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Breit-Wigner resonance in cosmology

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Motivated by the possibility of enhancing dark-matter self-interaction cross-section $\sigma_{\rm self}$, we have revisited the issue of dark matter annihilation through a Breit-Wigner resonance.
For instance the resonance-enhanced early-universe annihilation cross section implies so small cross section for elastic scattering between dark matter and the Standard Model, that effects of early kinetic decoupling of dark matter are crucial for correct prediction of relic dark matter abundance. Also the standard Breit-Wigner parametrization of a resonance propagator must be corrected by including momentum dependence of the resonance width. It has been shown that when coupling between the resonance and the dark matter is not negligible then consequences of momentum dependent width are important and can not be neglected.
Model independent discussion is illustrated within a theory of Abelian vector dark matter. The model assumes extra $U(1)$ symmetry group factor and an additional complex Higgs field needed to generate a mass for the dark vector boson, which provides an extra neutral Higgs boson h_2.
If $2M_{DM} \approx M_{h_2}$ then $\sigma_{\rm self}$ could be amplified by s-channel resonance and also the observed dark matter abundance could be properly reproduced.
The momentum dependence of the scalar resonance introduces a gauge dependance of annihilation amplitudes. Also unitarity constraints might be jeopardized. \bg{Both effects have been discussed.
It turns out that for the s-channel resonance enhancement, the Fermi-LAT data favor heavy dark matter with no substantial enhancement of
$\sigma_{\rm self}$.

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