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Superstring perturbation theory via super Riemann surfaces: an overview. (English)

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The basic foundations of superstring perturbation theory were all established by the mid-1980s. A couple of steps are necessary to complete that story.

(A) One should formulate all essential arguments on the moduli space of super Riemann surfaces rather than on the moduli space of ordinary Riemann surfaces.

(B) One needs a careful treatment of integrals that are only conditionally convergent in the infrared region. The supersymmetric version of the Deligne-Mumford compactification of moduli space provides a natural infrared regulator.

The author gave the detailed treatment in [ibid. 15, No. 1, 213–516 (2019; Zbl 1421.81101)]. The principal objective in this paper is to give a more informal explanation in the context of a class of models. In the most basic case, the SO (32) heterotic string compactified on a Calabi-Yau threefold with the spin connection embedded in the gauge group in the standard fashion is preferred. This example is a prototype for a large class of heterotic string compactifications to four dimensions which are supersymmetric at tree level but are of an anomalous $U(1)$ gauge field. The loop corrections canceling the anomaly also trigger the spontaneous breaking of supersymmetr, giving only known method of supersymmetry breakdown by loop effects in superstring perturbation theory. These models turn out to provide an important test case for arguments claiming to show why supersymmetry is valid in loops. The following three topics are dealt with in analyzing these models.

1. the mass splitting between bosons and fermions arising at one-loop order:
2. the vacuum energy arising at two-loop order:
3. the mechanism by which a Goldstone fermion appears in supersymmetric Ward identities, signaling the spontaneous breakdown of supersymmetry.

The paper consists of four sections, and the above three points are addressed respectively in Sections 2, 3 and 4. A procedure to generalize superstring perturbation theory to describe vacuum shifts that are necessary when tadpoles appear has been developed recently in [*A. Sen*, J. High Energy Phys. 2015, No. 12, Paper No. 75, 91 p. (2015; Zbl 1388.81888)], though a reformulation of the procedure in terms of super Riemann surfaces is to be seen.

Reviewer: Hirokazu Nishimura (Tsukuba)

MSC:

81T30	String and superstring theories
32C11	Complex supergeometry
81T60	Supersymmetric field theories
81T20	Quantum field theory on curved space backgrounds
32G15	Moduli of Riemann surfaces, Teichmüller theory
14J32	Calabi-Yau manifolds

Cited in **3** Reviews
Cited in **1** Document

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