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Exploring Ultraviolet Complete Extensions of a Vector Dark Matter Model via the so(4) algebra

In previous works it has been shown that a minimalist model for vector dark matter surfers from loss of unitarity because of the coupling between the vector field and the Higgs boson [1].

Nevertheless, algebraic manipulation of the vector sector by mixing the weak interaction fields with the vector dark matter fields reveals a possible path towards an ultraviolet completion. The resulting vector sector constructed by linear combinations of these fields reproduces the gauge sector of a Yang-Mills theory over a group with an $\mathfrak{so}(4)$ algebra [2]. The algebra isomorphism $\mathfrak{so}(4) \simeq \mathfrak{su}(2) \oplus \mathfrak{su}(2)$ implies that an ultraviolet completion can be constructed by using either $\mathrm{SO}(4)$ or its cover group $\mathrm{SU}(2) \times \mathrm{SU}(2)$ to formulate the desired Yang mills theory.

We have managed to construct an $\mathrm{SU}(2) \times \mathrm{SU}(2)$ based Yang-Mills theory which reproduces the desired gauge sector and we are currently studying the constraints on the parameter space coming from current experimental bounds related to dark matter and standard model mass spectrum. In parallel, we have begun the formulation of the alternative $\mathrm{SO}(4)$ model and we aim to compare their differences and ability to maintain a minimal structure once completed.

References

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[2] Alfonso R. Zerwekh. On the Quantum Chromodynamics of a Massive Vector Field in the Adjoint Representation (2013)

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