

## 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  $\phi$ ,  $h_1$ ,  $h_2$  and  $\lambda$  in the case of  $\rho = 1$  are

$$0 = h_1 h_2 (2\lambda_5 h_1 h_2 \cos \phi + \lambda_6 h_1^2 + \lambda_7 h_2^2) \sin \phi, \quad (1)$$

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

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

$$1 = h_1^2 + h_2^2. \quad (4)$$

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

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

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

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

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

$$- 2\lambda_6 \lambda_7]] / [2\lambda_5(\lambda_1 + \lambda_2 - \lambda_3 - \lambda_4 + \lambda_5) - (\lambda_6 - \lambda_7)^2]. \quad (8)$$

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

$$V_{\rho=0} > 0 \wedge D_{\cos \phi = \pm 1, \rho=1} \wedge (Q_{\cos \phi = \pm 1, \rho=1} > 0 \vee R_{\cos \phi = \pm 1, \rho=1} > 0) \wedge (0 < h_{1,\rho=1}^2 < 1 \wedge 0 < h_{2,\rho=1}^2 < 1) \wedge (0 < \cos^2 \phi_{\rho=1} < 1 \implies V_{\min,\rho=1} > 0) \wedge (0 < h_1^2 < 1 \wedge 0 < h_2^2 < 1) \wedge (0 < \rho^2 < 1 \implies V_{\min} > 0), \quad (9)$$

which includes the new condition involving  $\cos \phi_{\rho=1}$ ,  $h_{1,\rho=1}^2$  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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