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Neutron transport discretization methods based on using spectral expansions

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Abstract: We consider in this contribution the monoenergetic neutron transport equation in multiregion media and we review the discretization methods based on the use of spectral expansions in each homogeneous subregion, using the interface continuity requirements to determine the unknown coefficients of these expansions.

The spectral analysis of the monoenergetic neutron transport equation has been deeply investigated in the late century, following the well-known works by Case and Mika among others and various forms of the spectral representation of the monoenergetic neutron transport operator were established, in particular for infinite homogeneous media. One can use these representations to express the solution of a particular problem in a subcritical infinite homogeneous medium and, in the case of a multiregion medium, express in this way the solution in each homogeneous region separately but with unknown coefficients to be determined through the use of the continuity condition of the neutron flux at the interfaces.

These methods have today a well developed basis in 1D geometries and very accurate codes have been developed in these cases, mostly in plane geometry. We shall therefore concentrate in this talk on their developments in multidimensional geometries which have now been undertaken. 2D or 3D codes do not yet exist in this field but are planned and some preliminary checks have been conducted with the available 1D codes to select generalized techniques that can be expected to preserve the high accuracy obtained in the 1D case.

The existing codes are extremely accurate but are slow and their present scope is the calculation of reference solutions for use in the benchmarking of less accurate methods. However, another avenue of potential development that needs be considered is their use with less accurate but also less expensive expansions, that would make them usable more generally. We shall also review this aspect.

Abstract only