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3.

a). delay group k에서의 the source density of the precursor production

$$S_{dk} = \sum_i \int_0^\infty \nu_{dki} \Sigma_{fi} \phi \, dE'$$

i : isotope ν_{dki} : isotope i에 대한 delay group k의 fission당 precursor production rate.

Σ_{fi} : i의 fission cross-section

$\Sigma_{fi} = \Sigma_{fi}(\vec{r}, E')$

$\phi = \phi(\vec{r}, E', t)$

∘ average macroscopic $\nu_d \Sigma_f$

$$\nu_{dk} \Sigma_f = \sum_i \nu_{dki} \Sigma_{fi}$$

$$\nu_d \Sigma_f = \sum_k \nu_{dk} \Sigma_f$$

b) $$\frac{d C_k(\vec{r},t)}{dt} = \sum_i \int_0^\infty \nu_{dki} \Sigma_{fi}(\vec{r}, E') \phi(\vec{r}, E, t) \, dE' - \lambda_k C_k(\vec{r},t)$$

c) precursor decay const가 isotop에 의존하면 $C_k(\vec{r},t)$도 mixture에 포함된 isotopes의 함수로 표현된다.

즉 b)의 결과식은

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$$\frac{dC_k^*(\vec{r},t)}{dt} = \sum_i \int_0^\infty \nu_{dki} \Sigma_{fi} \phi \, dE' - \lambda_k^* C_k^*(\vec{r},t)$$

이다.

λ가 mixture, 조성에 따라 변화하면

λ_k^*은 $\vec{r}$, t dep't 하다.

따라서

윗 식은

$$\frac{dC_k^*(\vec{r},t)}{dt} = \sum_i \int_0^\infty \nu_{dki} \Sigma_{fi} \phi \, dE' - \lambda_k^*(\vec{r},t) C_k^*(\vec{r},t)$$

가 된다.

energy에 따라서 변화 하면

$$\frac{dC_k^*(\vec{r},t)}{dt} = \sum_i \int_0^\infty \nu_{dki} \Sigma_{fi} \phi \, dE' - \lambda_k^*(\vec{r},E,t) C_k^*(\vec{r},E,t)$$

가 된다.

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Chap3.

1. $\bar{v} = \dfrac{\int v \psi(E) dE}{\underbrace{\int \psi(E) dE}_{1\ (\text{normalized})}} = \int_0^\infty \sqrt{\frac{2E}{m}} \cdot \frac{E}{kT} \exp(-E/kT) \frac{dE}{kT}$

(where. $E = \frac{1}{2} m v^2 \quad v = \sqrt{\frac{2E}{m}}$).

let $\frac{E}{kT} = x$.

then 준식 $= \int_0^\infty \sqrt{\frac{2kT}{m}}\, x^{3/2} e^{-x} dx$

$= \sqrt{\frac{2kT}{m}} \left(\frac{3}{2}\right)! = \sqrt{\frac{2kT}{m}} \cdot \frac{3}{2} \cdot \frac{1}{2}\sqrt{\pi}$

$= \frac{3}{4}\sqrt{\frac{2\pi kT}{m}}$

$= \frac{3}{4}\sqrt{\frac{2\pi \times 1.38 \times 10^{-16} \times 10^{-7}\, \cancel{kg}\, m^2/s^2 \cdot \cancel{K} \times 900\cancel{K}}{1.67 \times 10^{-27}\, \cancel{kg}}}$

$\therefore \bar{v} \cong 5126.89\ m/s$

$\therefore \Lambda = \dfrac{1}{\bar{v} \nu \Sigma_f} = \dfrac{1}{5126.89 m/s \times 0.3 \times 10^{+2}/m}$

$\cong 0.065 \times 10^{-4}\ sec$

2.

a) for φ_1; normalize!

$$\int_{0.2ev}^{2MeV} a/_E \, dE = 1.$$

$$\therefore \quad a \ln \frac{2\times10^6}{0.2} = 1 \qquad a \cong 0.062.$$

for φ_2;

$$\int_0^\infty b \frac{E}{KT} \exp(-E/KT) \frac{dE}{KT}$$

$$= b \int_0^\infty x e^{-x} dx = b = 1$$

b)

$$\therefore \bar{v}_1 = 0.062 \int_{0.2ev}^{2MeV} \frac{v}{E} dE = 0.062 \int_{0.2ev}^{2MeV} \frac{1}{E}\sqrt{\frac{2E}{m}} c$$

$$= 0.062 \times \int_{0.2ev}^{2MeV} \sqrt{\frac{2}{m}} \frac{1}{\sqrt{E}} dE$$

$$= 0.062 \cdot \sqrt{\frac{2}{m}} \cdot 2 \cdot \sqrt{E} \Big|_{0.2ev}^{2MeV}$$

$$m = m_n \cong \underbrace{0.511 \text{ MeV}}_{\text{전자 정지질량}} \times 1840 \, /c^2$$

$$\therefore \bar{v}_1 = 0.062 \times \sqrt{\frac{2\times(3\times10^8 m/s)^2}{0.511 MeV \times 1840}} \times 2 \times (\sqrt{2MeV} - \sqrt{0.2}$$

$$\cong 2425.6 \text{ km/s}.$$

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마찬가지로

$$\bar{v}_2 = \int_0^\infty \frac{E}{(kT)^2} \exp(-E/kT)\sqrt{\frac{2E}{m}}\, dE$$

$$\cong 5127 \ m/s$$

$$\frac{1}{\bar{v}_1} = 0.062 \int_{0.2eV}^{2MeV} \frac{1}{E} \cdot \sqrt{\frac{m}{2E}}\, dE$$

$$= 0.062 \cdot \sqrt{\frac{m}{2}} \int_{0.2eV}^{2MeV} \frac{1}{E^{3/2}}\, dE$$

$$= 0.062 \cdot \sqrt{\frac{m}{2}} \left[-2 \frac{1}{\sqrt{E}}\right]_{0.2eV}^{2MeV}$$

$$m = m_n \cong \underbrace{0.511MeV}_{\text{전자 정지 질량}} \times 1840 \ /c^2 \qquad c : 3\times10^8 m/s$$

$$\therefore \frac{1}{\bar{v}_1} = 0.062 \times 2 \times \sqrt{\frac{0.511MeV \times 1840}{2\times(3\times10^8 m/s)^2}} \times \left(\frac{1}{\sqrt{0.2\times10^{-6} MeV}} - \frac{1}{\sqrt{2\ldots}}\right.$$

$$= 2.003\times10^{-5} \ (m/s)^{-1}$$

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마찬가지로

$$\frac{1}{\bar{v}_2} = \int_0^\infty \frac{E}{(kT)^2} \exp(-E/kT) \sqrt{\frac{m}{2E}}\, dE$$

$$= \int_0^\infty \sqrt{\frac{m}{2kT}}\, x^{1/2} e^{-x} dx = \sqrt{\frac{m}{2kT}} \cdot \left(\frac{1}{2}\right)$$

$$= \sqrt{\frac{m}{2kT}} \cdot \frac{1}{2}\sqrt{\pi} = 2.2979 \times 10^{-4} (m/s)^{-1}$$

c)

$$\frac{1}{\bar{v}} = \frac{\int \frac{1}{v_1}\varphi_1 dE + \int \frac{1}{v_2}\varphi_2 dE}{\int_{0.2eV}^{2MeV} \varphi_1 dE + \int_0^\infty \varphi_2 dE}$$

$$\begin{pmatrix} m \cong 1.67 \times 10 \\ k = 1.38 \times 10 \\ T = 900k \end{pmatrix}$$

$$= \frac{1}{2}\left(\frac{1}{\bar{v}_1} + \frac{1}{\bar{v}_2}\right)$$

$$\bar{v} = \frac{\bar{v}_1 \int_{0.2eV}^{2MeV} \varphi_1 dE + \bar{v}_2 \int_0^\infty \varphi_2 dE}{\int_{0.2eV}^{2MeV} \varphi_1 dE + \int_0^\infty \varphi_2 dE} = \frac{1}{2}(\bar{v}_1 + \bar{v}_2)$$

d)

$$\frac{1}{\bar{v}} \cong 1.2491 \times 10^{-4} \ (m/s)^{-1}$$

$$\bar{v} \cong 1.2154 \times 10^{6} (m/s)$$

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3.

a) $$\nu\Sigma_f = \frac{1}{\hat{\varphi}_1 + \hat{\varphi}_2}\left(\int_0^\infty \nu_{f1}\Sigma_{f1}(E)\varphi_1(E)\,dE + \int_0^\infty \nu_{f2}\Sigma_{f2}(E)\varphi_2(E)\,dE \right)$$

b) $$\Lambda = \frac{1}{\nu\Sigma_f}\left(\overline{\frac{1}{v}}\right)$$

$$= \frac{\cancel{\hat{\varphi}_1 + \hat{\varphi}_2}}{\int_0^\infty \nu_{f1}\Sigma_{f1}(E)\varphi_1(E)\,dE + \int_0^\infty \nu_{f2}\Sigma_{f2}(E)\varphi_2(E)\,dE} \times$$

$$\frac{1}{\cancel{\hat{\varphi}_1 + \hat{\varphi}_2}}\left(\int_0^\infty \frac{\varphi_1(E)}{v_1(E)}\,dE + \int_0^\infty \frac{\varphi_2(E)}{v_2(E)}\,dE \right)$$

$$= \frac{\int_0^\infty \frac{\varphi_1}{v_1}\,dE + \int_0^\infty \frac{\varphi_2}{v_2}\,dE}{\int_0^\infty \nu_{f1}\Sigma_{f1}\varphi_1\,dE + \int_0^\infty \nu_{f2}\Sigma_{f2}\varphi_2\,dE}$$