Questions and answers - Ilaria Brivio Lecture

The following questions were submitted through Google Form. Some / all may have been answered in the Q&A session already. Nevertheless, we request our lecturers to provide written answers here for the benefit of those who could not attend that session. Thank you!

Slide 7. You talk about dimensions from 5 to 12. Can you explain what these dimensions refer to?

They refer to the canonical dimension of the effective interactions.
We can assign one to each operator remembering that scalar fields and derivatives have dimension 1, fermions have dimension 3/2 and gauge field strengths have dimension 2.
these numbers correspond to mass dimensions in natural units and can be derived remembering that, to have a dimensionless action, the Lagrangian must always have dimension 4 = [dimension of d^4x]^(-1). also, derivatives have dimension 1 because they are inverse-spacetime.
Looking at kinetic terms, for scalars we have d_mu phi d^mu phi => dim(phi) = (4-2)/2 = 1 etc.

The SM Lagrangian contains interactions of dimension 4, while an EFT is a series that can go up to arbitrarily large dimensions.

Slide 16. Is there an example of an operator which was thought to have been negligible, but turned out to significantly contribute to an interaction after principal component analysis?

Not really, in the sense that principal component analysis is a tool employed to find linear combinations of operators that are better constrained than others. so we can have some operators that enter very constrained directions but we can't really say that they are relevant on their own.
in some cases, a pre-selection is also done before PCA, for instance removing all the operators that give relative corrections to a certain observable that are smaller than a selected threshold (eg 10^-4)

Page not specified. Recovering the UV completion from the Wilson coefficients seems to be a rather complicated quest. What are the hopes for the best case scenario? e.g. how many coefficients we need to measure, how far beyond d=6 we expect to go (if we have to go), how long should it take?

Indeed it can be complicated, and the difficulty largely depends on which coefficients appear to be nonzero in a hypothetical measurement.

The point of measuring many wilson coefficients simultaneously is required to make sure that we assign the deviation to the correct one(s) minimizing our bias. in general we expect more than one operator to show up simultaneous, but not necessarily too many of them.

As long as there are a handful non-zero coefficients, it won't be too hard to formulate hypotheses, especially given the matching dictionaries we already have available. most operators can only be generated by a small set of BSM states, and it will be possible to exclude some of those based on comparing multiple measurements. to give a recent example, the RK(*) anomalies in flavor physics pointed to a specific pair of 4-fermion operators being non-vanishing, which could be mediated by leptoquarks of various spins or by a Z'. the latter was disfavored by drell-yan measurements, and there were many studies discussing which of the leptoquarks could be more apt.
the general expectation is that - similar to what happened in the flavor case - the moment there is an anomaly many people will start looking directly at UV completions. essentially, the EFT should at least narrow down the options. the more information we can extract from it, the better, and it is important that it is not deceiving, but then we can always rely on a joint effort with model builders.

Going beyond dimension 6 is again something that depends on which operators are affected, and it is something still under investigation. At the moment the impression is that it could be relevant if new physics affects closely the Higgs/EWSB sector and if it is lighter than 3-4 TeV. no one is really foreseeing going beyond dim8 for phenomenology and interpretation, at the moment.