Magnetooptic Rotation of Electromagnetic Waves in Bianisotropic plasma

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Abstract-In this paper; we propose a study of the phenomena of rotatory polarization witch explaining the problem of electromagnetic waves propagation in longitudinal direction through the plasma and their comportment in the presence of chirality and statistic magnetic field. This is lead to study the electromagnetic properties of bianisotropic or chiral media with intrinsic magnetic structures which have a special interest. Their field of applications remains very wide, from microwaves to optics grace to their nonreciprocity which is traduced by the nonlinear constitutive relations

A chiral plasma medium is a macroscopically continuous medium composed of equivalent chiral objets, uniformly distributed and randomly oriented. A chiral object is three dimensional that cannot be superimposed on its mirror image by translation and rotation. A chiral object has the property of handedness: It must be either left-handed or right-handed. An equal amount of right- and left-handed chiral objects would cause the sample to be racemic and absence of handedness all together would make an achiral sample. Some chiral objets are naturally the mirror image of an others chiral objets (see Figure1). So, we said that to be enantiomorphs of each other. If a chiral objets is left-handed, its enantiomorph is right-handed, and vice verça (see Figure1).

Figure 1: Some chiral objets are naturally the mirror image of an others chiral objets.

In chiral media is not sufficient to describe it by ε and μ as a dielectric media permitting a single phase velocity, but we need to an additional parameter called parameter ξ to describe their handedlless (positive for righthanded and negative for left-handed medium).

For parallel propagation to the bias magnetic field $\left(\vec{k} \,//\, \vec{B}_0\right)$, i.e $\theta = 0$ and one gets in this case the system of equations:

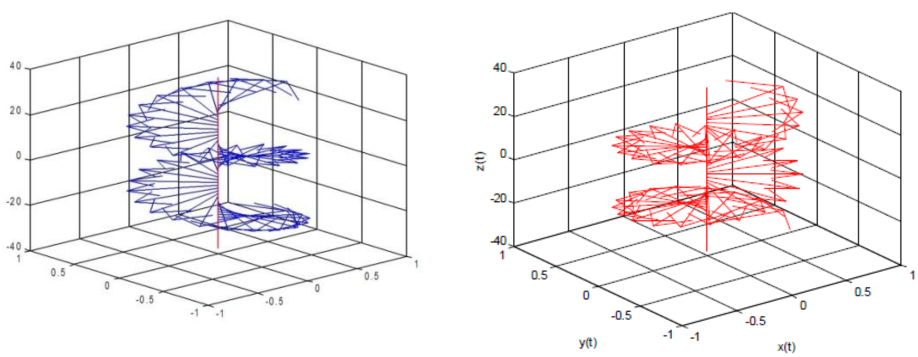
$$\begin{cases} \left(N^2 - \varepsilon_R\right)E_R = 0 \\ \left(N^2 - \varepsilon_L\right)E_L = 0 \\ \varepsilon_3\left(1 - \dfrac{\xi^2}{\varepsilon_3}\right)E_z = 0 \end{cases} \tag{3}$$

Discussion

From system (3), we solve the equation $\varepsilon_3\left(1-\frac{\xi^2}{\varepsilon_3}\right)E_z = 0$ and we obtain the longitudinal electron plasma oscillations mode modified by the chiral parameter ξ and for this mode there is not wave propagation along the magnetic field [5]. The solution of two others equations, $E_{R,L} = E_x \pm iE_y$, gives the following expressions:

$$k_R = \frac{\xi\omega}{c} \pm \frac{\omega}{c}\sqrt{\varepsilon_1 + \varepsilon_2} \tag{8}$$

$$k_L = -\frac{\xi\omega}{c} \pm \frac{\omega}{c}\sqrt{\varepsilon_1 - \varepsilon_2} \tag{9}$$



(a) (b)

Figure 2 : (a) Right-hand circular polarization (RHCP), E_R (b) Left-hand circular polarization (LHCP), E_L .

There are two senses of circular polarization, 2 right-hand circular polarizations (RHCP) and 2 left-hand circular polarizations (LHCP). The handedness property describes the rotation of the electric-field vector (clockwise or counterclockwise) relative to the direction of propagation as given on figure 2.

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