RESONANT TRAVELING WAVES INDUCED ON A RING SCATTERER

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An integro-differential equation for the current induced by a plane wave incident upon a thin circular conducting loop is solved using a combination of numerics and high frequency asymptotics. The thin-wire kernel approximation is used. Fourier coefficients of the ring current are evaluated using the FFT algorithm applied to the kernel function. The self-convergence of the numerical results plus agreement with published data by King and Smith indicate that the numerical implementation is accurate. Asymptotic formulae are derived for the Fourier coefficients of the thin wire kernel in the integral equation and checked against the FFT results. The total current induced on the ring by a plane electromagnetic wave is approximated by a modified physical optics term proportional to the incident field, plus resonant terms of lossy circulating waves. Numerical evaluation of the dominant poles and residues of the ring transfer function provides the amplitudes and complex propagation constants of these natural modes.

The real part of the dominant poles (in complex Fourier index n) is always close to ka. The Fourier coefficients of the excitation are roughly $J_n(ka \sin\theta_0)$, which demonstrates the increasing importance of the resonant currents for angles of incidence approaching grazing ($\theta_0 \to \pi/2$).

The phase velocity of the eigenwaves of the ring is therefore close to c; both faster and slower wave components are possible. The attenuation constant (imaginary part of the pole of the transfer function) must account for radiation damping by circulating charges. No meaningful purely analytic expressions have been found for these physically important parameters that are numerically extracted from the complex transfer function of the ring scatterer.

This conference paper is an oral presentation of research reported in:

Shaohua Li and R.W. Scharstein
High Frequency Scattering by a Conducting Ring
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