, the light is under-estimated in the outskirts of these objects. These deviations may be related with their stellar haloes. Furthermore, after B+D decomposition, a number of systems display evidence of galaxy substructures too subtle to be seen in the original image, such as nuclear bars or nuclear spiral patterns.

Summary

- Sérsic index does not offer a good proxy for the morphological type for our sample of massive galaxies.
- Two late-type galaxies in our sample are ~2σ smaller than expected from the local mass-size relation.
- Surface brightness profiles consistently show deviations between the best-fitting Sérsic model and the observed profile in the galactic outskirts, most probably related with the massive stellar haloes of these objects.

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