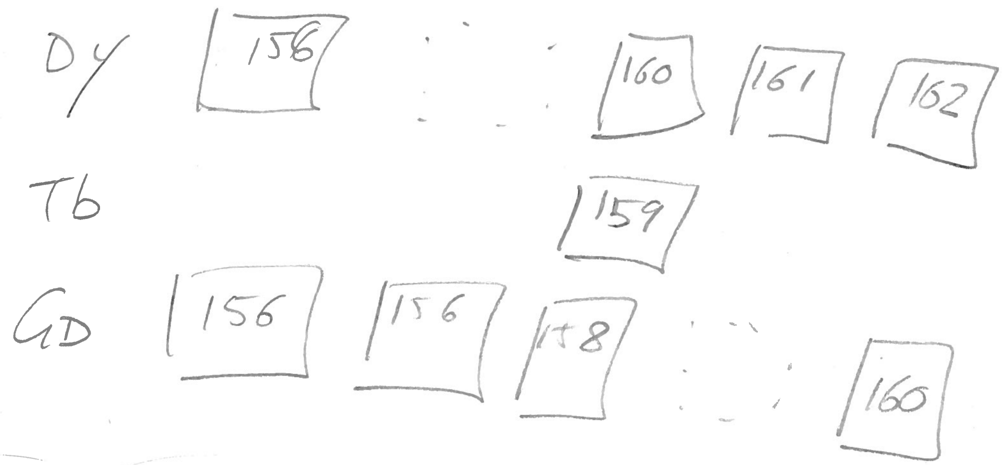
S-process



$\tau_\beta \ll \tau_{n\gamma}$, $\tau_\beta \gg \tau_{STAR/BURN}$

typical cross section @ $kT \sim 30$ keV

$$\langle\sigma\rangle_T \simeq \frac{\langle\sigma v\rangle}{v_T} \simeq 100 \text{ mb}$$

for $a \sim 60-200$

$$v_T \simeq \sqrt{2kT/m_a} \simeq 2.6 \times 10^8 \text{ cm/s}$$

typical: $\tau_{n\gamma} \gtrsim 10$ yr

$$\rightarrow N_n \sim \left(\tau_{n\gamma} \cdot \langle\sigma v\rangle_{n\gamma}\right)^{-1} \simeq 10^8 \text{ cm}^{-3}$$

S-proc end @ ^{209}Bi

→ can not make Th, U!

STAB ↙

$$\frac{dN_S(A)}{dt} = -N_n(t) \cdot N_S(A) \langle \sigma v \rangle_A + N_n(t) N_S(A-1) \langle \sigma v \rangle_{A-1}$$

$\Big[\langle \sigma v \rangle_A \longrightarrow \langle \sigma \rangle_A v_T$ MACS

$$= v_T N_n(t) \Big[-N_S(A) \langle \sigma_A \rangle + N_S(A-1) \langle \sigma \rangle_{A-1}$$

Neutron Flux $\phi = \frac{2}{\sqrt{\pi}} N_n v_T$ for thermal M-B neutrons

Neutron Exposure

$$\tau = v_T \int N_n(t)\, dt \rightarrow d\tau = \underbrace{v_T N_n(t)}_{\frac{\sqrt{\pi}}{2} \cdot \phi} dt$$

$$\frac{dN_S(A,\tau)}{d\tau} N_n(t) v_T =$$

$$v_T N_n(t) \left[-N_S(A,\tau) \langle\sigma\rangle_A + N_S(A-1,\tau) \langle\sigma\rangle_{A-1} \right.$$

$$\frac{dN_S(A,\tau)}{d\tau} = -N_S(A,\tau)\langle\sigma\rangle_A + N_S(A-1,\tau)\langle\sigma\rangle_{A-1}$$

$$\frac{dN_S}{d\tau} < 0 \quad \text{FOR} \quad N_S(A,\tau) > \left[\langle\sigma\rangle_{A-1} / \langle\sigma_A\rangle\right] N_S(A-1,\tau)$$

$$> 0 \qquad\qquad <$$

→ ABUNDANCES BUILD UP UNTIL EQU. IS REACHED

IN STEADY STATE:

$$N_S(A,\tau)\langle\sigma_A\rangle \simeq N_S(A-1)\langle\sigma\rangle_{A-1}$$

$$N_S(A,\tau)\langle\sigma\rangle_A \simeq \text{CONST.}\,!$$