Thesis advisor's report on the PhD thesis of Adam Smetana "ELECTROWEAK SYMMETRY BREAKING BY DYNAMICALLY GENERATED MASSES OF QUARKS AND LEPTONS"

Adam Smetana wrote a very nice diploma thesis on two-color QCD under my guidance, and in the fall of 2004 I agreed with pleasure to be his PhD thesis advisor. I suggested him a general subject "Spontaneous symmetry breaking in elementary particle physics", having in mind in particular the physics of Nambu-Goldstone bosons in the NJL models with chemical potential.

After a rather long time it turned out that the obtained partial results are not, according to my standards, good enough for publication. Adam had to change the subject to models of dynamical electroweak symmetry breakdown. Clearly, for a PhD student this is always painful. In this case even more, because the theoretical aspects of a particular model pretending to break dynamically the electroweak symmetry by strong Yukawa interactions which we were working on at that time were basically developed. Later I turned my religion back to the belief that dynamical symmetry breaking of the electroweak interactions is most natural without elementary scalars. In developing one particular idea of this sort Adam became simply my right hand.

I find the thesis a nice piece of work written in a concise, clear, and personal style. It consists of six chapters and three appendices.

In the Introduction the author expresses in particular his understanding of the Standard model, and his view how to extend it. Chapter II is a brief summary of two major representatives of models of dynamical electroweak symmetry breaking: the (extended) technicolor and the top quark condensation models. This section is really useful, because it contains the material discussed later in author's work.

Chapter III is an extended version of the paper "Top-quark and neutrino composite Higgses " published recently. Standard 'top-quark condensation' models deal from the start with appropriate four-fermion interaction. Smetana's in fact phenomenological analysis is fully motivated by an asymptotically free renormalizable model discussed later, and provides its partial justification. Evaluating this part of the thesis I quote from the referee's report: "The author studies a composite Higgs model with neutrino and top condensation, resulting in an effective two Higgs model below the renormalisation scale. Small neutrino masses arise from a seesaw mechanism. This scenario has been proposed already some time ago, however so far no detailed analysis of it, especially not of the predictions for the lightest Higgs mass, has been performed. To address this issue now is very timely, given the recent Higgs results of the LHC. The present manuscript contains a detailed analysis, as well as a discussion of the phenomenological consequences showing that the scenario should be tested within the next run of the LHC. I recommend the paper for publication in EPJC."

Chapter IV, containing the first authors results in the field of dynamical electroweak symmetry breaking, deals mainly with numerical analysis of the Schwinger-Dyson equations for the fermion self-energies in the electroweak gauge model with strong Yukawa interactions. The obtained results nicely complement similar results found for the same model by Petr Beneš.

Ganging the flavor index of the fermion sector of the Standard electroweak $SU(2)_I \times U(1)_Y$ gauge model results in chiral (expectedly nonconfining) $SU(3)_I$ gauge flavor dynamics. Chapter V is devoted to its analysis. First, there are firmly established perturbative properties of the model which Adam Smetana either derived of checked. I find particularly useful his analysis of the non-minimal versions of the model characterized by various right-handed neutrino representation

assignments. While I still swear to the minimal model, Adam at one point became rather stubborn, arguing in favor of non-minimal models. His main argument, expressed clearly in the thesis, is the natural existence of several condensation scales. In retrospect I am grateful to him for his stubbornness - his version is published in a good journal while mine is not (yet). Be it as it may, this type of models is in accord of what we consider a reasonable microscopic model underlying the exceedingly successful phenomenological Higgs one.

Conclusions of the present thesis could hardly be expected long. They honestly, evaluating each word, summarize the obtained results. The 'Epilogue' should , however, be explicitly praised. Three important appendices, containing technical aspects of the thesis, make the main text easy to read.

Both the thesis and the results on which it is based, manifest convincingly its author's understanding of the subject and his maturity as the theoretical physicist. He deserves, without doubt, the PhD degree.

Ing. Jiří Hošek, DrSc.
senior research scientist
head, Department of Theoretical Physics
Nuclear Physics Institute, Academy of Sciences of the Czech Republic
25068 Rez (Prague), Czech Republic
e-mail: hosek@ujf.cas.cz

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