SMEFT bookkeeping

Global fits are needed, but...

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G. Passarino (Torino)

How many BSM options do you know that have SU(3)×SU(2)×U(1) as their exact low scale limit?

How many BSM options do you know that have exactly one scalar doublet?

What happens if we only do global SMEFT fits to data from a Nature with more scalars?

How can we make sure to not miss BSM physics when performing SMEFT fits?

Proposal for a WG goal and concrete target

Given the myriad of viable BSM options with extended scalar sectors, the WG will foster a programme of activities that leads to the widespread use of SMEFT not just as a global fitting tool (that could miss out on deviations from extended scalar sectors) but also as a bookkeeping framework in which the results from SMEFT fits to individual observables are provided, reported, and archived in a consistent way. The compatibility of such individual results can then be assessed in the light of BSM models with extended scalar sectors.

Proposal for a WG goal and concrete target

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extended scalar sectors.

2HDMs, singlets, triplets...
None has SM scalar structure of single doublet.

What happens when “projecting” such scalar sectors onto SMEFT?
We may be pushing Nature’s “square peg” through SMEFT’s “round hole”.

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In fits to individual observables, c_i values may be sensitive to the differences between the Nature “peg” and the SMEFT “hole” for that observable.

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With multiple c_i results from multiple observables, c_i^j, one can then assess if the SMEFT assumptions are consistent with the data.

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Given the statistical issues, studies of extended scalar sectors can guide how to combine c_i^j results in the comparisons.

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Finally, “extended scalar sectors” are just the most obvious type of heavy-light mixing

Proposal for a WG goal and concrete target

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Crucial in order to perform any compatibility assessment: same SMEFT order, covariance matrices, etc.

Does not preclude identical effort for perennial observables (cross-sections, asymmetries, etc).

Additional clarifications added after the meeting

SMEFT bookkeeping - formal logic reasoning

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1. Null SMEFT results do not invalidate BSM

If
SM $\Rightarrow$ c_i(any data)$\asymp$0,
then
SM $\Rightarrow$ c_i(*all* data)$\asymp$0
and
c_i(all data)$\not\asymp$0 $\Rightarrow$ ¬SM.

But, critically,

c_i(all data)$\asymp$0 $\not\Rightarrow$ SM.

2. BSM outside SMEFT assumptions (BSMOSA) may be missed in fit to all data

If
BSMOSA $\Rightarrow$
  c_i(some data)$\not\asymp$0
$\wedge$ c_i(all data \some data)
$\not\asymp$0,

then
it is possible that
BSMOSA $\Rightarrow$ c_i(all data)$\asymp$0.

3. BSMOSA may be tested (and disproved) by grouping observables

If
$BSMOSA_j$ $\Rightarrow$
  c_i({some data}$_j$)$\not\asymp$0,

then
c_i({some data}$_j$)$\asymp$0
$\Rightarrow$ ¬$BSMOSA_j$.

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"$\asymp$" means "compatible with"

SMEFT bookkeeping - a parsimonious solution

Experiments cannot generate, process, and reconstruct simulated **event samples in every single framework.**

SMEFT d.o.f., c_i, **are being tested by experiments**, are being expanded and improved upon, and **are rather comprehensive** as to the types of BSM deformations they can encode.

Use SMEFT d.o.f. as a bookkeeping tool and explore the likelihood function, L, **for sets of observables**, $data_j$.

SMEFT bookkeeping can be reused to **test other frameworks by exploiting** $L(c_i|data_j)$, $L(c_i|data_k)$, **etc,** instead of reasoning in terms of
$L(fwk1_i|all\ data)$,
$L(fwk2_i|all\ data)$,
etc.

SMEFT bookkeeping - rethinking the meaning of “global”

“Global fit” usually means the fit of a model **to all data** that is available and diverse.

Global data provide **all information** that is used in order to arrive at the most precise result.

This *would* be correct, except that **fits to all data may miss certain BSM scenarios**, depending on the model used to fit.

“Global fit” can also mean the fit of a comprehensive model of broad generality.

Global models usually have **many d.o.f.**, something naively seen as an unattractive feature.

This *would* be correct, except that **general d.o.f. are ideal to perform the bookkeeping** and can be correlated a posteriori.

Likelihood functions
encode **all information** in an **observable-differential way.**