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On the Resonances of Characteristic Modes

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1 Extended Abstract

The theory of characteristic (TCM) modes provides excitation-independent eigensolutions of a problem that are able to describe all the possible states supported by the structure. This enables characterization of the electromagnetic properties of the structure relying only on its geometry and material properties. These characteristic solutions can provide important physical insight to the problem and lead to antenna designs with many attractive properties.

Most often the TCM analysis of a perfectly conducting (PEC) object is based on the electric field integral operator (EFIO) [1]. The method works fine as long as the problem includes open PEC surfaces only. For closed PEC surfaces TCM based on both EFIO and the magnetic field integral operator (MFIO) fail to produce correct modes as the frequency agrees with the internal resonance frequency of the body [2]. The problem becomes even more challenging as the structure is penetrable and the TCM equations can be formulated in many alternative ways [3, 4].

Our aim is to identify various resonances of characteristic modes, both physical and non-physical (spurious). As an example, Figure 1 shows the magnitudes of the eigenvalues of four lowest order modes computed with the EFIO and MFIO-based TCM for a PEC sphere of radius one meter versus frequency. The extremum of the eigenvalues show the resonances. Clearly, the modes of EFIO and MFIO have different resonant characteristics.

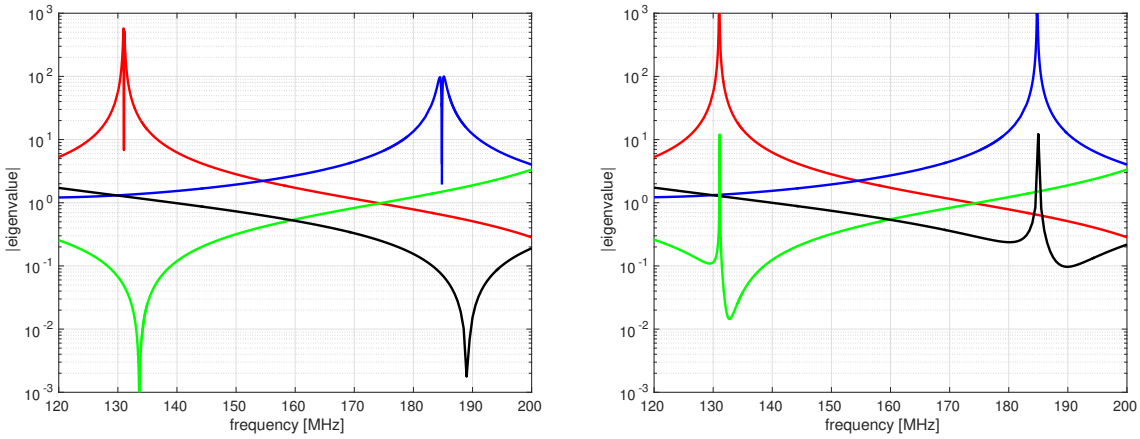

Figure 1. Magnitudes of the eigenvalues of four low order modes. EFIO left, MFIO right.

In the presentation the analysis of TCM resonances will be extended for imperfectly conducting bodies modelled with the impedance boundary condition and for homogeneous penetrable (dielectric) objects.

References

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