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Q-factor enhancement of open 2D resonators by placement of thin metallic rods near the aperture.

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Thin metallic rods or wires are often used for tuning slotted resonators and waveguides. A vast number of publications have appeared in the literature and some of the approaches are exemplified in references [1-5]. In this paper we consider a perfectly electrically conducting two-dimensional slotted cylindrical cavity of arbitrary cross-section, and a thin metallic rod or wire aligned with the axis of the cavity, also of arbitrary cross-section. The structure is illuminated by an E-polarised time-harmonic electromagnetic plane wave, incident from some specified direction.

The evaluation of the electromagnetic interaction between the rod and cavity may be posed as a classical boundary value problem for the 2D Helmholtz equation, and transformed with the use of the free-space 2D Green's function to an equivalent integral equation formulation for the currents induced on the cross-sectional surfaces. This has the form of a coupled set of integral equations of first kind that is unsatisfactory for the accurate evaluation of the currents and other physical observables, especially near the edges of the aperture, due to the ill-posedness of such systems of equations.

It is highly beneficial to transform the integral equations to an equivalent well-posed and well-conditioned system by employing the method of analytical regularization described in [10-11]. This produces well-posed coupled infinite systems of linear algebraic equations for the coefficients of the Fourier expansions of the surface currents induced on rod and slotted cavity. These systems of linear equations are of second kind and may be solved by a truncation method to obtain a solution that converges in a fast and reliable method to the exact solution as the truncation number increases, permitting solutions of any pre-specified accuracy to be obtained. This it becomes possible to investigate the spectral and scattering characteristics of the coupled rod-cavity pair at any desired level of accuracy.

The examples studied in this paper concern the accurate calculation of the complex eigenvalues for the coupled rod and slotted cavity and their dependence on the location of the rod relative to the cavity; from these studies the optimal location of the rod, at which significant enhancement of the Q-factor may be observed, can be deduced. This effect may be exploited in the design of advanced slot antennas and slotted waveguides. Typical structures of strong interest include the open circular cavity or the open rectangular cavity.

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