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A NEW LOOK AT SURFACE-WAVE SUSTAINED PLASMA: MAGNETIC CURRENT MODEL TREATED BY A FIXED-POINT METHOD

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An analytical description and numerical investigation of the cylindrical plasma columns produced and sustained by a weakly damped surface-wave is presented. This paper suggests using a simple magnetic current model in order to obtain a general expression for normalized power of surface-wave. This expression can be deduced theoretically from the full-wave theory already used for such plasmas. The diagrams of normalized power are computed by an iterative procedure known as the fixed-point method. The fixed-point method appears as the natural choice for the numerical treatment of formulae that could arise in a broad class of physical problems usually recognized as guided surface plasma waves.

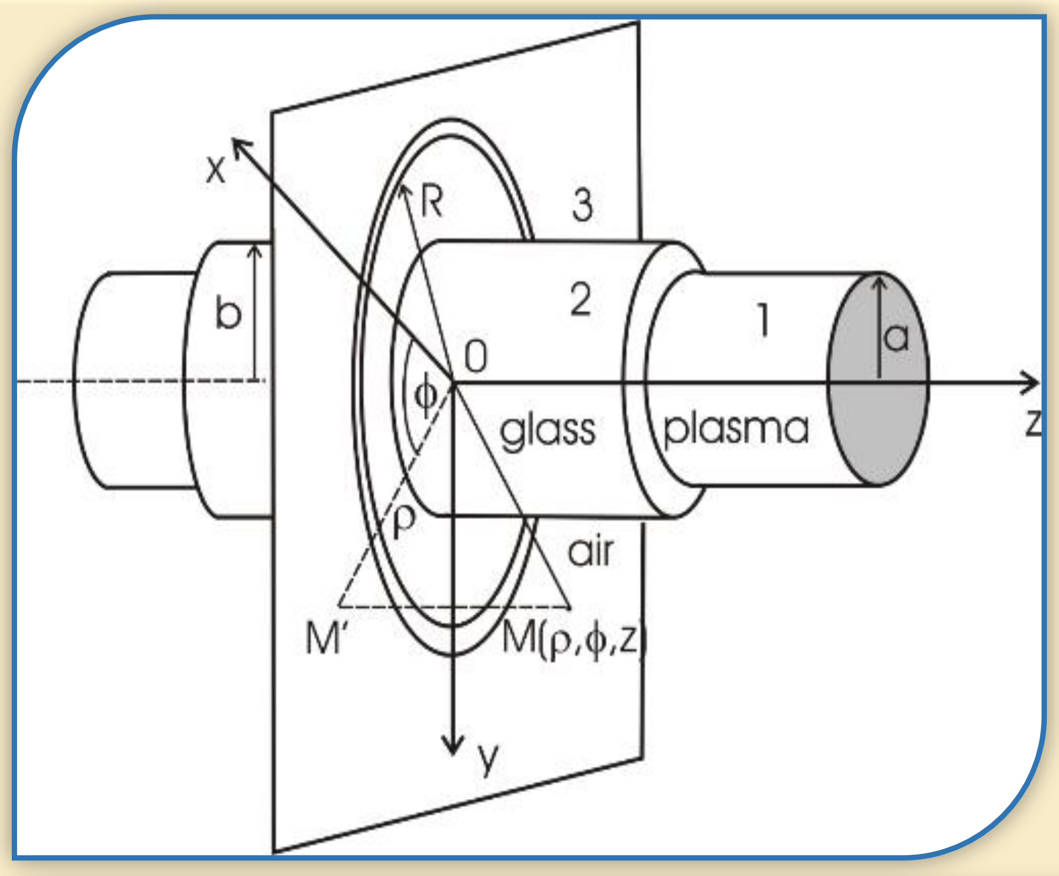

Figure 1:
(a) Geometric characteristic and applied cylindrical system

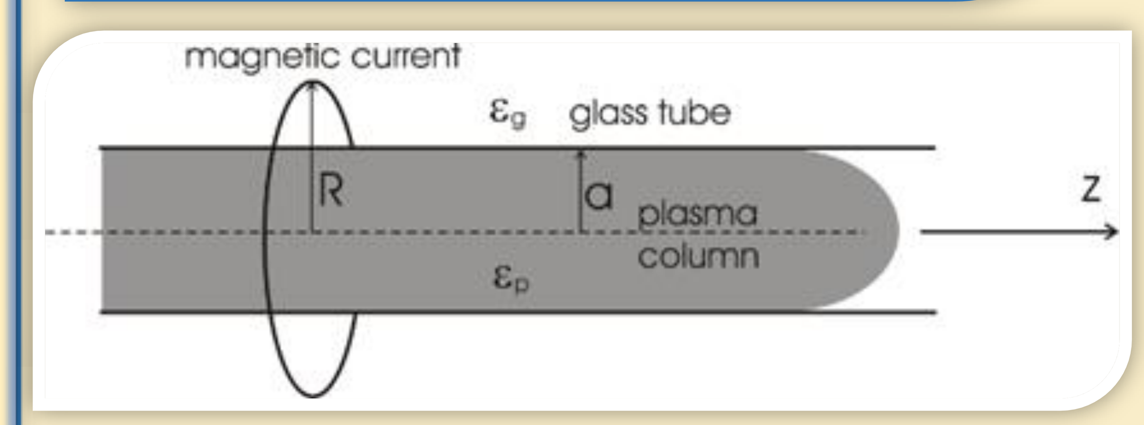

Figure 1:
(b) Plasma created by the magnetic current

MAGNETIC CURRENT MODEL: FEATURES OF THE FIELD

$$\nabla \times \vec{H} = \varepsilon_0 \varepsilon \, \partial \vec{E} / \partial t$$

$$\nabla \times \vec{E} = -\mu_0 \partial \vec{H} / \partial t - \vec{J}_m$$

$$J_{m\phi} = U \delta(\rho - R) \delta(z)$$

$$Q = \frac{1}{2} \int_{S_\perp} \sigma |E|^2 dS_\perp$$

$$Q_1 = \frac{\sigma_1}{2} \int_0^a |E_1|^2 \, 2\pi\rho \, d\rho = \pi\sigma_1 \int_0^a \left(|E_{1z}|^2 + |E_{1\rho}|^2 \right) \rho \, d\rho$$

$$Q_2 = \frac{\sigma_2}{2} \int_a^\infty |E_2|^2 \, 2\pi\rho \, d\rho = \pi\sigma_2 \int_a^\infty \left(|E_{2z}|^2 + |E_{2\rho}|^2 \right) \rho \, d\rho$$

$$\tilde{Q} = \tilde{Q}_1 + \tilde{Q}_2$$

An analytical model, known as a magnetic current model, for the axial structure of weakly collisional surface-wave sustained plasma was developed. In order to demonstrate the effectiveness of the fixed-point method, the normalized power vs. normalized wavenumber was calculated. The normalized power per unit length versus normalized phase coefficient for three values of tangent loss was presented. We notice that the absorbance of the power has a clearly expressed maximum around the point X~3 for the given parameters; the magnitude of the maximum depends on dielectric losses such that $\tilde{Q}$ in general increases as $tg\delta$ increases. This characteristic is very important for analyzing surfatron plasma as well as for calculation of the attenuation coefficient α.

RESULTS AND DISCUSSION

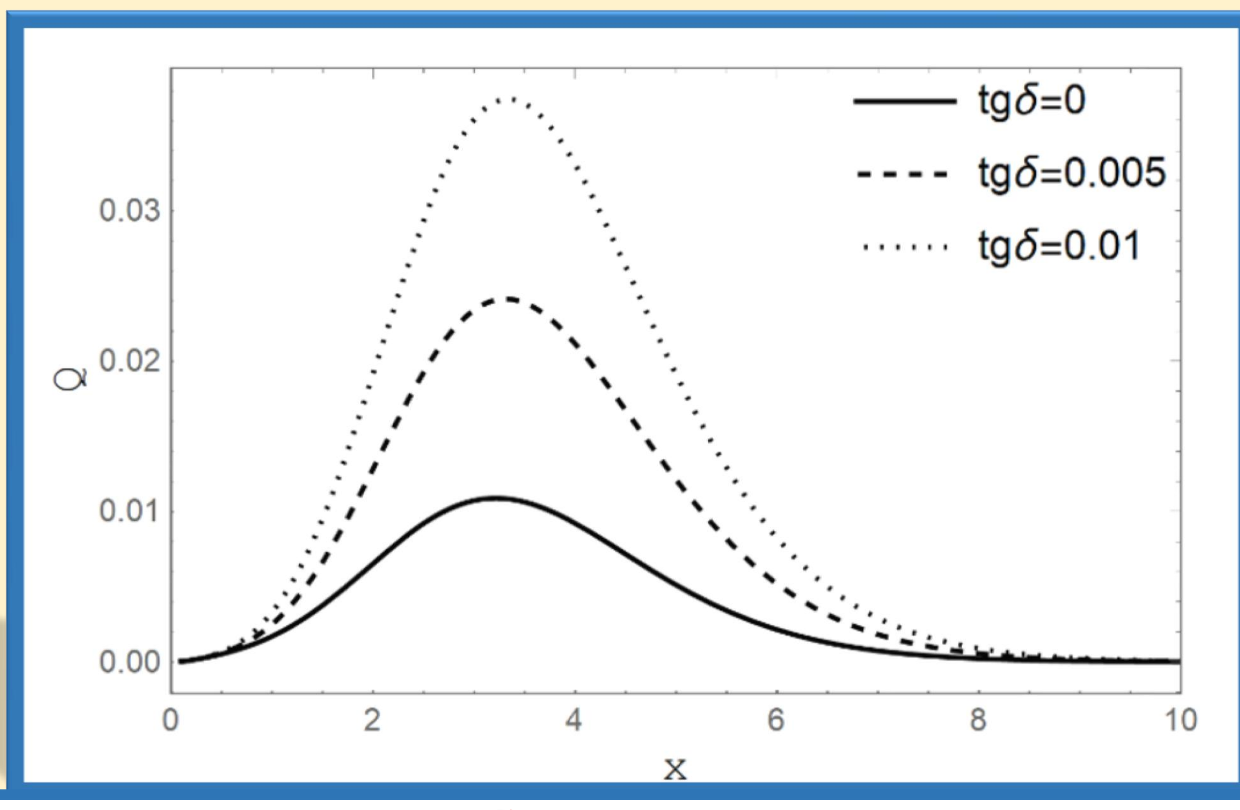

Figure 2: Normalized power $\tilde{Q}$ versus normalized wavenumber $X = \beta a$.

Acknowledgements

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