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Millicharged Atomic Dark Matter

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Abstract:

We present a simplified version of the atomic dark matter scenario, in which charged dark constituents are bound into atoms analogous to hydrogen by a massless hidden sector U(1) gauge interaction. Previous studies have assumed that interactions between the dark sector and the standard model are mediated by a second, massive Z' gauge boson, but here we consider the case where only a massless gamma' kinetically mixes with the standard model hypercharge and thereby mediates direct detection. This is therefore the simplest atomic dark matter model that has direct interactions with the standard model, arising from the small electric charge for the dark constituents induced by the kinetic mixing. We map out the parameter space that is consistent with cosmological constraints and direct searches, assuming that some unspecified mechanism creates the asymmetry that gives the right abundance, since the dark matter cannot be a thermal relic in this scenario. In the special case where the dark "electron" and "proton" are degenerate in mass, inelastic hyperfine transitions can explain the CoGeNT excess events. In the more general case, elastic transitions dominate, and can be close to current direct detection limits over a wide range of masses.

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