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Muonphilic dark matter explanation of gamma-ray galactic center excess

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The Galactic center gamma-ray excess (GCE) is a long-standing unsolved problem. One of candidate solutions, the dark matter (DM) annihilation, has been recently tested with other astrophysical observations, such as AMS-02 electron-positron spectra, Fermi Dwarf spheroidal galaxies gamma-ray data, and so on. By assuming that the DM particles annihilate purely into a normal charged fermion pair, Di Mauro and Winkle (2021) claimed that only a muon-pair is compatible with the null detection of all the corresponding astrophysical measurements and can explain GCE simultaneously. On the other hand, a muonphilic DM model may also lead to a signal in the recent Fermilab muon g−2 measurement or be constrained by the latest PandaX-4T limit. In this work, we comprehensively study interactions between DM and muon, including various combinations of DM and mediator spins. In agreement with GCE (not only 2μ but also 4μ final states), we test these interactions against all the thermal DM constraints. Our results show that only the parameter space near the resonance region of mediator can explain GCE and relic density simultaneously, and larger parameter spaces are still allowed if other poorly-known systematic uncertainties are included. Regardless of the DM spin, only the interactions with the spin-0 mediator can explain the recent muon g−2 excess on top of GCE, relic density, and other DM and mediator constraints.

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