Problem Set 3 Introduction to Supersymmetry and Supergravity WS 13/14

Problem 3.1

Consider a theory with superpotential

$$W = \lambda A_0 + m A_1 A_2 + Y A_0 A_1^2 \ , \qquad m^2 > 2\lambda Y \ .$$

a) Determine the minimum of the scalar potential V.

b) Compute the mass spectrum for all bosons and all fermions for $\langle A_0 \rangle = 0$.

c) Verify the sum rule $\mathrm{Str} M^2 = 0$.

Problem 3.2

Consider a supersymmetric $U(1)$ gauge theory with gauge coupling g and two massive chiral multiplets $\Phi_\pm$ of opposite $U(1)$ charge and with a non-vanishing FI-term ξ_{FI}.

a) Compute the scalar potential for $W = m\Phi_+\Phi_-$ (cf. problem 2.3).

b) Determine the minimum of V for $|m|^2 > \xi_{\mathrm{FI}} g$. Is the $U(1)$ spontaneously broken? Is supersymmetry spontaneously broken?

c) Determine the minimum of V for $|m|^2 < \xi_{\mathrm{FI}} g$. Which symmetries are spontaneously broken? Is there a choice of parameters where supersymmetry is unbroken and the $U(1)$ is broken?

Problem 3.3

Compute the mass matrix of the stops.

Problem 3.4

Compute the mass matrix of the charginos $\tilde{W}^\pm = \frac{1}{\sqrt{2}}(\lambda^1 \mp i\lambda^2), \tilde{h}_u^+, \tilde{h}_d^-$.