APPLICATION OF MATRIX MODELS AND SPIN CHAINS TO GAUGE THEORIES

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Abstract

In this thesis, we present various applications of matrix models and spin chains to gauge theories. In the first part, we discuss the Dijkgraaf–Vafa conjecture relating the effective superpotential in $\mathcal{N} = 1$ supersymmetric gauge theories to the perturbative computation of a matrix model. We survey some concepts of $\mathcal{N} = 1$ supersymmetric gauge theories, state the conjecture and extend it to include matter superfields in the fundamental representation. The extension is tested by comparing matrix model and field theory results. The conjecture is also applied to dynamical supersymmetry breaking and baryonic corrections to the superpotential. The second part is dedicated to a discussion of anomalous dimensions of local gauge invariant large-N QCD operators. To place this investigation into context, the connection between scaling dimensions of certain operators in $\mathcal{N} = 4$ SYM and the energy spectrum of dual string theory states is reviewed. The mixing matrix of the large-N QCD operators is identified with the Hamiltonian of a spin chain with nearest neighbor interaction. The algebraic Bethe ansatz is employed to reveal an integrable structure in the subsector of chiral operators. In the thermodynamic limit of long operators, the ground state is found to be anti-ferromagnetic and the low-lying excitations above it are investigated. In the last chapter, dealing with a different subject within string theory, we briefly discuss the orientifold compactification of type II A string theory with fluxes to three space-time dimensions.

Keywords: Gauge field theory, supersymmetry, Dijkgraaf–Vafa conjecture, effective superpotential, matrix model, large-N QCD, spin chain, algebraic Bethe ansatz

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