Contribution ID: **135** Type: **Talk**

Cyclic Leibniz rule, cohomology and non-renormalization theorem in lattice supersymmetry

Thursday 7 July 2016 15:00 (20 minutes)

We first discuss that a full supersymmetry algebra cannot be realized on lattice. This comes from the fact that the Leibniz rule of space-time derivatives in the continuum cannot hold for finite difference operators on lattice by the no-go theorem. We then propose a modified Leibniz rule, called a cyclic Leibniz rule (CLR), on lattice, and consider a complex supersymmetric quantum mechanics equipped with the CLR.
It is shown that the CLR allows two of four supercharges of the continuum theory to preserve, while a naive lattice model can realize one supercharge at the most. A striking feature of our lattice model is that there are no quantum corrections to potential terms in any order of perturbation theory. This is one of characteristic properties of supersymmetric theory in the continuum. It turns out that the CLR allows to have a non-trivial cohomology and plays a crucial role in the proof of the non-renormalization theorem.

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Session Classification: Formal Field and String Theory

Track Classification: Formal Field and String Theory