

# UCW Scattering by materials

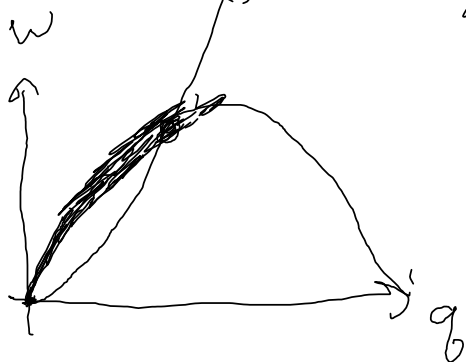
$$\frac{d^2 \sigma}{d\Omega d\omega} = a_{coh}^2 \left( \frac{\hbar f}{\hbar \omega_i} \right) e^{-2W(\omega)} \frac{(2\pi)^3 \hbar}{NB 2M} \sum_{s,q} \frac{|\vec{q} - \vec{\gamma}|^2}{\omega_s(q)}$$

abs

$$\left\{ \begin{aligned} & \delta^3(\omega + q - \omega') \delta(\hbar\omega_{\omega'} + \hbar\omega) \\ & \times \frac{1}{(e^{\hbar\omega/kT} - 1)} \end{aligned} \right.$$

emission  $(q, \omega)$

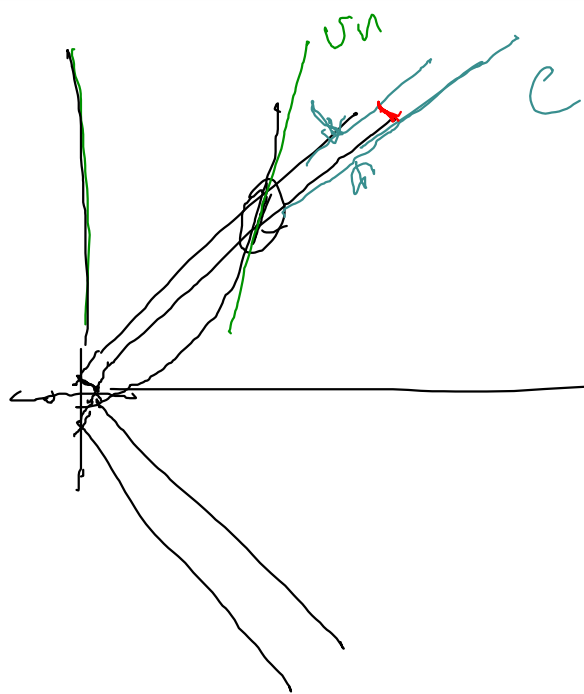
$$\left\{ \begin{aligned} & \delta^3(\omega - q - \omega') \delta(\hbar\omega_{\omega'} - \hbar\omega) \\ & \times \frac{1}{1 - e^{-\hbar\omega/kT}} \end{aligned} \right.$$



$$\omega = \frac{\hbar \omega_i^2}{2m} - \frac{\hbar \omega_f^2}{2m}$$

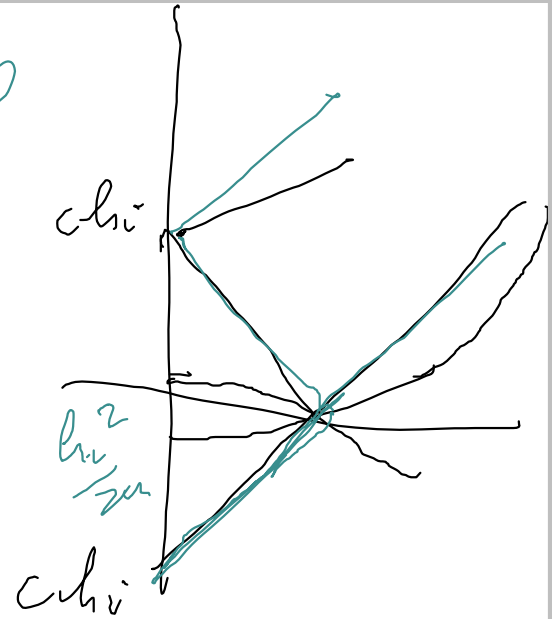


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$$\frac{h_f^2 - h_i^2}{2u_n} = w$$

$h_f$   
 $g \approx |h_f \pm b|$



$$\frac{d^2 \sigma}{d\Omega d\omega} = a_{coh}^2 \left( \frac{\hbar f}{\hbar \omega_i} \right) e^{-2\omega(\tau)} \left[ \frac{(2\pi)^3}{N B} \right] \frac{\hbar}{2M} \sum_{s,q} \frac{|\vec{q} - \vec{\gamma}|^2}{\omega_s(q)}$$

ahs

$$\left\{ \begin{aligned} & \delta^3(\vec{q} + \vec{q} - \vec{r}) \delta(\hbar\omega_{\vec{q}} + \hbar\omega) \\ & \times \frac{1}{(e^{\hbar\omega/\hbar T} - 1)} \end{aligned} \right.$$

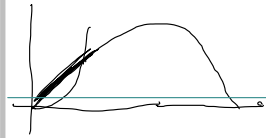
$$\delta^3(\vec{q} - \vec{q} - \vec{r}) \delta(\hbar\omega_{\vec{q}} - \hbar\omega)$$

$$\sum_{\vec{q}} \rightarrow \frac{N B}{(2\pi)^3} \int d^3 q$$

$$\frac{d^2 \sigma}{d\Omega d\omega} = a_{coh}^2 \left( \frac{h_f}{h_i} \right) e^{-2W(\mathbf{q})} \frac{1}{2M} \frac{(\vec{q} - \vec{q}')^2}{W_s(\mathbf{q})}$$

ahs

$$\left\{ \begin{array}{l} \delta(h_f - h_i) \\ \times \frac{1}{(e^{h\omega/hT} - 1)} \end{array} \right\} \delta(h_f - h_i) \delta(\omega - \omega')$$



$$W = \left( \frac{h_f^2 - h_i^2}{2m} \right)$$

$$d\omega = \frac{h_f}{m} dh_f = v_n dh_f$$

$$\int \delta[f(h_f)] dh_f$$

$$f(h_f^0) = 0$$

$$\int (f'(h_f^0)(h_f - h_f^0)) f(h_f) = 0 + f'(h_f^0)(h_f - h_f^0)$$

$$\delta(ax) = \frac{1}{|a|} \delta(x)$$

$$\int f(x) \delta(x - x_0) dx = f(x_0)$$

$$\frac{1}{f'(h_f^0)}$$

$$f(h_f) = W + W_{sg}$$

$$\frac{v_n}{f'} = \left( \frac{v_n}{v_n - \frac{\partial W}{\partial \mathbf{q}}} \right)$$

$$\frac{d\omega}{dh_f} = \frac{dW}{d\mathbf{q}} = v_n$$

$$\frac{dW_{sg}}{dh_f} = - \frac{\partial W(\mathbf{q})}{\partial \mathbf{q}}$$

$$\sigma_{\text{tot}}^{\text{inc}} = \frac{4\pi}{h_i} \frac{m}{M} \int \frac{e^{-2W(\hbar k_f)} |\gamma|^2 g(\omega) \sqrt{u\omega/\hbar}}{(e^{\hbar\omega/\hbar} - 1)} d\omega$$

$$k_{\text{uon}} = h_i \ll h_f$$

$$\vec{Q} = \vec{h}_i - \vec{h}_f = \vec{h}_u$$

$$\omega = \frac{\hbar}{2m} (k_f^2 - k_i^2)$$

$$dQ = 2 h_{\text{uon}}$$

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

$$Q^2 = h_{u^2}^2 + h_i^2 - 2h_u h_f \cos\theta$$

$$2Q dQ = 2h_u h_f \sin\theta d\theta$$

$$\frac{d^2 \sigma}{d\Omega d\omega} \approx a_{coh}^2 \left( \frac{h_f}{h_i} \right) e^{-2W(\omega)}$$

$$\frac{\hbar}{2M}$$

$$\frac{(\vec{q} - \vec{\gamma})^2}{W(\omega)}$$

ahs

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x

$$\left( e^{h\omega/hT} - 1 \right)$$

$$\frac{v_n}{v_n - \partial\omega/\partial q}$$

$$\left[ \frac{v_n - \partial\omega/\partial q}{v_n} \right]$$

↑

$$\vec{q} = \vec{\gamma} - \vec{q}$$

coherent ops scattering of U CW