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Transverse magnetic mode excitation in an atomic mirror

Abstract

We present a study of a transverse magnetic mode excitation in a multi-layer atomic mirror. We give the continuity relationships at the interfaces of the setting.[1] We deduce the transverse and parallel components of the electric field through the atomic mirror and then the total component. We show that there is no enhancement of the electric field in the vaccum contrarily to the transverse electric field excitation.[2]

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Introduction

We introduce a detailed study of a transverse magnetic mode excitation in an atomic mirror. It is easy to demonstrate that in this geometry, we have: $\frac{\partial}{\partial y}=0$. There are two independant solutions of the Maxwell equations.[1] One introduces a TE excitation (E_y, B_x and B_z). The other one gives a TM excitation (B_y, E_x and E_z) coupled between them.

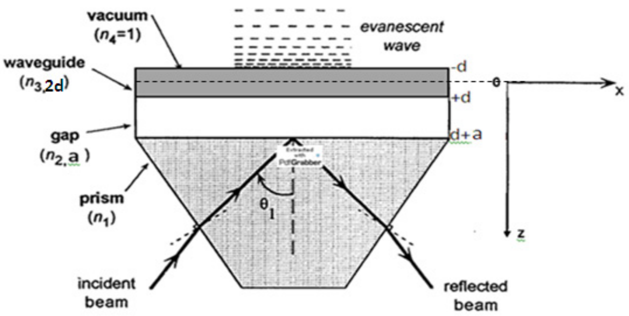

Figure 1 Resonant dielectric structure: the waveguide (TiO_2, refraction index n_3=2.387 and thickness 2d=67.9nm) is separated from the glass prism (LaSFN18, refraction index n_1=1.893) by a layer of low index, the gap, (SiO_2, thickness a=700nm, refraction index n_2=1.49). The dielectric layers are deposited by a laser beam at λ =780nm. The fourth medium is vacuum (refraction index n_4=1).

Maxwell equations:

The Maxwell equations [1, 3] give:

$$\vec{\nabla}\wedge\vec{E}=-\frac{1}{C}\frac{\partial\vec{B}}{\partial t}$$

$$\vec{\nabla}\wedge\vec{H}=\frac{4\pi}{C}\vec{J}+\frac{1}{C}\frac{\partial\vec{D}}{\partial t}$$

$$\vec{\nabla}.\vec{E}=4\pi\rho$$

$$\vec{\nabla}.\vec{B}=0$$

In order to introduce the right relationships, we present the electric field in the multi-layer system for a TE excitation.

$$E_y^{(1)}=A\,exp(-i\gamma_1 z)+A^{\backslash}\,exp(i\gamma_1 z)$$

$$E_y^{(2)}=B\,exp(\beta_2 z)+B^{\backslash}\,exp(-\beta_2 z)$$

$$E_y^{(3)}=C\,exp(-i\gamma_3 z)+C^{\backslash}\,exp(i\gamma_3 z)$$

$$E_y^{(4)}=D\,exp(\beta_4 z)$$

For a transverse magnetic mode excitation, we give the two components of the electric field deduced from the Maxwell equations. The magnetic field B_y for the TM excitation has the same form as the perpendicular electric field E_y for the TE excitation.[1] See the above equations.

$$\vec{E}=E\vec{i}+E\vec{k}$$

$$\vec{\nabla}\wedge\vec{E}=\begin{vmatrix} i & j & k \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ E & 0 & E \end{vmatrix}=i(\frac{\partial E}{\partial y})-j(\frac{\partial E}{\partial x}-\frac{\partial E}{\partial z})+k(-\frac{\partial E}{\partial y})=iK\vec{B}$$

$$E_x^{(1)}(z)=\frac{\gamma_1}{K_0 n_1^2}(-A\,exp(-i\gamma_1 z)+A^{\backslash}\,exp(i\gamma_1 z))$$

$$E_x^{(2)}(z)=\frac{\beta_2}{iK_0 n_2^2}(B\,exp(\beta_2 z)-B^{\backslash}\,exp(-\beta_2 z))$$

$$E_x^{(3)}(z)=\frac{\gamma_3}{K_0 n_3^2}(-C\,exp(-i\gamma_3 z)+C^{\backslash}\,exp(i\gamma_3 z))$$

$$E_x^{(4)}(z)=\frac{\beta_4}{iK_0 n_4^2}D\,exp(\beta_4 z)$$

The polarisation of the transmitted wave in the second medium is obtained from the Snell-Descartes law.

$$de\ (21)\qquad E_x=\frac{1}{iK_0 n^2}\frac{\partial B_y}{\partial z}$$

$$de\ (20)\qquad iK_0 B_y=(\frac{\partial E_x}{\partial z}-\frac{\partial E_z}{\partial x})$$

$$i\mu\varepsilon K_0 E_z=-iK_x B_y$$

$$E_z=-\frac{K_x}{K_0 n^2}B_y$$

$$B_y^{(1)}=A\,exp(-i\gamma_1 z)+A^{\backslash}\,exp(i\gamma_1 z)$$

$$B_y^{(2)}=B\,exp(\beta_2 z)+B^{\backslash}\,exp(-\beta_2 z)$$

$$B_y^{(3)}=C\,exp(-i\gamma_3 z)+C^{\backslash}\,exp(i\gamma_3 z)$$

$$B_y^{(4)} = D\,exp(\beta_4 z)$$
$$y_1^2 = n_1^2 k_0^2 \cos^2\theta$$
$$\beta_2^2 = (n_1^2 \sin\theta - n_2)K_0^2$$
$$y_3^2 = (n_3^2 - n_1^2 \sin^2\theta)K_0^2$$
$$\beta_4^2 = (n_1^2 \sin^2\theta - n_4^2)K_0^2$$
$$E_x = \frac{1}{iK_0 n^2}\frac{\partial B_y}{\partial z}$$
$$E_x^{(1)}(z) = \frac{\gamma_1}{K_0 n_1^2}(-A\,exp(-i\gamma_1 z) + A^{\backslash}\,exp(i\gamma_1 z))$$
$$E_x^{(2)}(z) = \frac{\beta_2}{iK_0 n_2^2}(B\,exp(\beta_2 z) - B^{\backslash}\,exp(-\beta_2 z))$$
$$E_x^{(3)}(z) = \frac{\gamma_3}{K_0 n_3^2}(-C\,exp(-i\gamma_3 z) + C^{\backslash}\,exp(i\gamma_3 z))$$
$$E_x^{(4)}(z) = \frac{\beta_4}{iK_0 n_4^2}D\,exp(\beta_4 z)$$

We give the continuity equations in the multi-layer system:

$$\vec{s}.(\vec{D}_2 - \vec{D}_1) = 0$$
$$n_i^2 E_i^1(z) = n_{i+1}^2 E_{i+1}^1(z)$$
$$\vec{s} \times (\vec{E}_2 - \vec{E}_1) = \vec{0}$$
$$E_x(i) = E_x(i+1) \qquad i = 1;2;3 \qquad \text{at each interface.}$$
$$\vec{s} \times (\vec{H}_2 - \vec{H}_1) = \vec{0}$$

$$\begin{cases} B_y^1(d+a) = B_y^2(d+a) \\ E_x^1(d+a) = E_x^2(d+a) \\ B_y^2(d) = B_y^3(d) \\ E_x^2(d) = E_x^3(d) \\ B_y^3(-d) = B_y^4(-d) \\ E_x^3(-d) = E_x^4(-d) \\ n_i^2 E_z(i) = n_{i+1}^2 E_z(i+1) \quad \text{for i=1,2,3 for each interface in the multi-layer.} \end{cases}$$

$$\begin{cases} A exp(-i\gamma_1(d+a)) = -A`exp(-i\gamma_1(d+a)) + Bexp(\beta_2(d+a)) + B`exp(-\beta_2(d+a)) \\ \frac{\gamma_1}{n_1^2 K_0} Aexp(-i\gamma_1(d+a)) = \frac{\gamma_1}{n_1^2 K_0} - A`exp(-i\gamma_1(d+a)) - \frac{\beta_2}{in_1^2 K_0}[Bexp(\beta_2(d+a)) - B`exp(-\beta_2(d+a)) \\ 0 = -Bexp(\beta_2 d) - B^{\backslash}exp(-\beta_2 d) + Cexp(-i\gamma_3 d) + C^{\backslash}exp(i\gamma_3 d) \\ 0 = +\frac{\beta_2}{in_2^2 K_0}[Bexp(\beta_2 d) - B^{\backslash}exp(-\beta_2 d) + \frac{\gamma_3}{n_3^2 K_0}[Cexp(-i\gamma_3 d) - C^{\backslash}exp(i\gamma_3 d) \\ 0 = -Cexp(i\gamma_3 d) + C^{\backslash}exp(-i\gamma_3 d) + Dexp(-\beta_4 d) \\ 0 = \frac{\beta_4}{iK_0}Bexp(-\beta_4 d) - \frac{\gamma_3}{n_3^2 K_0}[Cexp(i\gamma_3 d) - C^{\backslash}exp(-i\gamma_3 d) \end{cases}$$

We extract some factors from the matrix and call them I, II, III, IV, V, VI and VII:

$$\mathrm{I} = exp(-i\gamma_1(d+a)) \qquad \mathrm{II} = exp(i\gamma_1(d+a)) \qquad \mathrm{III} = exp(\beta_2 d) \qquad \mathrm{IV} = exp(-\beta_2 d)$$
$$\mathrm{V} = exp(-i\gamma_3 d) \qquad \mathrm{VI} = exp(i\gamma_3 d) \qquad \mathrm{VII} = exp(-\beta_4 d)$$

$$\mathrm{I}_1 = \begin{vmatrix} 1 & -1 & -1 & 0 \\ \frac{\beta_2}{in_2^2 K_0} & \frac{-\gamma_3}{n_3^2 K_0} & \frac{\gamma_3}{n_3^2 K_0} & 0 \\ 0 & exp(2\gamma_3 d) & exp(-2\gamma_3 d) & -1 \\ 0 & \frac{\gamma_3}{n_3^2 K_0}exp(2\gamma_3 d) & \frac{-\gamma_3}{n_3^2 K_0}exp(-2\gamma_3 d) & \frac{\beta_4}{iK_0} \end{vmatrix} \qquad \mathrm{I}_2 = \begin{vmatrix} 1 & -1 & -1 & 0 \\ -\frac{\beta_2}{in_2^2 K_0} & \frac{-\gamma_3}{n_3^2 K_0} & \frac{\gamma_3}{n_3^2 K_0} & 0 \\ 0 & exp(2\gamma_3 d) & exp(-2\gamma_3 d) & -1 \\ 0 & \frac{\gamma_3}{n_3^2 K_0}exp(2\gamma_3 d) & \frac{-\gamma_3}{n_3^2 K_0}exp(-2\gamma_3 d) & \frac{\beta_4}{iK_0} \end{vmatrix}$$

$$\mathrm{I}_1 = \frac{2i}{K_0^2}\left[\frac{\gamma_3}{n_3^2}(\frac{\beta_2}{n_2^2} + \beta_4)cos(2\gamma_3 d) - (\frac{\gamma_3^2}{n_3^4} - \frac{\beta_2\beta_4}{n_2^2})sin(2\gamma_3 d)\right]$$
$$\mathrm{I}_2 = \frac{2i}{K_0^2}\left[\frac{\gamma_3}{n_3^2}(-\frac{\beta_2}{n_2^2} + \beta_4)cos(2\gamma_3 d) - (\frac{\gamma_3^2}{n_3^4} + \frac{\beta_2\beta_4}{n_2^2})sin(2\gamma_3 d)\right]$$

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$$\begin{cases} X = \frac{\gamma_3}{n_3^2}(\frac{\beta_2}{n_2^2} + \beta_4)cos2\gamma_3 d - (\frac{\gamma_3^2}{n_3^4} - \frac{\beta_2\beta_4}{n_2^2})sin2\gamma_3 d \\ Y = \frac{\gamma_3}{n_3^2}(-\frac{\beta_2}{n_2^2} + \beta_4)cos2\gamma_3 d - (\frac{\gamma_3^2}{n_3^4} + \frac{\beta_2\beta_4}{n_2^2})sin2\gamma_3 d \end{cases}$$

$$det\, A = \frac{2}{K_0^3}(G + iH) \quad det\, A = \frac{2}{K_0^3}(G + iH)$$

$$det\, A = \frac{2}{K_0^3}(G + iH)exp(i\gamma_3(d + a))exp(-\beta_4 d)$$

With:

$$\begin{cases} G = \frac{\beta_2}{n_2^2}(X exp(\beta_2 a) + Y exp(-\beta_2 a)) \\ H = \frac{\gamma_1}{n_1^2}(-X exp(\beta_2 a) + Y exp(-\beta_2 a)) \end{cases}$$

$$\begin{pmatrix} -1 & -exp(\beta a) & -exp(-\beta a) & 0 & 0 & 0 \\ \frac{-\gamma}{nK} & \frac{\beta}{inK}exp(\beta a) & \frac{-\beta}{inK}exp(-\beta a) & 0 & 0 & 0 \\ 0 & 1 & 1 & -1 & -1 & 0 \\ 0 & \frac{-\beta}{inK} & \frac{\beta}{inK} & \frac{-\gamma}{nK} & \frac{\gamma}{nK} & 0 \\ 0 & 0 & 0 & exp(2i\gamma d) & exp(-2i\gamma d) & -1 \\ 0 & 0 & 0 & \frac{\gamma}{nK}exp(2i\gamma d) & -\frac{\gamma}{nK}exp(-2i\gamma d) & \frac{\beta}{iK} \end{pmatrix}$$

$$det\, A^{\backslash} = -\frac{\beta_2}{in_2^2K_0}exp(\beta_2 a)\begin{vmatrix} 1 & -1 & -1 & 0 \\ \frac{\beta_2}{in_2^2K_0} & \frac{-\gamma_3}{n_3^2K_0} & \frac{\gamma_3}{n_3^2K_0} & 0 \\ 0 & exp(2\gamma_3 d) & exp(-2\gamma_3 d) & -1 \\ 0 & \frac{\gamma_3}{n_3^2K_0}exp(2\gamma_3 d) & \frac{-\gamma_3}{n_3^2K_0}exp(-2\gamma_3 d) & \frac{\beta_4}{iK_0} \end{vmatrix} - \frac{\beta_2}{in_2^2K_0}exp(-\beta_2 a)\begin{vmatrix} 1 & -1 & -1 & 0 \\ -\frac{\beta_2}{in_2^2K_0} & \frac{-\gamma_3}{n_3^2K_0} & \frac{\gamma_3}{n_3^2K_0} & 0 \\ 0 & exp(2\gamma_3 d) & exp(-2\gamma_3 d) & -1 \\ 0 & \frac{\gamma_3}{n_3^2K_0}exp(2\gamma_3 d) & \frac{-\gamma_3}{n_3^2K_0}exp(-2\gamma_3 d) & \frac{\beta_4}{iK_0} \end{vmatrix}$$

$$-\frac{\gamma_1}{n_1^2K_0}exp(\beta_2 a)\begin{vmatrix} 1 & -1 & -1 & 0 \\ \frac{\beta_2}{in_2^2K_0} & \frac{-\gamma_3}{n_3^2K_0} & \frac{\gamma_3}{n_3^2K_0} & 0 \\ 0 & exp(2\gamma_3 d) & exp(-2\gamma_3 d) & -1 \\ 0 & \frac{\gamma_3}{n_3^2K_0}exp(2\gamma_3 d) & \frac{-\gamma_3}{n_3^2K_0}exp(-2\gamma_3 d) & \frac{\beta_4}{iK_0} \end{vmatrix} + \frac{\gamma_1}{n_1^2K_0}exp(-\beta_2 a)\begin{vmatrix} 1 & -1 & -1 & 0 \\ -\frac{\beta_2}{in_2^2K_0} & \frac{-\gamma_3}{n_3^2K_0} & \frac{\gamma_3}{n_3^2K_0} & 0 \\ 0 & exp(2\gamma_3 d) & exp(-2\gamma_3 d) & -1 \\ 0 & \frac{\gamma_3}{n_3^2K_0}exp(2\gamma_3 d) & \frac{-\gamma_3}{n_3^2K_0}exp(-2\gamma_3 d) & \frac{\beta_4}{iK_0} \end{vmatrix}$$

$$detA^{\backslash} = -(\frac{\beta_2}{in_2^2K_0} + \frac{\gamma_1}{n_1^2K_0})exp(\beta_2 a)I_1 - (\frac{\beta_2}{in_2^2K_0} - \frac{\gamma_1}{n_1^2K_0})exp(-\beta_2 a)I_2$$

$$detA^{\backslash} = -\frac{2}{K_0^3}(G - iH)exp(-i\gamma_3(d + a))exp(-\beta_4 d)$$

$$j = \frac{2}{K_0^3}\, exp(-i\gamma_3(d + a))\, exp(-\beta_4 d)$$

$$\begin{cases} detA = j(G+iH) \qquad j^* \text{ is the conjugate of } j \\ detA^{\backslash} = -j^*(G-iH) \\ \begin{pmatrix} 1 & -1 & -exp(-\beta a) & 0 & 0 & 0 \\ \frac{-\gamma}{nK} & \frac{-\gamma}{nK} & \frac{-\beta}{inK}exp(-\beta a) & 0 & 0 & 0 \\ 0 & 0 & 1 & -1 & -1 & 0 \\ 0 & 0 & \frac{\beta}{inK} & \frac{-\gamma}{nK} & \frac{\gamma}{nK} & 0 \\ 0 & 0 & 0 & exp(2i\gamma d) & exp(-2i\gamma d) & -1 \\ 0 & 0 & 0 & \frac{\gamma}{nK}exp(2i\gamma d) & -\frac{\gamma}{nK}exp(-2i\gamma d) & \frac{\beta}{iK} \end{pmatrix} \end{cases}$$

$$det\, B = -\frac{2\gamma}{nK} I \qquad \text{with } I = \frac{2i}{K} X$$

$$det\, B = -4\frac{i\gamma}{nK} X\, exp(-d(\beta + \beta))$$

$$\begin{pmatrix} 1 & -exp(\beta a) & -1 & 0 & 0 & 0 \\ \frac{-\gamma}{nK} & \frac{\beta}{inK}exp(\beta a) & \frac{-\gamma}{nK} & 0 & 0 & 0 \\ 0 & 1 & 0 & -1 & -1 & 0 \\ 0 & \frac{-\beta}{inK} & 0 & \frac{-\gamma}{nK} & \frac{\gamma}{nK} & 0 \\ 0 & 0 & 0 & exp(2i\gamma d) & exp(-2i\gamma d) & -1 \\ 0 & 0 & 0 & \frac{\gamma}{nK}exp(2i\gamma d) & -\frac{\gamma}{nK}exp(-2i\gamma d) & \frac{\beta}{iK} \end{pmatrix}$$

$$det\, B = \frac{2\gamma}{nK} I \qquad \text{with } I = \frac{2i}{K} Y$$

$$det\, B = 4\frac{i\gamma}{nK} Y\, exp(d(\beta - \beta))$$

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$$\begin{pmatrix} 1 & -exp(\beta a) & -exp(-\beta a) & -1 & 0 & 0 \\ \frac{-\gamma}{nK} & \frac{\beta}{inK}exp(\beta a) & \frac{-\beta}{inK}exp(-\beta a) & \frac{-\gamma}{nK} & 0 & 0 \\ 0 & 1 & 1 & 0 & -1 & 0 \\ 0 & \frac{-\beta}{inK} & \frac{\beta}{inK} & 0 & \frac{\gamma}{nK} & 0 \\ 0 & 0 & 0 & 0 & exp(-2i\gamma d) & -1 \\ 0 & 0 & 0 & 0 & -\frac{\gamma}{nK}exp(-2i\gamma d) & \frac{\beta}{iK} \end{pmatrix}$$

$$det\,C = \frac{2\beta\gamma}{in\,nK}\begin{vmatrix} -\frac{\gamma}{K} & 0 & 0 \\ 0 & exp(-2\gamma d) & -1 \\ 0 & -\frac{\gamma}{K}exp(-2\gamma d) & \frac{\beta}{iK} \end{vmatrix}$$

$$det\,C = \frac{4\beta\gamma}{n\,nK}(\beta - i\frac{\gamma}{n})\; exp(-2i\gamma d)$$

$$det\,C = \frac{4\beta\gamma}{n\,nK}(\beta - i\frac{\gamma}{n})\; exp(-2i\gamma d)exp(-\beta d)$$

$$\begin{pmatrix} 1 & -exp(\beta a) & -exp(-\beta a) & 0 & -1 & 0 \\ \frac{-\gamma}{nK} & \frac{\beta}{inK}exp(\beta a) & \frac{-\beta}{inK}exp(-\beta a) & 0 & \frac{-\gamma}{nK} & 0 \\ 0 & 1 & 1 & -1 & 0 & 0 \\ 0 & \frac{-\beta}{inK} & \frac{\beta}{inK} & \frac{-\gamma}{nK} & 0 & 0 \\ 0 & 0 & 0 & exp(2i\gamma d) & 0 & -1 \\ 0 & 0 & 0 & \frac{\gamma}{nK}exp(2i\gamma d) & 0 & \frac{\beta}{iK} \end{pmatrix}$$

$$det\,C\; = -\frac{4\beta\gamma}{in\,nK}(\beta + i\frac{\gamma}{n})\; exp(2i\gamma d)$$

$$det\,C\; = -\frac{4\beta\gamma}{in\,nK}(\beta + i\frac{\gamma}{n})\; exp(2i\gamma d)exp(-\beta d)$$

$$\begin{pmatrix} 1 & -exp(\beta a) & -exp(-\beta a) & 0 & 0 \\ \frac{-\gamma}{K} & \frac{\beta}{iK}exp(\beta a) & \frac{-\beta}{iK}exp(-\beta a) & 0 & 0 \\ 0 & 1 & 1 & -1 & -1 \\ 0 & \frac{-\beta}{iK} & \frac{\beta}{iK} & \frac{-\gamma}{K} & \frac{\gamma}{K} \\ 0 & 0 & 0 & exp(2i\gamma d) & exp(-2i\gamma \\ 0 & 0 & 0 & \frac{\gamma}{K}exp(2i\gamma d) & -\frac{\gamma}{K}exp(-2 \end{matrix}$$

$$det\,D = \frac{-8i\gamma\gamma\beta}{K}$$

The coefficients A, A, B, B, C, C, D are given by the following relationship:

$$\frac{A}{det\,A} = \frac{A}{det\,A} = \frac{B}{det\,B} = \frac{B}{det\,B} = \frac{C}{det\,C} = \frac{C}{det\,C} = \frac{D}{det\,D}$$

$$A\; = -A\frac{\mathrm{j}(G - iH)}{\mathrm{j}(G + iH)}$$

$$B = -A\frac{4i\gamma \mathrm{X}}{K\,\mathrm{J}(G + iH)}\; exp(-d(\beta + \beta))$$

$$B\; = A\frac{4i\gamma \mathrm{Y}}{K\,\mathrm{J}(G + iH)}\; exp(-d(\beta - \beta))$$

$$C = A\frac{4\beta\gamma}{K\,\mathrm{J}(G + iH)}\;(\beta - i\gamma)\; exp(-d\beta)\; exp(-i\gamma d)$$

$$C\; = -A\frac{4\beta\gamma}{K\,\mathrm{J}(G + iH)}\;(\beta + i\gamma)\; exp(-d\beta)\; exp(i\gamma d)$$

$$D = -A\frac{8i\gamma\gamma\beta}{K\,\mathrm{j}(G + iH)}$$

Results:

We take an incidence angle close to the critical angle (optimum of transmission in the TE mode). See reference.[1]

$\theta_{inc} = 52^0$

$$\begin{cases} E_x = \frac{1}{iK_0 n^2}\frac{\partial B_y}{\partial z} \\ E_z = -\frac{K_x}{K_0 n^2}B_y \end{cases}$$

$$\vec{E}_T = E_x\vec{i} + E_z\vec{k}$$

$$\vec{E}_T(4) = E_x(4)\vec{i} + E_z(4)\vec{k}$$

$$\vec{E}_T = \frac{\beta_4}{iK_0 n^4}D\,exp(\beta_4 z)\vec{i} - \frac{K_x}{K_0 n^4}D\,exp(\beta_4 z)\vec{k}$$

$$\vec{E}_T(4).conj(\vec{E}_T(4)) = \left|D\right|^2 \exp(2\beta_4 z)$$

$$\vec{E}_T(1) = \frac{\gamma_1}{K_0 n_1^2}(-A exp(-i\gamma_1 z) + A`exp(i\gamma_1 z))\vec{i} - \frac{K_x}{K_0 n_1^2}(A exp(-i\gamma_1 z) + A`exp(i\gamma_1 z))\vec{k}$$

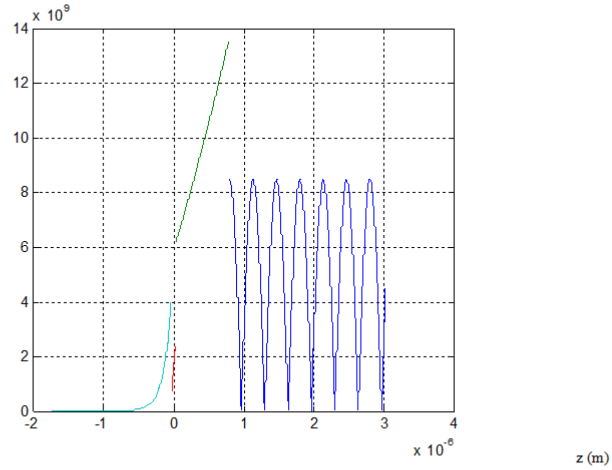

Figure 2 The perpendicular component E_Z of the electric field (V/m).

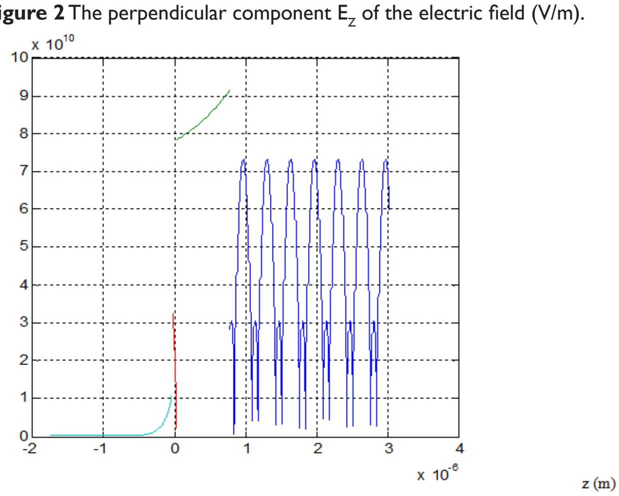

Figure 3 The parallel component E_X of the electric field (V/m).

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$$\begin{cases} E_x = \dfrac{1}{iK_0 n^2}\dfrac{\partial B_y}{\partial z} \\ E_z = -\dfrac{K_x}{K_0 n^2} B_y \end{cases}$$

$$\vec{E}_T = E_x \vec{i} + E_z \vec{k}$$

$$\vec{E}_T(4) = E_x(4)\vec{i} + E_z(4)\vec{k}$$

$$\vec{E}_T = \frac{\beta_4}{iK_0 n^4} D\exp(\beta_4 z)\vec{i} - \frac{K_x}{K_0 n^4} D\exp(\beta_4 z)\vec{k}$$

$$\vec{E}_T(4).conj(\vec{E}_T(4)) = |D|^2 \exp(2\beta_4 z)$$

$$\vec{E}_T(1) = \frac{\gamma_1}{K_0 n_1^2}(-A\exp(-i\gamma_1 z) + A`\exp(i\gamma_1 z))\vec{i} - \frac{K_x}{K_0 n_1^2}(A\exp(-i\gamma_1 z) + A`\exp(i\gamma_1 z))\vec{k}$$

$$\vec{E}_T(1).conj(\vec{E}_T(1)) = \frac{|A|^2}{n_1^4}$$

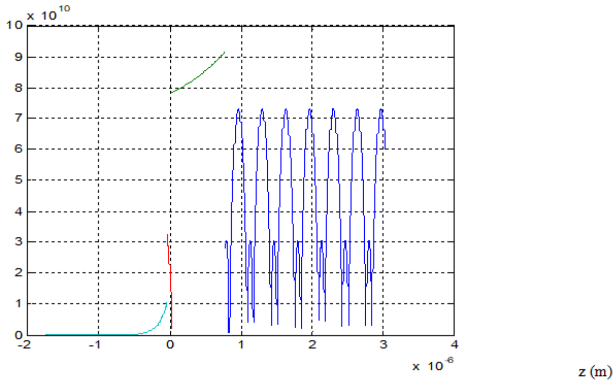

Figure 4 The total electric field E_T in the atomic mirror function of the transverse coordinate z.

We notice that the electric field is bigger in the gap and then decreases in the vaccum where it is smaller than in the prism.

The transmission factor is given by:[4]

$$T = \left| \frac{\vec{E}_T(4) \quad z=-d}{\vec{E}_T(1) \quad z=d+a} \right|^2 = \frac{\vec{E}_T(4).\,conj(\vec{E}_T(4)) \quad z=-d}{\vec{E}_T(1)\,.conj(\vec{E}_T(1)) \quad z=d+a}$$

$$T = \frac{(4\gamma_1\gamma_3\beta_2)^2}{n_2^2 n_3^2 (G^2 + H^2)}$$

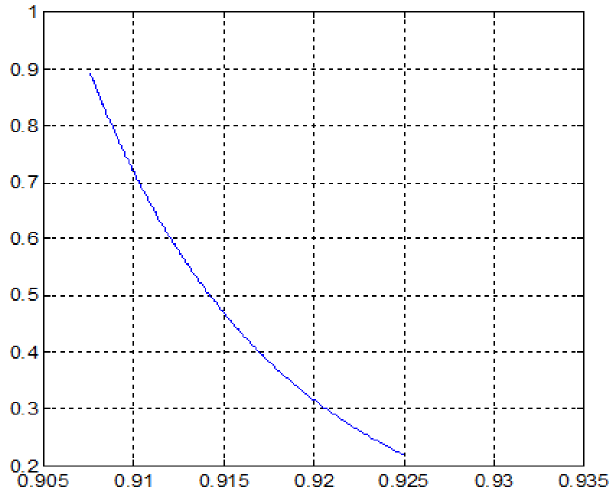

Figure 5 The transmission factor in the atomic mirror.

We conclude that there is no enhancement in the vaccum for the electric field and there is no technological progress or advantage for this kind of excitation.[1,5-7]

Acknowledgments

None.

Conflicts of Interset

None.

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