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Title of the Thesis: "Non-Perturbative Dynamics In Supersymmetric Gauge Theory"

ABSTRACT

My research topic is "Non-perturbative dynamics in supersymmetric gauge theory". In chapter first we introduce the motivation behind the research work and studies under the topics provided. We have addressed how the transition from the classical mechanics to quantum mechanics changed the understanding of different phenomenon of the nature. The birth of quantum mechanics, special theory of relativity and their combination -quantum field theory is also emphasised. A possible solution to the shortcomings of SM through supersymmetry- a symmetry of spacetime relating the two different species of particles named bosons and fermions has been discussed and need for nonperturbative calculations in the regime of strong interaction of QCD has been addressed.

In second chapter we have introduced the supersymmetry and its formal structure. Each representation of supersymmetry algebra has equal number of fermion as well boson degree of free-dom. In this chapter we have also introduced the supersymmetric quantum mechanics. The effect of supersymmetry to quantum harmonic oscillator is that its ground state energy (vacuum energy) vanishes explicitly.

In chapter third we have introduced the basic ingredients of supersymmetric field theories. With grading parameter one can construct a

commutation/anticommutation bracket which dictate the relation of bosonic operator in between and with fermionic operators but anticommutaion for the fermionic operators in between. Going through the proof for a superjacobi identity we also exercised the non-linear constraint for the structure constants. The supermultiplet construction is exercised by direct method.

The anticommutation relation between the spinor field and the supersymmetry generator has been performed.To construct the mafifest lorentz invariant action we redefine scalars in

terms of new variables and two component spinor transformed into four component Majorana spinor and their supersymmetric transformation rules are given.

Different commutation/anticommutaion relation between superfield, supersymmetric differential operator and sypersymmetry generator has been studied. The most general function of the commuting and anticommuting (Grassman) number has been constructed and the supersymmetric transformation of the different component in the expansion has been performed. Furtherwe have studied $\mathcal{N} = 1$ Abelian gauge theory, $\mathcal{N} = 1$ and $\mathcal{N} = 2$ Super Yang-Mills theory and the non-perturbative dynamics in this supersymmetric gauge theory. The solitonic type solution of the $\mathcal{N} = 2$ SYM theories in Minkowski and Euclidean spacetime has been analysed. In the same chapter we have added one more section about our study of cosmology and in particular the Cosmological Tracking Solutions. we have calculated possible extra term in the function Γ which dictate whether the existence of tracking solution.

In the last chapter we have studied the BRST symmetry and see that the nilpotency of the mass deformed ABJ theory in nonlinear gauges lost. The BLG theory is the theory of multiple M2 branes which is based on gauge symmetry generated by a Lie 3-algebra rather than a Lie algebra describing two M2 branes. A generalization of this theory which describes N M2 branes is known as the ABJM theory.

A further generalization of this theory is called the ABJ theory . This generalization is a superconformal Chern-Simons-matter theory with gauge group $U(M)_k \times U(N)_{-k}$, with $M > N$. A brane construction of this theory is equivalent to the low energy $(M - N)$ fractional M2 branes sitting at the $C4/Z_k$ singularity in one sector and N M2 branes freely moving on the other. We have analysed the non-linear gauges in deformed ABJ theory. The nilpotency of BRST and anti-BRST symmetries lost in this case for this theory.