**Subgrid Methods for Resolving Axial Heterogeneity in Planar Synthesis Solutions for the Boltzmann Transport Equation**

As computing power has increased in recent years, there has been a strong interest in using direct whole-core transport calculations for reactor analysis to improve on the traditional nodal methods used by industry. Because 3D transport is still prohibitively expensive for practical calculations, a new class of planar synthesis methods has been developed. These methods decompose the reactor into a stack of 2D planes, performing high fidelity transport on each 2D plane before using a lower order method to couple the planes. These methods are faster than 3D transport and more accurate than nodal methods. Despite the more palatable runtimes compared with 3D transport, these methods are still much slower than nodal methods. Thus, reducing computational expense is still important to make these methods useful.

One means of accomplishing this is to reduce the number of 2D planes used in the transport calculations, since these are the most expensive parts of the calculations. Doing this improves the efficiency of the calculation, but also increases the likelihood of subgrid heterogeneity within a 2D plane, introducing error into the solution. To eliminate this error while maintaining the efficiency improvements from the coarse axial mesh, a subgrid method must be employed to resolve the subgrid information.

In this work, three new subgrid methods are presented in the context of the 2D/1D method. The polynomial method uses pregenerated sixth-order polynomials to correct the homogenization of the subgrid heterogeneity. The subplane collision probabilities (CP) method uses 1D CP calculations to capture the radial effects of the subgrid heterogeneity, then uses subplane coarse mesh finite difference (CMFD) and 1D spherical harmonics (PN) to capture the axial effects of the heterogeneity. The axial flux profiles produced by these calculations are then used to generate improved homogenized cross sections for the 2D MOC calculations. Finally, the subray method of characteristics (MOC) performs a modified transport sweep of each of the 2D planes to directly resolve the subgrid flux shape during the transport calculations while making use of the subplane scheme to improve the CMFD and PN calculations.

Each of these methods was applied to the rod cusping problem, the most severe type of axial heterogeneity in planar synthesis methods. The polynomial methods reduced the errors in 3D power distribution from greater than 25% to around 10% for most problems. The subplane CP method performed much better, reducing the errors in power distribution to less than 5% for most problems. Finally, subray MOC reduced the errors to less than 2% for all problems it was tested on.