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Erratum

Erratum to: Vacuum stability of a general scalar potential of a few fields

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In the original, it was erroneously assumed in the derivation of the vacuum stability conditions for the two Higgs doublet model (2HDM) with real couplings that in the case of $\rho = 1$, it is sufficient to consider only $\cos\phi = \pm 1$. In fact, the solution with $\rho = 1$, $\cos\phi \neq \pm 1$ may exist, yielding an extra condition.

The minimisation equations for ϕ, h_1, h_2 and λ in the case of $\rho = 1$ are

$$0 = h_1 h_2 \left(2\lambda_5 h_1 h_2 \cos\phi + \lambda_6 h_1^2 + \lambda_7 h_2^2\right) \sin\phi, \tag{1}$$

$$\lambda h_1 = 4\lambda_1 h_1^3 + 2(\lambda_3 + \lambda_4 + \lambda_5 \cos 2\phi)\, h_1 h_2^2 + 6\lambda_6 \cos\phi\, h_1^2 h_2 + 2\lambda_7 \cos\phi\, h_2^3, \tag{2}$$

$$\lambda h_2 = 4\lambda_2 h_2^3 + 2(\lambda_3 + \lambda_4 + \lambda_5 \cos 2\phi) h_1^2 h_2 + 2\lambda_6 \cos\phi\, h_1^3 + 6\lambda_7 \cos\phi\, h_1 h_2^2, \tag{3}$$

$$1 = h_1^2 + h_2^2. \tag{4}$$

Their solutions with $\cos\phi \neq \pm 1$ are given by

$$\cos\phi_{\rho=1} = -\frac{\lambda_6 h_1^2 + \lambda_7 h_2^2}{2\lambda_5 h_1 h_2}, \tag{5}$$

$$h^2_{1,\rho=1} = [\lambda_5(2\lambda_2 - \lambda_3 - \lambda_4 + \lambda_5) + \lambda_7(\lambda_6 - \lambda_7)] /[2\lambda_5(\lambda_1 + \lambda_2 - \lambda_3 - \lambda_4 + \lambda_5) - (\lambda_6 - \lambda_7)^2], \tag{6}$$

$$h^2_{2,\rho=1} = [\lambda_5(2\lambda_1 - \lambda_3 - \lambda_4 + \lambda_5) - \lambda_6(\lambda_6 - \lambda_7)] /[2\lambda_5(\lambda_1 + \lambda_2 - \lambda_3 - \lambda_4 + \lambda_5) - (\lambda_6 - \lambda_7)^2], \tag{7}$$

$$V_{\min,\rho=1} = \frac{1}{2}[4\lambda_1\lambda_2\lambda_5 - 2\lambda_2\lambda_6^2 - 2\lambda_1\lambda_7^2 - (\lambda_3 + \lambda_4 - \lambda_5)[\lambda_5(\lambda_3 + \lambda_4 - \lambda_5) - 2\lambda_6\lambda_7]]/[2\lambda_5(\lambda_1 + \lambda_2 - \lambda_3 - \lambda_4 + \lambda_5) - (\lambda_6 - \lambda_7)^2]. \tag{8}$$

Altogether, the conditions for the 2HDM potential with real couplings to be bounded from below are

$$\begin{aligned} V_{\rho=0} > 0 \wedge D_{\cos\phi=\pm1,\,\rho=1} \\ \wedge\ (Q_{\cos\phi=\pm1,\,\rho=1} > 0 \vee R_{\cos\phi=\pm1,\,\rho=1} > 0) \\ \wedge\ (0 < h^2_{1,\rho=1} < 1 \wedge 0 < h^2_{2,\rho=1} < 1 \\ \wedge\ 0 < \cos^2\phi_{\rho=1} < 1 \implies V_{\min,\rho=1} > 0) \\ \wedge\ (0 < h_1^2 < 1 \wedge 0 < h_2^2 < 1 \\ \wedge\ 0 < \rho^2 < 1 \implies V_{\min} > 0), \end{aligned} \tag{9}$$

which includes the new condition involving $\cos\phi_{\rho=1}, h^2_{1,\rho=1}, h^2_{2,\rho=1}$ and $V_{\min,\rho=1}$.

Figures 3 and 4 that present examples of the allowed parameter space for the 2HDM remain unaffected by the change.

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