Positivity limiting and moment realizability for a class of quadrature-based moment closure methods

James Rossmanith (Iowa State University), Yongtao Cheng

Kinetic models in plasma physics describe the evolution of the plasma in terms of a probability density function (PDF) in phase space. These models generally produce high-fidelity results, but are expensive to solve due to the high-dimensionality of the phase space. Fluid models reduce the complexity of kinetic models by evolving only a small number of moments of the distribution function, but require some model assumptions in order to arrive at a closed system – these assumptions are referred to as the *moment closure*. Developing accurate and robust moment closures is difficult in general and still very much a topic of ongoing research. In this work we study a class of moment closures known as *quadrature-based moment closures*. In particular, we consider the problems of hyperbolicity and moment realizability. We develop a class of numerical methods with *positivity-preserving limiters* that have the ability to approximately evolve a small number of moments of the PDF in a such way that a physically valid PDF can be reconstructed from the moments. The resulting numerical methods are tested on a variety of test problems. In this work we focus on the one-dimensional case, while extensions to higher dimensions are part of ongoing research.
This is joint work with Yongtao Cheng (University of Wisconsin - Madison).