Research Summary

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Background

The Standard Model (SM) of particle physics has been tested by several astrophysical observations and ground experiments. There are no significant deviations between the observed values and the SM so far, but there are some issues in the SM. One of the biggest issues is how to quantize gravity. The most promising candidate of the quantum gravity is the superstring theory. It is defined in 10-dimensional space-time, and if the superstring is the true quantum gravity, all the particles and interactions in the universe would be unified by string. Thus, the superstring is a candidate of a unified theory as well as quantum gravity. I studied relationships between the superstring and the SM.

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There are 3 generations of quarks and leptons in the SM. They are distinguished by flavor, and their masses and interactions are different. There is no guiding principle for the flavor structure in the SM. If the superstring is the true quantum gravity, mysterious flavor structure can be reproduced by the superstring. Intersecting D-brane model (and its T-dual, magnetized extra-dimension) is an interesting technique to construct an explicit vacuum and give an effective theory of the superstring. I studied discrete symmetries of the effective theories given by D-brane models. For instance, I studied perturbative flavor symmetries of the D-brane models and their breaking patterns by non-perturbative effects [1]. I also studied modular symmetry of magnetized torus and found that the modular symmetry is non-commutative with internal symmetries of D-brane models [2]. I construct modular symmetric models which reproduce the quark mass and mixing angles too [3].

I also studied a generalized CP-symmetry. CP is the symmetry between matters and antimatters, and it is violated only through the weak interactions in the SM. The origin of CP-violation (CPV) is unclear. I considered CPV comes from generalized CP-symmetry. I also find spontaneous CPV and restorations in CP-like symmetric models [4].

[1] Tatsuo Kobayashi, Yoshiyuki Tatsuta, and SU,Phys.Rev. D93 (2016) no.6, 065029.
[2] Hiroshi Ohki, SU, Risa Watanabe, Phys.Rev.D 102 (2020) 8, 085008.
[3] Hitomi Kuranaga, Hiroshi Ohki, SU, JHEP 07 (2021) 068.
[4] Hiroshi Ohki, SU, [arXiv: 2310.16710 [hep-ph]].