Electron coupling to a waveguide mode

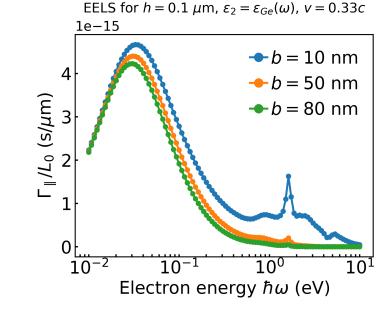
$$\frac{d\Gamma}{dy}(\mathbf{r},\omega) = \frac{2e^2}{\pi\hbar v^2} \int_0^\infty \frac{\mathrm{d}k_x}{k_{\parallel}^2} \mathrm{Re} \left\{ k_{z1} \mathrm{e}^{2\mathrm{i}k_{z1}z_{\mathrm{e}}(\mathbf{r})} \left[\left(\frac{k_x v}{k_{z1} c} \right)^2 r_{123}^{\mathrm{s}}(k_{\parallel}) - \frac{1}{\epsilon_1} r_{123}^{\mathrm{p}}(k_{\parallel}) \right] \right\}, \text{\#paper149 Eq. (25)}$$

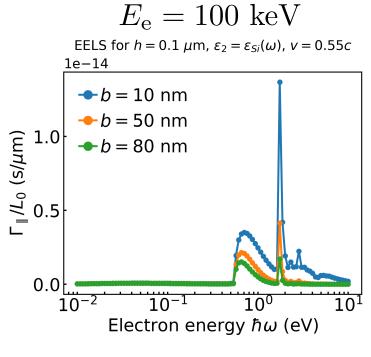
$$\Gamma(\omega) = \frac{2e^2}{\pi\hbar v^2} \int_0^\infty \frac{dk_x}{k_{\parallel}^2} \text{Re} \left\{ \underbrace{\int_{-\infty}^\infty dy \, e^{2ik_{z1}z_e(y)}}_{-\infty} k_{z1} \left[\left(\frac{k_x v}{k_{z1} c} \right)^2 r_{123}^{\text{s}}(k_{\parallel}) - \frac{1}{\epsilon_1} r_{123}^{\text{p}}(k_{\parallel}) \right] \right\},\,$$

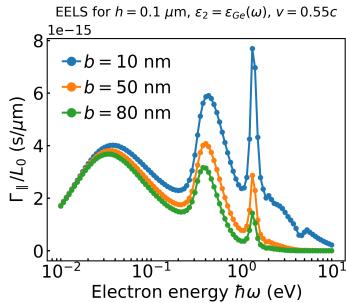
$$L^{\text{eff}}(k_{\parallel}) \approx L_0 e^{-2k_{\parallel}b} \sqrt{\frac{\beta q_0}{k_{\parallel}}},$$

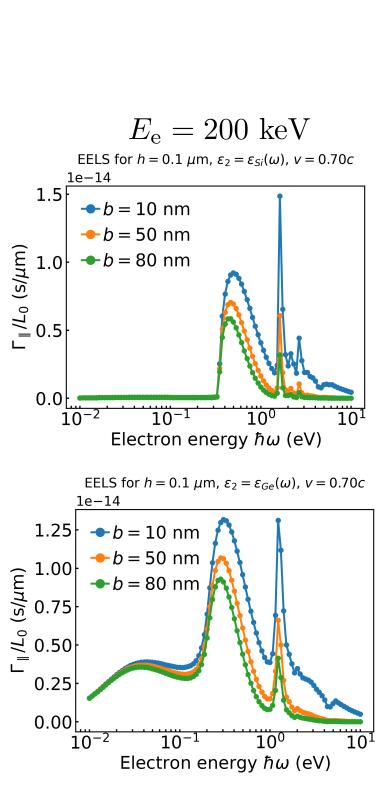
$$E_{\rm e} = 30~{\rm keV}$$
 EELS for $h = 0.1~\mu{\rm m}$, $\varepsilon_2 = \varepsilon_{\rm Si}(\omega)$, $v = 0.33c$ 1.25
$$\begin{array}{c} 1.25 \\ -b = 10~{\rm nm} \\ -b = 50~{\rm nm} \\ -b = 80~{\rm nm} \\ \end{array}$$
 0.75
0.50
0.25
0.00
$$\begin{array}{c} 0.50 \\ 0.25 \\ 0.00 \end{array}$$

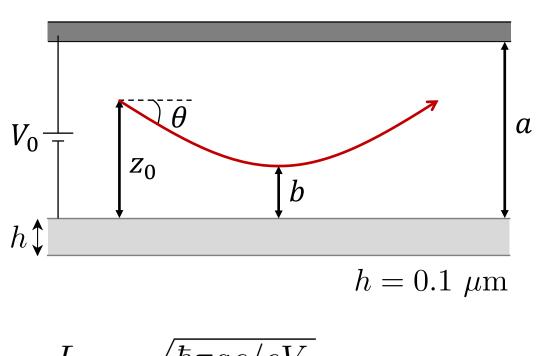
Electron energy $\hbar\omega$ (eV)











$$L_0 = \sqrt{\hbar \pi a c / e V_0},$$

$$q_0 = m_e v \gamma / \hbar, \ \beta = v / c.$$

