University of Zurich[UZH]

Pseudo Observables in Higgs Physics

[a concise status report in view of YR4]

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- Introduction [*What are and why we need Higgs PO*]
- PO in Higgs decays
- PO in Higgs EW production [→ *more in the next talk*]
- PO vs. EFT, parameter counting & symmetry limits
- Outlook [*YR4 and beyond*]

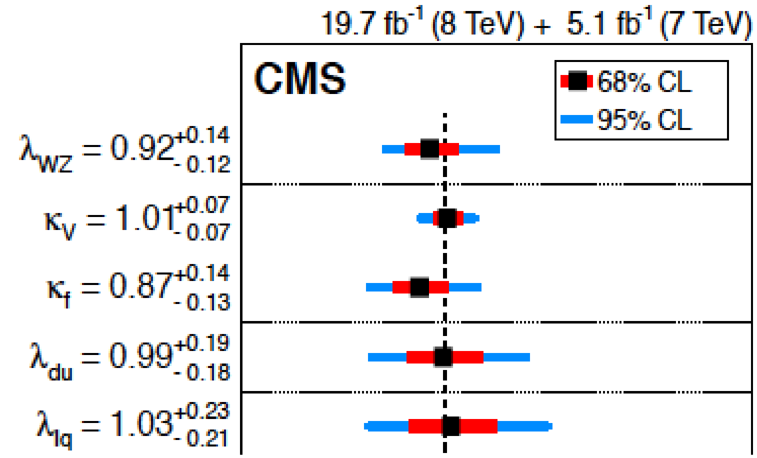
Introduction

So far, possible non-standard properties of the Higgs boson (in process with a leading SM amplitude) have been analyzed from the experimental point of view using the so-called "kappa-formalism":

$$\sigma(ii \to h+X) \times BR(h \to ff) = \sigma_{ii} \frac{\Gamma_{ff}}{\Gamma_h} = \frac{\kappa_{ii}^2 \kappa_{ff}^2}{\kappa_h^2} \sigma_{SM} \times BR_{SM}$$

Main virtues:

- Clean SM limit [best up-to-date TH predictions recovered for $\kappa_i \to 1$]
- Well-defined both on TH and EXP sides
- (*almost*) Model independent



Main problem:

- Loss of information on possible NP effects modifying the kinematical distributions

N.B.: *easy to conceive NP effects showing up mainly in kin. effects rather than in total rates* (e.g. CPV)

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Main virtues:

- Clean SM limit [best up-to-date TH predictions recovered for $\kappa_i \to 1$]
- Well-defined both on TH and EXP sides
- (*almost*) Model independent

Main problem:

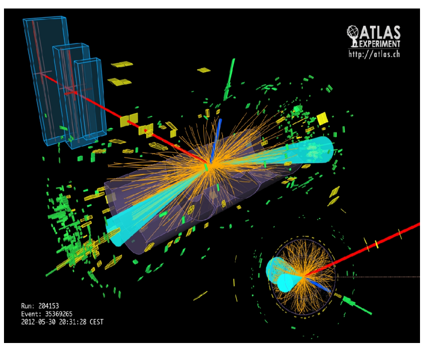
- Loss of information on possible NP effects modifying the kinematical distributions

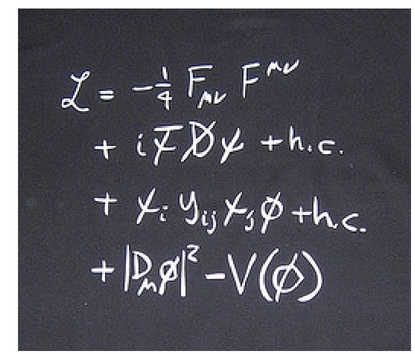
→ We need to identify a larger set of “pseudo-observables” able to characterize NP in the Higgs sector in general terms

Introduction

- The goal of the PO is to provide a general encoding of the exp. results in terms of a limited number of "simplified" (idealized) observables of easy th. interpretation [*old idea - heavily used and developed at LEP times*]

- The experimental determination of an appropriate set of PO will "help" and not "replace" any explicit NP approach to Higgs physics (*including the EFT*)





Experimental data ⟷ Pseudo Observables ⟷ Lagrangian parameters

The PO can be <u>computed</u> in terms of Lagrangian parameters in any specific th. framework (SM, SM-EFT, SUSY, ...)

Introduction

- The goal of the PO is to provide a general encoding of the exp. results in terms of a limited number of "simplified" (idealized) observables of easy th. interpretation [*old idea - heavily used and developed at LEP times*]
- The experimental determination of an appropriate set of PO will "help" and not "replace" any explicit NP approach to Higgs physics (*including the EFT*)

↓

- The PO should be defined from kinematical properties of on-shell processes (*no problems of renormalization, scale dependence,…*)
- The theory corrections applied to extract them should be universally accepted as "NP-free" (*soft QCD and QED radiation*)

▶ Introduction

There are two main categories of PO:

A) "Ideal observables"

M_W, $\Gamma(Z \to ll)$, …

M_h, $\Gamma(h \to \gamma\gamma)$, $\Gamma(h \to 4\mu)$, …
but also $d\sigma(pp \to hZ)/dm_{hZ}$ ...

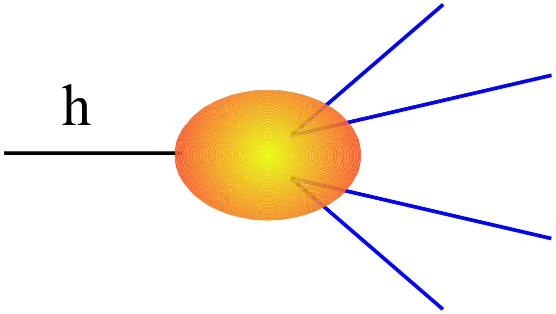
B) "Effective on-shell couplings"

g_Z^f, g_W^f, ...

- Both categories are useful
(*there is redundancy having both, but that's not an issue...*).

- For B) one can write an effective Feynman rule, not to be used beyond tree-level (its just a practical way to re-write, *and code in existing tools,* an on-shell amplitude).

PO in Higgs decays



PO in Higgs decays

Multi-body modes

e.g. $h \to 4\ell$, $\ell\ell\gamma$, ...

↓

There is more to extract from data other than the κ_i

Two-body (on-shell) decays

[*no polarization properties of the final state accessible*]

e.g. $h \to \gamma\gamma$, $\mu\mu$, $\tau\tau$, bb

↓

The κ_i $(\leftrightarrow\Gamma_i)$ *is all what one can extract from data*

[+ *one more parameter if the polarization is accessible*]

PO in Higgs decays

Multi-body modes
e.g. $h \to 4\ell$, $\ell\ell\gamma$, ...

↓

Form factors → $f_i(s)$ [E.g.: $s = m^2_{\ell\ell}$]

Two-body (on-shell) decays
[*no polarization properties of the final state accessible*]

e.g. $h \to \gamma\gamma$, $\mu\mu$, $\tau\tau$, bb

E.g.: $\mathcal{A}(h \to Z\, ee) \sim$

$$\varepsilon^Z_\mu J^{e_L}_\mu [f_1^{Ze_L}(q^2) g^{\mu\nu} + f_3^{Ze_L}(q^2)(pq\, g^{\mu\nu} - q^\mu p^\nu) + \ldots]$$

N.B.: There is noting "wrong" or "dangerous" in using *f.f.*, provided

- they are defined from on-shell amplitudes
  [*ill-defined for* $h \to WW^*$, ZZ^* *but perfectly ok for* $h \to 4\ell$]
- no model-dependent assumptions are made on their functional form

PO in Higgs decays

Multi-body modes

e.g. $h \to 4\ell,\ \ell\ell\gamma, \ldots$

↓

Form factors $\to f_i(s)$ [E.g.: $s = m^2_{\ell\ell}$]

↓

Momentum expansion of the *f.f.* around leading poles

$$\text{E.g.:}\quad f_i^{SM+NP} = \frac{\kappa_i}{s - m_Z^2 + i m_Z \Gamma_Z} + \frac{\varepsilon_i}{m_Z^2} + O(s/m_Z^4)$$

Two-body (on-shell) decays

[*no polarization properties of the final state accessible*]

e.g. $h \to \gamma\gamma,\ \mu\mu,\ \tau\tau,\ bb$

↓

$\kappa_i\ (\leftrightarrow \Gamma_i)$

Gonzales-Alonso *et al.* 1412.6038

- No need to specify any detail about the EFT, but for the absence of light new particles → momentum expansion very well justified by the Higgs kinematic
- The $\{\kappa_i, \varepsilon_i\}$ thus defined are well-defined PO → systematic inclusion of higher-order QED and QCD (soft) corrections possible (and necessary...)

PO in Higgs decays [e.g.: the $h \to$ 4f case]

$$\epsilon_{\gamma\gamma}^{\text{SM-1L}} \simeq 3.8 \times 10^{-3}$$
$$\epsilon_{Z\gamma}^{\text{SM-1L}} \simeq 6.7 \times 10^{-3}$$

$$P_Z(q^2) = q^2 - m_Z^2 + i m_Z \Gamma_Z$$

$$\begin{aligned}\mathcal{A} = & i\frac{2m_Z^2}{v_F} \sum_{e=e_L,e_R} \sum_{\mu=\mu_L,\mu_R} (\bar{e}\gamma_\alpha e)(\bar{\mu}\gamma_\beta \mu)\times \\ & \left[\left(\kappa_{ZZ} \frac{g_Z^e g_Z^\mu}{P_Z(q_1^2)P_Z(q_2^2)} + \frac{\epsilon_{Ze}}{m_Z^2}\frac{g_Z^\mu}{P_Z(q_2^2)} + \frac{\epsilon_{Z\mu}}{m_Z^2}\frac{g_Z^e}{P_Z(q_1^2)} \right) g^{\alpha\beta} + \right. \\ & + \left(\epsilon_{ZZ} \frac{g_Z^e g_Z^\mu}{P_Z(q_1^2)P_Z(q_2^2)} + \kappa_{Z\gamma}\epsilon_{Z\gamma}^{\text{SM-1L}} \left(\frac{eQ_\mu g_Z^e}{q_2^2 P_Z(q_1^2)} + \frac{eQ_e g_Z^\mu}{q_1^2 P_Z(q_2^2)} \right) + \kappa_{\gamma\gamma}\epsilon_{\gamma\gamma}^{\text{SM-1L}} \frac{e^2 Q_e Q_\mu}{q_1^2 q_2^2} \right) \frac{q_1 \cdot q_2\, g^{\alpha\beta} - {q_2}^\alpha {q_1}^\beta}{m_Z^2} + \\ & \left. + \left(\epsilon_{ZZ}^{\text{CP}} \frac{g_Z^e g_Z^\mu}{P_Z(q_1^2)P_Z(q_2^2)} + \epsilon_{Z\gamma}^{\text{CP}} \left(\frac{eQ_\mu g_Z^e}{q_2^2 P_Z(q_1^2)} + \frac{eQ_e g_Z^\mu}{q_1^2 P_Z(q_2^2)} \right) + \epsilon_{\gamma\gamma}^{\text{CP}} \frac{e^2 Q_e Q_\mu}{q_1^2 q_2^2} \right) \frac{\varepsilon^{\alpha\beta\rho\sigma} q_{2\rho} q_{1\sigma}}{m_Z^2} \right]\end{aligned}$$

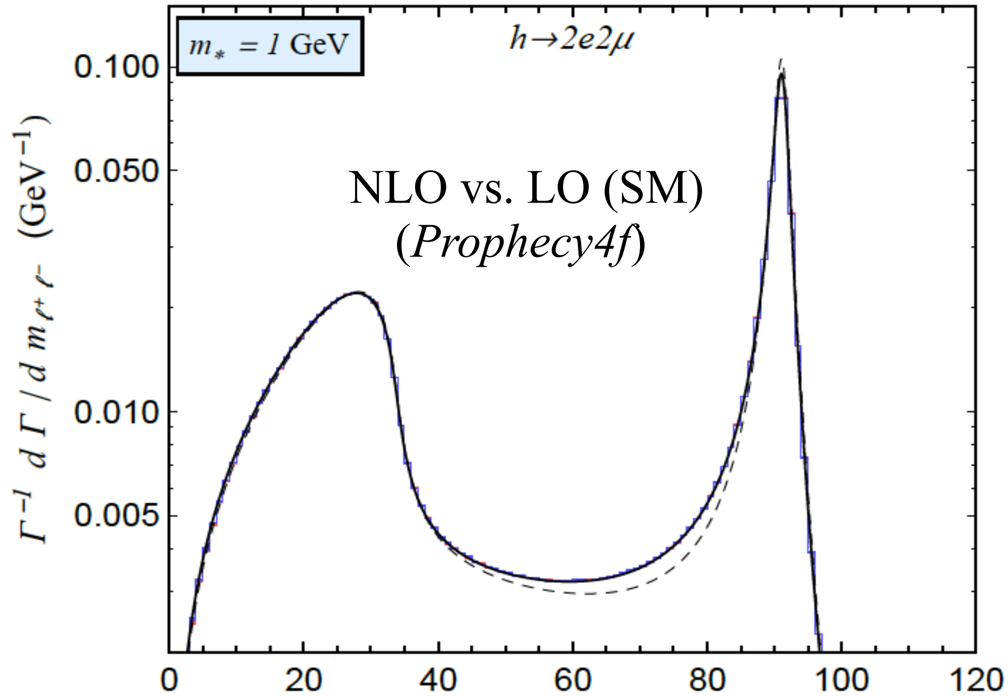
- The $\{\kappa_i, \varepsilon_i\}$ are defined from the residues of the amplitude on the physical poles → well-defined PO that can be extracted from data and computed to desired accuracy in a given BSM framework (including the SMEFT)
- By construction, the g_Z^f are the PO from Z-pole measurements
- $\kappa_{\gamma\gamma}$ and $\kappa_{Z\gamma}$ are the standard "kappas" from on-shell h → γγ and h → Zγ, the ε_i are sub-leading terms in the SM: SM recovered for $\kappa_i \to 1$, $\varepsilon_i = O(10^{-3}) \to 0$
- To this amplitude we must apply a "radiation function" to take into account QED radiation → excellent description of SM (and NP) beyond the tree level.

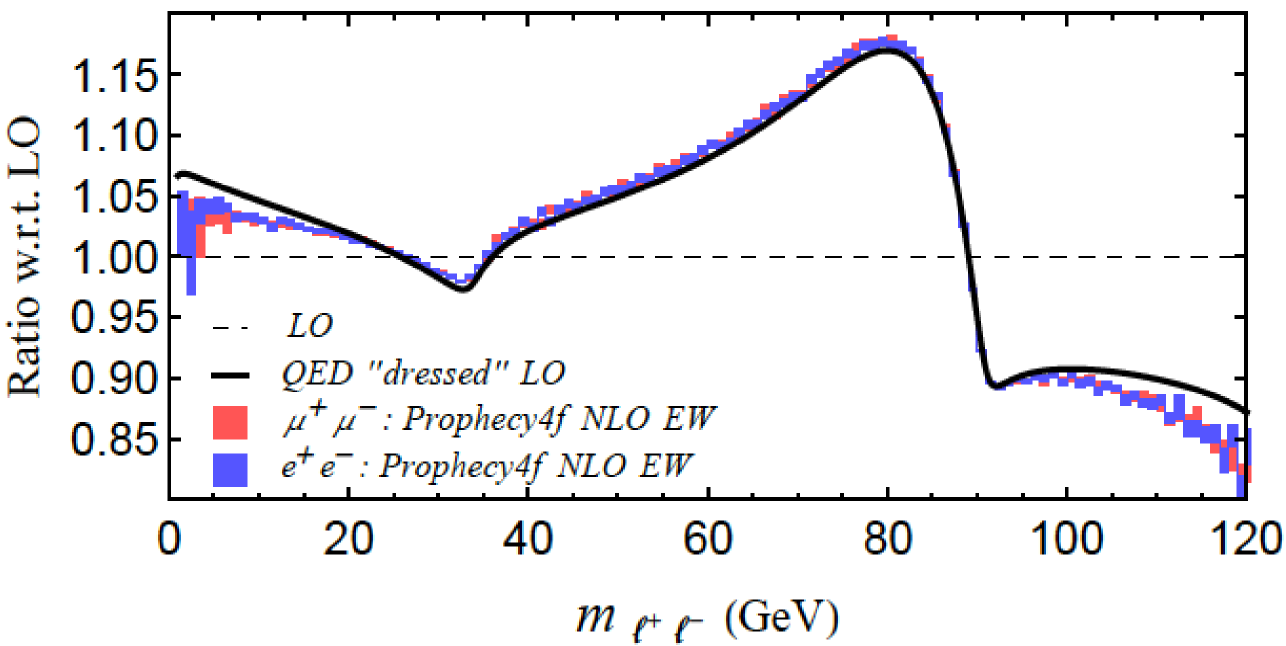
PO in Higgs decays

"Dressing" with QED radiation

excellent description of NLO SM
(*when setting PO to SM values*)

tool able to describe
(*general*) NP beyond LO





Bordone *et al.* 1507.02555

PO in Higgs decays

The “physical meaning” of the parameters appearing in this decomposition is not obvious at first sight, but it is actually quite simple [→ *physical PO*]:

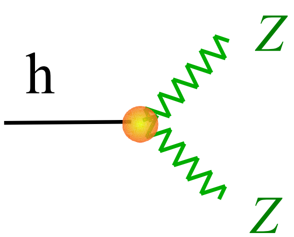
$$\mathcal{A} = i\frac{2m_Z^2}{v_F}\sum_{e=e_L,e_R}\sum_{\mu=\mu_L,\mu_R}(\bar{e}\gamma_\alpha e)(\bar{\mu}\gamma_\beta\mu)\times$$

$$\left[\left(\kappa_{ZZ}\frac{g_Z^e g_Z^\mu}{P_Z(q_1^2)P_Z(q_2^2)} + \frac{\epsilon_{Ze}}{m_Z^2}\frac{g_Z^\mu}{P_Z(q_2^2)} + \frac{\epsilon_{Z\mu}}{m_Z^2}\frac{g_Z^e}{P_Z(q_1^2)}\right)g^{\alpha\beta} + \right.$$

$$+\left(\epsilon_{ZZ}\frac{g_Z^e g_Z^\mu}{P_Z(q_1^2)P_Z(q_2^2)} + \kappa_{Z\gamma}\epsilon_{Z\gamma}^{\text{SM-1L}}\left(\frac{eQ_\mu g_Z^e}{q_2^2 P_Z(q_1^2)} + \frac{eQ_e g_Z^\mu}{q_1^2 P_Z(q_2^2)}\right) + \kappa_{\gamma\gamma}\epsilon_{\gamma\gamma}^{\text{SM-1L}}\frac{e^2 Q_e Q_\mu}{q_1^2 q_2^2}\right)\frac{q_1\cdot q_2\; g^{\alpha\beta} - q_2{}^\alpha q_1{}^\beta}{m_Z^2} +$$

$$\left.+\left(\epsilon_{ZZ}^{\text{CP}}\frac{g_Z^e g_Z^\mu}{P_Z(q_1^2)P_Z(q_2^2)} + \epsilon_{Z\gamma}^{\text{CP}}\left(\frac{eQ_\mu g_Z^e}{q_2^2 P_Z(q_1^2)} + \frac{eQ_e g_Z^\mu}{q_1^2 P_Z(q_2^2)}\right) + \epsilon_{\gamma\gamma}^{\text{CP}}\frac{e^2 Q_e Q_\mu}{q_1^2 q_2^2}\right)\frac{\varepsilon^{\alpha\beta\rho\sigma}q_{2\rho}q_{1\sigma}}{m_Z^2}\right]$$

“double Z-pole”



$$\Gamma(h\to Z_L Z_L) \equiv \frac{\Gamma(h\to 2e2\mu)[\kappa_{ZZ}]}{\mathcal{B}(Z\to 2e)\mathcal{B}(Z\to 2\mu)} = 0.209\;|\kappa_{ZZ}|^2\ \text{MeV}$$

$$\Gamma(h\to Z_T Z_T) \equiv \frac{\Gamma(h\to 2e2\mu)[\epsilon_{ZZ}]}{\mathcal{B}(Z\to 2e)\mathcal{B}(Z\to 2\mu)} = 0.0189\;|\epsilon_{ZZ}|^2\ \text{MeV}$$

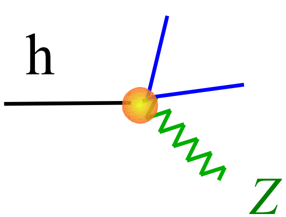
$$\Gamma^{\text{CPV}}(h\to Z_T Z_T) \equiv \frac{\Gamma(h\to 2e2\mu)[\epsilon_{ZZ}^{\text{CP}}]}{\mathcal{B}(Z\to 2e)\mathcal{B}(Z\to 2\mu)} = 0.00799\;|\epsilon_{ZZ}^{\text{CP}}|^2\ \text{MeV}$$

PO in Higgs decays

The "physical meaning" of the parameters appearing in this decomposition is not obvious at first sight, but it is actually quite simple [→ *physical PO*]:

$$\mathcal{A} = i\frac{2m_Z^2}{v_F}\sum_{e=e_L,e_R}\sum_{\mu=\mu_L,\mu_R}(\bar{e}\gamma_\alpha e)(\bar{\mu}\gamma_\beta\mu)\times$$
$$\left[\left(\kappa_{ZZ}\frac{g_Z^e g_Z^\mu}{P_Z(q_1^2)P_Z(q_2^2)}+\frac{\epsilon_{Ze}}{m_Z^2}\frac{g_Z^\mu}{P_Z(q_2^2)}+\frac{\epsilon_{Z\mu}}{m_Z^2}\frac{g_Z^e}{P_Z(q_1^2)}\right)g^{\alpha\beta}+\right.$$
$$+\left(\epsilon_{ZZ}\frac{g_Z^e g_Z^\mu}{P_Z(q_1^2)P_Z(q_2^2)}+\kappa_{Z\gamma}\epsilon_{Z\gamma}^{\text{SM-1L}}\left(\frac{eQ_\mu g_Z^e}{q_2^2 P_Z(q_1^2)}+\frac{eQ_e g_Z^\mu}{q_1^2 P_Z(q_2^2)}\right)+\kappa_{\gamma\gamma}\epsilon_{\gamma\gamma}^{\text{SM-1L}}\frac{e^2 Q_e Q_\mu}{q_1^2 q_2^2}\right)\frac{q_1\cdot q_2\; g^{\alpha\beta}-q_2{}^\alpha q_1{}^\beta}{m_Z^2}+$$
$$\left.+\left(\epsilon_{ZZ}^{\text{CP}}\frac{g_Z^e g_Z^\mu}{P_Z(q_1^2)P_Z(q_2^2)}+\epsilon_{Z\gamma}^{\text{CP}}\left(\frac{eQ_\mu g_Z^e}{q_2^2 P_Z(q_1^2)}+\frac{eQ_e g_Z^\mu}{q_1^2 P_Z(q_2^2)}\right)+\epsilon_{\gamma\gamma}^{\text{CP}}\frac{e^2 Q_e Q_\mu}{q_1^2 q_2^2}\right)\frac{\varepsilon^{\alpha\beta\rho\sigma}q_{2\rho}q_{1\sigma}}{m_Z^2}\right]$$

"single Z-pole"



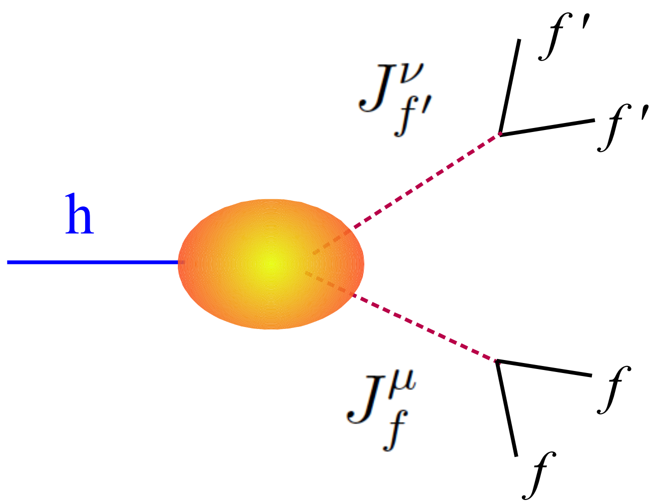
$$\Gamma(h\to Z\ell^+\ell^-) = 0.0366|\epsilon_{Z\ell}|^2\ \text{MeV}$$

PO in Higgs decays

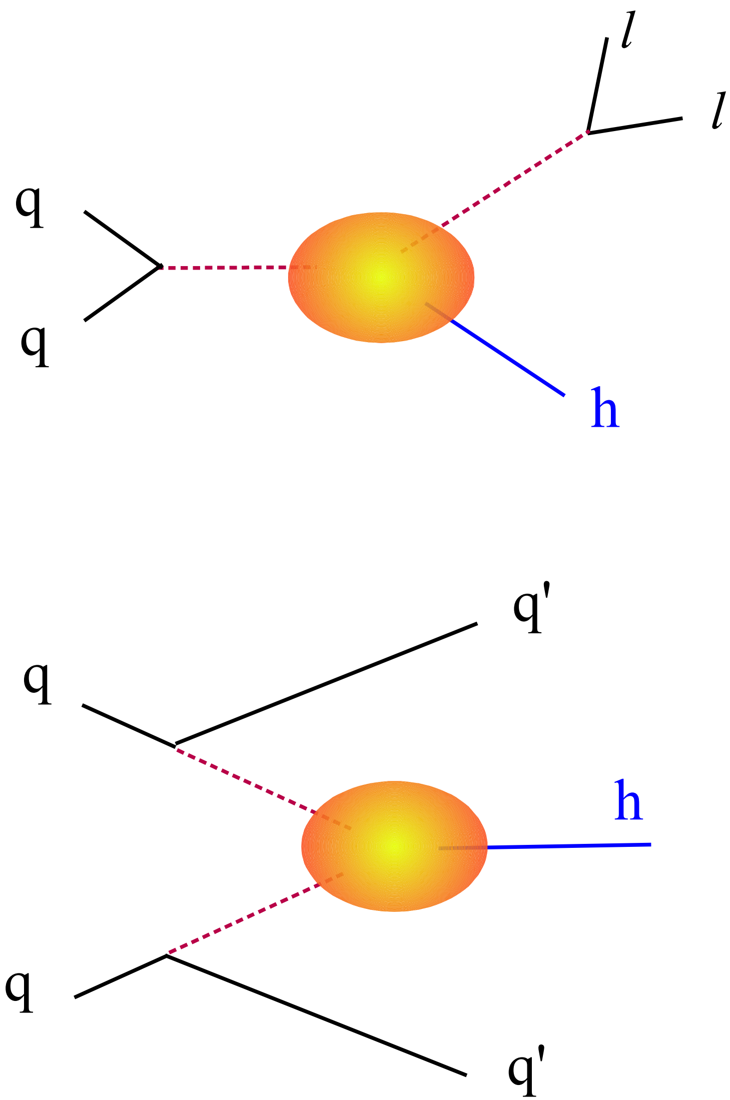
The "physical meaning" of the parameters appearing in this decomposition is not obvious at first sight, but it is actually quite simple [→ *physical PO*]:

PO	Physical PO		Relation to the eff. coupl.
$\kappa_f,\ \lambda_f^{\rm CP}$	$\Gamma(h\to f\bar f)$	$=$	$\Gamma(h\to f\bar f)^{\rm (SM)}[(\kappa_f)^2+(\lambda_f^{\rm CP})^2]$
$\kappa_{\gamma\gamma},\ \lambda_{\gamma\gamma}^{\rm CP}$	$\Gamma(h\to\gamma\gamma)$	$=$	$\Gamma(h\to\gamma\gamma)^{\rm (SM)}[(\kappa_{\gamma\gamma})^2+(\lambda_{\gamma\gamma}^{\rm CP})^2]$
$\kappa_{Z\gamma},\ \lambda_{Z\gamma}^{\rm CP}$	$\Gamma(h\to Z\gamma)$	$=$	$\Gamma(h\to Z\gamma)^{\rm (SM)}[(\kappa_{Z\gamma})^2+(\lambda_{Z\gamma}^{\rm CP})^2]$
κ_{ZZ}	$\Gamma(h\to Z_L Z_L)$	$=$	$(0.209\ {\rm MeV})\times\lvert\kappa_{ZZ}\rvert^2$
ϵ_{ZZ}	$\Gamma(h\to Z_T Z_T)$	$=$	$(1.9\times10^{-2}\ {\rm MeV})\times\lvert\epsilon_{ZZ}\rvert^2$
$\epsilon_{ZZ}^{\rm CP}$	$\Gamma^{\rm CPV}(h\to Z_T Z_T)$	$=$	$(8.0\times10^{-3}\ {\rm MeV})\times\lvert\epsilon_{ZZ}^{\rm CP}\rvert^2$
ϵ_{Zf}	$\Gamma(h\to Zf\bar f)$	$=$	$(3.7\times10^{-2}\ {\rm MeV})\times N_c^f\ \lvert\epsilon_{Zf}\rvert^2$
κ_{WW}	$\Gamma(h\to W_L W_L)$	$=$	$(0.84\ {\rm MeV})\times\lvert\kappa_{WW}\rvert^2$
ϵ_{WW}	$\Gamma(h\to W_T W_T)$	$=$	$(0.16\ {\rm MeV})\times\lvert\epsilon_{WW}\rvert^2$
$\epsilon_{WW}^{\rm CP}$	$\Gamma^{\rm CPV}(h\to W_T W_T)$	$=$	$(6.8\times10^{-2}\ {\rm MeV})\times\lvert\epsilon_{WW}^{\rm CP}\rvert^2$
ϵ_{Wf}	$\Gamma(h\to Wf\bar f')$	$=$	$(0.14\ {\rm MeV})\times N_c^f\ \lvert\epsilon_{Wf}\rvert^2$

PO in Higgs EW production



vs.



PO in Higgs EW production

The same Green Function controlling $h \to 4f$ decays is accessible also in $pp \to hV$ and $pp \to h$ via VBF, i.e. the two leading EW-type Higgs production processes (*N.B.: this follows from "plain QFT" no need to invoke any EFT...*)

$$\langle 0 | \mathcal{T} \left\{ J^{\mu}_{f}(x), J^{\nu}_{f'}(y), h(0) \right\} |0\rangle$$

Same approach as in $h \to 4f$ (and, to some extent, same PO) but for three important differences:

Greljo et al. 1512.06135

- different flavor composition ($q \leftrightarrow \ell$) $\to$ new param. associated to the physical PO $\Gamma(h \to Zqq)$ & $\Gamma(h \to Wud)$ — trivial
- large impact of (facotrizable) QCD corrections — conceptually easy
- different kinematical regime: <u>momentum exp. not always justified</u> (*large momentum transfer*) — delicate point

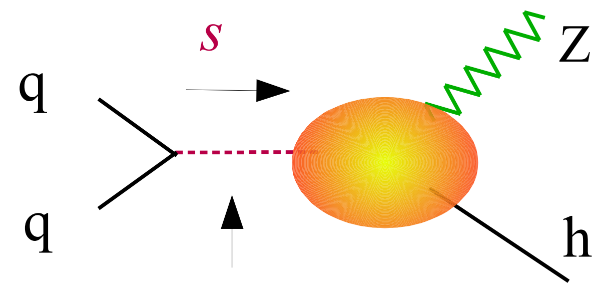
PO in Higgs EW production

Twofold problem:

I. identify which are the "dangerous" kinematical variables (and how to access them when not directly measurable → p_T^{jet} in VBF, p_T^Z in Zh [→ see next talk])

II. how to control the validity of the expansion

E.g.: $pp \to Zh$



$s = (m_{hZ})^2$

$$\frac{1}{s - m_Z^2} \left[\, g^Z_q\, \kappa_{ZZ} + \varepsilon_{Zq}\, (s - m_Z^2)/m_Z^2 \; + \ldots \;\right]$$

Key point: since we expand on a measurable kinematical variable, <u>the validity of the expansion can be directly checked/validated by data</u>

PO in Higgs EW production

Twofold problem:

I. identify which are the "dangerous" kinematical variables (and how to access them when not directly measurable → p_T^{jet} in VBF, p_T^Z in Zh [→ see next talk])

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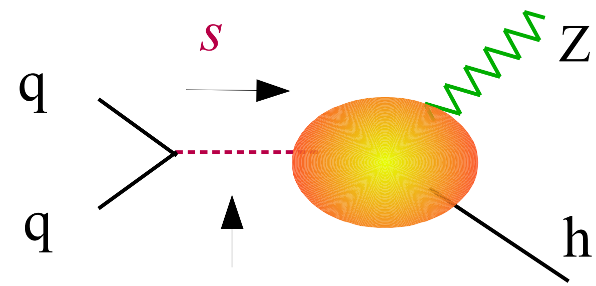


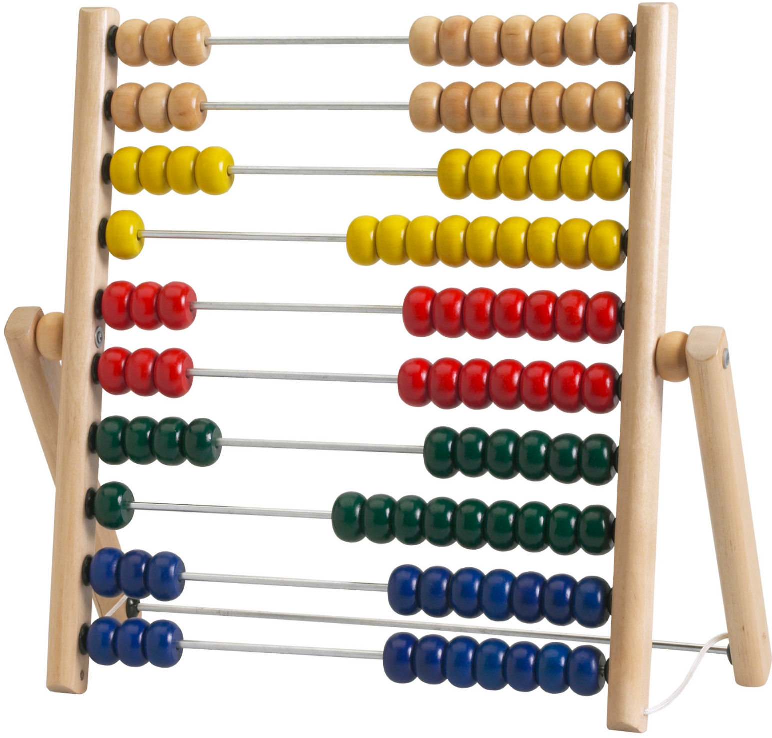
$$s = (m_{hZ})^2$$

$$\frac{1}{s - m_Z^2} \left[g^Z_q \, \kappa_{ZZ} + \varepsilon_{Zq} (s - m_Z^2)/m_Z^2 + \ldots \right]$$

General procedure:

- Measure the PO setting close to the threshold region, setting a cut on the "dangerous" kinematical variable [→ a-posteriori data-driven check of the validity of the momentum expansion = definition of threshold region]
- Report the cross-section as a function of the kinematical variable in the high-momentum region [→ natural link/merging with template cross-section]

PO vs. EFT,
parameter counting & symmetry limits



PO vs. EFT

PO and couplings in EFT Lagrangians are *intimately related but are not the same thing* (on-shell amplitudes vs. Lagrangians parameters) → full complementarity

- The PO are calculable in any EFT approach (*linear, non-linear, LO, NLO...*)
  - In the limit where we work at the tree-level in the EFT there is a simple linear relation between PO and EFT couplings: each PO represent a unique linear combination of couplings of the most general Higgs EFT.
  - This does not hold beyond the tree-level (the PO do not change, but their relation to EFT couplings is more involved....)

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  - This does not hold beyond the tree-level (the PO do not change, but their relation to EFT couplings is more involved....)

- For Higgs production also the PO involve an expansion in momenta; however, this is different that the operator expansion employed within the EFT
  - To define the PO we expand only on a measurable kinematical variables, this is why the validity of the *expansion can be checked directly by data* (on the same process used to determine the PO)

- In each process the PO are the maximum number of independent observables that can be extracted by that process only → naturally optimized for data analyses

Parameter counting & symmetry limits

Number of independent PO for EW Higgs decays [$h \to 4\ell$ (ℓ=e,μ,ν) + $\ell\ell\gamma$ + $\gamma\gamma$]:

EW decay modes	*flavor +CP symm.*	*flavor non univ.*	*CP violation*
$h \to \gamma\gamma, 2e\gamma, 2\mu\gamma$ $4e, 4\mu, 2e2\mu$	$\kappa_{ZZ}, \kappa_{Z\gamma}, \kappa_{\gamma\gamma}$ $\epsilon_{ZZ}, \epsilon_{Ze_L}, \epsilon_{Ze_R}$ (6)	$\epsilon_{Z\mu_L}, \epsilon_{Z\mu_R}$ (2)	$\epsilon^{CP}_{ZZ}, \epsilon^{CP}_{Z\gamma}, \epsilon^{CP}_{\gamma\gamma}$ (3)
$h \to 2e2\nu, 2\mu2\nu, e\nu\mu\nu$	κ_{WW} $\epsilon_{WW}, \epsilon_{Z\nu_e}, \mathrm{Re}(\epsilon_{We_L})$ (4)	$\epsilon_{Z\nu_\mu}, \mathrm{Re}(\epsilon_{W\mu_L})$ $\mathrm{Im}(\epsilon_{W\mu_L})$ (5)	$\epsilon^{CP}_{WW}, \mathrm{Im}(\epsilon_{We_L})$
all EW decay modes *with custodial symmetry*	$\kappa_{ZZ}, \kappa_{Z\gamma}, \kappa_{\gamma\gamma}$ $\epsilon_{ZZ}, \epsilon_{Ze_L}, \epsilon_{Ze_R}$ $\mathrm{Re}(\epsilon_{We_L})$ (7)	$\epsilon_{Z\mu_L}, \epsilon_{Z\mu_R}$	$\epsilon^{CP}_{ZZ}, \epsilon^{CP}_{Z\gamma}, \epsilon^{CP}_{\gamma\gamma}$

20 (no symmetries) → 7 (CP + Lepton Univ + Custodial)

Parameter counting & symmetry limits

Number of independent PO for EW Higgs decays + EW production + Yukawa modes (h → ff):

	PO with maximal symmetry [CP + Lepton Univ + Custodial]:
Production & decays	$\kappa_{ZZ}, \kappa_{Z\gamma}, \epsilon_{ZZ}$
EW decays only	$\kappa_{\gamma\gamma}, \epsilon_{Ze_L}, \epsilon_{Ze_R}, \mathrm{Re}(\epsilon_{We_L})$
EW productions only	$\epsilon_{Zu_L}, \epsilon_{Zu_R}, \epsilon_{Zd_L}, \epsilon_{Zd_R}$
	(11) [⟶ 32 with no symm.]
Yukawa modes	$\kappa_b, \kappa_c, \kappa_\tau, \kappa_\mu$ (4) [⟶ 8 with no symm.]
	(*as in the original κ-formalism*)

Tools

A first automated public tool (*UFO model* for MG5_aMC@NLO or Sherpa) is now

- fully available for decays (*QED corrections fully accounted by standard shower algorithms, as verified by the comparison with Profecy4f*)

- will soon be available also for EW production, with inclusion of NLO QCD corrections (*work in prog.... → see next talk*)

Universität Zürich[UZH]

Higgs PO

DESCRIPTION DOWNLOAD CONTACTS

http://www.physik.uzh.ch/data/HiggsPO

Outlook

- The PO represent a general tool for the exploration of Higgs properties (in view of high-statistics data), with minimum loss of information and minimum theoretical bias → *full complementary to EFT* (and explicit BSM)

- The formalism is now fully developed and the corresponding note for YR4 is well in progress [incomplete version available as additional material to this talk, 1st complete version expected next week → will be circulated within WG2 for comments/feedback]

- But there is still a lot of work to be done, especially from the tool/implementation side → worth to conceive a dedicated subgroup within the HXSWG, beyond YR4 (*if sufficient interest shown by the exp. collab....*).