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Towards N-body Modelling of Self-Interacting Dark Matter Structures with GIZMO

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The standard cosmological model Λ CDM, successfully describes large-scale structure of the Universe. However, several problems on galactic scales motivate studies of alternative dark matter (DM) models. One of such models is self-interacting dark matter (SIDM), where interactions between DM particles can change the internal structure of DM halos.

In previous studies, our group considered SIDM models with a dark interaction as a possible explanation of the cosmic-ray positron excess. An important question for such models is whether a two-component DM distribution can be formed dynamically, where one component creates a separate spatial structure and contributes to the positron signal. In this work, we develop N -body simulation framework based on GIZMO to study this problem. At the current stage, we compare collisionless CDM and SIDM halos and study the evolution of their density profiles, the formation of SIDM cores, and the dependence of these effects on the interaction parameters. These simulations are also used to test and validate the numerical setup. The next step is to extend the simulations to two-component DM models and study the conditions under which the required spatial distributions can form and remain dynamically stable. This approach allows us to connect the microscopic properties of SIDM models with the formation and evolution of DM structures relevant for indirect DM searches.

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