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Nonthermal Two Component Dark Matter Model for Fermi-LAT γ-ray excess and 3.55 keV X-ray Line

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A two component model of nonthermal dark matter is formulated to simultaneously explain the Fermi-LAT results indicating a γ-ray excess observed from our Galactic Centre in the 1-3 GeV energy range and the detection of an X-ray line at 3.55 keV from extragalactic
sources. Two additional Standard Model singlet scalar fields S_2 and S_3 are introduced. These fields couple among themselves and with the Standard Model Higgs doublet H. The interaction terms among the scalar fields, namely H, S_2 and S_3, are constrained by the application of a discrete $\mathbb{Z}_2 \times \mathbb{Z}_2'$ symmetry which breaks softly to a remnant $\mathbb{Z}_2''$ symmetry. This residual discrete symmetry is then spontaneously broken through an MeV order vacuum expectation value u of the singlet scalar field S_3. The resultant physical scalar spectrum has the Standard Model like Higgs as χ_1 with $M_{\chi_1} \sim 125$ GeV, a moderately heavy scalar χ_2 with $50 \text{ GeV} \leq M_{\chi_2} \leq 80$ GeV and a light χ_3 with $M_{\chi_3} \sim 7$ keV. There is only tiny mixing between χ_1 and χ_2 as well as between χ_1 and χ_3. The lack of importance of domain wall formation in the present scenario from the spontaneous breaking of the discrete symmetry $\mathbb{Z}_2''$, provided $u \leq 10$ MeV, is pointed out. We find that our proposed two component dark matter model is able to
explain successfully both the above mentioned phenomena – the Fermi-LAT observed γ-ray excess (from the $\chi_2 \to \mathrm{b\bar{b}}$ decay mode) and the observation of the X-ray line (from the decay channel $\chi_3 \to \gamma\gamma$) by the XMM-Newton observatory.

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