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Strongly coupled physics Beyond the Standard Model with Petascale computing

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One of the open questions in theoretical physics is the real origin of mass and it is related to electroweak symmetry breaking and the Higgs mechanism. The dynamical origin of electroweak symmetry breaking can have several viable explanations, many of which require new strongly coupled physics. In these systems, the Higgs boson appears as a composite bound state in a new gauge theory.
Increased statistics at the run II of LHC will further constrain the phenomenologically viable models of this kind in the near future. Therefore, it is highly desirable to understand the general properties and specific features of the different competing models from the theoretical point of view. Given the strong dynamics of the new interactions, large non-perturbative lattice calculations are needed.
We present results for the spectrum of a strongly interacting SU(3) gauge theory with $N_f = 8$ light fermions in the fundamental representation. Carrying out non-perturbative lattice calculations at the lightest masses and largest volumes considered to date, we confirm the existence of a remarkably light singlet scalar particle. This feature seems to be a generic trait of gauge theories near the conformal window. We also explore the rich resonance spectrum of the 8-flavor theory in the context of the search for new physics beyond the standard model at the LHC. Connecting our results to models of dynamical electroweak symmetry breaking, we estimate the vector resonance mass to be about 2 TeV with a width of roughly 450 GeV, and predict additional resonances with masses below ˜3 TeV.

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