

$$\begin{aligned}
& -k_0 (\eta_{10}(t) - \eta_{P2}(t)) - \\
& \frac{1}{2} M_{P2} \left( 2 \left( \cos(\theta(t) + \psi(t)) \sin(\alpha(t)) \alpha'(t) + \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) (\theta'(t) + \psi'(t)) \right) \right. \\
& \quad \left( \cos(\theta(t)) R'(t) + \cos(\theta(t) + \psi(t)) \sin(\alpha(t)) (L_0 + \eta_6(t) + \eta_7(t) + \eta_8(t) + \eta_9(t) + \eta_{10}(t) + \eta_{P2}(t)) \right. \\
& \quad \left. \alpha'(t) - R(t) \sin(\theta(t)) \theta'(t) + \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) \right. \\
& \quad \left. (L_0 + \eta_6(t) + \eta_7(t) + \eta_8(t) + \eta_9(t) + \eta_{10}(t) + \eta_{P2}(t)) (\theta'(t) + \psi'(t)) - \right. \\
& \quad \left. \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) (\eta_6'(t) + \eta_7'(t) + \eta_8'(t) + \eta_9'(t) + \eta_{10}'(t) + \eta_{P2}'(t)) \right) - \\
& 2 \cos(\alpha(t)) \alpha'(t) (-\cos(\alpha(t)) (L_0 + \eta_6(t) + \eta_7(t) + \eta_8(t) + \eta_9(t) + \eta_{10}(t) + \eta_{P2}(t)) \alpha'(t) - \\
& \quad \sin(\alpha(t)) (\eta_6'(t) + \eta_7'(t) + \eta_8'(t) + \eta_9'(t) + \eta_{10}'(t) + \eta_{P2}'(t))) + \\
& 2 \left( \sin(\alpha(t)) \sin(\theta(t) + \psi(t)) \alpha'(t) - \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) (\theta'(t) + \psi'(t)) \right) \\
& \quad \left( \sin(\theta(t)) R'(t) + \sin(\alpha(t)) \sin(\theta(t) + \psi(t)) (L_0 + \eta_6(t) + \eta_7(t) + \eta_8(t) + \eta_9(t) + \eta_{10}(t) + \eta_{P2}(t)) \right. \\
& \quad \left. \alpha'(t) + \cos(\theta(t)) R(t) \theta'(t) - \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) \right. \\
& \quad \left. (L_0 + \eta_6(t) + \eta_7(t) + \eta_8(t) + \eta_9(t) + \eta_{10}(t) + \eta_{P2}(t)) (\theta'(t) + \psi'(t)) - \right. \\
& \quad \left. \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) (\eta_6'(t) + \eta_7'(t) + \eta_8'(t) + \eta_9'(t) + \eta_{10}'(t) + \eta_{P2}'(t)) \right) + \\
& \frac{1}{2} M_{P2} \left( 2 \cos(\theta(t) + \psi(t)) \sin(\alpha(t)) \alpha'(t) (\cos(\theta(t)) R'(t) + \cos(\theta(t) + \psi(t)) \sin(\alpha(t)) (L_0 + \right. \\
& \quad \eta_6(t) + \eta_7(t) + \eta_8(t) + \eta_9(t) + \eta_{10}(t) + \eta_{P2}(t)) \alpha'(t) - R(t) \sin(\theta(t)) \theta'(t) + \cos(\alpha(t)) \\
& \quad \sin(\theta(t) + \psi(t)) (L_0 + \eta_6(t) + \eta_7(t) + \eta_8(t) + \eta_9(t) + \eta_{10}(t) + \eta_{P2}(t)) (\theta'(t) + \psi'(t)) - \\
& \quad \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) (\eta_6'(t) + \eta_7'(t) + \eta_8'(t) + \eta_9'(t) + \eta_{10}'(t) + \eta_{P2}'(t))) + \\
& 2 \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) (\theta'(t) + \psi'(t)) (\cos(\theta(t)) R'(t) + \\
& \quad \cos(\theta(t) + \psi(t)) \sin(\alpha(t)) (L_0 + \eta_6(t) + \eta_7(t) + \eta_8(t) + \eta_9(t) + \eta_{10}(t) + \eta_{P2}(t)) \alpha'(t) - \\
& \quad R(t) \sin(\theta(t)) \theta'(t) + \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) \\
& \quad (L_0 + \eta_6(t) + \eta_7(t) + \eta_8(t) + \eta_9(t) + \eta_{10}(t) + \eta_{P2}(t)) (\theta'(t) + \psi'(t)) - \\
& \quad \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) (\eta_6'(t) + \eta_7'(t) + \eta_8'(t) + \eta_9'(t) + \eta_{10}'(t) + \eta_{P2}'(t))) - \\
& 2 \cos(\alpha(t)) \alpha'(t) (-\cos(\alpha(t)) (L_0 + \eta_6(t) + \eta_7(t) + \eta_8(t) + \eta_9(t) + \eta_{10}(t) + \eta_{P2}(t)) \alpha'(t) - \\
& \quad \sin(\alpha(t)) (\eta_6'(t) + \eta_7'(t) + \eta_8'(t) + \eta_9'(t) + \eta_{10}'(t) + \eta_{P2}'(t))) + \\
& 2 \sin(\alpha(t)) \sin(\theta(t) + \psi(t)) \alpha'(t) (\sin(\theta(t)) R'(t) + \sin(\alpha(t)) \sin(\theta(t) + \psi(t)) (L_0 + \eta_6(t) + \\
& \quad \eta_7(t) + \eta_8(t) + \eta_9(t) + \eta_{10}(t) + \eta_{P2}(t)) \alpha'(t) + \cos(\theta(t)) R(t) \theta'(t) - \cos(\alpha(t)) \\
& \quad \cos(\theta(t) + \psi(t)) (L_0 + \eta_6(t) + \eta_7(t) + \eta_8(t) + \eta_9(t) + \eta_{10}(t) + \eta_{P2}(t)) (\theta'(t) + \psi'(t)) - \\
& \quad \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) (\eta_6'(t) + \eta_7'(t) + \eta_8'(t) + \eta_9'(t) + \eta_{10}'(t) + \eta_{P2}'(t))) - \\
& 2 \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) (\theta'(t) + \psi'(t)) (\sin(\theta(t)) R'(t) + \sin(\alpha(t)) \sin(\theta(t) + \psi(t)) \\
& \quad (L_0 + \eta_6(t) + \eta_7(t) + \eta_8(t) + \eta_9(t) + \eta_{10}(t) + \eta_{P2}(t)) \alpha'(t) + \cos(\theta(t)) R(t) \theta'(t) - \\
& \quad \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) (L_0 + \eta_6(t) + \eta_7(t) + \eta_8(t) + \eta_9(t) + \eta_{10}(t) + \eta_{P2}(t)) \\
& \quad (\theta'(t) + \psi'(t)) - \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) \\
& \quad (\eta_6'(t) + \eta_7'(t) + \eta_8'(t) + \eta_9'(t) + \eta_{10}'(t) + \eta_{P2}'(t))) - 2 \cos(\alpha(t)) \cos(\theta(t) + \psi(t))
\end{aligned}$$

$$\begin{aligned}
& \left( \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) (L_0 + \eta_6(t) + \eta_7(t) + \eta_8(t) + \eta_9(t) + \eta_{10}(t) + \eta_{P2}(t)) \alpha'(t)^2 - \right. \\
& \quad 2 \sin(\alpha(t)) \sin(\theta(t) + \psi(t)) (L_0 + \eta_6(t) + \eta_7(t) + \eta_8(t) + \eta_9(t) + \eta_{10}(t) + \eta_{P2}(t)) \\
& \quad \left( \theta'(t) + \psi'(t) \right) \alpha'(t) + 2 \cos(\theta(t) + \psi(t)) \sin(\alpha(t)) \\
& \quad \left( \eta_6'(t) + \eta_7'(t) + \eta_8'(t) + \eta_9'(t) + \eta_{10}'(t) + \eta_{P2}'(t) \right) \alpha'(t) - \cos(\theta(t)) R(t) \theta'(t)^2 + \\
& \quad \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) (L_0 + \eta_6(t) + \eta_7(t) + \eta_8(t) + \eta_9(t) + \eta_{10}(t) + \eta_{P2}(t)) \\
& \quad \left( \theta'(t) + \psi'(t) \right)^2 - 2 \sin(\theta(t)) R'(t) \theta'(t) + 2 \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) \left( \theta'(t) + \psi'(t) \right) \\
& \quad \left( \eta_6'(t) + \eta_7'(t) + \eta_8'(t) + \eta_9'(t) + \eta_{10}'(t) + \eta_{P2}'(t) \right) + \cos(\theta(t)) R''(t) + \\
& \quad \cos(\theta(t) + \psi(t)) \sin(\alpha(t)) (L_0 + \eta_6(t) + \eta_7(t) + \eta_8(t) + \eta_9(t) + \eta_{10}(t) + \eta_{P2}(t)) \alpha''(t) - \\
& \quad R(t) \sin(\theta(t)) \theta''(t) + \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) \\
& \quad (L_0 + \eta_6(t) + \eta_7(t) + \eta_8(t) + \eta_9(t) + \eta_{10}(t) + \eta_{P2}(t)) (\theta''(t) + \psi''(t)) - \\
& \quad \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) (\eta_6''(t) + \eta_7''(t) + \eta_8''(t) + \eta_9''(t) + \eta_{10}''(t) + \eta_{P2}''(t)) \Big) - \\
& \quad 2 \sin(\alpha(t)) \Big( \sin(\alpha(t)) (L_0 + \eta_6(t) + \eta_7(t) + \eta_8(t) + \eta_9(t) + \eta_{10}(t) + \eta_{P2}(t)) \alpha'(t)^2 - \\
& \quad 2 \cos(\alpha(t)) (\eta_6'(t) + \eta_7'(t) + \eta_8'(t) + \eta_9'(t) + \eta_{10}'(t) + \eta_{P2}'(t)) \alpha'(t) - \\
& \quad \cos(\alpha(t)) (L_0 + \eta_6(t) + \eta_7(t) + \eta_8(t) + \eta_9(t) + \eta_{10}(t) + \eta_{P2}(t)) \alpha''(t) - \sin(\alpha(t)) \\
& \quad (\eta_6''(t) + \eta_7''(t) + \eta_8''(t) + \eta_9''(t) + \eta_{10}''(t) + \eta_{P2}''(t)) \Big) - 2 \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) \\
& \quad \left( \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) (L_0 + \eta_6(t) + \eta_7(t) + \eta_8(t) + \eta_9(t) + \eta_{10}(t) + \eta_{P2}(t)) \alpha'(t)^2 + \right. \\
& \quad 2 \cos(\theta(t) + \psi(t)) \sin(\alpha(t)) (L_0 + \eta_6(t) + \eta_7(t) + \eta_8(t) + \eta_9(t) + \eta_{10}(t) + \eta_{P2}(t)) \\
& \quad \left( \theta'(t) + \psi'(t) \right) \alpha'(t) + 2 \sin(\alpha(t)) \sin(\theta(t) + \psi(t)) \\
& \quad \left( \eta_6'(t) + \eta_7'(t) + \eta_8'(t) + \eta_9'(t) + \eta_{10}'(t) + \eta_{P2}'(t) \right) \alpha'(t) - R(t) \sin(\theta(t)) \theta'(t)^2 + \\
& \quad \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) (L_0 + \eta_6(t) + \eta_7(t) + \eta_8(t) + \eta_9(t) + \eta_{10}(t) + \eta_{P2}(t)) \\
& \quad \left( \theta'(t) + \psi'(t) \right)^2 + 2 \cos(\theta(t)) R'(t) \theta'(t) - 2 \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) \left( \theta'(t) + \psi'(t) \right) \\
& \quad \left( \eta_6'(t) + \eta_7'(t) + \eta_8'(t) + \eta_9'(t) + \eta_{10}'(t) + \eta_{P2}'(t) \right) + \sin(\theta(t)) R''(t) + \\
& \quad \sin(\alpha(t)) \sin(\theta(t) + \psi(t)) (L_0 + \eta_6(t) + \eta_7(t) + \eta_8(t) + \eta_9(t) + \eta_{10}(t) + \eta_{P2}(t)) \alpha''(t) + \\
& \quad \cos(\theta(t)) R(t) \theta''(t) - \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) \\
& \quad (L_0 + \eta_6(t) + \eta_7(t) + \eta_8(t) + \eta_9(t) + \eta_{10}(t) + \eta_{P2}(t)) (\theta''(t) + \psi''(t)) - \\
& \quad \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) (\eta_6''(t) + \eta_7''(t) + \eta_8''(t) + \eta_9''(t) + \eta_{10}''(t) + \eta_{P2}''(t)) \Big) \Big) + \\
& \quad \left( \mu M_{P2} \left( 2 (L_0 + \eta_6(t) + \eta_7(t) + \eta_8(t) + \eta_9(t) + \eta_{10}(t) + \eta_{P2}(t)) \sin^2(\alpha(t)) - \right. \right. \\
& \quad 2 \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) (\cos(\theta(t)) R(t) - \\
& \quad \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) (L_0 + \eta_6(t) + \eta_7(t) + \eta_8(t) + \eta_9(t) + \eta_{10}(t) + \eta_{P2}(t))) - \\
& \quad 2 \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) (R(t) \sin(\theta(t)) - \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) \\
& \quad (L_0 + \eta_6(t) + \eta_7(t) + \eta_8(t) + \eta_9(t) + \eta_{10}(t) + \eta_{P2}(t))) \Big) \Big) / \\
& \quad \left( 2 \left( \sin^2(\alpha(t)) (L_0 + \eta_6(t) + \eta_7(t) + \eta_8(t) + \eta_9(t) + \eta_{10}(t) + \eta_{P2}(t))^2 + (\cos(\theta(t)) R(t) - \right. \right.
\end{aligned}$$

$$\begin{aligned} & \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) \left( L_0 + \eta_6(t) + \eta_7(t) + \eta_8(t) + \eta_9(t) + \eta_{10}(t) + \eta_{\mathbf{P}2}(t) \right)^2 + \\ & \left( R(t) \sin(\theta(t)) - \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) \left( L_0 + \eta_6(t) + \eta_7(t) + \eta_8(t) + \right. \right. \\ & \quad \left. \left. \eta_9(t) + \eta_{10}(t) + \eta_{\mathbf{P}2}(t) \right) \right)^2 \Big)^{3/2} = -c_0(\dot{\eta}_{10} - \dot{\eta}_{\mathbf{P}2}) \end{aligned}$$