Sign-preserving of principal eigenfunctions in P1 finite element approximation of eigenvalue problems of second-order elliptic operators

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Abstract
This talk is concerned with the P1 finite element approximation of the eigenvalue problem of second-order elliptic operators subject to the Dirichlet boundary condition. The focus is on the preservation of basic properties of the principal eigenvalue and eigenfunctions of continuous problems. We shall show that when the stiffness matrix is an irreducible M-matrix, the algebraic eigenvalue problem maintains those properties such as the smallest eigenvalue being real and simple and the corresponding eigenfunctions being either positive or negative inside the physical domain. Mesh conditions leading to such a stiffness matrix are also discussed. A sufficient condition is that the mesh is simplicial, acute when measured in the metric specified by the inverse of the diffusion matrix, and interiorly connected. The acute requirement can be replaced by the Delaunay condition in two dimensions. Numerical results are presented to verify the theoretical findings.