h-p Finite Element Method for the Simplified P_N equations

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ABSTRACT

The neutron transport equation describes the power distribution inside the core of a nuclear reactor. The usual approximation of this equation by the multigroup neutron diffusion equation does not provide enough accurate results for complex fuel assemblies or fine mesh calculations. To improve the results, a method that incorporates some angular dependence, as the simplified spherical harmonics method (SP_N), must be employed [1].

To discretize the problem a finite element method with *h-p*-adaptivity is used [2]. This method allows different refinements such as the use of *h*-adaptive meshes, reducing the size of specific cells, and *p*-refinement, increasing the polynomial degree of the basic functions used in the expansions of the solution in the different cells. Mesh refinement techniques rely on the use of a posteriori error estimators which approximate discretization errors and select which cell will be refined [3].

In this work, an automated *h-p*-finite element method for the Simplified P_N equations is proposed, where a physics coherent error estimator is employed. The performance of the proposed methodology has been tested for different two-dimensional and three-dimensional reactor benchmarks. Numerical results show that *h-p*-adaptable meshes need a smaller number of degrees of freedom and CPU time to achieve the same accuracy as globally refined meshes.

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