Insights into high redshift clumpy galaxies from the NIHAO simulations

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Many massive star forming disc galaxies in the redshift range $z = 3$ to $z = 0.5$ are observed to have a clumpy morphology showing giant clumps of size ∼1 kpc and masses of about $10^7 M_\odot$ to $10^{10} M_\odot$ (Genzel et al., 2008; Förster Schreiber et al., 2011; Guo et al., 2015). The nature and fate of these giant clumps is still under debate. In this work we use 19 high-resolution simulations of disc galaxies from the NIHAO sample (Wang et al., 2015) to study the formation and the evolution of the clumps in the discs of high redshift galaxies. We use mock HST - CANDELS observations created with the radiative transfer code GRASIL-3D to carry out, for the first time, a quantitative comparison of the observed fraction of clumpy galaxies and its evolution with redshift with simulations. We find a good agreement between the observed clumpy fraction and the one of the NIHAO galaxies. We find that dust attenuation can suppress intrinsically bright clumps and enhance less luminous ones. In our galaxy sample we only find clumps in light (u-band) from young stars but not in stellar mass surface density maps as is indicated in the figure shown below. This means that the NIHAO sample does not show clumpy stellar discs but rather a clumpy light distribution originating from clumpy star formation events. The clumps found in the NIHAO sample match several observed properties well, like e.g. the age/color gradients as a function of distance from the galaxy center, but they show no sign of inward migration. Clumps in our simulations disperse on timescales of a about a hundred Myr and their contribution to bulge growth is negligible.

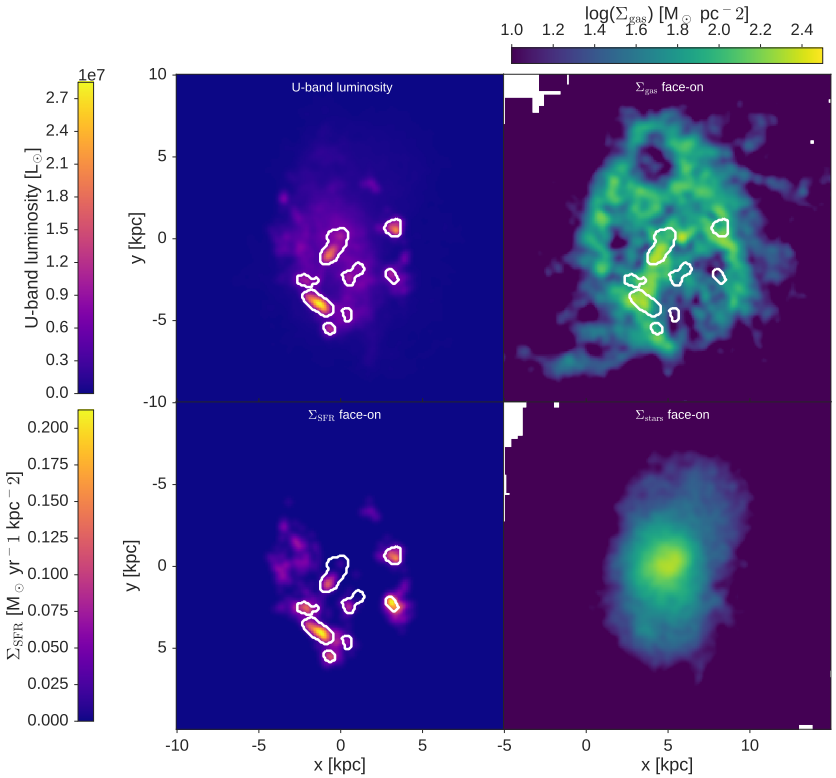

Figure 1: Face-on maps of u-band luminosity (upper left), SFR surface density (lower left), cold gas surface density (upper right) and stellar mass surface density maps (lower right). White contours show the clumps selected in the u-band luminosity map which correspond well with a clumpy star formation morphology. The stellar mass surface density map however is extremely smooth.

References

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