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The importance of the way in which resolution elements are selected for supernova feedback in simulations of galaxies

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Supernova (SN) feedback plays a fundamental role in galaxy evolution. However, modelling SN feedback in simulations of galaxy formation remains challenging because the simulations cannot resolve the scales on which SN feedback occurs. Therefore, SN feedback is generally implemented as a subgrid model that has a number of free parameters, which are calibrated such that the simulated galaxies have realistic morphologies and masses. Differences in how the energy from SNe is coupled to the gas have resulted in a variety of SN feedback models used by different groups. However, the importance of the selection of resolution elements in which young stellar particles inject their SN energy has largely been overlooked. In this work, we study five methods of gas-element selection in SN feedback. We consider the mass-weighted method, which was used in the Eagle simulations; the isotropic method, which produces a statistically isotropic distribution of SN energy; the minimum-distance method, in which stellar particles inject SN energy into their closest gas neighbour; and the minimum (maximum) density method, where the gas neighbour with the lowest (highest) density receives the energy. We run a suite of simulations of an isolated Milky Way-mass galaxy and small cosmological volumes. We demonstrate that different neighbour-selection strategies result in significant variations in galaxy star formation rates, morphologies, gas densities, and wind mass loading. We conclude that the way in which the SN energy is distributed among the resolution elements surrounding an SN event is as important as changing the energy by factors of a few.

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