Spectral-Hermite Approximation of the Linearized Boltzmann Collision

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ABSTRACT

A sequence of approximate linear collision models for hard-sphere and inverse-power-law gases is introduced. These models are obtained by expanding the linearized Boltzmann collision operator into a Hermite series, and a practical algorithm is proposed for evaluating the coefficients in the series. The sequence approximates the linearized Boltzmann operator to high accuracy, and it establishes a connection between the BGK model, the Shakhov model and the linearized collision operator. The convergence is demonstrated by solving the spatially homogeneous Boltzmann equation. By observing the magnitudes of the coefficients, simpler yet accurate collision models are developed after compressing the collision operator by neglecting small modes.

Even though these models can be used in any discretization of the Boltzmann equation, they are most appropriate to be coupled to moment approximations of kinetic equations, see [1] and [2]. We will present some preliminary results for flow problems obtained with this approach.

REFERENCES

[1] Cai Z and Li R, Numerical regularized moment method of arbitrary order for Boltzmann-BGK equation, *SIAM J. Sci. Comput.* **32**, (2010), 2875-2907

[2] Struchtrup H., Macroscopic transport equations for rarefied gas flows, Interactions of Mechanics and Mathematics, Springer, New York (2005)