Problème de contrôle optimal multiphase

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0.1 General Problem

Control : $u = (u_1, u_2, u_3)^T$
State : $X = (x, y, z, \dot{x}, \dot{y}, \dot{z}, m)^T$
Dynamic : $\dot{X} = F_0(X) + \frac{T_{max}}{m} \sum_{i=1}^{3} u_i F_i - T_{max}\beta ||u(t)|| F_4$

Final/Initial conditions :

- q_{rdv} = state of a point aloung a choosen TCO's orbit.
- θ_{rdv} = corresponding anomaly of the Sun when TCO is at q_{rdv}

  Δv -minimal transfert from $\mathcal{O}_H$ (= Halo of orbit L_2) to q_{rdv} leads to solve the OCP :

$$(OCP)_1 \begin{cases} \dot{X} = F_0(X) + \frac{T_{max}}{m} \sum_{i=1}^{3} u_i F_i - T_{max}\beta ||u(t)|| F_4 \\ min \displaystyle\int_0^{t_f} ||u(t)|| dt \\ q(0) \in \mathcal{O}_H \\ m(0) = m_0 \\ q(t_f) = q_{rdv} \\ \theta(t_f) = \theta_{rdv} \end{cases}$$

Let's note $Z = (X, P)$.
Shooting equations are as follows :

$$\begin{aligned} S : \mathbb{R}^{15} &\to \mathbb{R}^9 \\ (t_f, Z(0))^T &\mapsto \begin{pmatrix} q(t_f) - q_{rdv} \\ p_m(t_f) \\ P_q(0) \perp T_{q(0)}\mathcal{O}_H \\ H_r(P(t_f), X(t_f), \bullet) \end{pmatrix} \end{aligned}$$