OBSERVATION OF BIREFRINGENCE OF WAVES IN A BOUNDED INHOMOGENEOUS PLASMA CONFINED IN A MAGNETOSTATIC WELL*

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The interaction of electromagnetic (EM) waves with magnetized plasmas is an active area of research[1]. Most of the research so far have focused upon waves launched in the ($\boldsymbol{k} \parallel \boldsymbol{B_o}$) mode where the wave vector ($\boldsymbol{k}$) is parallel to the static magnetic field ($\boldsymbol{B_o}$), and $\boldsymbol{B_o}$ is approximately uniform over the plasma volume with the dimension of the plasma much larger than the free space wavelength λ_o, corresponding to the launched waves. There are only a few investigations in the $\boldsymbol{k} \perp \boldsymbol{B_o}$ mode.

We study wave interaction with bounded plasmas in the $\boldsymbol{k} \perp \boldsymbol{B_o}$ mode where the waveguide cutoff wavelength λ_c is comparable [λ_c(≅14 cm) ~λ_o(≅12 cm)] to λ_o. A high-density, radially inhomogeneous argon plasma is generated and confined in a cylindrically symmetric magnetostatic well ($B_o \propto r^3$), created by an octupole arrangement of permanent magnets surrounding the waveguide[2].

In this work, the effect of the inhomogeneous, anisotropic magneto-plasma[3] on the polarization of the penetrating waves is experimentally investigated. Polar measurement of the wave electric-field ($\boldsymbol{E}$) intensity reveals that $\boldsymbol{E}$ is linearly polarized in the radial plane as expected. However, an asymmetry is observed in the lobes of the dipole-like $\boldsymbol{E}$-field polar intensity variation. The axis of polarization with respect to vacuum rotates with increase in plasma density and axial plasma interaction length (L_o). We found that for $L_o \sim 15$ cm, the rotation angle $\Delta\phi \sim 10°$. Such rotation hitherto unreported in laboratory bounded plasmas may be attributed to birefringence of the wave in the medium similar to optical crystals. Measurement of the wave vector $\boldsymbol{k}$ in the magneto-plasma by heterodyne technique is expected to shed further light on the nature of the birefringence.

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