SUSY PHENOMENOLOGY

Sheet 4

Exercice 1: MSSM Higgs boson masses

We look at the following MSSM Higgs potential:

$$\begin{aligned} V &= m_1^2 H_1^{\dagger i} H_1^i + m_2^2 H_2^{\dagger i} H_2^i - m_{12}^2 (\epsilon_{ij} H_1^i H_2^j + h.c.) \\ &\quad + \frac{g^2 + g'^2}{8} [H_1^{\dagger i} H_1^i - H_2^{\dagger i} H_2^i]^2 + \frac{g^2}{2} |H_1^{\dagger i} H_2^i|^2 + \frac{\epsilon}{2v^2 \sin^2\beta} [H_2^{\dagger i} H_2^i]^2 \end{aligned}$$

with

$$\begin{aligned} H_1^1 &= \frac{1}{\sqrt{2}} [v_1 + H^0 \cos\alpha - h^0 \sin\alpha + iA^0 \sin\beta - iG^0 \cos\beta] \\ H_1^2 &= H^- \sin\beta - G^- \cos\beta \\ H_2^1 &= H^+ \cos\beta + G^+ \sin\beta \\ H_2^2 &= \frac{1}{\sqrt{2}} [v_2 + H^0 \sin\alpha + h^0 \cos\alpha + iA^0 \cos\beta + iG^0 \sin\beta] \end{aligned}$$

and the parameters

$$\begin{aligned} v_1 &= v \cos\beta \\ v_2 &= v \sin\beta \\ M_Z^2 &= \frac{g^2 + g'^2}{4} v^2 \\ M_W^2 &= \frac{g^2}{4} v^2 \end{aligned}$$

The leading contribution of the radiative corrections can be added through the universal parameter

$$\epsilon = \frac{3G_F}{\sqrt{2}\pi^2} \frac{m_t^4}{\sin^2\beta} \log \frac{M_{\tilde{t}_1} M_{\tilde{t}_2}}{m_t^2} .$$

Calculate all MSSM Higgs boson masses from the above potential and show that the mass of the lightest scalar Higgs boson h is bounded. To do so express $m_{1,2}$ through $v_{1,2}$ and μB through M_A by using the condition, that the potential is minimized at the vacuum expectation values.