Investigations on self-shielding calculation for 3-D spatial domains using Iso-Geometric Analysis

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With the IGA approach, the goal is to perform calculations for any kind of geometrical domain. We chose to use the sub-group method [1] for self-shielding calculation because it can be used directly with any transport calculations formalism. Possibility to perform self-shielding calculation for 3-D spatial domains represented by Iso-geometric Analysis method is presented.

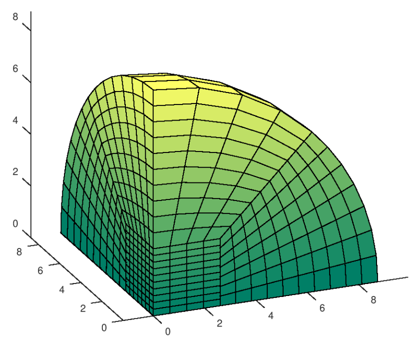
Keywords: Self-shielded calculation, Subgroup method, Iso-Geometric Analysis, 3-D spatial domains

1 Introduction

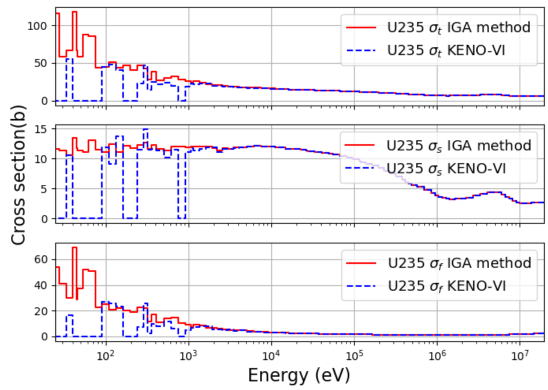
In our laboratory, we are developing an innovative simulation code based on Iso-Geometric Analysis (IGA), which allows resolving neutron transport equation for any geometrical domains with the multi-group "Sn" formalism. To treat the issue of self-shielding, we implemented the subgroup method. The validation of the subgroup implementation was conducted in a previous research. However, we validated our solver for 2-D spatial domains. From theoretical point, there is no reason to not work with 3-D spatial domains and that is what we are trying to show.

2 Validation of self-shielding calculation for 3-D spatial domain

To show the possibility to perform self-shielding calculation for 3-D spatial domains, we have decided to perform calculations for a water-reflected sphere of plutonium nitrate solution based on the experiment Godiva, HEU-MET-FAST-001, conducted by Los Alamos Scientific Laboratory [2]. To simplify the calculation, we have decided to use a quarter of the system, represented in Figure (a). For reference calculation we used the Monte Carlo module KENO-VI of SCALE6.2.3 [3].



(a) Quarter sphere of plutonium (93.71% of ^{235}U) nitrate solution in water.



(b) Comparison of ^{235}U self-shielded cross section (IGA) with multi-group cross section (KENO-VI).

Figure (b) shows the total, scatter and fission cross sections of ^{235}U, the isotope with the strongest self-shielding effect, calculated with our IGA code and with the Monte Carlo calculation. Above 1000 eV, the self-shielded cross section given by our solver our similar to the multi-group cross sections given by KENO-VI. However, under 1000 eV, we had some issue to generate multi-group cross sections with KENO-VI, so we cannot do the comparison. We are actually investigating the reasons and will get better results for the presentation.

3 Conclusion

We show that it is possible to use the subgroup method with the IGA and S_N methods to perform the calculation on 3-D spatial domain. For the moment, we cannot compare the results with reference calculation. We will need to fix this issue to be sure that the results given by our code are correct. Moreover, even if the geometry was quite simple (a quarter sphere), the calculation take many time to converge and give results.

References

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