

A Visible QCD Axion Portal to GeV Scale Dark Matter

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We consider a model involving a “visible” QCD axion with mass in the MeV range with flavour non-universal couplings to the Standard Model (SM) first generation fermions. Such a heavy axion must evade a variety of stringent constraints which precisely fix the couplings to the SM fields: the requirement of “pion-phobia” determines the Peccei-Quinn (PQ) charges of the light quarks to be $2/3$ and $1/3$ for the up and down quarks, respectively, while the precise measurement of the electron’s anomalous magnetic moment, combined with collider and beam dump constraints, require the PQ charge of the electron to be $O(1)$. By letting the axion also couple to a Dark Matter (DM) fermion χ , we solve the Boltzmann equations to find the regions of the parameter space that yield the correct relic abundance. The coupling of the DM with the electrons is subject to indirect detection constraints from the CMB, while those with the light quarks induce elastic DM-nucleus collisions that are subject to nuclear recoil constraints. This restricts the allowed region of the parameter space that reproduces the correct relic abundance to the GeV mass range and PQ charges of $O(0.1)$.

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