Perturbation de période due au développement excentrique du spiral

Spiral cylindrique sans courbes terminales

Exemple numérique

$n_{sp} := 10$ $\quad \psi := 2\cdot\pi\cdot n_{sp}$ $\quad \theta_0 := 270deg$ $\quad h_{déc} := 0.2\cdot mm$ $\quad \beta_{déc} := 20\cdot deg$

$R := 5\cdot mm$ $\quad L := R\cdot\psi$ $\quad T_0 := 0.4\cdot s$ $\quad \omega_0 := \dfrac{2\cdot\pi}{T_0}$ $\quad \theta_0\cdot\dfrac{R}{L} = 0.075$

Spiral non déformé en position de repos

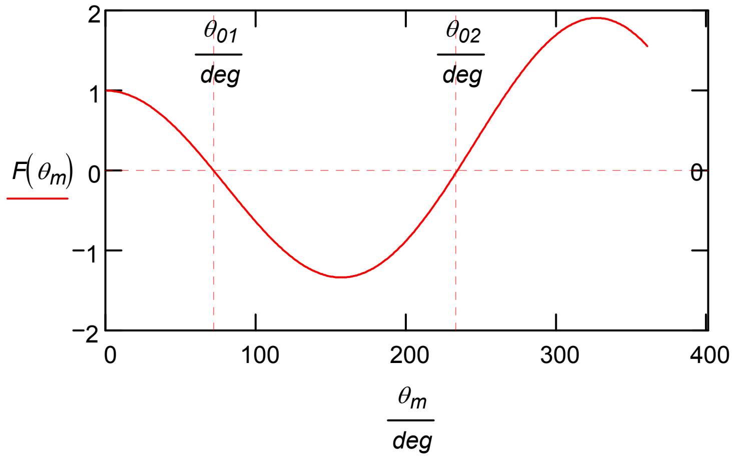
$F(\theta_0) := J0(\theta_0) - \theta_0\cdot J1(\theta_0)$ $\quad F(\theta_0) = 1.061$ $\quad Delta(\theta_0) := \dfrac{2}{\psi^2}\cdot(-1 + F(\theta_0)\cdot\cos(\psi)$ $\quad Delta(\theta_0) = 3.1\times 10^{-5}$

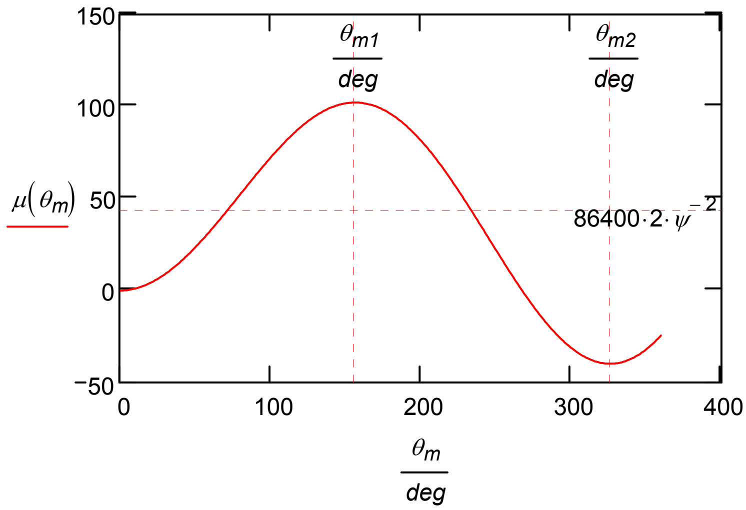
$\mu(\theta_0) := -86400\cdot Delta(\theta_0)$ $\quad \boxed{\mu(\theta_0) = -2.689}$ $\quad \boxed{\mu(220\cdot deg) = 60.857}$

$x := 100\cdot deg$ $\quad \theta_{01} := racine(F(x), x)$ $\quad \theta_{01} = 72deg$ $\quad \theta_{m1} := racine\left(\dfrac{d}{dx}F(x), x\right)$ $\quad \theta_{m1} = 156.7deg$

$x := 300\cdot deg$ $\quad \theta_{02} := racine(F(x), x)$ $\quad \theta_{02} = 233.7deg$ $\quad \theta_{m2} := racine\left(\dfrac{d}{dx}F(x), x\right)$ $\quad \theta_{m2} = 326.1deg$

$\theta_m := 1\cdot deg, 2\cdot deg .. 360\cdot deg$





$\mu_{m1} := -86400\cdot Delta(\theta_{m1})$

$\mu_{m1} = 102.238$

$\mu_{m2} := -86400\cdot Delta(\theta_{m2})$

$\mu_{m2} = -39.728$

Spiral déformé en position de repos

$$\delta_1(\theta_0) := \left[\frac{2}{\psi^2}\cdot(-1 + F(\theta_0)\cdot cos(\psi))\right] \qquad \delta_1(\theta_0) = 3.112\times10^{-5}$$

$$\delta_2(\theta_0,h) := \frac{-2\cdot h^2}{R^2}\cdot\frac{J1(\theta_0)}{\theta_0} \qquad \delta_2(\theta_0,h_{déc}) = 1.913\times10^{-4}$$

$$\delta_3(\theta_0,h,\beta) := \frac{2\cdot h}{\psi\cdot L}\cdot(cos(\psi-\beta) + cos(\beta))\cdot(1 - F(\theta_0)) - \frac{2\cdot h}{L}\cdot(sin(\psi-\beta) + sin(\beta))\cdot J0(\theta_0)$$

$$\delta_3(\theta_0,h_{déc},\beta_{déc}) = -2.339\times10^{-6}$$

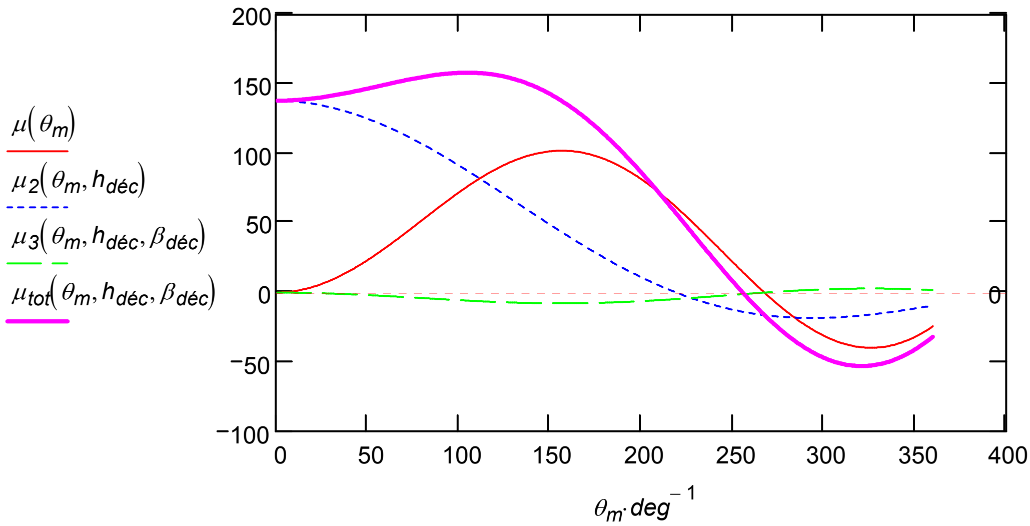
$$\delta_{tot}(\theta_0,h,\beta) := \delta_1(\theta_0) + \delta_2(\theta_0,h) + \delta_3(\theta_0,h,\beta) \qquad \delta_{tot}(\theta_0,h_{déc},\beta_{déc}) = 2.2\times10^{-4}$$

$$\mu_2(\theta_0,h) := -86400\cdot(\delta_2(\theta_0,h)) \qquad \boxed{\mu_2(\theta_0,h_{déc}) = -16.525}$$

$$\mu_3(\theta_0,h,\beta) := -86400\cdot(\delta_3(\theta_0,h,\beta)) \qquad \boxed{\mu_3(\theta_0,h_{déc},\beta_{déc}) = 0.202}$$

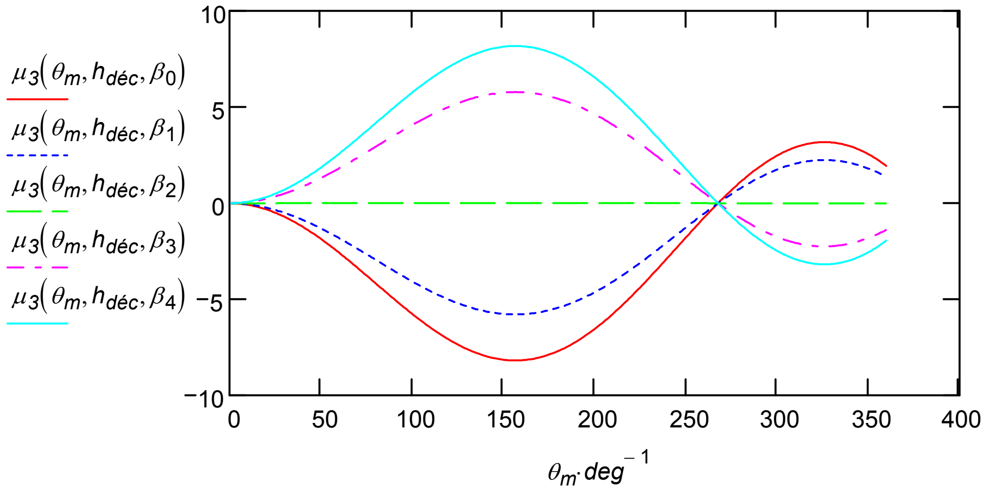
$$\mu_{déc}(\theta_0,h,\beta) := -86400\cdot(\delta_2(\theta_0,h) + \delta_3(\theta_0,h,\beta)) \qquad \boxed{\mu_{déc}(\theta_0,h_{déc},\beta_{déc}) = -16.323}$$

$$\mu_{tot}(\theta_0,h,\beta) := -86400\cdot(\delta_1(\theta_0) + \delta_2(\theta_0,h) + \delta_3(\theta_0,h,\beta)) \qquad \boxed{\mu_{tot}(\theta_0,h_{déc},\beta_{déc}) = -19.012}$$



Influence de la position angulaire du décentrage initial

$i := 0, 1 .. 4 \qquad \beta_i := 45\cdot deg\cdot i$

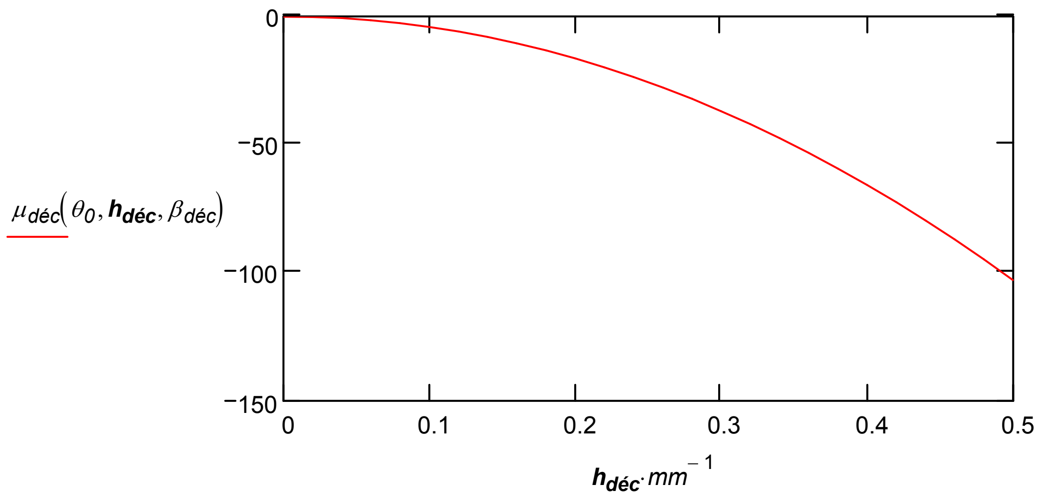


$h_{déc} = 0.2\,mm$

$\theta_0 = 270\,deg$

Influence de la position radiale du décentrage initial

$\mathbf{h_{déc}} := 0 \cdot mm, .02 \cdot mm .. 0.5mm$ $\beta_{déc} = 20\,deg$ $\theta_0 = 270\,deg$



Vérification par calcul numérique

$\theta(\varphi) := \theta_0 \cdot cos(\varphi)$ $\sigma := R$

$$\Delta_1(\theta) := i \cdot \frac{\theta \cdot R^2}{L} \cdot exp(i \cdot \theta) \cdot \int_0^{\psi} exp(i \cdot \alpha) \cdot exp\left(-i \cdot \frac{\theta \cdot R \cdot \alpha}{L}\right) d\alpha \qquad \Delta_1(\theta) := \theta \cdot \frac{R^2}{L} \cdot \left(1 + \theta \cdot \frac{R}{L}\right) \cdot (exp(i \cdot \psi) - exp(i \cdot \theta))$$

$$\Delta_2(\theta, h, \beta) := i \cdot \frac{\theta}{L} \cdot exp(i \cdot \theta) \cdot \int_0^{L} h \cdot exp(i \cdot \beta) \cdot exp\left(-i \cdot \theta \cdot \frac{s}{L}\right) ds \qquad \Delta_2(\theta, h, \beta) := -h \cdot exp(i \cdot \beta) \cdot (1 - exp(i \cdot \theta))$$

$$\Delta(\theta) := \Delta_1(\theta) + \Delta_2(\theta, h_{déc}, \beta_{déc})$$

$$\chi(\theta) := \frac{\Delta(\theta) \cdot \overline{\Delta(\theta)}}{\sigma^2} \qquad \chi(\theta_0) = 4.079 \times 10^{-3} \qquad \gamma(\theta) := \frac{d}{d\theta}\chi(\theta) \qquad Gamma(\varphi) := \gamma(\theta(\varphi))$$

$$\delta_{num} := \frac{-1}{2\cdot\pi\cdot\theta_0{}^2}\cdot\int_0^{2\cdot\pi}\theta(\varphi)\cdot Gamma(\varphi)\,d\varphi$$

$\boxed{\delta_{num} = 2.182\times 10^{-4}}$ $\delta_{tot}(\theta_0, h_{déc}, \beta_{déc}) = 2.2\times 10^{-4}$

$\mu_{num} := -86400\cdot\delta_{num}$ $\boxed{\mu_{num} = -18.853}$ $\mu_{tot}(\theta_0, h_{déc}, \beta_{déc}) = -19.012$