$$= \frac{k_f}{k_i} \left\{ \frac{1}{N} \sum_{i,j} a_i a_j \left| \langle n_f | e^{iQ\cdot R_i(t)} | n_i \rangle \right|^2 \delta(E_f' - E_i') \right\}$$

$$\delta(x) = \int e^{ixy}\, dy$$

$$e^{iQ\cdot R_i(t)} = e^{iHt}\, e^{i\vec{Q}\cdot R_i(0)}\, e^{-iHt}$$

$$= \frac{k_f}{k_i} \, S(Q,\omega)$$

$$= \frac{k_f}{k_i}\left(\frac{1}{L^3}\sum_{i,j} a_i a_j \left|\langle n_f | e^{iQ\cdot R_i} | n_i\rangle\right|^2 \delta(E_f' - E_i')\right)$$

$$G(r,t) = \int \frac{1}{L^3}\sum_{n_f, n_i}\sum_{i,j} a_i a_j \langle n_i | e^{-iQ\cdot R_i} | n_f\rangle \langle n_f | e^{iQ\cdot R_j} | n_i\rangle \delta(E_f - E_i - \hbar\omega)\, e^{-i\vec{Q}\cdot\vec{r} + i\omega t}\, d\omega\, d^3Q$$

$$\frac{1}{\hbar}\int d^3Q \langle n_i | e^{-iQ\cdot R_i} | n_f\rangle \langle n_f | e^{iQ\cdot R_j} | n_i\rangle$$

$$e^{-i\vec{Q}\cdot\vec{r}}\; e^{i(E_f - E_i)t/\hbar}$$

$e^{iE_f t/\hbar}$ $\quad$ $e^{-iE_i t/\hbar}$

$e^{iH_s t/\hbar}$ $\quad$ $e^{-iH_s t/\hbar}|n_i\rangle$

$$\langle n_f | \underbrace{e^{iH_s t}\, e^{iQ\cdot R_j}\, e^{-iH_s t/\hbar}}_{e^{iQ\cdot R_j(\tau)}} | n_i\rangle$$

$$G(r,\tau) = \frac{1}{\hbar}\int d^3Q \langle n_i | e^{-iQ\cdot R_i} \left(|n_f\rangle\langle n_f|\right) e^{iQ\cdot R_j(\tau)} | n_i\rangle e^{-iQ\cdot r}$$

$$\boxed{\frac{1}{L^3\hbar}\sum_{n_i, n_f} P_{n_i}\sum_{i,j} a_i a_j \int d^3Q \langle n_i | e^{iQ\cdot (R_j(\tau) - R_i)} | n_i\rangle e^{-iQ\cdot r}}$$

$G_{tot}(r,t)$

$$\frac{1}{L^3\hbar}\sum_{n_i,n_f} P_{n_i} \sum_{i,j} a_i a_j \int d^3Q \langle n_i | e^{iQ\cdot(R_j(\tau)-R_i)} | n_i \rangle e^{-iQ\cdot r}$$

$$\overline{\langle a_i a_j \rangle} = |\langle a \rangle|^2 + \delta_{ij} \underbrace{[\langle |a|^2\rangle - |\langle a \rangle|^2]}_{a_{i,inc}^2}$$

$G(r,t)$

$$\frac{1}{L^3\hbar} \sum_{n_i} P_{n_i} \sum_{i,j} a^2_{coh} \int d^3Q \langle n_i | e^{iQ\cdot(R_j(\tau)-R_i)} | n_i \rangle e^{-iQ\cdot r}$$

$$G_{self}(r,t) = \frac{1}{\hbar L^3} \sum_{n_i} P_{n_i} \sum_i a^2_{i,inc} \int d^3Q \langle n_i | e^{iQ\cdot(R_i(\tau)-R_i)} | n_i \rangle e^{-iQ\cdot r}$$

$$\langle n_i | \int d^3Q\, e^{iQ\cdot R} e^{-iQ\cdot \vec{r}} | n_i \rangle$$

$$= \frac{1}{(2\pi)^3} \delta^{(3)}(\vec{r}-\vec{R})$$

$$G(r,t) = \langle n_i | \int \delta^3(r+R_i-r')\, \delta^3(r'-R_j(\tau)) | n_i \rangle \, d^3r'$$

$$= \langle n_i | \delta^3(r+R_i-R_j(\tau)) | n_i \rangle$$

$$\frac{d^2\sigma}{d\Omega\, dw} = \frac{k_f}{k_i} S(Q, w)\, (a^2)_{inc}$$

$$\int d\tau\, dr\, G^{sys}_{self}(r, \tau)\, e^{i(\vec{Q}\cdot\vec{r} - w\tau)}$$

$E_i > W$

$$= a^2 \int S(Q, w)\, dw$$

$$\left(\int dr\, G(r, 0)\, e^{i\vec{Q}\cdot\vec{r}} \right)$$

$$\left\{ 1 + \int d^3r\, g(r)\, e^{i(Q\cdot r)} \right\} = S(Q)$$