

$$\begin{aligned}
& -\cos(\alpha(t)) \cos(\theta(t) + \psi(t)) m_0 \\
& \left(\cos(\theta(t)) R(t) + \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) \left(\frac{9 L_0}{10} + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) \right) \right) \\
& \zeta_1'(t)^2 - \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) M_{P1} \\
& (\cos(\theta(t)) R(t) + \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) (L_0 + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) + \eta_{P1}(t))) \\
& \zeta_{P1}'(t)^2 - \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) m_0 \\
& \left(\cos(\theta(t)) R(t) + \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) \left(\frac{9 L_0}{10} + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) \right) \right) \\
& \chi_1'(t)^2 - \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) M_{P1} \\
& (\cos(\theta(t)) R(t) + \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) (L_0 + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) + \eta_{P1}(t))) \\
& \chi_{P1}'(t)^2 + k_0 (\eta_1(t) - \eta_2(t)) - k_0 (\eta_{P1}(t) - \eta_1(t)) - \\
& \frac{1}{2} m_0 \left(2 (-\cos(\theta(t) + \psi(t)) \sin(\alpha(t)) \alpha'(t) - \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) (\theta'(t) + \psi'(t))) \right. \\
& \left(\cos(\theta(t)) R'(t) - \cos(\theta(t) + \psi(t)) \sin(\alpha(t)) \left(\frac{9 L_0}{10} + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) \right) \alpha'(t) - \right. \\
& \left. R(t) \sin(\theta(t)) \theta'(t) - \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) \left(\frac{9 L_0}{10} + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) \right) \right. \\
& \left. (\theta'(t) + \psi'(t)) + \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) (\eta_1'(t) + \eta_2'(t) + \eta_3'(t) + \eta_4'(t) + \eta_5'(t)) \right) \Bigg) + \\
& 2 \cos(\alpha(t)) \alpha'(t) \left(\cos(\alpha(t)) \left(\frac{9 L_0}{10} + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) \right) \alpha'(t) + \right. \\
& \left. \sin(\alpha(t)) (\eta_1'(t) + \eta_2'(t) + \eta_3'(t) + \eta_4'(t) + \eta_5'(t)) \right) \Bigg) + \\
& 2 (\cos(\alpha(t)) \cos(\theta(t) + \psi(t)) (\theta'(t) + \psi'(t)) - \sin(\alpha(t)) \sin(\theta(t) + \psi(t)) \alpha'(t)) \\
& \left(\sin(\theta(t)) R'(t) - \sin(\alpha(t)) \sin(\theta(t) + \psi(t)) \left(\frac{9 L_0}{10} + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) \right) \alpha'(t) + \right. \\
& \left. \cos(\theta(t)) R(t) \theta'(t) + \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) \left(\frac{9 L_0}{10} + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) \right) \right. \\
& \left. (\theta'(t) + \psi'(t)) + \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) (\eta_1'(t) + \eta_2'(t) + \eta_3'(t) + \eta_4'(t) + \eta_5'(t)) \right) \Bigg) - \\
& \frac{1}{2} M_{P1} \left(2 (-\cos(\theta(t) + \psi(t)) \sin(\alpha(t)) \alpha'(t) - \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) (\theta'(t) + \psi'(t))) \right. \\
& \left. (\cos(\theta(t)) R'(t) - \cos(\theta(t) + \psi(t)) \sin(\alpha(t)) (L_0 + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) + \eta_{P1}(t))) \right)
\end{aligned}$$

$$\begin{aligned}
& \alpha'(t) - R(t) \sin(\theta(t)) \theta'(t) - \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) \\
& \quad (L_0 + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) + \eta_{P1}(t)) (\theta'(t) + \psi'(t)) + \\
& \quad \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) (\eta_1'(t) + \eta_2'(t) + \eta_3'(t) + \eta_4'(t) + \eta_5'(t) + \eta_{P1}'(t)) + \\
& 2 \cos(\alpha(t)) \alpha'(t) (\cos(\alpha(t)) (L_0 + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) + \eta_{P1}(t)) \alpha'(t) + \\
& \quad \sin(\alpha(t)) (\eta_1'(t) + \eta_2'(t) + \eta_3'(t) + \eta_4'(t) + \eta_5'(t) + \eta_{P1}'(t))) + \\
& 2 (\cos(\alpha(t)) \cos(\theta(t) + \psi(t)) (\theta'(t) + \psi'(t)) - \sin(\alpha(t)) \sin(\theta(t) + \psi(t)) \alpha'(t)) \\
& \quad (\sin(\theta(t)) R'(t) - \sin(\alpha(t)) \sin(\theta(t) + \psi(t)) (L_0 + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) + \eta_{P1}(t)) \\
& \quad \alpha'(t) + \cos(\theta(t)) R(t) \theta'(t) + \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) \\
& \quad (L_0 + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) + \eta_{P1}(t)) (\theta'(t) + \psi'(t)) + \\
& \quad \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) (\eta_1'(t) + \eta_2'(t) + \eta_3'(t) + \eta_4'(t) + \eta_5'(t) + \eta_{P1}'(t)))) + \\
& \frac{1}{2} m_0 \left(-2 \cos(\theta(t) + \psi(t)) \sin(\alpha(t)) \alpha'(t) \left(\cos(\theta(t)) R'(t) - \cos(\theta(t) + \psi(t)) \sin(\alpha(t)) \right. \right. \\
& \quad \left. \left(\frac{9 L_0}{10} + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) \right) \alpha'(t) - R(t) \sin(\theta(t)) \theta'(t) - \right. \\
& \quad \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) \left(\frac{9 L_0}{10} + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) \right) (\theta'(t) + \psi'(t)) + \\
& \quad \left. \left. \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) (\eta_1'(t) + \eta_2'(t) + \eta_3'(t) + \eta_4'(t) + \eta_5'(t)) \right) \right) - \\
& 2 \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) (\theta'(t) + \psi'(t)) \left(\cos(\theta(t)) R'(t) - \cos(\theta(t) + \psi(t)) \sin(\alpha(t)) \right. \\
& \quad \left. \left(\frac{9 L_0}{10} + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) \right) \alpha'(t) - R(t) \sin(\theta(t)) \theta'(t) - \right. \\
& \quad \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) \left(\frac{9 L_0}{10} + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) \right) (\theta'(t) + \psi'(t)) + \\
& \quad \left. \left. \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) (\eta_1'(t) + \eta_2'(t) + \eta_3'(t) + \eta_4'(t) + \eta_5'(t)) \right) \right) + \\
& 2 \cos(\alpha(t)) \alpha'(t) \left(\cos(\alpha(t)) \left(\frac{9 L_0}{10} + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) \right) \alpha'(t) + \right. \\
& \quad \left. \sin(\alpha(t)) (\eta_1'(t) + \eta_2'(t) + \eta_3'(t) + \eta_4'(t) + \eta_5'(t)) \right) - 2 \sin(\alpha(t)) \sin(\theta(t) + \psi(t)) \alpha'(t) \\
& \quad \left(\sin(\theta(t)) R'(t) - \sin(\alpha(t)) \sin(\theta(t) + \psi(t)) \left(\frac{9 L_0}{10} + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) \right) \alpha'(t) + \right. \\
& \quad \left. \cos(\theta(t)) R(t) \theta'(t) + \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) \left(\frac{9 L_0}{10} + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) \right) \right)
\end{aligned}$$

$$\begin{aligned}
& \left(\theta'(t) + \psi'(t) \right) + \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) \left(\eta_1'(t) + \eta_2'(t) + \eta_3'(t) + \eta_4'(t) + \eta_5'(t) \right) \Bigg) + \\
& 2 \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) \left(\theta'(t) + \psi'(t) \right) \left(\sin(\theta(t)) R'(t) - \sin(\alpha(t)) \sin(\theta(t) + \psi(t)) \right. \\
& \quad \left(\frac{9L_0}{10} + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) \right) \alpha'(t) + \cos(\theta(t)) R(t) \theta'(t) + \\
& \quad \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) \left(\frac{9L_0}{10} + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) \right) \left(\theta'(t) + \psi'(t) \right) + \\
& \quad \left. \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) \left(\eta_1'(t) + \eta_2'(t) + \eta_3'(t) + \eta_4'(t) + \eta_5'(t) \right) \right) \Bigg) + \\
& 2 \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) \left(-\cos(\alpha(t)) \cos(\theta(t) + \psi(t)) \right. \\
& \quad \left(\frac{9L_0}{10} + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) \right) \alpha'(t)^2 + 2 \sin(\alpha(t)) \sin(\theta(t) + \psi(t)) \\
& \quad \left(\frac{9L_0}{10} + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) \right) \left(\theta'(t) + \psi'(t) \right) \alpha'(t) - 2 \cos(\theta(t) + \psi(t)) \\
& \quad \sin(\alpha(t)) \left(\eta_1'(t) + \eta_2'(t) + \eta_3'(t) + \eta_4'(t) + \eta_5'(t) \right) \alpha'(t) - \cos(\theta(t)) R(t) \theta'(t)^2 - \\
& \quad \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) \left(\frac{9L_0}{10} + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) \right) \left(\theta'(t) + \psi'(t) \right)^2 - \\
& \quad 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_1'(t) + \eta_2'(t) + \eta_3'(t) + \eta_4'(t) + \eta_5'(t) \right) + \cos(\theta(t)) R''(t) - \cos(\theta(t) + \psi(t)) \\
& \quad \sin(\alpha(t)) \left(\frac{9L_0}{10} + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) \right) \alpha''(t) - R(t) \sin(\theta(t)) \theta''(t) - \\
& \quad \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) \left(\frac{9L_0}{10} + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) \right) \left(\theta''(t) + \psi''(t) \right) + \\
& \quad \left. \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) \left(\eta_1''(t) + \eta_2''(t) + \eta_3''(t) + \eta_4''(t) + \eta_5''(t) \right) \right) \Bigg) + \\
& 2 \sin(\alpha(t)) \left(-\sin(\alpha(t)) \left(\frac{9L_0}{10} + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) \right) \alpha'(t)^2 + \right. \\
& \quad 2 \cos(\alpha(t)) \left(\eta_1'(t) + \eta_2'(t) + \eta_3'(t) + \eta_4'(t) + \eta_5'(t) \right) \alpha'(t) + \\
& \quad \left. \cos(\alpha(t)) \left(\frac{9L_0}{10} + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) \right) \alpha''(t) + \right.
\end{aligned}$$

$$\begin{aligned}
& \sin(\alpha(t)) (\eta_1''(t) + \eta_2''(t) + \eta_3''(t) + \eta_4''(t) + \eta_5''(t)) \Bigg) + 2 \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) \\
& \left(-\cos(\alpha(t)) \sin(\theta(t) + \psi(t)) \left(\frac{9L_0}{10} + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) \right) \alpha'(t)^2 - \right. \\
& 2 \cos(\theta(t) + \psi(t)) \sin(\alpha(t)) \left(\frac{9L_0}{10} + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) \right) (\theta'(t) + \psi'(t)) \\
& \alpha'(t) - 2 \sin(\alpha(t)) \sin(\theta(t) + \psi(t)) (\eta_1'(t) + \eta_2'(t) + \eta_3'(t) + \eta_4'(t) + \eta_5'(t)) \alpha'(t) - R(t) \\
& \sin(\theta(t)) \theta'(t)^2 - \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) \left(\frac{9L_0}{10} + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) \right) \\
& (\theta'(t) + \psi'(t))^2 + 2 \cos(\theta(t)) R'(t) \theta'(t) + 2 \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) (\theta'(t) + \psi'(t)) \\
& (\eta_1'(t) + \eta_2'(t) + \eta_3'(t) + \eta_4'(t) + \eta_5'(t)) + \sin(\theta(t)) R''(t) - \sin(\alpha(t)) \sin(\theta(t) + \psi(t)) \\
& \left(\frac{9L_0}{10} + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) \right) \alpha''(t) + \cos(\theta(t)) R(t) \theta''(t) + \\
& \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) \left(\frac{9L_0}{10} + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) \right) (\theta''(t) + \psi''(t)) + \\
& \left. \left. \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) (\eta_1''(t) + \eta_2''(t) + \eta_3''(t) + \eta_4''(t) + \eta_5''(t)) \right) \right) \Bigg) + \\
& \frac{1}{2} M_{P1} \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)) \right. \\
& (L_0 + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) + \eta_{P1}(t)) \alpha'(t) - R(t) \sin(\theta(t)) \theta'(t) - \cos(\alpha(t)) \\
& \sin(\theta(t) + \psi(t)) (L_0 + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) + \eta_{P1}(t)) (\theta'(t) + \psi'(t)) + \\
& \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) (\eta_1'(t) + \eta_2'(t) + \eta_3'(t) + \eta_4'(t) + \eta_5'(t) + \eta_{P1}'(t)) \Bigg) - \\
& 2 \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) (\theta'(t) + \psi'(t)) (\cos(\theta(t)) R'(t) - \cos(\theta(t) + \psi(t)) \sin(\alpha(t)) \\
& (L_0 + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) + \eta_{P1}(t)) \alpha'(t) - R(t) \sin(\theta(t)) \theta'(t) - \cos(\alpha(t)) \\
& \sin(\theta(t) + \psi(t)) (L_0 + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) + \eta_{P1}(t)) (\theta'(t) + \psi'(t)) + \\
& \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) (\eta_1'(t) + \eta_2'(t) + \eta_3'(t) + \eta_4'(t) + \eta_5'(t) + \eta_{P1}'(t)) \Bigg) + \\
& 2 \cos(\alpha(t)) \alpha'(t) (\cos(\alpha(t)) (L_0 + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) + \eta_{P1}(t)) \alpha'(t) + \\
& \sin(\alpha(t)) (\eta_1'(t) + \eta_2'(t) + \eta_3'(t) + \eta_4'(t) + \eta_5'(t) + \eta_{P1}'(t)) \Bigg) - \\
& 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_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) + \eta_{P1}(t)) \alpha'(t) + \cos(\theta(t)) R(t) \theta'(t) + \cos(\alpha(t)) \\
& \cos(\theta(t) + \psi(t)) (L_0 + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) + \eta_{P1}(t)) (\theta'(t) + \psi'(t)) + \\
& \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) (\eta_1'(t) + \eta_2'(t) + \eta_3'(t) + \eta_4'(t) + \eta_5'(t) + \eta_{P1}'(t)) \Bigg) + \\
& 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)) \\
& (L_0 + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) + \eta_{P1}(t)) \alpha'(t) + \cos(\theta(t)) R(t) \theta'(t) + \cos(\alpha(t))
\end{aligned}$$

$$\begin{aligned}
& \cos(\theta(t) + \psi(t)) (L_0 + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) + \eta_{P1}(t)) (\theta'(t) + \psi'(t)) + \\
& \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) (\eta_1'(t) + \eta_2'(t) + \eta_3'(t) + \eta_4'(t) + \eta_5'(t) + \eta_{P1}'(t)) + 2 \cos(\alpha(t)) \\
& \cos(\theta(t) + \psi(t)) \left(-\cos(\alpha(t)) \cos(\theta(t) + \psi(t)) (L_0 + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) + \eta_{P1}(t)) \right. \\
& \quad \alpha'(t)^2 + 2 \sin(\alpha(t)) \sin(\theta(t) + \psi(t)) (L_0 + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) + \eta_{P1}(t)) \\
& \quad (\theta'(t) + \psi'(t)) \alpha'(t) - 2 \cos(\theta(t) + \psi(t)) \sin(\alpha(t)) \\
& \quad (\eta_1'(t) + \eta_2'(t) + \eta_3'(t) + \eta_4'(t) + \eta_5'(t) + \eta_{P1}'(t)) \alpha'(t) - \cos(\theta(t)) R(t) \theta'(t)^2 - \\
& \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) (L_0 + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) + \eta_{P1}(t)) \\
& \quad (\theta'(t) + \psi'(t))^2 - 2 \sin(\theta(t)) R'(t) \theta'(t) - 2 \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) (\theta'(t) + \psi'(t)) \\
& \quad (\eta_1'(t) + \eta_2'(t) + \eta_3'(t) + \eta_4'(t) + \eta_5'(t) + \eta_{P1}'(t)) + \cos(\theta(t)) R''(t) - \\
& \cos(\theta(t) + \psi(t)) \sin(\alpha(t)) (L_0 + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) + \eta_{P1}(t)) \alpha''(t) - \\
& R(t) \sin(\theta(t)) \theta''(t) - \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) \\
& \quad (L_0 + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) + \eta_{P1}(t)) (\theta''(t) + \psi''(t)) + \\
& \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) (\eta_1''(t) + \eta_2''(t) + \eta_3''(t) + \eta_4''(t) + \eta_5''(t) + \eta_{P1}''(t)) \Big) + \\
& 2 \sin(\alpha(t)) \left(-\sin(\alpha(t)) (L_0 + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) + \eta_{P1}(t)) \alpha'(t)^2 + \right. \\
& \quad 2 \cos(\alpha(t)) (\eta_1'(t) + \eta_2'(t) + \eta_3'(t) + \eta_4'(t) + \eta_5'(t) + \eta_{P1}'(t)) \alpha'(t) + \\
& \cos(\alpha(t)) (L_0 + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) + \eta_{P1}(t)) \alpha''(t) + \sin(\alpha(t)) \\
& \quad (\eta_1''(t) + \eta_2''(t) + \eta_3''(t) + \eta_4''(t) + \eta_5''(t) + \eta_{P1}''(t)) \Big) + 2 \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) \\
& \left(-\cos(\alpha(t)) \sin(\theta(t) + \psi(t)) (L_0 + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) + \eta_{P1}(t)) \alpha'(t)^2 - \right. \\
& \quad 2 \cos(\theta(t) + \psi(t)) \sin(\alpha(t)) (L_0 + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) + \eta_{P1}(t)) \\
& \quad (\theta'(t) + \psi'(t)) \alpha'(t) - 2 \sin(\alpha(t)) \sin(\theta(t) + \psi(t)) \\
& \quad (\eta_1'(t) + \eta_2'(t) + \eta_3'(t) + \eta_4'(t) + \eta_5'(t) + \eta_{P1}'(t)) \alpha'(t) - R(t) \sin(\theta(t)) \theta'(t)^2 - \\
& \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) (L_0 + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) + \eta_{P1}(t)) \\
& \quad (\theta'(t) + \psi'(t))^2 + 2 \cos(\theta(t)) R'(t) \theta'(t) + 2 \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) (\theta'(t) + \psi'(t)) \\
& \quad (\eta_1'(t) + \eta_2'(t) + \eta_3'(t) + \eta_4'(t) + \eta_5'(t) + \eta_{P1}'(t)) + \sin(\theta(t)) R''(t) - \\
& \sin(\alpha(t)) \sin(\theta(t) + \psi(t)) (L_0 + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) + \eta_{P1}(t)) \alpha''(t) + \\
& \cos(\theta(t)) R(t) \theta''(t) + \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) \\
& \quad (L_0 + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) + \eta_{P1}(t)) (\theta''(t) + \psi''(t)) + \\
& \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) (\eta_1''(t) + \eta_2''(t) + \eta_3''(t) + \eta_4''(t) + \eta_5''(t) + \eta_{P1}''(t)) \Big) \Big) + \\
& \left(\mu m_0 \left(2 \left(\frac{9 L_0}{10} + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) \right) \sin^2(\alpha(t)) + 2 \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) \right. \right. \\
& \quad \left. \left(\cos(\theta(t)) R(t) + \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) \left(\frac{9 L_0}{10} + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) \right) \right) \right) + \\
& \quad \left. 2 \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) \right)
\end{aligned}$$

$$\begin{aligned}
& \left(R(t) \sin(\theta(t)) + \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) \left(\frac{9 L_0}{10} + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) \right) \right) \Bigg) \Bigg) \Bigg) \Bigg) / \\
& \left(2 \left(\sin^2(\alpha(t)) \left(\frac{9 L_0}{10} + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) \right)^2 + \left(\cos(\theta(t)) R(t) + \cos(\alpha(t)) \cos(\right. \right. \right. \\
& \quad \left. \left. \left. \theta(t) + \psi(t)) \left(\frac{9 L_0}{10} + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) \right) \right)^2 + \left(R(t) \sin(\theta(t)) + \right. \right. \right. \\
& \quad \left. \left. \left. \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) \left(\frac{9 L_0}{10} + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) \right) \right)^2 \right)^{3/2} \right) + \\
& \left(\mu M_{P1} \left(2 \left(L_0 + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) + \eta_{P1}(t) \right) \sin^2(\alpha(t)) + \right. \right. \\
& \quad \left. \left. 2 \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) \left(\cos(\theta(t)) R(t) + \right. \right. \right. \\
& \quad \left. \left. \left. \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) \left(L_0 + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) + \eta_{P1}(t) \right) \right) + \right. \right. \\
& \quad \left. \left. 2 \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) \left(R(t) \sin(\theta(t)) + \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) \right. \right. \right. \\
& \quad \left. \left. \left. \left(L_0 + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) + \eta_{P1}(t) \right) \right) \right) \right) \Bigg) \Bigg) / \\
& \left(2 \left(\sin^2(\alpha(t)) \left(L_0 + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) + \eta_{P1}(t) \right)^2 + \left(\cos(\theta(t)) R(t) + \right. \right. \right. \\
& \quad \left. \left. \cos(\alpha(t)) \cos(\theta(t) + \psi(t)) \left(L_0 + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \eta_5(t) + \eta_{P1}(t) \right) \right)^2 + \right. \\
& \quad \left. \left(R(t) \sin(\theta(t)) + \cos(\alpha(t)) \sin(\theta(t) + \psi(t)) \left(L_0 + \eta_1(t) + \eta_2(t) + \eta_3(t) + \eta_4(t) + \right. \right. \right. \\
& \quad \left. \left. \left. \eta_5(t) + \eta_{P1}(t) \right) \right)^2 \right)^{3/2} \Bigg) = c_0(\dot{\eta}_{P1} - \dot{\eta}_1) - c_0(\dot{\eta}_1 - \dot{\eta}_2)
\end{aligned}$$