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Kaluza-Klein Portal Matter

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In models of thermal dark matter with MeV-GeV masses, a common simplified construction relies on a U(1) dark sector (and corresponding dark photon of MeV-GeV mass) which kinetically mixes with the Standard Model (SM) hypercharge to serve as a mediator to achieve the observed relic abundance. This kinetic mixing will arise at one-loop order if the theory includes so-called "portal matter"– heavy particles charged under both the dark gauge group and the SM hypercharge. It has been previously argued that if the portal matter is assumed to be fermionic, then phenomenological and theoretical concerns suggest that these portal matter fields will be vector-like copies of SM particles, albeit with additional charge under the dark gauge group, and should have a delicate cancellation of charges such that the resulting kinetic mixing is both finite and calculable. In this talk, we shall argue that extra dimensions present a natural framework in which to realize phenomenologically and theoretically satisfactory fermionic portal matter– if the dark U(1) gauge group is embedded in a larger Lie group that is broken by boundary conditions on the branes, then portal matter will naturally arise as massive Kaluza-Klein states if SM fermions are embedded in dark multiplets in the bulk. To demonstrate, we present a semi-realistic toy model with a single TeV-scale flat extra dimension, discussing the collider phenomenology of this setup and how the inclusion of a portal matter sector would alter the familiar phenomenological constraints on such 5D theories.

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