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An approach for the efficient solution of the time-dependent linear Boltzmann equation

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Kinetic equations have proven to be useful models in different applications as, e.g., neutron transport, gas dynamics, semiconductors, photon propagation, opinion dynamics or biological network formation. One of the key challenges in the numerical simulation of kinetic equations is their high-dimensionality. For instance, in neutron transport, the solution depends in general on three spatial, three angular and one temporal variable. Based on the mixed variational formulation analyzed in [1] we will present a strategy for the design of efficient numerical approximation schemes. The formulation of [1] incorporates boundary conditions in a weak sense. Unfortunately, the bilinear form corresponding to the boundary conditions couples spatial and angular variables in a non-smooth way rendering a tensor product approximation not straight-forward. As a remedy we introduce an absorbing layer and consider a perturbed variational problem which leads to matrices with tensor product structure. Hence, even in the full tensor product approximation, the resulting discrete operators can be stored efficiently. We provide corresponding error estimates for our approach.

References

[1] H. Egger and M. Schlottbom, *A class of Galerkin schemes for time-dependent radiative transfer*. SIAM J. Numer. Anal., Vol. 54, No. 6, pp. 3577-3599, 2016. doi: 10.1137/15M1051336