

# Result

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A field of my research is on invariants of 3-manifolds including finite type invariants of 3-manifold inspired by Witten's work on the Chern-Simons quantum field theory. In particular, I study the Chern-Simons perturbation theory developed by Kontsevich, Axelrod and Singer. The Chern-Simons perturbation theory gives sequences of invariants of 3-manifolds with acyclic local systems. Kuperberg and Thurston established a purely topological construction of the Chern-Simons perturbation theory at the trivial local system. There are deeply studies of the invariants by them, Taubes and Lescop. In particular, it is known that the Chern-Simons perturbation theory at the trivial local system gives a universal finite type invariant of integral homology 3-spheres. Although, the Chern-Simons perturbation theory at non-trivial local systems are not enough studied. A purely topological construction was given by Bott and Cattaneo. But there was a gap in their original construction. A purpose of my research is to establish and understand the non-trivial local system cases and to compare with the trivial local system case.

(1) I proved in [1] that the Chern-Simons perturbation theory at the trivial local system coincides with the Morse homotopy defined by T. Watanabe and K. Fukaya.

(2) (joint work with Alberto S. Cattaneo) We revisited the Bott-Cattaneo construction of the Chern-Simons perturbation theory and removed the gap. Our construction is a generalization of the Bott-Cattaneo original construction.

(3) I proved that the Reidemeister-Turaev torsion of the universal representation of the 1st homology group of a 3-manifold coincide with an invariant related to the Chern-Simons perturbation theory.

## References

[1] Tatsuro Shimizu, An invariant of rational homology 3-spheres via vector fields, Algebraic and Geometric Topology, 16 (2016) pp.3073-3101

[2] Alberto S. Cattaneo and Tatsuro Shimizu, A note on the  $\Theta$ -invariant of 3-manifolds, arXiv:1903.04386, 2019

[3] Tatsuro Shimizu, Chern-Simons perturbation theory and Reidemeister-Turaev torsion, RIMS Kokyuroku, No.2163, 2020, pp29--pp35