$$\sigma^{inc}_{tot} = \frac{4\pi a_{inc}^2 m}{\hbar k_i M} \int e^{-2W(\hbar \kappa)} \frac{|\gamma|^2 g(\omega) \sqrt{m\omega/\hbar}}{\left(e^{\hbar\omega/T} - 1\right)} d\omega$$

$$g(\omega) = \delta(\omega - \omega_0)$$

$$\sim \frac{1}{\left(e^{\hbar\omega_0/T} - 1\right)} \sim T$$

$$e^{-\hbar\omega_0/T}$$

$$\sigma^{inc}_{tot} = \frac{4\pi}{k_i}\frac{m}{M}\int e^{-2W(k_f)} \frac{|\gamma|^2 g(\omega)\sqrt{m\omega/\hbar}}{(e^{\hbar\omega/T}-1)} d\omega$$

$$S_{inc}(Q,\omega) = \sum_i \int dt \, \langle e^{-iQ\cdot R_i(0)} e^{+iQ\cdot R_i(t)} \rangle e^{-i\omega t}$$

$$R(t) = R(0) + \vec{v}t \qquad \iint dt \left(e^{+iQ\cdot vt}\right) e^{-i\omega t} \, P(v)\, dv$$

$$\delta(\omega - \vec{Q}\cdot\vec{v})$$

$$\frac{d^2\sigma}{d\omega\, d\Omega} = \left(\frac{k_f}{k_i}\right) a_{inc}^2 \, S_{i}(Q,\omega)$$

$$d\Omega = \frac{Q^2\, dQ}{k_i k_f}$$

$$2Q\,dQ = 2k_i k_f \sin\theta\, d\theta \qquad 2\pi \sin\theta\, d\theta = \frac{Q\,dQ}{k_i k_f}$$

$$\frac{1}{k_i^2}\int P(v)\, dv \iint d\Omega\, \delta(\omega - Q\cdot\vec{v})\, d\omega$$

$$\omega = \frac{Q^2}{2m} \qquad x = \cos\theta \qquad 2\pi\, dx$$

$$\int_{-1}^{1} dx\, \delta\left(\frac{Q^2}{2m} - Qvx\right) Q\,dQ$$

$$\int P(v)\, dv \int_{-2mv/\hbar} \frac{1}{(Qv)} Q\,dQ \sim \langle v \rangle \sim \sqrt{T}$$

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$$\frac{d^2\sigma}{d\Omega\, d\omega} = \frac{k_f}{k_i}\, a_{inc}^2\, S(Q,\omega)$$

$\omega = \hbar Q^2/2m$

$Q = k_f$

$$\frac{d\sigma}{d\Omega} = a_{inc}^2 \int S(Q,\underset{\frac{Q^2}{2m}}{\omega})\, Q^2\, dQ$$

$d\omega = \frac{Q}{m}\, dQ$

$S(Q,\omega) \to \delta(\omega - \vec{Q}\cdot\vec{v})$

$d\Omega = 2\pi \sin\theta\, d\theta$

$\quad = 2\pi\, dx$

$x = \cos\theta$

$$\sigma_{tot} \sim \int \rho(v)\, dv \int dx \int Q^2\, dQ\, \delta(\omega - \vec{v}\cdot\vec{Q})$$

$(\omega - vQx)$

$$\int \rho(v)\, dv\, \frac{1}{vQ} \int_0^{2mv/\hbar} Q^{2}\, dQ = \langle v \rangle \sim \sqrt{T}$$

$$\Sigma = N\sigma_{int} \quad cm^{-1} \qquad 1/\Sigma \sim \langle l \rangle$$

$$\frac{d\,g}{dt} \sim \cancel{N\sigma}\,(\underbrace{N\sigma}_{\Sigma}\,\underbrace{v\,g}_{\phi}) \qquad dt = \frac{\langle l \rangle}{v} = \frac{1}{(N\sigma v)}$$

$$\Sigma(E \to E_{ucn}) = N \frac{d\sigma}{dE_{ucn}}(E \to E_{ucn})$$

E_{ucn}

$E_{ucn_i} + dE_{ucn}$

$$\int_{ucn}^{\infty} \left(\Sigma(E \to E_{ucn}) \;\; \phi(E)\,dE \right) dE_{ucn} \qquad \frac{d\sigma}{d\omega}\Big|\, \omega = E - E_{ucn}$$

$\phi(E)\,dE \to$

$$S(E_{ucn})\,dE_{ucn} = prod/cm^3/sec$$

$$\Sigma(E \to E_{ucn}) = (\;) \, \Sigma(E_{ucn} \to E)$$

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