Physikalisches Institut
Universität Bonn
Theoretische Physik

Exercises 10
16.6.2014
SS 2014

Exercises on Theoretical Particle Physics II

Prof. Dr. H.P. Nilles

Due 23.6.2014

18. Kähler-Weyl transformations (*4 credits*)

(a) Show that

$$V = -e^{-G}\left(3 + G^{i\bar{j}}G_i G_{\bar{j}}\right), \qquad G = -K - \log|W|^2$$

can be written as

$$V = e^{K}\left(D_i W D_{\bar{j}} W^* K^{i\bar{j}} - 3|W|^2\right), \qquad D_i W = W_i + K_i W.$$

(*2 credits*)

(b) W and K are not independent. Assume $W \to We^{-f(\phi)}$ with some holomorphic function $f(\phi)$. Find a transformation for K under which G is invariant. Transformations of this kind are called Kähler-Weyl transformations.

(*2 credits*)

19. No Scale Model (*16 credits*)

(a) Take the Kähler potential

$$K = -3\log(T + T^*)$$

and the superpotential

$$W = b$$

where b is an arbitrary complex number and T is a chiral superfield. Show that the scalar potential vanishes. Calculate the local F-term equation for T to show that SUSY is broken.

(*2 credits*)

(b) Let us introduce two additional chiral superfields S and C together with

$$K = -\log(S + S^*) - 3\log(T + T^* - CC^*), \qquad W = C^3 + ae^{-\alpha S} + b$$

where a is a complex number and $\alpha > 0$. Calculate the F-term equations for S, T and C and check that SUSY is broken.

(*2 credits*)

(c) Calculate the Kähler metric $K_{i\bar{j}}$ and its inverse $K^{i\bar{j}}$ for the Kähler potential given in part (b).

(3 credits)

(d) Use your results from part (b) and (c) to show that

$$K^{i\bar{j}} K_i K_{\bar{j}} = 4.$$

(2 credits)

(e) Show that the scalar potential V for K and W from part (b) can be written as

$$V = \frac{1}{S+S^*}\left(\frac{3|C|^4}{(T+T^*-CC^*)^2} + \frac{\left|C^3 + ae^{-\alpha S}(1+\alpha(S+S^*))+b\right|^2}{(T+T^*-CC^*)^3}\right).$$

(3 credits)

(f) Assume that C is a matter field which implies $\langle C\rangle = 0$. What is then the stable minimum value for V in the vacuum? What does this mean for $\langle S\rangle$? What is the value of $\langle T\rangle$?

(2 credits)

(g) What is the gravitino mass? Interpret your result.

(2 credits)