

Higgs EFT basics

- Outline
- ① EFT in a nutshell
 - ② Why EFT 4 Higgs?
 - ③ Example EFT
 - ④ EFT@LHC
 - ⑤ SMEFT \leftarrow
 - ⑥ Observables \leftarrow
 - ⑦ Global fits
 - ⑧ Future outlook / challenges

①

Nature
measurements



Theoretic
calculations QFT

micro \rightarrow macro

\hookrightarrow SIMPLER
theory



\mathcal{L}_e (def, interactions)

SM $\mathcal{O}(100)$

BSM



$q \lesssim \Lambda$ $|in\rangle |out\rangle$ real propagating
 $m \lesssim \Lambda$

heavier particles \rightarrow virtual level

S. Weinberg PLB91(80)
 Peskin-Schroeder Ch8.

$$\mathcal{L}_0 \text{ (light dof)} \approx \mathcal{L}_{UV}^{\text{full}}$$

$$\mathcal{L}_{\text{eff}}(\Phi_L) \sim \int d\Phi_H \mathcal{L}_{UV}(\Phi_L, \Phi_H)$$

Observable (EFT) \approx observable (full) as long as $q < \Lambda$

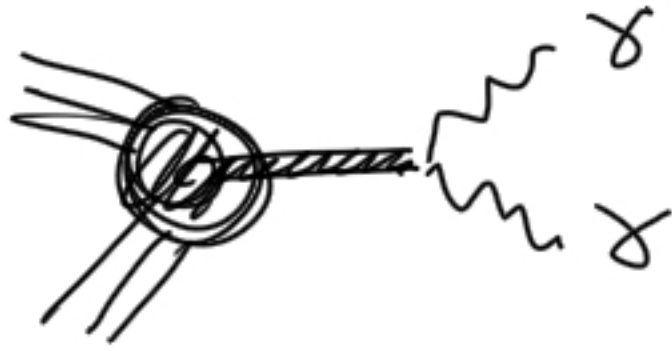
if you don't know UV safely compute \rightarrow m_H

\mathcal{L}_{EFT}

- \rightarrow contain only light dof
- \rightarrow preserve known symms
- \rightarrow doesn't have to look renorm.

② Why EFT 4 Higgs? NOW

2012



compared w/ SM Higgs
roughly consistent

- J^{CP}
- coupling as mass

Fast forward...

$m, \text{ couplings to SM}$

PRECISION few %

$$\Rightarrow \mathcal{L}_{\text{Higgs}} = \mathcal{L}_{\text{Higgs}}^{\text{SM}} + \delta \mathcal{L} \quad \left. \vphantom{\mathcal{L}_{\text{Higgs}}} \right\} \text{EFT}$$

\Rightarrow direct searches

BSM \rightarrow virtual effects

$\delta \mathcal{L}$ heavy new physics
(INDIRECT)

@ LHC

Precision

\oplus

large kin regime

$\left. \vphantom{\delta \mathcal{L}} \right\} \rightarrow$ perfect for EFT studies

Why Higgs? BSM effects

Higgs → window to NP

- light fermions \rightarrow 4 fermion
- gauge bosons \rightarrow UEP
- top Termination \rightarrow LHC

UEP, Termination

TGC QGC

3W

③ Simple example EFT

h, S Extensions of Higgs section

$\mathcal{L}_e(h, S)$

$\mathcal{L}_{eff}(h)$?

$\lambda_{hs} S^2 h^2$ $m_S \gg q$ 1502.07352

$\sim \lambda_{hs}^2 \frac{1}{m_S^2} (p^2 - m_S^2) \rightarrow \frac{\lambda_{hs}^2}{m_S^2} (1 + \# \frac{p^2}{m_S^2} + \# \frac{p^4}{m_S^4} + \dots)$

