

The condition $\bar{f} = 0$ determining the swallowtail point $\bar{\varphi}_1$:

$$\begin{aligned}\bar{f} &\equiv (b+1)^2(2b^2+5b+a+2) \\ &\times [(b^2+2ab+2b+a+2)f_D+2(b+1)^2(b^2+4b+a+2)]^2 \\ &+ [(-b^4+b^3+2ab^2+11b^2+7ab+12b+a^2+3a+4)f_D \\ &+ 2(b^3+7b^2+ab+12b+3a+4)(b+1)^3]^2 \Delta \cos^2 2\bar{\varphi}_1 = 0,\end{aligned}\tag{1}$$

where $f_D = (a-1)(a+b) + \Delta(b+1)^2$.