$$\begin{pmatrix} 1+\lambda_{12C}\Delta t\,\gamma_{12C} & \lambda_{12C}\Delta t\,\gamma_{1H} & 0 \\ \lambda_{12C}\gamma_{12C}\Delta t & 1+\lambda_{12C}\Delta t\,\gamma_{1H} & 0 \\ -\lambda_{12C}\Delta t\,\gamma_{12C} & -\lambda_{12C}\Delta t\,\gamma_{1H} & +1 \end{pmatrix} \begin{pmatrix} \Delta\gamma_{1H} \\ \Delta\gamma_{12C} \\ \Delta\gamma_{13N} \end{pmatrix} = \begin{pmatrix} -\lambda_{12C}\gamma_{12C}\gamma_{1H} \\ -\lambda_{12C}\gamma_{12C}\gamma_{1H} \\ +\lambda_{12C}\gamma_{12C}\gamma_{1H} \end{pmatrix} \Delta t$$

divide by Δt

GENERALLY MULTIPLE HEAVY ION REACTIONS FEW

(RECALL BUDDING STAGES)

$^{12}C + {}^{12}C$ ... $^{12}C + {}^{16}O$, $^{16}O + {}^{16}O$ ...

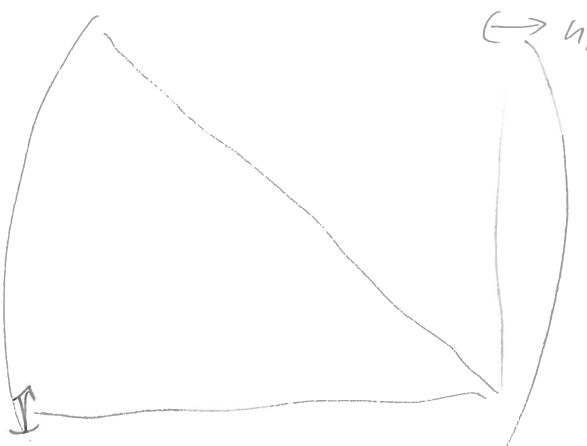
most are (x, y) with $x, y \in \{\gamma, n, p, \alpha, e^+, \nu$

→ STRUCTURE

→ SPARSE MATRIX

FOR PRACTICAL PURPOSE: PUT FULL COLUMNS TO END OF MATRIX (VECTOR OF ISOTOPES)

↔ n, p, α



(for LU DECOMPOSITION)

LET'S TRY: ^{4}He BURN REACTIONS $3\alpha \rightarrow {}^{12}C(\alpha,\gamma)$

• CNO CYCLE ?