The Role of Tidal Interactions in Driving Galaxy Evolution

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Summary. We carry out a statistical analysis of galaxy pairs selected from chemical hydrodynamical simulations with the aim at assessing the capability of hierarchical scenarios to reproduce recent observational results for galaxies in pairs. Particularly, we analyse the effects of mergers and interactions on the star formation (SF) activity, the global mean chemical properties and the colour distribution of interacting galaxies. We also assess the effects of spurious pairs.

In order to determine the effects of interactions on the SF activity, we have used a cosmological Λ-CDM simulation ($\Lambda = 0.7$, $\Omega = 0.3$, $H_0 = 100$ h km $s^{-1}Mpc^{-1}$, h = 0.7) run with the chemical GADGET-2 code [7] which includes the enrichment of the interstellar medium by SNIa and SNII. In agreement with observations [3], our results indicate that close encounters (with relative projected separation (r_p) smaller than 25 kpc h^{-1}) can enhance the SF activity to levels higher than those observed for galaxies without a close companion (or control sample). We also find that the triggering of SF activity by interactions depend on the internal properties of galaxies, described by the depth of their potential wells and gas reservoirs [5]. Currently passive star forming pairs (systems with SF levels lower than that measured for the control sample) are older and more evolved objects, with deeper potential wells and less leftover gas than active star-forming systems.

We constructed a 3D and a projected 2D galaxy pair catalogs to study the effects of spurious pairs. Consistently with observations [4], we estimated a ∼27% of contamination by projection for systems with $r_p < 100\,\mathrm{kpc}\ h^{-1}$, and a ∼19% of spurious pairs for close systems ($r_p < 25\,\mathrm{kpc}\ h^{-1}$). However, comparing the 2D and 3D simulated galaxy pair samples, we find that these levels of contamination by projection do not affect significantly the correlations between the SF activity and the relative separation, colour distributions and global chemical properties.

The analysis of colours for galaxy pairs shows a clear bimodal distribution [1] with a blue peak populated basically by the closest pairs with a currently strong or recently past SF activity induced by interactions. Instead, the red peak is more consistent with currently passive star forming systems, older and more evolved than those of the blue peak. The analysis of merging and interacting pairs shows that the former contribute with a larger fraction of stellar mass to the blue colours than the latter, demostrating the role of interactions in driving the colour bimodality.

Finally, we study the global mean chemical abundance of the stellar populations (SP) and the interstellar medium (ISM) of galaxies in pairs. The analysis of the chemical abundance as a function of the projected separation shows that while the SP are enriched with respect to galaxies without a close companion, regardless of their current SF activity or relative separation, the ISM stores record fossils of the interactions. Galaxies with a close companion but passively forming stars show a clear correlation of their ISM chemical abundances with distance, fossils of previous past interactions. Conversely, galaxies in pairs with active SF show an enhancement of their ISM abundances as expected. We also analyse the luminosity-metallicity and mass-metallicity relations in order to determine if interactions modify the observed relations [2]; [8]. Our results show the same trends for galaxy pairs and the control sample, indicating that these correlations might not be strongly affected by interactions. This point will be addressed in more detail by Pérez et al. [6].

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