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Eigensolvers for radiation transport applications

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An area of active interest in nuclear reactor analysis is the solution of the generalized eigenvalue problem corresponding to the discretized Boltzmann radiation transport equation. In particular, the dominant eigenvalue has a physical interpretation as the multiplication factor of the system. We are interested in identifying this dominant eigenvalue and the corresponding eigenvector (the neutron flux). The most commonly used method for approaching this task is a straightforward power iteration, possibly with some form of acceleration (Chebyshev, diffusion-based, etc.). For difficult problems, however, convergence can be unacceptably slow, motivating the desire for more effective techniques. In this study we provide a comparison of the performance of several eigensolvers including Rayleigh quotient iteration, Newton's method, the implicitly restarted Arnoldi method, and a Jacobi-Davidson method. Difficulties in solving linear sub-problems will be addressed, including a discussion of potential preconditioners.