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Early kinetic decoupling and Higgs invisible decay in simple dark matter models

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We revisit the Higgs-invisible decay branching ratio in Higgs-portal dark matter models.
If the mass of the dark matter is slightly below the half of the mass of the Higgs boson, then pairs of the DM particles annihilate into the SM particles efficiently thanks to the Higgs resonance. The DM-Higgs coupling is required to be small to obtain the right amount of the dark matter relic abundance. As a result, the DM-nucleon scattering is highly suppressed and can explain the current null result of the dark matter signal at the direct detection experiments such as the XENON1T experiment. Another consequence of the tiny coupling is that the kinetic decoupling of dark matter from the thermal plasma in the early Universe may happen earlier. This implies that the standard calculation of the relic abundance may not be justified. We reevaluate the DM relic abundance with the evolution of the DM temperature. We show that the DM-Higgs coupling was underestimated in the literatures. Therefore, the Higgs invisible decay branching ratio is larger than previously expected, and the future collider experiments, such as the ILC experiment, can probe larger parameter space.

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