Scalars 2017

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Heavy Quarks Flavored Real Scalar Dark Matter

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Content :

The absence of confirmed signal in dark matter (DM) direct detection (DD) may suggest a weak coupling between DM and the first generation quarks. In this work we consider a real scalar dark matter S which has new Yukawa interactions with charm c and top quark t via a vector-like fermion mediator ψ. By setting the Higgs portal to be negligible, we focus on the new Yukawa interactions. Since there is no valence c,t quark in nucleons, DM-gluon scattering at loop level becomes important. We found that renormalization group equation (RGE) effects are crucial in calculating the DM-nucleon scattering rate at $\mu_{had}\sim 1\, {\rm GeV}$ if one constructs the effective theory at $\mu_{EFT}\sim m_Z$. For the perturbative benchmark couplings we choose, combined results from relic abundance requirement $\Omega h^2=0.12$, direct/indirect detection constraints, 13 TeV LHC data have excluded a thermal relic DM with $m_S<m_t/2$ in this model. FCNC processes of top quark can be generated at both tree level $t\to \psi^{(*)}S \to cSS$ and loop level $t\to c+\gamma/g/Z$, of which the branching fractions are usually below 10^{-9} after passing the other constraints, which are still safe from the current top quark width measurements.

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