EXCITATION OF PLASMONS IN 2D CONDUCTING PLANE MATERIAL BY A PARALLEL DIPOLE LINE

We start from the Coulomb field produced by the linear dipole of the tip, whose components on the exploring surface are:

\[ E_x(x) = -\frac{4\pi n}{(x^2 + p^2)^{3/2}} \]

where \( n \) is the height of the dipole above the surface. Thiers Fourier transforms are:

\[ \psi_{0q} = -2i/|q| e^{-|q|h}, \psi_{0q} = 2i/|q| e^{-|q|h} \]

Solution of Poisson equation can be found as:

\[ \psi^{(0)}(x) = \int \frac{\psi_{0q}(x) e^{i(qx)}}{2|q|} dq \]

where \( \psi^{(0)}(x) \) is the potential distribution above the surface (excluding the tip’s dipole compound), and \( \psi^{(0)} \) is below it.

From the boundary conditions at the surface:

\[ \rho \equiv 2|q| e^{-|q|h} \psi_{0q}^{(0)} + i|q| \psi_{0q}^{(0)} = 0 \]

where \( \psi_{0q}^{(0)} \) is the Fourier components of the charge density \( \psi(x, t) \) induced on the surface, \( \psi(x, t) = \int \psi_{0q}^{(0)} e^{iqxt} dq \).

Then, using continuity Eq. \[ \psi_{0q}^{(0)} = 0 \] where \( \psi(x, t) \) is the linear current in the surface given as \( j_{\text{lin}} = -\gamma E_{\text{lin}} \) where \( \gamma \) is the surface conductivity. \( E_{\text{lin}} \) is the E-field component producing the current in the surface, one can obtain \( \psi_{0q}^{(0)} \) and:

\[ \beta = \frac{\omega_0}{\gamma} \left( 1 - 4q^2 \left( \frac{\rho_{\text{max}}}{\rho_{\text{lin}}}, \frac{\rho_{\text{min}}}{\rho_{\text{lin}}} \right) \right) \]

After transformations, Eq. (7) is reduced to:

\[ \beta = \frac{1}{2|q|^2} \left( \frac{1}{q} + \frac{1}{q} \right) \cdot \frac{1}{2|q|^2} \cdot \frac{1}{2|q|^2} \cdot \frac{1}{2|q|^2} \cdot \frac{1}{2|q|^2} \cdot \frac{1}{2|q|^2} \cdot \frac{1}{2|q|^2} \cdot \frac{1}{2|q|^2} \cdot \frac{1}{2|q|^2} \cdot \frac{1}{2|q|^2} \cdot \frac{1}{2|q|^2} \cdot \frac{1}{2|q|^2} \cdot \frac{1}{2|q|^2} \cdot \frac{1}{2|q|^2} \cdot \frac{1}{2|q|^2} \cdot \frac{1}{2|q|^2} \cdot \frac{1}{2|q|^2} \cdot \frac{1}