Reactor Physics

Burnup

March 1, 2021

$$\frac{dN_{U235}}{dt} = -\sigma_{a,U235}N_{U235}(t)\phi(t) - \sigma_{f,U235}N_{U235}(t)\phi(t) \tag{1}$$

$$\frac{dN_{U238}}{dt} = -\sigma_{a,U238}N_{U238}(t)\phi(t) \tag{2}$$

$$\begin{aligned}\frac{dN_{Pu239}}{dt} =& -\sigma_{a,Pu239}N_{Pu239}(t)\phi(t) - \sigma_{f,Pu239}N_{Pu239}(t)\phi(t) \\ &+ \sigma_{a,U238}N_{U238}(t)\phi(t)\end{aligned} \tag{3}$$

$$\begin{aligned}\frac{dN_{Xe135}}{dt} =& -\sigma_{a,Xe135}N_{Xe135}(t)\phi(t) - \lambda_{Xe135} \\ &+ \gamma_{Xe135}\sigma_{f,U235}N_{U235}(t)\phi(t) \\ &+ \gamma_{Xe135}\sigma_{f,Pu239}N_{Pu239}(t)\phi(t)\end{aligned} \tag{4}$$

$$\begin{aligned}\frac{dN_{FP}}{dt} =&(2-\gamma_{Xe135})\sigma_{f,U235}N_{U235}(t)\phi(t) \\ &+ (2-\gamma_{Xe135})\sigma_{f,Pu239}N_{Pu239}(t)\phi(t)\end{aligned} \tag{5}$$

Matrix:

$$A = \begin{bmatrix} -\sigma_{a,U235}\phi(t) - \sigma_{f,U235}\phi(t) & 0 & 0 & 0 \\ 0 & -\sigma_{a,U238}\phi(t) & 0 & 0 \\ 0 & \sigma_{a,U238}\phi(t) & -\sigma_{a,Pu239}\phi(t) - \sigma_{f,Pu239}\phi(t) & 0 \\ \gamma_{Xe135}\sigma_{f,U235}\phi(t) & 0 & \gamma_{Xe135}\sigma_{f,Pu239}\phi(t) & -\sigma_{a,Xe135}\phi(t) - \lambda_{Xe135} \end{bmatrix} \tag{6}$$