

Aspects of electroweak symmetry breaking in light of new data from the LHC

Abstract

Recent years mark a great success of the Standard Model. Discovery of the Higgs boson confirmed that electroweak symmetry is broken by a vacuum expectation value of a scalar field, thus finally proving the fifty year old theoretical idea. However a modification of the SM is required to accommodate many already observed phenomena such as the existence of dark matter or proper inclusion of gravitational interactions.

Discovery of the Higgs boson opened a new era of precision measurements which can guide us to the correct extension of the SM by the determination of the properties of new particle. Currently all the data is consistent with the SM prediction, however the accuracy of these measurements leaves open a possibility of significant modification of the SM. Due to lack of direct evidence of new physics at the LHC it is the new data about the Higgs boson properties that we will use as a guide towards its extension. We will begin by discussing the properties of the SM Higgs boson in the Standard Model and its supersymmetric extension which still is the best hope against the SM Hierarchy problem.

Next we will exhibit a more practical approach and address issues present in the Standard Model, namely the vacuum stability issue. While the SM does not require an extension to be consistent, having a vacuum which is not absolutely stable is not a comfortable situation. We will also discuss bounds on theories beyond the SM coming from requirement of not destabilizing the electroweak vacuum too much. Here we will use the very generic framework of higher dimensional operators provided by nonrenormalisable theories.

Lastly we will discuss baryogenesis, another necessary phenomenon, absent in the Standard Model. We will again use effective field theory approach and focus on the bounds on such extensions, that we can extract from requiring successful baryogenesis. Our main focus here will be the possible modification of such bounds coming from our lack of knowledge of the early universe cosmological history.