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The Inflaton Portal to a Highly decoupled EeV Dark-Matter Particle

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We explore the possibility that the relic abundance of dark matter is generated in a context where the inflaton is the only mediator between the visible and the hidden sectors of our universe. Due to the relatively large mass of the inflaton field suggested by large-field inflation scenarios, such a portal leads to an extremely feeble interaction between the dark sector and the Standard Model suggesting that the dark sector cannot reach any thermal equilibrium with the visible sector. In the context of highly-decoupled dark sector scenarios the entropy dilution mechanism, which is necessary to produce the correct relic abundance, requires the presence of a very late decay of a dark component
into the Standard Model. Assuming that the only contact between the dark and the visible thermal baths is the inflationary sector, the decay width of this dark component is naturally suppressed by the inflaton propagator. We show that an inflaton mass of order 1013 GeV – as is predicted by various large-field inflation models – together with natural values of the couplings are fully
compatible with a dark-matter relic abundance $\Omega h^2 \sim 0.1$. As a general feature of the model, the entropy dilution mechanism is systematically accompanied by a period of early matter domination.
The existence of such a period modifies the amount of e-folds between horizon crossing and the end of inflation. Besides, the coupling of the inflaton to the dark and visible sectors brings loop contributions to the inflationary potential which can destabilize the inflation trajectory. Considering all these complementary constraints, we show that, in the context of a plateau-inflation scenario such as the α-attractor model, the inflaton can constitute a viable mediator between the Standard Model and O(10-500) EeV dark-matter candidate. Furthermore, we show that better constraints on the tensor-to-scalar ratio and spectral index could potentially rule out such dark-matter production scenario in the future.

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