Block iterative methods to compute the lambda modes of a nuclear power reactor

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Abstract

Given a configuration of a nuclear reactor core, it is possible to force its criticality dividing the neutron production rate by a positive number, λ, obtaining a neutron balance equation, known as the λ-modes problem. This is a differential eigenvalue problem, which is discretized using a finite element method to obtain a generalized algebraic eigenvalue problem.

Generally, the dominant eigenvalues and their corresponding eigenfunctions are computed for different applications, such as studying the criticality of reactor and to develop modal methods for transient analysis. Thus, it will be interesting to develop efficient methods to compute a set of eigenpairs. For that purpose, Krylov subspace based method have shown effective. As an alternative, we propose to solve the generalized eigenvalue problem combining a hierarchy of meshes with block iterative methods to solve the eigenvalue problem in each one of the meshes. In particular, different block methods are studied. The first is a procedure based on the Modified Block Newton method [1]. The second, an eigensolver based on subspace iteration and accelerated with Chebyshev polynomials [2]. And also, a block algorithm based on the Locally Optimal Block Preconditioned Conjugate Gradient method [3] for non-symmetric eigenvalue problems will be analyzed. To test the performance of the different methods, different benchmark problems will be studied comparing their performance with Krylov-Schur method implemented in SLEPc library [4].

References

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