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FIMP Dark matter from Flavor models

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We investigate the phenomenology of a non-thermal dark matter (DM) in the context of flavor models that explain the hierarchy in the masses and mixings of quarks and leptons via the Froggatt-Nielsen (FN) mechanism. A flavor-dependent $U(1)_{FN}$ symmetry explains the fermion mass and mixing hierarchy, and also provides a mechanism for suppressed interactions of the DM, assumed to be a Majorana fermion, with the Standard Model (SM) particles, resulting in its FIMP (feebly interacting massive particle) character. Such feeble interactions are mediated by a flavon field through higher dimensional operators governed by the $U(1)_{FN}$ charges. We point out a natural stabilizing mechanism for the DM within this framework with the choice of half-integer charge for the DM fermion and integer charges for the SM fermions and the flavon field. In this scenario, the DM is non-thermally produced from the decay of the flavon in the early universe, and becomes a relic through the freeze-in mechanism. We explore the allowed parameter space for this DM candidate from relic abundance by solving the relevant Boltzmann equations. We find that there is some preference for sub-MeV range for the DM mass since the experimental and theoretical constraints are less stringent in this range.

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