Renormalization Group Scaling of Higgs Operators

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Motivation

- We are trying to capture the effects of BSM physics by introducing higher dimensional operators. These would come from integrating out objects with masses $M_{BSM} \geqslant \Lambda_{weak}$.
- Recent measurements from LHC suggest excess in $h \to \gamma\gamma$ channel of 1.8 ± 0.3 (ATLAS[1]) and 1.56 ± 0.43 (CMS[2])

How to obtain theoretical prediction for crossection?

- Explicit perturbative expansion (1–loop) & RG–flow
- Higgs Low Energy Theorem

- Consistency checks w/ EW Precision Data

[1] ATLAS Collaboration, Observation and study of the Higgs boson candidate in the two photon decay channel with the ATLAS detector at the LHC, ATLAS-CONF-2012-168 (2012)

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The Operatorbasis

- 59 independent operators of dimension six (*"on shell"*)

- Focus on subset of eight phenomenologically most relevant

$$-\mathcal{L}^{(6)} = c_{GG}\mathcal{O}_{GG} + c_{WW}\mathcal{O}_{WW} + c_{BB}\mathcal{O}_{BB} + c_{WB}\mathcal{O}_{WB} + c_{GG}\tilde{\mathcal{O}}_{GG} + c_{WW}\tilde{\mathcal{O}}_{WW} + c_{BB}\tilde{\mathcal{O}}_{BB} + c_{WB}\tilde{\mathcal{O}}_{WB}$$

with $c_i = c_i(\mu)$

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$$\mathcal{O}_{GG} = \frac{g_3^2}{2\Lambda} H^\dagger H \, G^a_{\mu\nu} G_a^{\mu\nu} \qquad \tilde{\mathcal{O}}_{GG} = \frac{g_3^2}{2\Lambda} H^\dagger H \, G^a_{\mu\nu} \tilde{G}_a^{\mu\nu}$$

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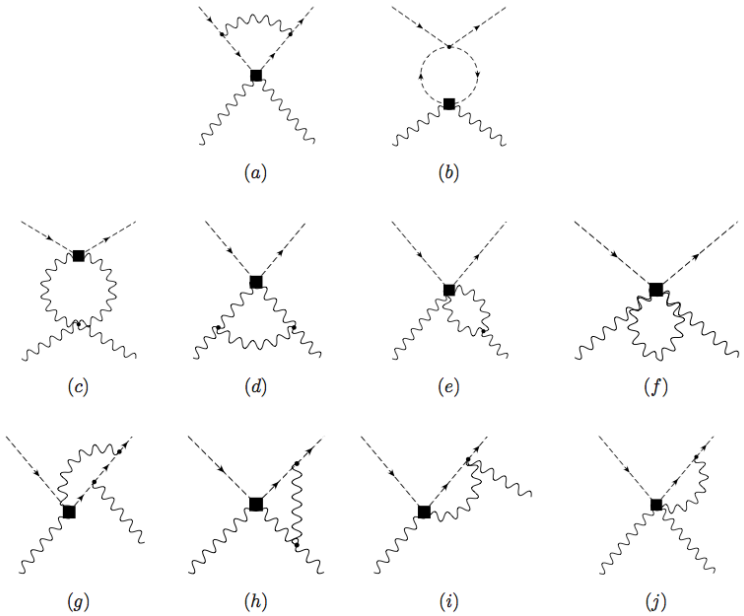
$$\mathcal{O}_{BB} = \frac{g_1^2}{2\Lambda} H^\dagger H \, B_{\mu\nu} B^{\mu\nu} \qquad \tilde{\mathcal{O}}_{BB} = \frac{g_1^2}{2\Lambda} H^\dagger H \, B_{\mu\nu} \tilde{B}^{\mu\nu}$$

$$\mathcal{O}_{WB} = \frac{g_1 g_2}{2\Lambda} H^\dagger \sigma^a H \, B_{\mu\nu} W_a^{\mu\nu} \qquad \tilde{\mathcal{O}}_{WB} = \frac{g_1 g_2}{2\Lambda} H^\dagger \sigma^a H \, B_{\mu\nu} \tilde{W}_a^{\mu\nu}$$

Renormalization Group Equation



$$\left[\frac{\partial}{\partial \ln \mu} - \gamma_G\right] c_G(\mu) = 0$$

$$\left[\frac{\partial}{\partial \ln \mu} - \gamma_{WB}\right] \begin{pmatrix} c_{WW} \\ c_{BB} \\ c_{WB} \end{pmatrix} = 0$$

leading to e.g.

$$\frac{c(M_h)}{c(\Lambda)} = \frac{1}{1.08}\left[1 - \gamma_{WB}|_{y_t \to 0} \log \frac{\Lambda}{M_h}\right]$$

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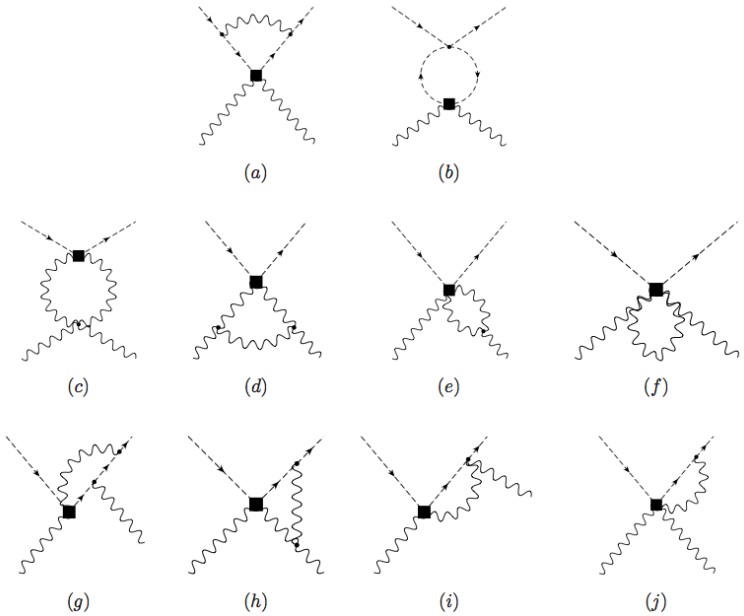

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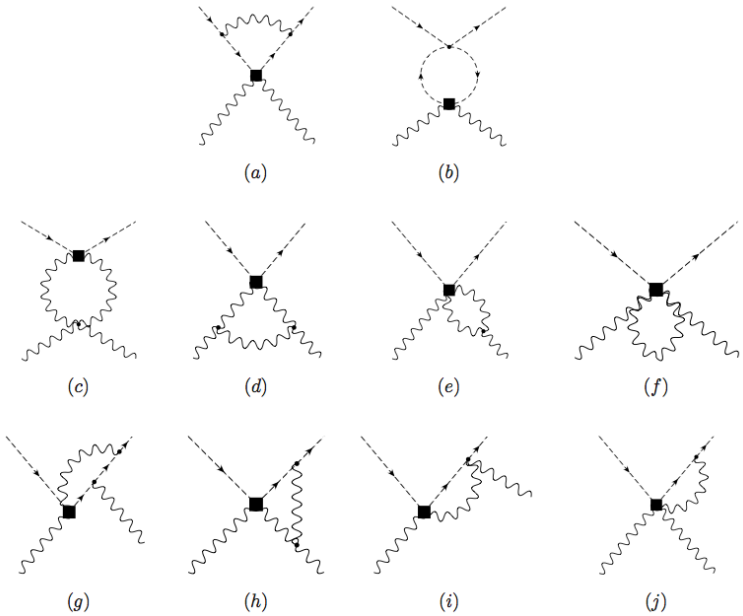

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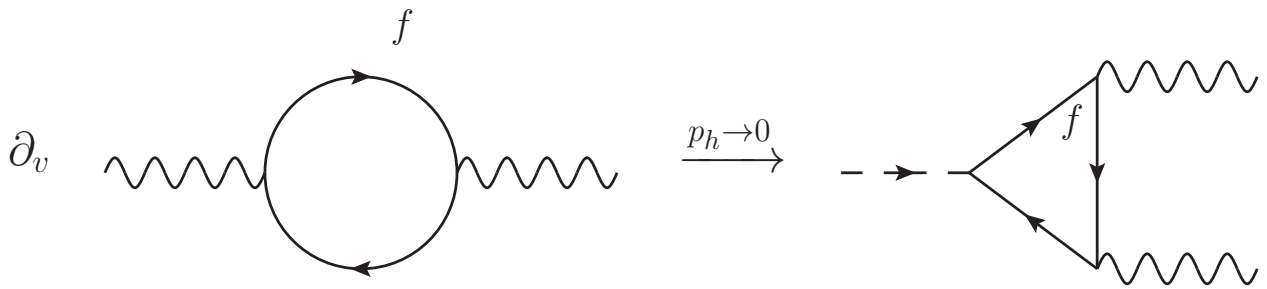

$$\mathcal{L}^{\text{eff}}_{h\to gg} = \frac{\alpha_s}{12\pi} G^a_{\mu\nu} G^{a\mu\nu} \frac{h}{v} \,.$$

To be expected since the higgs is electrically and colour neutral and this is the lowest order coupling that is gauge–invariant.

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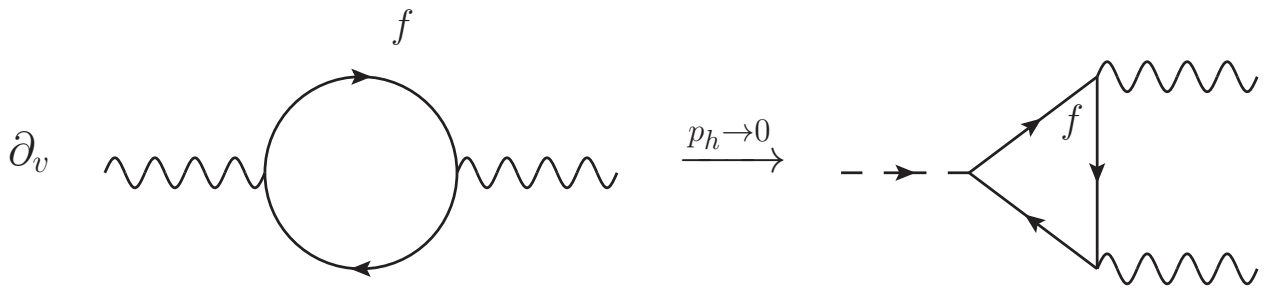

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- Obtain numerical results
- Understand relation to Higgs Low Energy Theorem
- Impact on Peskin–Takeuchi–Parameter S

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References & Sources

- C. Grojean, E Jenkins, A. Manohar, M. Trott (hep-ph/1301.2588)
- ATLAS Collaboration, Observation and study of the Higgs boson candidate in the two photon decay channel with the ATLAS detector at the LHC, ATLAS-CONF-2012-168 (2012)
- Own work in progress

Thank you for your attention