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A Novel Scheme for Dark Matter Annihilation Feedback in Cosmological Simulations

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We present a new self-consistent method for incorporating dark matter annihilation feedback (DMAF) in cosmological N-body simulations. The power generated by DMAF is evaluated at each dark matter (DM) particle which allows for flexible energy injection into the surrounding gas based on the specific DM annihilation model under consideration. Adaptive, individual time steps for gas and DM particles are supported and a new time-step limiter, derived from the propagation of a Sedov–Taylor blast wave, is introduced. We compare this donor-based approach with a receiver-based approach used in recent studies and illustrate the differences by means of a toy example. Furthermore, we consider an isolated halo and a cosmological simulation and show that for these realistic cases, both methods agree well with each other. The extension of our implementation to scenarios such as non-local energy injection, velocity-dependent annihilation cross-sections, and DM decay is straightforward.

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