Quadrature-Based Moment Methods for Kinetics-Based Flow Models

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Abstract

Kinetic theory is a useful theoretical framework for developing multiphase flow models that account for complex physics (e.g., particle trajectory crossings, particle size distributions, etc.) (1). For most applications, direct solution of the kinetic equation is intractable due to the high-dimensionality of the phase space. Thus a key challenge is to reduce the dimensionality of the problem without losing the underlying physics. At the same time, the reduced description must be numerically tractable and possess the favorable attributes of the original kinetic equation (e.g. hyperbolic, conservation of mass/momentum, etc.)

Starting from the seminal work of McGraw (2) on the quadrature method of moments (QMOM), we have developed a general closure approximation referred to as *quadrature-based moment methods* (3; 4; 5). The basic idea behind these methods is to use the local (in space and time) values of the moments to reconstruct a well-defined local distribution function (i.e. non-negative, compact support, etc.). The reconstructed distribution function is then used to close the moment transport equations (e.g. spatial fluxes, nonlinear source terms, etc.).

In this seminar, I will present the underlying theoretical and numerical issues associated with quadrature-based reconstructions. The transport of moments in real space, and its numerical representation in terms of fluxes, plays a critical role in determining whether a moment set is *realizable*. Using selected examples, I will introduce recent work on *realizable* high-order flux reconstructions developed specifically for finite-volume schemes (6).

References

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