International Journal of Modern Physics A

MODULI STABILIZATION IN STRINGY ISS MODELS

MASAHITO YAMAZAKI

Department of Physics, the University of Tokyo, Hongo, Bunkyo-ku, Tokyo 113-0033, Japan *

Received Day Month Year
Revised Day Month Year

We present a stringy realization of the ISS metastable SUSY breaking model with moduli stabilization. The mass moduli of the ISS model is stabilized by gauging of a $U(1)$ symmetry and its D-term potential. The SUSY is broken both by F-terms and D-terms. It is possible to obtain de-Sitter vacua with a vanishingly small cosmological constant by an appropriate fine-tuning of flux parameters. The content of this article is based on our recent paper[1], which is in collaboration with Yu Nakayama (Berkeley) and Tsutomu Yanagida (Tokyo).

Keywords: ISS model; moduli stabilization; Fayet-Illiopoulos D-term.

PACS numbers: 12.60.Jv, 11.25.Wx

1. The Problem and the Solution

Dynamical breaking of supersymmetry (SUSY) is an appealing possibility bacause it will provide a natural solution to the hierarchy problem. Quite a few models within the field theory have been proposed and investigated from various viewpoints (see e.g. Ref. 2 and Ref. 3 for reviews). Given their success, string theoretic realization of such dynamical SUSY breaking models is of great significance but the attempts have been successful almost exclusively in a non-compact global SUSY limit, where the gravity decouples.

In the global SUSY limit, metastable SUSY breaking vacua are now known ubiquitous in string theory [4]. However, almost all such realizations from the string theory have been done in the global SUSY limit so far, where the gravity decouples and the moduli are fixed by hand. One simple example of such metastable SUSY breaking models is the SQCD with small mass deformation recently proposed by Intriligator, Seiberg and Shih (ISS) [5], which breaks the SUSY by the F-term vacuum expectation value. It is easy to embed the ISS model and its variants in the string theory, but only in the global SUSY limit. Once we couple them to the supergravity, few viable models are known.

*yamazaki@hep-th.phys.s.u-tokyo.ac.jp

Indeed, it is not clear whether or not the ISS(-like) models are in the swampland [6,7] once we introduce finite gravitational coupling. More generally, any SUSY breaking models in the global SUSY limit suffer the same problem of moduli stabilization because typically the order parameter of the SUSY breaking tends to be zero once such a parameter becomes dynamical.

In our paper[1], we gave a concrete solution to the moduli stabilization problem in the string compactification with the dynamical SUSY breaking. We used type IIB flux compactifications on compact Calabi-Yau with O7-planes and D7-branes, and with magnetic flux turned on 4-cycles wrapped by D7-branes.

Our key idea to stabilize the moduli is to introduce a dynamical Fayet-Iliopoulos (FI) term, which arise from the presence of magnetic flux [8]. The dynamical FI term itself will also be stabilized by the competition between the F-term potential and the D-term potential.

In our construction, the SUSY is broken both by F-terms and D-terms, and we can obtain a de-Sitter vacuum by an appropriate fine-tuning of flux parameters. The necessity of the D-term has an interesting phenomenological consequence: one may be able to realize the strongly coupled D-term gauge mediation [9], where very light gravitino ($\sim O(1)$ eV) can be realized with a possible natural candidate for the dark matter [10].

Unfortunately, in our construction, the SUSY breaking scale is naturally related with the string scale unless we allow a rather significant amount of fine-tuning of parameters. One possibility to obtain a low energy SUSY breaking more naturally is to use a warped compactification, which would drastically reduce the relevant energy scale of the physics on the 4-cycle where the SUSY breaking occurs.

Acknowledgments

We would like to express our gratitude to Yu Nakayama and Tsutomu Yanagida for collaboration. We also thank the organizers of the workshop “Progress of String Theory and Quantum Field Theory” for providing stimulating atmosphere.

References

1. Y. Nakayama, M. Yamazaki and T. T. Yanagida, arXiv:0710.0001 [hep-th].
2. Y. Shadmi and Y. Shirman, Rev. Mod. Phys. **72**, 25 (2000) [arXiv:hep-th/9907225].
3. K. Intriligator and N. Seiberg, arXiv:hep-ph/0702069.
4. H. Ooguri and Y. Ookouchi, Nucl. Phys. B **755**, 239 (2006) [arXiv:hep-th/0606061]. H. Ooguri, Y. Ookouchi and C. S. Park, arXiv:0704.3613 [hep-th].
5. K. Intriligator, N. Seiberg and D. Shih, JHEP **0604**, 021 (2006) [arXiv:hep-th/0602239].
6. C. Vafa, arXiv:hep-th/0509212.
7. H. Ooguri and C. Vafa, Nucl. Phys. B **766**, 21 (2007) [arXiv:hep-th/0605264].
8. M. Dine, N. Seiberg and E. Witten, Nucl. Phys. B **289**, 589 (1987).
9. Y. Nakayama, M. Taki, T. Watari and T. T. Yanagida, arXiv:0705.0865 [hep-ph].
10. K. Hamaguchi, S. Shirai and T. T. Yanagida, arXiv:0707.2463 [hep-ph].