SUPERSYMMETRY
Problems: set 3

January 26, 2009

1. Let us consider the O'Raifeartaigh model with the superpotential

$$W = g\Phi_1\Phi_3^2 - gm^2\Phi_1 + M\Phi_2\Phi_3\,.$$

Assume all fields to be canonically normalized. Find out all global symmetries of this model (including discrete ones). Discuss the issue of supersymmetry breakdown for arbitrary values of real parameters g, m, M. Perturb the model by adding the term

$$\Delta W = \tfrac{1}{2}\epsilon M\Phi_2^2\,.$$

Discuss the breakdown of supersymmetry in the perturbed case as far as you manage. Remember about the possibility of the metastable supersymmetry breaking.

2. Suggest a simple generalization of the gauge kinetic term in the abelian case, $-\frac{1}{4}W^\alpha W_\alpha|_F + \text{h.c.}$, which could give a mass term for the gaugini.

3. Consider a locally supersymmetric model with the superpotential

$$\tilde{W}(Z,Y) = \mu^2(Z+\beta) + W(Y)\,,$$

and all fields canonically normalized. The parameters μ, β are real, the Planck mass M_P has been set to 1, and all mass scales in the superpotential $W(Y)$ are much smaller than μ and $\mu << M_P$. Assume that there are 3 fields Y_i and the low energy effective theory for these fields should be renormalizable. Find out explicitly all the soft terms for Y_i (in the flat limit: $M_P \to \infty$ while gravitino mass $m_{3/2} = const.$).

4. As in the previous problem but with the Kähler function for Z of the form $K(Z) = -3\log(Z + \bar{Z})$.

5. *This problem is raher difficult and non-obligatory*
   Consider a locally supersymmetric model with 3 chiral superfields S, T, C. Let the Kähler function be of the form

$$K = -\log(S + \bar{S}) - 3\log(T + \bar{T} - 2\bar{C}C)\,,$$

   and with the superpotential

$$W = C^3 + Ae^{-\alpha S} + B\,.$$

   In the above the A, B are arbitrary complex numbers and real α is positive. Discuss the supersymmetry breakdown in this model. What is the value of the vacuum energy at the minimum? Are there flat directions? What is the gravitino mass?