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Relic Abundance in Secluded Dark Matter Scenario with Massive Mediator

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The relic abundance of the dark matter (DM) particle d
is studied in a secluded DM scenario, in which the d number
decreasing process dominantly occurs not through the pair annihilation
of d into the standard model particles, but via the $dd \to mm$
scattering process with a subsequently decaying mediator particle m.
It is pointed out that the cosmologically observed relic abundance of DM
can be accomplished even with a massive mediator having a mass m_m
non-negligibly heavy compared with the DM particle mass m_d.
In the degenerated d-m case
($m_d = m_m$),
the DM relic abundance is realized by adjusting
the $dd \to mm$ scattering amplitude large enough and by choosing
an appropriate mediator particle life-time.
The DM evolution in the early universe exhibits characteristic
"terrace" behavior, or two-step number density decreasing behavior,
having a "fake" freeze-out at the first step.
Based on these observations, a novel possibility of the DM model
buildings is introduced
in which the mediator particle m is unified with the DM particle
d in an approximate dark symmetry multiplet.
A pionic DM model is proposed to illustrate this idea
in a renormalizable field theory framework.

S. Okawa, M. Tanabashi and M. Yamanaka,
"Relic Abundance in Secluded Dark Matter Scenario with Massive Mediator,"
arXiv:1607.08520 [hep-ph].

Summary

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