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Evaluation of the Surface Response Function and Inverse Reflectivity as a Function of $\left({}^{\omega}/_{\omega_p}\right)$ with different r_s

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Abstract: Theoretical study of the nonlinear response function has been described by optical second harmonic generation in nonlocal metal optics. Now day's nonlinear conductivity response function incorporate nonlocal effect in all orders. Plasma effects usually neglected in bulk studies are retained. It is demonstrated that the polarisation selection rule on which several conclusions about the relative strength of magnetic and electric effects have been drawn previously are violated in a fully nonlocal treatment. The most general polarisation selection rules for nonlocal second harmonic generation in Centro symmetric metal are established.

Keywords: Polarisation selection, Greens function, nonlocal optics, nonlinear conductivity, longitudinal plasma

I. INTRODUCTION

Optical second harmonic generation in Centro symmetric metal stems from the breaking of inversion symmetry in the selvedge and from nonlocal effects. A random phase approximation description of the nonlocal nonlinear conductivity tensor of an inhomogeneous jellium has been presented. Main emphasis is devoted to a study of the electric dipole response from a selvedge and to the magnetic dipole and electric quadric pole responses from the profile region and the bulk. A detailed analysis of the tensor symmetry schemes associated with the $\bar{p}.\bar{A}$ and $\bar{A}.\bar{A}$ in interaction (where $\bar{p}$ and $\bar{A}$ are momentum operator and vector potential) are discussed. Dipole and quadripole transition are identified and the role of direct and indirect quantum process are discussed.As we know that the light interacting with metal surfaces or interfaces can excite longitudinal plasma waves inside the metal. The phenomenon becomes more important at frequencies of the order of metal plasma frequencies ($\hbar\omega$ = 10 ev). This is the region in which the advent of synchrotron radiation has opened up a rapidly growing field of optical experiments. One can demonstrate that reflection from and transmission through metal layers, electro reflection and ellipsometry from metal surfaces, the surface Plasmon and Eigen modes in this layers and spheres and also the field near the surface as encountered by the photoemission. These things cannot be understood even quality without taking plasma waves into account. In this thesis we have studied two very specific problems as a first problem we have evaluated the surface response function $\mathrm{Re}\{d_\perp(\omega)\}$ and $\gamma\ (\omega) = \sqrt{8({}^{\omega}/_{c})}\left\{\left({}^{\omega}/_{\omega_p}\right)^2 - 1\right\}\mathrm{Im}\{d_\perp(\omega)\}$ for $r_s = 4$ my FEBELMAN'S relation with surface damping $r_s = 0.3\omega_p$ and $0.15\omega_p$.

We have used equation $d_\perp(\omega) = \frac{\mathscr{E}_a}{\mathscr{E}_a-\mathscr{E}_t}\int_{\xi_1}^{\xi_2} dz\ z\ \frac{d}{dz}\left(\frac{E_z(z)}{E_z^{>}(0)}\right)$ and $d_\perp(\omega) = \int_{-\infty}^{+\infty} dz\ z\rho^{ind}(z) / \int_{-\infty}^{+\infty} dz\ \rho^{ind}(z)$ for evaluation of surface response function $d_\perp(\omega)$. $\mathrm{Re}\{d_\perp(\omega)\}$ measures the position of the peak. In case of diffuse surface a strong electric field can be induced owing to a local Plasmon excitation. Then $E_z(z)$ can be strongly peaked in the surface region so that lye positive and negative charges are induced and in that case $\mathrm{Re}\{d_\perp(\omega)\}$ measures the dipole moment rather than the position of the induced charge. The imaginary part of $d_\perp(\omega)$ is important for the total power absorption. In table $4T_1$ we have given the result of $Re\{d_\perp(\omega)\}$for three different calculations as a function of${}^{\omega}/_{\omega_p}$. RPA calculation has been performing for$r_s = 4$. It indicates that $Re\{d_\perp(\omega)\}$ is negative${}^{\omega}/_{\omega_p} = 0.85$. It crosses zero between these two values. Now for the hydrodynamic approximation with $r_s = 0.3\omega_p$. the negative increase in ${}^{\omega}/_{\omega_p} = 0.80$ and then becomes positive and increase sharply. After reducing the value of $r_s = 0.15\omega_p$. $Re\{d_\perp(\omega)\}$increases sharply from negative to positive value and showing a peak at ${}^{\omega}/_{\omega_p} = 0.85$ and the decreases. The physical interpretation of these result are following for low frequencies in has negative value which means a position in the time

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region outside the positive backyard change for the static response. With increasing frequency the induced charges penetrate deeper into the metal i.e. their mean position assumed layer value and mutually diverges as ω approach to ω_p, If no bulk damping is included, Bulk damping level the penetration of induced charge at the value of $Re\{d_\perp(\omega)\}$ near ω_p. In table $4T_2$, we have given the result of $\text{lm}(d_\perp(\omega)) = \gamma(\omega)$. Our result indicates that $\gamma(\omega)$ is always positive as a function of ω/ω_p. For RPA result the peak is obtained at $\omega/\omega_p = 0.85$ and the values are lower. For hydrodynamic approximation peak is obtained at $\omega/\omega_p = 0.80$ and the values are longer than RPA values for $r_s = 0.15\omega_p$ hydrodynamic approximation result the peak is obtained at the same position but the value of $\gamma(\omega)$ are very large.As a second problem we have evaluated inverse reflectivity as a function of ω/ω_p. We have the value of surface response function $d_\perp$ calculated for different value of k_X/k_F. We have taken the value of k_X/k_F as 0.005, 0.05 and 0.1 respectively. There evaluation has been performed from Feilbelman's treatment. Reflection coefficient in surface regime $(k_X > \omega/c)$ has been calculated with Feilbelman's $d_\perp(\omega)$ result for $r_s = 4$. Feilbelman's $d_\perp(\omega)$ result for $r_s = 4$ is RPA result. From our result it indicates that with increasing value of k_X $1/|r_p|^2$ increases very fastly. We have also evaluated $1/|r_p|^2$ with hydrodynamic approximation keeping the value of $k_X/k_F = 0.1$ and surface damping $r_s = 0.3\omega_p$ and $0.15\omega_p$. In their calculation $1/|r_p|^2$ gives a peak and after that it decay. That peak is must more proved the value of $r_s = 0.1\omega_p$. These peaks are supposed to be damped multi pole surface Plasmon. This result is not really in conflict with the calculation of Inglefield and Kborg[36] who used a single stop model for the electron potential at a clean surface. The resulting density profile is similar to that for the IBM and much deeper than the self consistent Lang-Kohn profile. RPA calculation for the IBM[37] also yield no MSP mode for r_s values in metallic range (2 to 6)[38]. Since the surface region of low density is too small. This region increases with increasing value of r_s and for very large r_s values (for bulk densities) MSP modes appear in the quantum mechanical mode. Recent microscopic calculating for charge surface support their arguments[39].Finally one wants to emphasise an important difference between hydrodynamic and RPA calculations, namely the role played by damping effects. In hydrodynamic calculation damping (r , r_s) appears as a free parameter which can be neglected completely ($r = r_s = 0$) for multi pole surface Plasmon. In RPA calculation damping mechanism is included automatically, namely optical excitation of electron hole pair in the surface region, owing to the breaking of translational invariance. In strength of this damping effect depends susceptibility on shape of electron density profile[40]. For the Lang-Kohn profile and probably for real metals, the damping effects are so large that the MSP modes may easily be overlooked. Owing to the strong damping, direct observation of multi pole surface Plasmon, even at a perfectly flat surface by incident light become. They are related to peak in $\text{lm}\{d_\perp(\omega)\}$ i.e. in the absorptance. There for excitation of MSP would lead to a reduced intensity of reflected light.

II. CONCLUSION

Thus we conclude from the present investigation about the nonlinear response function in nonlocal metal optics, that HD approximation along with FEIBELMAN formalism for the surface response function gives very accurate values for this function for the metal whose r_s is about 0.1 to $0.3\omega_p$ where ω_p is the Plasmon frequency. We have evaluated the surface response function for other metal whose value of r_s is larger than the above stated value. This will be our future work of investigation.

REFERENCES

[1] J.E.Sepe, Surf sci,84,75-105(1979)
[2] R.G.Bassera and A.Bagahi, phys. Rev.B20, 3186-3196 (1979)
[3] P. Apell, Phys. Sci 17, 535-542 (1978)
[4] F. Sauter Z. Phys. 203,488 (1967)
[5] G. D. Mahan many particle Physics (Plenum, New York)
[6] F. Forstmann, Z. Phys. 1332,385(1979)
[7] F. Bloch Helv. PhysicaActa 1, 385 (1934)
[8] G. Mukhopadhyay and S. Lundqvist, phys. Sci 17, 69-81 (1978)
[9] H.Raether, Physics of thin film 9, 147, (1977)
[10] J. Haris, Phys. Rev. B4,1022 (1971)
[11] P.J.Feibelmen, Phys. Rev. 176, 551 (1968)
[12] J. Haris and A.Griffin, Phys. Lett. 37A, 387 (1971)
[13] J.L Bermen and J.J.Sein Phys. Rev . B6, 2482 (1972)
[14] A.A.Maradudin and D.L. Mills, Phys.Rev.B7,2787(1973)
[15] R.Kotz, D.M.Kols and F.Forstmann, Surface Sci. 91,489(1980)
[16] S.S. Jha, phys. Rev. Lett. 15, 412-414 (1965)

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[17] S.S.Jha, phys. Rev. 140 A 2020- A 2030 (1965)
[18] Y.J.Chen and E. Burstein, NuovoCimento 39B, 807-816 (1977)
[19] S.IPeker: Zh.Ekps.Teor.Fiz.33,1022(1957)
[20] F. Forstmann: Z.Physik 32, 385(1979)
[21] F. Forstmann: Z. Physik 203, 495 (1967)
[22] D.L.Johnson, P.R.Rimbey: Phys. Rev.B 14,2398(1976)
[23] K.L.Kliwer: Surface Sci, 101,57(1980)
[24] P.J.Feibelman: Phys. Rev. B 22, 3654(1980)
[25] W.Hanke:Adv Phys.27,287(1978)