# On high-order methods for moment-closure approximaons of kinetic Boltzmann equaons

2018.**08.13, 4PM**

**A.S.T.C 615** 첨단관 615호

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In many applicaons, the dynamics of gas and plasma can be accuraely modeled using kinetic Boltzmann equaons. These equaons are integro-differentil systems posed in a high-dimensional phase space, which is typically comprised of the spaal coordinaes and the velocity coordinaes. If the system is sufficiently collisional the kinetic equaons may be replaced by a fluid approximaon tha is posed in physical space (i.e., a lower dimensional space than the full phase space). The precise form of the fluid approximaon depends on the choice of the moment-closure. In general, finding a suitle robust moment-closure is still an open scientific problem.

In this work we consider two specific closure methods: (1) a regularized quadraure-based closure (QMOM) and (2) a nonextensible entropy-based closure (QEXP).

In QMOM, the distribution function is approximaed by Dirac delts with variable weights and abscissas. The resulting fluid approximaons have differing properties depending on the detiled construction of the Dirac delts. We develop a high-order discontinuous Galerkin scheme to numerically solve resulting fluid equaons. We also develop limiters tha guarantee tha the inversion problem between moments of the distribution function and the weights and abscissas of the Dirac deltas is well-posed.
In QEXP, the true distribution is replaced by a Maxwellian distribution multiplied by a quasi-exponentil function. We develop a high-order discontinuous Galerkin scheme to numerically solve resulting fluid equaons. We break the numerical updae into two parts: (1) an updae for the background Maxwellian distribution, and (2) an updae for the non-Maxwellian corrections. We again develop limiters to keep the moment-inversion problem well-posed.

The work on the regularized quadraure-based closures is joint with Erica Johnson (Bexar County) and Christine Wiersma (Iowa Stte), and the work on the nonextensible entropy-based closures is joint with Chi-Wang Shu (Brown).