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Gauge invariant approach to resonant annihilation of vector dark matter

Transition amplitudes describing dark-matter annihilation processes through a resonance may become highly inaccurate close to a production threshold if a Breit-Wigner propagator with a constant width is used. To partially overcome this problem, the BW propagator needs to be modified by including a momentum dependent decay width. However, such an approach to resonant transition amplitudes generically suffers from gauge artefacts that may also give rise to a bad or ambiguous high-energy behaviour of the amplitudes. We address the two problems of gauge dependence and high-energy unitarity within a gauge-independent framework of resummation implemented by the so-called e Technique. We study DM annihilation via scalar resonances in a gauged U(1)_X complex-scalar extension of the Standard Model that features a massive stable gauge field which can play the role of the DM. We find that the predictions for the DM abundance may vary significantly from previous studies using Breit-Wigner ansatz and propose an alternative simple approximation which leads to the correct DM phenomenology.

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