An updated proper orthogonal decomposition to approximate the time-dependent neutron diffusion equation

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Abstract: Accurate and fast simulations in nuclear reactors depend on obtaining efficient approximations to the neutron transport equation. The prohibitive cost of its resolution has recently led to the application of Reduced Order Model (ROM) especially for the neutron diffusion equation [1]. These algorithms approximate high-dimensional systems by low-dimensional ones, which are much faster to solve and have, as far as possible, the accuracy of the full model [2]. In this context, this work proposes a ROM method for the time-dependent multigroup neutron diffusion equation based on the Proper Orthogonal Decomposition (POD) approach.

This projection-based method consists of two steps. In the offline step, a reduced space has to be built from previously known data, called 'snapshots', and singular value decompositions. Several types of sampling techniques are tested to obtain efficient methods for a given reactor transient. A strategy for selecting the dimension of the basis of the snapshots is also investigated. In the online step, the reduced model is solved on the reduced space, which requires much less computational time than the original problem. Additionally, this work investigates the updating of the reduced space along the transient to improve the reduced model with a moderate number of snapshots. The accuracy and computational time of the proposed POD method are verified in several benchmark problems. The numerical results are compared with the full order model.

References:

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