

# APPLIED MATHEMATICS COLLOQUIUM

## COMPUTING EIGENVALUES OF ELECTROMAGNETIC RESONATOR CAVITIES

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### ABSTRACT:

The talk addresses the computation of a few selected resonant modes of lossy axisymmetric resonator cavities. These modes are known to obey the Maxwell equations, and are solutions of a vector wave equation described in form of a boundary value problem. Since the latter can hardly ever be solved exactly, we approximate the sought solutions by means of the finite element method. More precisely, we recast the vector wave problem into an appropriate weak form which is particularly well suited for axisymmetric cavities.

The very nature of the wave equation requires that special finite elements be used in order to avoid spurious solutions. The choice of hybrid Nedelec elements guarantees the desired avoidance of non-physical modes. Another peculiarity of the axisymmetric approach concerns the accurate evaluation of the aforementioned weak form. By exploiting rotational symmetry, some of the quantities to be computed exhibit displeasing characteristics and can hence no longer be computed in a straightforward manner. To this end we developed numerical schemes that allow for an accurate and efficient evaluation of the critical quantities.

A further speciality of our problems concerns the proper consideration of leaky waves. Lossy cavities radiate into their surroundings – an effect which has to be appropriately incorporated, in order for the simulation results to be meaningful. The use of perfectly matched layers, particular layers of absorbing material which can seamlessly be incorporated in our finite element model, provides an attenuation of leaky waves and leads to the desired consideration.

The discretisation of the vector wave equation by means of the finite element method in combination with the use of perfectly matched layers transforms the resonator cavity problem into a generalized complex-symmetric eigenvalue problem. The computation of a few selected resonant modes translates into the computation of a few selected eigenpairs. To accomplish this task, we derived a subspace eigenvalue solver which belongs to the family of Jacobi–Davidson solvers. In order for the algorithm to be efficient, we geared the solver and all related components towards the complex-symmetric case.

In particular, this entailed the design and adaption of subspace extraction routines, linear system solvers and preconditioners, the latter being a key ingredient of the eigenvalue solver.

**MONDAY, SEPTEMBER 11, 2006**

**4:30 PM**

**Building 2, Room 105**

*Refreshments at 4:00 PM in Building 4, Room 174  
(Math Majors Lounge)*

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