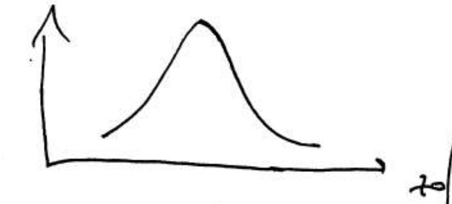
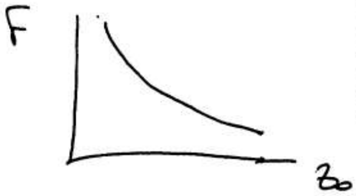
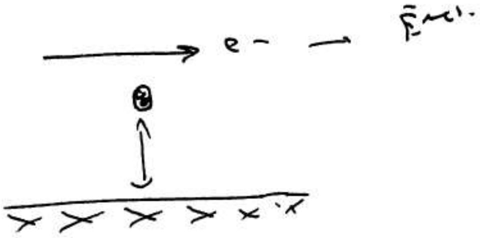
$$\bar{p} = \frac{1}{1/\alpha - \mathcal{G}} \text{ "}\bar{E}^{ext}\text{"}$$

$$\Gamma_{sp} = |p|^2 \; F$$







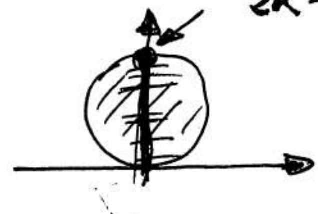
$$\mathrm{Im}\left\{\frac{-1}{\alpha}\right\} \leq \frac{2K^3}{3}$$

= → lossless

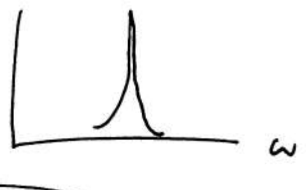
$$\mathrm{Re}\{1/\alpha\} = \mathrm{Re}\{\mathcal{G}\}$$

lossless & if $\mathrm{Re}\{\alpha\} = 0$

$$\longrightarrow \mathrm{Im}\{\alpha\} = \frac{3}{2K^3}$$



$\Gamma_{EELS}(\omega)$



$$\left[\int d\omega \, \Gamma_{EELS}(\omega)\right] = 1$$

$$\left[\Gamma_{EELS}(\omega)\right] = \left[\frac{1}{\omega}\right] = T$$

$$\left[\bar{E}(t)\right] = \frac{C}{L^2}$$

$$\left[\bar{E}(\omega)\right] = \frac{C}{L^2}\left[\frac{1}{\omega}\right] = \frac{CT}{L^2}$$

~~$[\Gamma_{sp}]$ "=" L^3 $[$"$\bar{E}^{ext}(\omega)$"$]$ = CTL~~

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Cluster)

$$\Gamma_{sp} = \frac{2}{\hbar} \left| \overbrace{\frac{1}{1/\alpha_1 - S^{real}} E^{ext}}^{p} \right|^2 \qquad S_i \simeq \frac{2}{\hbar} \frac{|E^{ext}|^2}{S_i}$$

$$S_i \gg S_i^{0} = -\frac{2k^3}{3}$$

$\llcorner$ S_i^{ref}

$$\Gamma_{EEU} : \frac{2}{\hbar} |\alpha_2|^2 \frac{2k^3}{3} |E^{ext}|^2 \simeq \frac{2}{\hbar} \frac{|E^{ext}|^2}{S_i^{0}}$$

$S^{ref} = 0$ $\qquad \alpha_2 \in \mathbb{I} \qquad \alpha_2 = \frac{1}{\left(\frac{2k^3}{3}\right)} \Longrightarrow = \frac{1}{\left(\frac{2k^3}{3}\right)}$

$$S_i^{0} = \lim_{r\to 0} \mathrm{Im}\left\{ (k^2\mathbb{I} + \nabla\nabla) \frac{e^{ikr}}{r} \right\}$$

$$= \lim_{r\to 0} \mathrm{Im}\left\{ \int \frac{d\bar q}{(2\pi)^3} \frac{4\pi e^{i\bar q \cdot \bar r}}{q^2 - k^2 - i0^+} (k^2\mathbb{I} - \bar q \bar q) \right\}$$

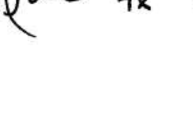
$$\overset{(?)}{=} -\frac{4\pi^2}{(2\pi)^3} \int d\bar q \; \delta(q^2 - k^2) (k^2\mathbb{I} - \bar q \bar q) \qquad \left(\int d\Omega \; q_x^2 = \frac{4\pi q^2}{3}\right)$$

$$= -\frac{1}{2\pi}\mathbb{I} \; 4\pi \int_0^\infty q^2 dq \; \underbrace{\delta(q^2 - k^2)}_{\frac{1}{2k}\delta(q-k)} \left(k^2 - \frac{q^2}{3}\right)$$

$$= -\mathbb{I} \frac{1}{k} k^2 k^2 \left(1 - \frac{1}{3}\right) = -\frac{2k^3}{3}\mathbb{I}$$

~~$\Gamma_{sp} / \Gamma_{EEU} = \left| \frac{1}{1/\alpha_1 - S^{r}} \right|^2 \frac{S_i}{S_i} \frac{2k^3}{3} = \ldots$~~

$S_i \sim S_i^{0}$



$$\frac{1}{\alpha_1} - S^{ref} = \mathrm{Im}\left\{\frac{1}{\alpha_1}\right\} - S_i = -\frac{2k^3}{3} - S_i$$

$$\frac{\Gamma_{sp}}{\Gamma_{EEU}} \simeq \frac{S_i^{0}}{S_i} \ll 1 \quad \text{if} \quad S_i \gg S_i^{0}$$

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optical distance $\rightarrow$ $S_i \sim S_i^{0}$ $\longrightarrow$ $\Gamma_{sp} / \Gamma_{EEU} \sim 1$

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$$\Gamma_{SP} = \frac{2}{\hbar} \left| \frac{1}{\frac{1}{\alpha_1} - S_{mol}} \bar{E}^{ext} \right|^2 G^i_{mol}$$

$$\Gamma_{FERS} = \frac{2}{\hbar} \left| \frac{1}{\alpha_2} \bar{E}^{ext} \right|^2 (-S^i_0) \rightarrow \frac{2k^3}{3}$$

$$I_= \left(\frac{1}{\alpha_1}, \frac{1}{\alpha_2} \right) = -\frac{2k^3}{3}$$

$$\frac{2}{\hbar} |E^{ext}|^2 \left| \frac{\alpha_1}{S^i_0 - S^i_{mol}} \right|^2 S^i_{mol}$$

$$\frac{2}{\hbar} |E^{ext}|^2 \frac{1}{S^i_0}$$

$$\frac{\Gamma_{SP}}{\Gamma_{FERS}} \sim 1$$

$$\frac{S^i_0}{S^i_{mol}} \sim 1$$