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Dark Matter in an Evanescent Three-Brane Randall-Sundrum Scenario

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Apart from its gravitational interactions, dark matter (DM) has remained so far elusive in laboratory searches. One possible explanation is that the relevant interactions to explain its relic abundance are mainly gravitational. In this work we consider an extra-dimensional Randall-Sundrum scenario with a TeV-PeV IR brane, where the Standard Model is located, and a GeV-TeV deep IR (DIR) one, where the DM lies. When the curvatures of the bulk to the left and right of the IR brane are very similar, the tension of the IR brane is significantly smaller than that of the other two branes, and therefore we term it “evanescent”. In this setup, the relic abundance of DM arises from the freeze-out mechanism, thanks to DM annihilations into radions and gravitons. Focusing on a scalar singlet DM candidate, we compute and apply current and future constraints from direct, indirect and collider-based searches. Our findings demonstrate the viability of this scenario and highlight its potential testability in upcoming experiments. We also discuss the possibility of inferring the number of branes if the radion and several Kaluza-Klein graviton resonances are detected at a future collider.

Abstract

Apart from its gravitational interactions, dark matter (DM) has remained so far elusive in laboratory searches. One possible explanation is that the relevant interactions to explain its relic abundance are mainly gravitational. In this work we consider an extra-dimensional Randall-Sundrum scenario with a TeV-PeV IR brane, where the Standard Model is located, and a GeV-TeV deep IR (DIR) one, where the DM lies. When the curvatures of the bulk to the left and right of the IR brane are very similar, the tension of the IR brane is significantly smaller than that of the other two branes, and therefore we term it “evanescent”. In this setup, the relic abundance of DM arises from the freeze-out mechanism, thanks to DM annihilations into radions and gravitons. Focusing on a scalar singlet DM candidate, we compute and apply current and future constraints from direct, indirect and collider-based searches. Our findings demonstrate the viability of this scenario and highlight its potential testability in upcoming experiments. We also discuss the possibility of inferring the number of branes if the radion and several Kaluza-Klein graviton resonances are detected at a future collider.

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