NON-HARMONIC GAUGE COUPLING CONSTANTS IN SUPERSYMMETRY AND SUPERSTRING THEORY*

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ABSTRACT

Recent developments in understanding non-harmonic gauge coupling constants in supersymmetry and superstring theory are summarized.

1. Introduction

The gauge coupling constant in $N = 1$ supersymmetric field theories arises as a chiral integral over the supersymmetric field strength $W_\alpha = -\frac{1}{4}\bar{D}^2 e^{-V} D_\alpha e^V$ (V being the vector superfield) in the following way:[1]

$$\tfrac{1}{4}\sum_a \int d^2\theta f_a(\phi)(W^\alpha W_\alpha)_a + \text{h.c.} = -\tfrac{1}{4}\sum_a (\text{Re}f_a(F_{\mu\nu}F_{\mu\nu})_a - \text{Im}f_a(F\tilde{F})_a + \ldots) \ . \quad (1)$$

The index a labels different factors in the gauge group $G = \prod_a G_a$. f_a is an arbitrary holomorphic function of the chiral superfields in the theory.† Eq. (1) identifies $\text{Re}f_a$ as the field-dependent gauge couplings and $\text{Im}f_a$ as the θ-angle:

$$f_a(\phi) = \frac{1}{g_a^2(\phi)} - \frac{i\theta_a(\phi)}{8\pi^2} \ . \quad (2)$$

One loop corrections of the gauge coupling constant are of the generic form

$$\frac{16\pi^2}{g_a^2(\mu)} = \frac{16\pi^2}{g_{\text{GUT}}^2} + b_a \ \ln\frac{M_{\text{GUT}}^2}{\mu^2} + \Delta_a \quad (3)$$

where b_a is related to the one loop β-function via $\beta_a = b_a\, g_a^3/16\pi^2$. Δ_a are the infrared finite one loop threshold corrections which generally arise from integrating out the

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† Here we restrict our attention to gauge neutral functions f_a. The most general f could transform in the adjoint representation of the gauge group.[1]