EFT correspondence of new physics models

Keisuke Fujii (KEK), Junping Tian (U' of Tokyo)

Asian Physics & Software Meeting, January 26, 2018

motivation

what is the corresponding effective field theory for a certain model

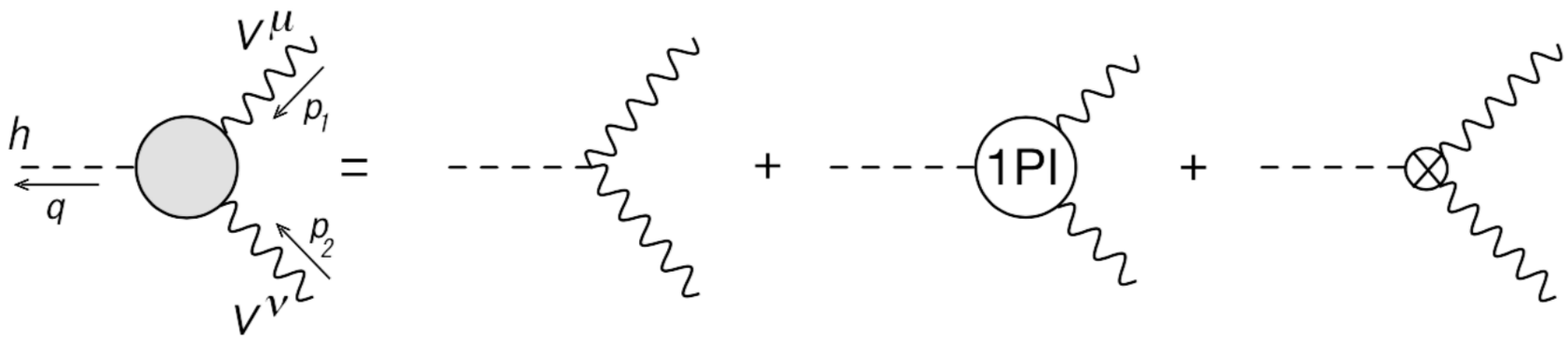
how do the EFT operators depend on the mass of new particles

how would the EFT break down

what would be the strategy if EFT is invalid

a first step

look at effective hZZ coupling in models: SM, HSM, 2HDM



renormalized hZZ vertex can be decomposed into 3 form factors

$$\hat{\Gamma}^{\mu\nu}_{hVV}(p_1^2, p_2^2, q^2) = g^{\mu\nu}\hat{\Gamma}^1_{hVV} + \frac{p_1^\mu p_2^\nu}{m_V^2}\hat{\Gamma}^2_{hVV} + i\epsilon^{\mu\nu\rho\sigma}\frac{p_{1\rho}p_{2\sigma}}{m_V^2}\hat{\Gamma}^3_{hVV},$$

the three Γs, which are usually functions of (p_i^2,q^2), can be calculated numerically by H-Coup (arXiv:1710.04603)

a first step

if we start from EFT Lagrangian for hZZ coupling

$$\delta\mathcal{L} = (1+a)\frac{m_Z^2}{v} h Z_\mu Z^\mu + b\frac{h}{2v} Z_{\mu\nu} Z^{\mu\nu} + \tilde{b}\frac{h}{2v} Z_{\mu\nu} \tilde{Z}^{\mu\nu}$$

$$Z_{\mu\nu} = \partial_\mu Z_\nu - \partial_\nu Z_\mu$$

$$\tilde{Z}_{\mu\nu} = \frac{1}{2}\epsilon_{\mu\nu\rho\sigma} Z^{\rho\sigma}$$

let's focus on CP-even terms for now

vertex from a-term: $g^{\mu\nu}\,\frac{2m_Z^2}{v}(1+a)$

vertex from b-term: $(g^{\mu\nu} p_1 \cdot p_2 - p_1^\mu p_2^\nu)\frac{2b}{v}$

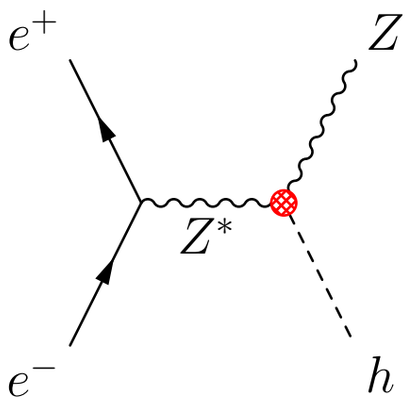
a first step

by comparing the vertices in two approaches:

$$\hat{\Gamma}^1_{hZZ} = \frac{2m_Z^2}{v}(1+a) + p_1 \cdot p_2 \frac{2b}{v}$$

$$\hat{\Gamma}^2_{hZZ} = -\frac{2m_Z^2}{v} b$$

in case of



$$p_1 = (\sqrt{s}, \mathbf{0})$$

$$p_2 = (E_Z, \mathbf{p}_Z)$$

$$a = \frac{v}{2m_Z^2}\hat{\Gamma}^1 + \frac{\sqrt{s}E_Z v}{2m_Z^4}\hat{\Gamma}^2 - 1$$

$$b = -\frac{v}{2m_Z^2}\hat{\Gamma}^2$$

(first EFT correspondence…)

questions to theorists

1. is there any problem in this naive correspondence?

2. how to deal with the imaginary part of Γ^i (in H-Coup)?

3. if we add s-channel photon diagram, can we obtain the similar decomposed hγZ vertices in H-Coup? (there seems now only partial width for h->γZ)