

A domain decomposition method for the resolution of an eigenvalue problem in neutron physics

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Abstract

The simulation of the neutron transport inside a nuclear reactor leads to the computation of the lowest eigen pair of a simplified transport operator T [1]. The numerical strategy at our disposal today presents two drawbacks. On the one hand, the memory requirement is so high that certain case studies cannot be carried out on standard workstations. On the other hand, the solver is based on a conforming cartesian mesh, which does not allow us to locally refine the mesh in zones of interest.

The computation of the lowest eigen pair of T is done by computing the highest eigenmode of T^{-1} with the power algorithm. At each iteration, a block Gauss-Seidel algorithm is used to solve a linear system of the form $Ax = b$. For our application, one Gauss-Seidel iteration is already sufficient to ensure the right convergence of the power algorithm.

For the resolution of the linear system, we propose a non overlapping domain decomposition based on the introduction of Lagrange multipliers in order to deal with different numerical approximations (mesh size, finite element order) between two adjacent subdomains [2].

The method performs well on simple test cases provided that the linear system is solved sufficiently accurately. Furthermore, we present results from parallel computations on up to 100 procesors for an industrial test case.

REFERENCES

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