Report on the doctoral thesis
"Level Truncation Approach to Open String Field Theory"
by Matej Kudrna

In this doctoral thesis, the author studies numerical solutions to the equations of motion in bosonic open string field theory using the level truncation approximation. The main results are described in chapters 4, 5, 6, 7, and 8, which are based on the author's six papers on the arXiv [hep-th]. Three of them have been published in the Journal of High Energy Physics.

In chapters 1 and 2, Witten's cubic bosonic open string field theory and related topics are reviewed in terms of conformal field theory from modern point of view. Various formulas and results, which are used in the following chapters, are explained in detail.

In chapter 3, the author's numerical algorithms in order to perform various computations using the level truncation method are described concretely. In particular, matrix representations of operators, which are usually omitted in the literature treating level truncation in string field theory, are written down. The level-truncated equations of motion for various setups are solved by Newton's method basically. In order to construct seeds for solutions the homotopy continuation method is used. It may be a good strategy for finding "all" solutions. In subsection 3.7.4, an extrapolation method to infinite level, which is adopted to obtain results in the following chapters, is explained concretely.

In chapters 4 to 8, results of numerical computations are summarized. In chapter 4, universal solutions are described. In particular, the tachyon vacuum solution at level 30, which is the highest level in the literatures so far, has been achieved in the Siegel gauge. It is quite impressive because the existence of the minimum of its energy at level 28 predicted in the papers by W. Taylor and Gaiotto-Rastelli in 2002 was confirmed straightforwardly. In addition to the tachyon vacuum, existence of some brane solutions is suggested numerically.

In chapters 5 and 7, numerical results for the free boson theory on a circle and on a two-dimensional torus are given. Various lump solutions including exotic ones are obtained.

In chapter 6, numerical solutions for marginal deformation in boundary conformal field theory are investigated using tachyon approach and marginal one. Relationship between parameters in open string field theory and boundary conformal field theory is discussed in detail. Furthermore, perturbative approach by computing the star products numerically is also adopted. It has not been analyzed in the earlier works and therefore it gives new results.

In chapter 8, numerical solutions for minimal models such as Ising model are given. These computations in the framework of open string field theory are valuable and comparison with known results in the context of boundary conformal field theory seems to be significant to consider applications of string field theory to various situations in string theory.

Overall, the thesis contains lots of interesting scientific results in open string field theory using the level truncation method. Various numerical computations have been performed at the highest level in the world since Sen-Zwiebach's calculation in 1999. Some numerical analysis is improved from one in the author's published papers. The results in this thesis are very important in the field of string field theory because performing such high-level computations is quite difficult for other researchers. They would be useful for future developments in string theory. In this thesis many interesting issues are well organized and it demonstrates that the author has ability for creative scientific work.

The thesis is of high quality and thus I am happy to recommend its acceptation as a doctoral thesis at the Faculty of Mathematics and Physics, the Charles University.

I would like to ask the following questions:

How can we justify the extrapolation method for various quantities of solutions truncated at level L using fitting with polynomial in 1/L? Is it sufficient to evaluate the first out-of-Siegel equation as a consistency check for solutions in the Siegel gauge? How can we examine cohomology of BRST operators around solutions numerically?

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