in general good agreement with observations. However, at rotation velocities below $\sim$100 km s^{-1}, the sTFR becomes steep and the residuals of the linear fit depart systematically from zero, consistently with the findings of McGaugh et al. (2000). To analyse the role of SN feedback on the origin of the bend of the sTFR, we run a feedback-free simulation. We found that, when SN feedback is suppressed from the model, the sTFR describes a linear behaviour indicating the crucial role of SNe in the modulation of this relation.

With respect to the bTFR, both the SN feedback model and the feedback-free run show a single slope for the relation at least for the range of velocities resolved by these simulations (40 km s^{-1} $< V <$ 250 km s^{-1}). These results are not in disagreement with the findings of McGaugh et al. (2010) because they reported a bend in the bTFR at $\sim$20 km s^{-1}.

By analysing the simulations at higher redshifts ($0 < z < 3$), we obtained similar trends. We have also checked that our results are robust against numerical resolution. For further details, the reader is referred to De Rossi et al. (2010).

Finally, we explore how the SN feedback model is capable of reproducing these behaviours without introducing scale-dependent parameters. To analyse the impact of galactic outflows in the simulated galaxies, we defined the fraction $f_{\rm b}^{\rm vir}$ as the ratio between the baryonic mass within the virial radius to the one inferred from the universal baryonic fraction ($\Omega_{\rm b}/\Omega_{\rm m}$). In these simulations, $f_{\rm b}^{\rm vir}$ is within the range 0.2–0.8 showing that for the whole sample a significant percentage of the gas in blown away as a consequence of efficient galactic winds. The more prominent losses are obtained for smaller galaxies.

Moreover, by comparing the SN feedback model with the feedback-free run, we found that SN winds generate an important decrease in the star formation activity of galaxies with the larger effects in slow-rotating systems, consistently with the bend of the sTFR. Indeed, our results suggest that the role of SN feedback on the regulation of the star formation strongly depends on the mass of the galaxies. In particular, we distinguish two distinct regimes for the thermodynamical transitions of the gas phase. In the case of smaller galaxies, the virial temperatures are lower and SN heating is more efficient at promoting gas from a cold to a hot phase (see Scannapieco et al. 2006 for more details about the model). However, the cooling times of these systems are shorter than the dynamical times and the hot gas can return to the cold phase in short time-scales. Therefore, for slow-rotators, SN feedback leads to a self-regulated cycle of heating and cooling strongly influencing the star formation activity of these systems. In the case of massive galaxies, the hot phase is established at a higher temperature and SN heating cannot generate an efficient transition of the gas from the cold to the hot phase. Meanwhile, the cold gas remains available for star formation. On the other hand, the cooling times for these galaxies get longer compared to the dynamical times and the hot gas is able to remain in the hot phase during longer time-scales. Hence, SN feedback is not efficient at regulating the star formation in larger galaxies. Interestingly, in this model, the transition from the efficient to the inefficient cooling regime for the hot-gas phase occurs at the same characteristic rotation velocity where the sTFR bends ($\sim$100 km s^{-1}) and is also in agreement with previous observational (e.g. McGaugh et al. 2000) and theoretical works (Larson 1974; Dekel & Silk 1986).

4. CONCLUSION

We studied the Tully-Fisher relation by performing numerical simulations in a cosmological framework. We obtained a sTFR and a bTFR in general agreement with observations. The SN feedback model is able to reproduce the observed bend of the sTFR at a characteristic velocity of $\sim$100 km s^{-1} without introducing scale dependent parameters. We found that this characteristic velocity separates two different regimes: slow-rotators develop a self-regulated cycle of efficient SN heating and radiative cooling while, in fast-rotators, the cold an hot gas-phases seem to be more disconnected. The reader is referred to De Rossi et al. (2010) for more details about this work.

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