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Forbidden Dark Matter Combusted Around Supermassive Black Hole

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The forbidden dark matter cannot annihilate into a pair of heavier partners, either SM particles or its partners in the dark sector, at the late stage of cosmological evolution by definition. We point out the possibility of reactivating the forbidden annihilation channel around supermassive black holes. Being attracted towards a black hole, the forbidden dark matter is significantly accelerated to overcome the annihilation threshold. The subsequent decay of the annihilation products to photon leaves a unique signal around the black hole, which can serve as a smoking gun for the forbidden dark matter. For illustration, the Fermi-LAT data around Sgr A$*$ provides a preliminary constraint on the thermally averaged cross section of the reactivated forbidden annihilation that is consistent with the DM relic density requirement.

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