

# Indirect detection of (Late-decoupling) Semi-Annihilating Dark Matter

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Semi-annihilation describes processes with an initial state of two dark matter particles, and a final state of one plus standard model states. It is a generic feature of dark matter whenever the symmetry group enforcing stability is not a discrete  $Z_2$ . Semi-annihilation changes the expected signals in current dark matter searches, weakening limits from direct and collider searches, but can still be probed using cosmic ray observations. We discuss generic features of semi-annihilating searches and derive model-independent bounds using effective operators. We additionally discuss the relation between semi-annihilation and kinetic decoupling of the dark and visible sectors. The scattering processes that maintain thermal contact are related by crossing symmetry to dark matter annihilation, which can have an important effect on thermal freeze out. However, interesting parameter space remains where the indirect signals today can be significantly enhanced. We illustrate this general feature using a specific example, a dark matter explanation of the AMS positron flux.

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