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# Sparse tensor product methods for radiative transfer


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When simulating a dense gas at very high temperatures, energy transport by means of radiation has to be taken into account.

However, as even the non-scattering stationary monochromatic radiative transfer equation

$$\mathbf{s} \cdot \nabla_{\mathbf{x}} I(\mathbf{x}, \mathbf{s}) + \kappa(\mathbf{x}) I(\mathbf{x}, \mathbf{s}) = \kappa(\mathbf{x}) f(\mathbf{x}), \ \mathbf{x} \in \mathbb{R}^2, \ \mathbf{s} \in S^2,$$

is stated in five dimensions, with the intensity $I$ depending on space and direction, it is a bottleneck of such computations.

Sparse tensor product methods have been used to overcome this 'curse of dimension' of multidimensional problems in many applications. Applying an adaptive sparse discretization to the radiative transfer equation [1] allows to significantly reduce the number of degrees of freedom in the discretization with essentially no loss of accuracy. This, however, does not guarantee that the computational time to solve the equation scales down at the same rate.

In this project we prove approximation properties of a sparse tensor product space that is adapted for the radiative transfer equation and develop and implement efficient algorithms tailored to adaptive sparse finite elements. The aim is solve the radiative transfer equation at overall computational costs that are proportial to the number of degrees of freedom in the adaptive sparse discretization.

## References


[1] G. Widmer, R. Hiptmair and Ch. Schwab, *Sparse Adaptive Finite Elements for Radiative Transfer*, J. Comp. Phys. 227(2008), no. 12, 6071-6105.