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The importance of heavy-quark loops for dark matter searches

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Effective operators are a convenient way to parameterise our ignorance of the interactions between Dark Matter (DM) particles and the Standard Model. However, if we want to apply the same effective operator to different processes (e.g. DM production at the LHC and DM direct detection in underground experiments), we need to worry about the large separation of scales. For example, to calculate direct detection cross sections, we need to evolve all effective operators from the TeV scale down to the MeV scale. In the process, new interactions may be induced at loop-level, leading to additional operators, which are absent at the TeV scale.

Summary

We demonstrate the effects of heavy-quark loops for two interesting cases, namely Yukawa-like couplings and tensor couplings. For the former case, top quark loops lead to an effective coupling of DM to gluons, which significantly improves the bound from LHC monojet searches compared to direct detection experiments. For the latter case, loop-induced magnetic dipole moments lead to spin-independent interactions which strongly enhance the direct detection cross section. In both cases we therefore find that loop-level processes may give the dominant contribution to the interactions of DM with Standard Model particles.

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