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Searching for Dark Photon Dark Matter with Cosmic Ray Antideuterons

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Cosmic ray antideuterons have received attention as a rare event probe of dark matter (DM) physics due to their low astrophysical background. As conventional thermal relic WIMP models have become increasingly constrained by direct detection, these indirect channels become essential as they access the "hidden sector" DM interactions that direct detection is blind to.

We consider models of dark photon dark matter, thermal relic DM with a massive dark photon kinetically mixed with the Standard Model photon. We find that ~ 30 GeV DM candidates are poorly constrained by CMB and anti-proton indirect detection bounds. Moreover direct detection sensitivities to these models are suppressed by the mixing parameter if annhilation into dark photons is kinematically allowed. This makes anti-deuteron annihilation signatues ideal places to search. We investigate the expected anti-deuteron flux on Earth for a range of propagation models, and report prospects of detection by the future GAPS experiment.

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