

ANALYSIS OF A SCALAR DARK MATTER CANDIDATE IN SIX-DIMENSIONAL EFFECTIVE FIELD THEORY

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Abstract

We study a real scalar gauge-singlet dark matter (DM) candidate within a six-dimensional effective field theory (EFT), where interactions with Standard Model particles are described by dimension-six operators grouped as pure scalar, vector–scalar and scalar–fermion interactions. The model is implemented in FeynRules, and the resulting UFO file is analyzed with MadDM and MadGraph5_aMC@NLO to examine relic density, direct and indirect detection, and collider signatures. Comparison of the thermal relic density with WMAP data shows that the model is compatible for cut-off scales $\Lambda = 2$ TeV and $\Lambda = 2.5$ TeV, whereas for $\Lambda = 3$ TeV the mass range $0 < M_\varphi < 225$ GeV is excluded. Among the couplings, the scalar-quark interactions affect the relic density most strongly. No transition amplitude is obtained for DM–nucleus scattering in comparison with LUX, PICO60 and XENON1T. Velocity-averaged annihilation cross-sections are compared with Fermi-LAT limits from dwarf spheroidal galaxies. For $\Lambda = 1.5$ TeV, annihilation into W^+W^- excludes $M_\varphi \geq 620$ GeV, while for $\Lambda = 2$ TeV and 2.5 TeV the model remains consistent over $0 < M_\varphi < 1$ TeV. Finally, scalar DM pair production with dijets and missing transverse energy at the 13 TeV LHC yields signal cross-sections of order 10^{-8} – 10^{-10} pb, several orders of magnitude below the background. This indicates that the dijet channel is not a viable search channel for this candidate at hadron colliders.