Ramses simulations with resolved stars

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Abstract

Hydrodynamic simulations of galaxies strive toward higher resolution in both stellar and gaseous material in order to better probe the relevant physical mechanisms governing their formation and evolution. However, increasing resolution also requires adapting our models for physical processes on these newly unlocked scales. Today, many state-of-the-art zoomed simulations of galaxies are reaching mass resolutions of a few tens of solar masses, implying that the most massive stars can no longer be encapsulated by a single resolution element. This motivates a transition to models resolving stars.

In my talk, I will describe a model where stars more massive than a chosen mass threshold are treated individually, on a star-by-star basis rather than through unresolved stellar populations. This model samples each stellar progenitor from an IMF, and generate stellar particles evolved within Ramses with their individual feedback, metal yields and local gravitational field.

I will showcase applications of this model, focussing first on the effect of runaway stars in Milky-Way-sized galaxies (Andersson et al. 2020, 2021). I will demonstrate how fast-travelling massive stars can (i) boost galactic outflows thanks to supernova explosions in low-density gas, away from their dense star-formation site and (ii) affect the observationally-inferred star formation law, particularly in the outskirts of disc galaxies. I will also briefly show preliminary results from simulations of dwarf galaxies, where all stars down to 0.5 Msol are resolved as individuall stars.

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