EFT Truncation

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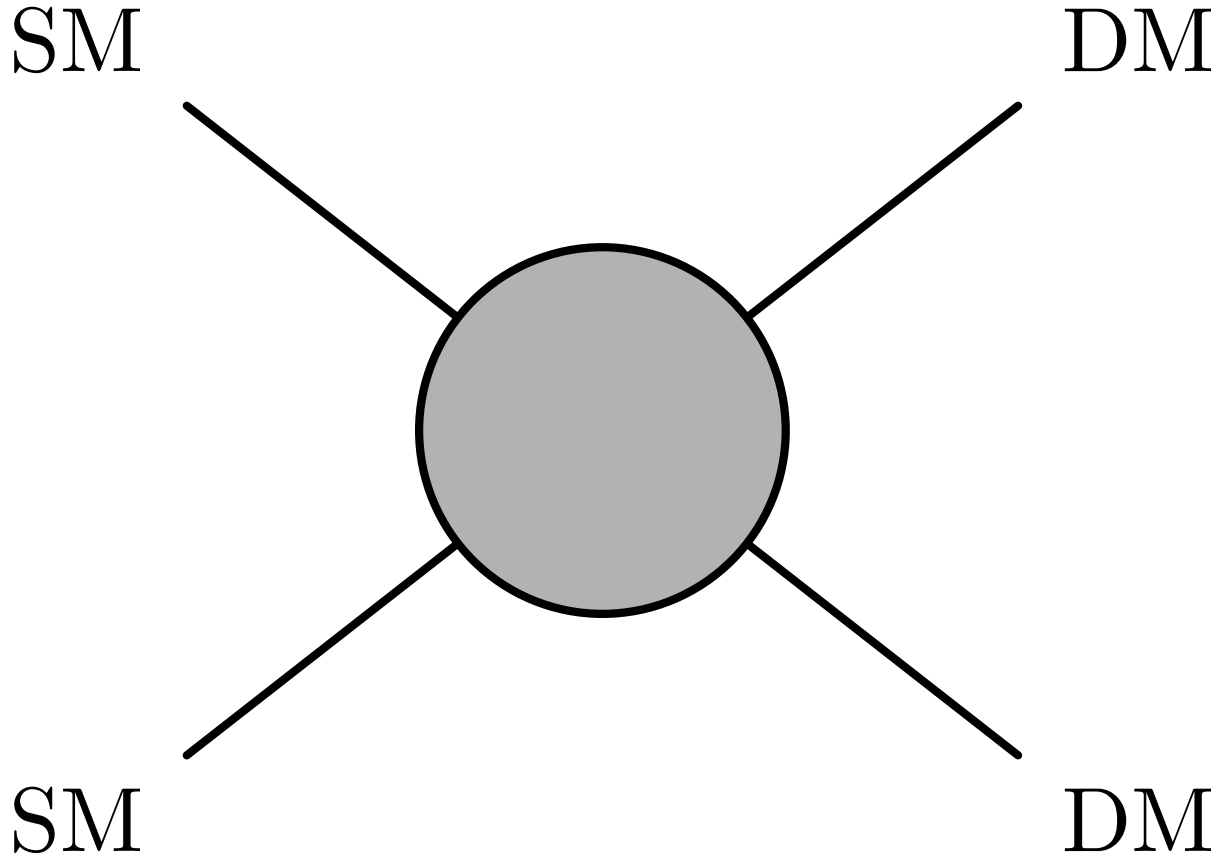
Introduction

The purpose of these slides is keep in the DM LHC discussion the topic of Effective Field Theory (EFT) models, and the truncation methods necessarily with dealing with their validity.



EFT's provide a more model independent way to search for dark matter.

EFT Validity

EFT models are not valid when the momentum transfer of a process (Q_{tr}) becomes comparable to the mass of the underlying non-specified mediator (M_{med}).

The idea of truncation is to throw out events for which:

$$Q_{\mathrm{tr}} \geq M_{\mathrm{med}} \tag{1}$$

To do this, we need to figure out a form of M_{med} and Q_{tr} in terms of EFT parameters, such as Λ.

M_{med}

To have an expression for M_{med}, we must assume some underlying UV-complete form of the EFT. For example, for some operators:

$$\sigma \sim \frac{g_q^2 g_\chi^2}{(Q_{\mathrm{tr}}^2 - M_{\mathrm{med}}^2)^2 + \Gamma_{\mathrm{med}}^2 M_{\mathrm{med}}^2} = \frac{1}{\Lambda^4} \tag{2}$$

If $M_{\mathrm{med}} \gg Q_{\mathrm{tr}}$ then $M_{\mathrm{med}} = \sqrt{g_q g_\chi}\Lambda$.

In the past, many searches used this completion for all of there operators, however it is only valid for some EFT operators.

Q_{tr}, and $\sigma_{95\%\mathrm{CL}}$

So far in ATLAS results, we take $Q_{\mathrm{tr}} = m_{\chi\bar{\chi}}$ and we take $g_q = g_\chi = 1$ or $g_q = g_\chi = 4\pi$ (g_q and g_χ must both be less than or equal to 4π).

Then, to calculate the 95% CL limit on the cross section, we note that:

$$\sigma_{95\%\mathrm{CL}} = \sigma(\Lambda) \cdot A_{\mathrm{fiducial}}(\Lambda) \cdot A_{\mathrm{truncation}}(\Lambda, \sqrt{g_q g_\chi}) \cdot \mathrm{efficiency}(\Lambda) \tag{3}$$

Notes on Truncation Methods

To calculate $\sigma_{95\%\mathrm{CL}}$ then, we must iterate over Λ - this leads to a few different iterative truncation methods.

Some are easier to implement than others, for example if efficiency is not a function of Λ, then a full simulation for the scan of Λ points is not necessary, and only a truth level simulation would suffice.

For some explicit truncation methods, see the following talk and the papers linked to within: indico link.

Note again that the completion which gives $M_{\mathrm{med}} = \sqrt{g_q g_\chi}\Lambda$ is only valid for some EFT operators.

To Use or Not to Use?

- Some analyses are moving away from EFT models.
- The validity concerns of EFT models is one reason simplified models are preferred.
- In my mind, EFT models should only be used if no corresponding simplified model is implemented.
- However, if there is no proposed completion of the EFT model, then it is unclear how to implement truncation.