

Dark photon mixing effects and CP violation

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The dark photon portal, a leading framework for connecting the Standard Model (SM) with dark matter, is extended in this work to include several novel and consequential mechanisms. Beyond the standard kinetic mixing with the hypercharge field, we incorporate mass mixing via an additional Higgs doublet. Furthermore, we introduce a non-Abelian kinetic mixing between the $U(1)_X$ and $SU(2)_L$ gauge fields, achieved through a dimension-five operator involving a Higgs triplet. Most significantly, we present a renormalizable, CP-violating non-Abelian kinetic mixing scenario within the Type-III Seesaw model. This unified framework not only accounts for the origin of neutrino mass but also provides a viable exploration for the electron electric dipole moment (EDM), offering a multifaceted portal with rich phenomenological implications.

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