The Hong Kong University of Science and Technology

Department of Mathematics

PhD THESIS EXAMINATION

Computation of Optical Eigenstates in Dielectric Systems

By

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ABSTRACT

The optical eigenstates are the quasi time-steady states of electromagnetic fields in the dielectric systems. As the electromagnetic fields evolve according to Maxwell's equations, energy of the system keeps radiating to infinity. This makes the physical system non-Hermitian and the boundary condition for the eigen problem exponentially growing at infinity. In this thesis, a numerical method and a perturbation method are developed for computing the optical eigenstates in dielectric systems.

The numerical approach is developed based on the perfectly-matched-layer method by introducing the complex stretching technique to transform the original eigen problem into its equivalent damping one, which can be solved by the finite element method. The numerical method is validated by successful applications to the whispering-gallery eigenstates in circular disks. The numerical method is applied to investigate the eigenstates transitions near exceptional points, to study the symmetries of eigenstates in axial-symmetric cavities and to inspect the evolution of a pair of degenerate eigenstates as cavity shape deforming from circle to square.

The perturbation approach is developed by splitting the original eigen problem into a summation of perturbation orders, which can be solved one by one in ascending orders. The analytical perturbation approximation is applied to calculate the optical eigenstates in different types of deformed cavities. The perturbation method also successfully explains the splitting of clockwise and counter-clockwise degeneracy in whispering-gallery modes.

The numerical method and perturbation method presented in this thesis are able to facilitate the research of the inverse problem: engineering the optical eigenstates by manipulating the dielectric distributions.

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Time: **3:00 p.m.**

Venue: **Online via Zoom**
https://hkust.zoom.us/j/97983024253 (Passcode: 046983)

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The student's thesis is now being displayed on the reception counter in the General Administration Office (Room 3461).