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g-2 Bounds on Scalar Dark Matter Annihilation

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g-2 correction has been accurately measured in the E821 experiment at Brookhaven National Lab (BNL). Theoretical calculations of the loop corrections to the fermion bremsstrahlung predict the observations quite well. Yet there remains a 10^-4

One way that this discrepancy can be interpreted is by new candidate particles running in the loop. The smallness of the discrepancy leaves only small room for corrections to the standard model. Thus providing a tight constraint on the coupling of such particles to standard model particles. Popular scenarios involve particles such as the supersymmetric particles, the "dark photon", and dark matter. Previously, the bound has been applied to constrain scattering cross sections of these new particles for direct detection.

In this work the bound is applied to constrain the annihilation cross section for indirect detection. The g-2 contribution comes from the $F_2(0)$ term of the vertex correction. This puts an upper bound on the real part of the coupling constant. For this model where the mediator is electromagnetically charged, one can also repeat the same exercise for an electric dipole moment (EDM). The EDM contribution comes from the $F_3(0)$ term of the vertex correction. This puts an upper bound on the imaginary part of the coupling constant which is the CP violating part. This combination will be shown to put a complete upper bound on the annihilation cross section of a scalar dark matter in the $m_f \to 0$ limit.

If we consider the limit where the mediator is a lot heavier than dark matter, we find that the bound on annihilation to the electrons is 1.0x10^-7pb + 2.2x10^-15pb and the muons is 1.4x10^-4pb + 45pb. The parentheses indicate the quantity used to obtain the values. It is interesting to note that the bound on the electron is dominated by the g-2 measurement, whereas the muon is dominated by the EDM measurement. Especially interesting is this latter case of muon bound. If the dark matter is observed through an annihilation to muon channels with a cross section high above the g-2 bound of 1.4x10^-4[pb], then EDM contribution must be dominant. The dark matter coupling is CP violating in this scenario.

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