Rediscovering our Galaxy
Proceedings IAU Symposium No. 334, 2017
C. Chiappini, I. Minchev, E. Starkenburg & M. Valentini, eds.

doi:10.1017/S1743921317006482

A code comparison of the interaction between Milky Way disc and satellites

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Abstract. We present a comparison of previous simulations of the interaction of the Galactic disc with the Milky Way (MW) satellites using SUPERBOX-10 with new simulations performed with GADGET-2 and ChaNGa. The robust performance of GADGET-2 motivates us to employ more recent versions of GADGET to identify the satellite debris in the MW halo, disc and bulge.

Keywords. methods: n-body simulations, Galaxy: disc, Galaxy: kinematics and dynamics

1. Introduction and goal

By means of N-body simulations with the code SUPERBOX-10 (Bien *et al.* 2013), Moetazedian & Just (2016) - MJ16 - have focused on quantifying the vertical thickening $z_{\rm rms}$ and heating $\sigma_{z,t}^2 - \sigma_{z,0}^2$ of the MW disc induced by its interaction with the MW satellites. They find low disc thickening and heating after a time $t = 2$ Gyr. Here, we compare these results with new results (pure N-body again) obtained with GADGET-2 (Springel 2005) and ChaNGa (Jetley *et al.* 2008, 2010; Menon *et al.* 2015). The goal is to prove the robustness of GADGET-2 and to use one of the latest releases of GADGET to study the final properties of the satellite debris, focusing on its phase-space distribution and its abundance patterns within the MW.

2. Numerical set-up and simulations

The high-resolution Initial Conditions for the MW and the satellites are the same as in MJ16 and follow the cosmological simulation Aq-D-2 (Springel *et al.* 2008). Due to the low speed of ChaNGa, we chose a softening of 100 pc for disc particles in ChaNGa and GADGET-2, against the disc vertical resolution of 40pc in MJ16. We simulated both 1 Gyr of MW in interaction with satellites and 1 Gyr of isolated MW.

3. Results

Fig. (1) shows the comparison of the radial profiles of disc vertical thickening (left panel) and heating (right panel) after 1 Gyr. The final vertical disc thickening in interaction is compared to the isolated case. GADGET-2 and ChaNGa reproduce the higher (but anyway low) thickening in interaction found with SUPERBOX-10. The final vertical heating profile is similar among the three codes. At the galactocentric distance of the solar circle (R = 8 kpc), the three codes cannot reproduce the vertical disc heating of 72 $\rm km^2\ s^{-2}\ Gyr^{-1}$ found by Holmberg *et al.* (2009; filled diamond in the Figure), even accounting for a delay of 0.5 Gyr in the interaction ($\sigma_{z,t}^2 - \sigma_{z,0}^2 = 36\ \rm km^2\ s^{-2}\ Gyr^{-1}$; open

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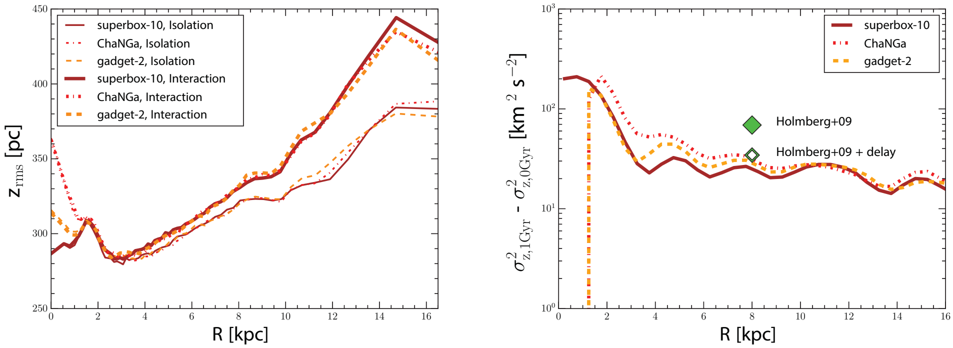

Figure 1. *Left panel*: radial profile of disc thickening after 1 Gyr in the three codes (SUPERBOX-10: solid line; CHANGA: dot-dashed line, GADGET-2: dashed line) for the interaction (thick lines) and the isolation (thin lines) cases. *Right panel*: radial profile of disc heating after 1 Gyr in the three codes for the interaction case, using the same legend. The diamonds are the values obtained following Holmberg *et al.* (2009).

diamond). In the inner disc, both CHANGA and GADGET-2 produce strongly different results with respect to SUPERBOX-10 due to the resolution limitations discussed above.

4. Conclusion and future perspectives

With CHANGA and GADGET-2 we found again low levels of disc thickening and heating due to the interaction with the satellites. These tests show that GADGET-2 is robust, if compared to CHANGA and SUPERBOX-10. Hence, for future work, we will make use of recent releases in the GADGET family to take advantage of the implemented gas dynamics and of the SF and feedback recipes. In this way, we will properly address the deposit of satellite matter not only in the disc, but also in the other MW components.(†)

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† This work was supported by Sonderforschungsbereich SFB 881 "The Milky Way System" (subproject A2) of the German Research Foundation (DFG). The authors acknowledge support by the state of Baden-Württemberg through bwHPC and the German Research Foundation (DFG) through collaboration to Computing Project bw16F005. M. Mazzarini thanks R. Moetazedian, V. Springel and T. R. Quinn for useful discussion.

https://doi.org/10.1017/S1743921317006482 Published online by Cambridge University Press