Sparse Discrete Ordinates Method in Radiative Transfer

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The stationary monochromatic radiative transfer equation (RTE) is a partial differential transport equation stated on a five-dimensional phase space, the Cartesian product of physical and angular domain.

We solve the RTE with a Galerkin FEM in physical space and collocation in angle, corresponding to a discrete ordinates method (DOM). To reduce the complexity of the problem and to avoid the "curse of dimension", we adapt the sparse grid combination technique to the solution space of the RTE and show that we obtain a sparse DOM which uses essentially only as many degrees of freedom as required for a purely spatial transport problem. For smooth solutions, the convergence rates deteriorate only by a logarithmic factor.

We compare the sparse DOM to the standard full DOM and a sparse tensor product approach developed earlier with Galerkin FEM in physical space and a spectral method in angle. Numerical experiments confirm our findings.

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