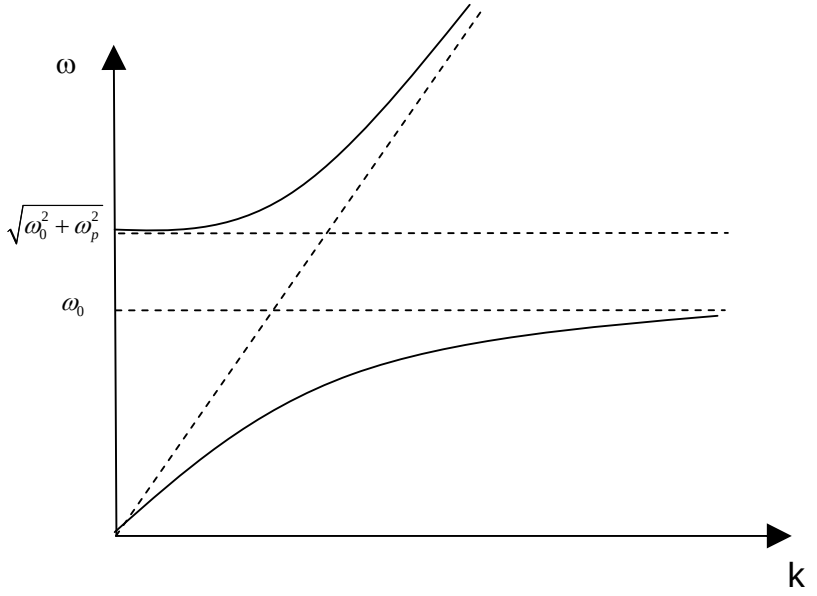
EECS 598-002 Nanophotonics and Nanofabrication
Winter 2006
Homework 2 (due Feb 21 Tuesday by 5 pm)

Problem 1. Dispersion relation of a Plasmon polariton

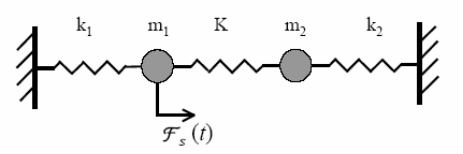
In the class, we derived the dispersion relation for an ensemble of free electron gas in a metal or in a semiconductor. We noticed that the dispersion curve of the plasmon polariton has two branches as follows.



There is no density of states between ω_0 and $\sqrt{\omega_0^2+\omega_p^2}$. Please explain why that is the case and what happens to an incident light with a frequency falls between these two points.

Problem 2. Dispersion relation of a system consisting of two coupled SHO's (e.g. EIT)

A three-level excitonic system can be described by a coupled SHO's as follows.



1. Please derive the dispersion relation for the particle m_1 subject to an external force $F_s(t) = Fe^{-i\omega_s t}$. Please assume $k_1 = k_2 = k$, $m_1 = m_2 = m$, $\Omega^2 \equiv K/m$, $\omega_0^2 \equiv k/m$ and the decay rates for m_1 and m_2 SHO's to be γ_1 and γ_2, respectively.
2. The mechanical power absorbed by m_1 is $P(t) = Fe^{-i\omega_s t}\frac{dx_1(t)}{dt}$. Assumeing $\gamma_1 = 10^{-7}$, $\gamma_2 = 0.04$,

$F/m = 0.1$ and $\omega_0^2 \equiv 4$, plot *P(t)* versus the detuning $\omega_s - \omega$ for Ω=0, 0.1, 0.2, 0.3, 0.4, and 0.5, respectively.

3. Apply the Kramers-Kronig relation to *P(t)* and compare the results with the dispersion relation obtained in (1). Show that it is the same as the electromagnetically-induced transparency as we discussed in the class. The EIT is a result of two coherently coupled exciton-polaritons.

Problem 3. Surface polaritons

Please show that there does not exist a TE-polarized surface polariton.