Preface

With the discovery of a 125 GeV resonance by the ATLAS and CMS Collaborations at the Large Hadron Colliders, we have entered a new era in High Energy Physics. While the particle seems to have properties very close to what the Standard Model (SM) predicts, we are still to ascertain, beyond any reasonable doubt, that this is indeed the case.

In light of all the results from the LHC so far, it is not easy to answer whether the SM is all that there is to physics at the TeV scale or does the new discovery bring, along with it, some hints of new physics beyond the SM? The first step of answering this question would be to re-examine not only the Higgs discovery analysis (not limiting ourselves to the $\gamma\gamma$ and ZZ channels), but also consider how sensitive our conclusions may be to the (model) assumptions that, inherently, are part of any such deciphering of complex experimental data. This is of particular relevance, on the one hand, in deciding whether the remaining 'discrepancies' in the Higgs observations are of any importance, and, on the other hand, in understanding possible post-Higgs signals such as the purported excess in the $\gamma\gamma$ final state at 750 GeV, reported in December 2015.

Another important question that haunts the community of particle physicists now is the following: if the discovery is indeed that of the SM Higgs, what keeps it light and protected from large quantum corrections? Apart from Supersymmetry, does there exist a *natural* resolution of the hierarchy problem? Or should we be happy enough with extensions that may not be seem as natural?

Equally valid is another query: if the discovered particle is only approximately the SM Higgs, then is the electroweak breaking mechanism driven by an extended scalar sector? This question assumes particular significance in the context of the aforementioned excess at 750 GeV. Is new physics (at the few TeV scale), then, well-approximated by a simple two-Higgs doublet model or should we consider more elaborate structures such as the minimal supersymmetric SM?

Should our pursuit of understanding physics at higher energy scales be guided by notions of symmetry and/or a more fundamental construct or should we be happy enough with the more agnostic frame of effective theories that allow us to explore the unknown in small steps? This, again, could be related to the very first questions raised in this preface.

And, finally, what does this discovery (and/or the theoretical explorations associated with it) tell us about other questions related to symmetry breaking, whether it is the understanding of the QCD vacuum or the resolution of the puzzle related to the observed baryon asymmetry in the Universe?

This is a collection of reviews on the state of the field, which examine some of these questions, and, in attempting to answer them, raises other intriguing ones.

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