NCTS-NCKU 2016 Summer Course on Kinetic Theory

Speaker：Prof. Kazuo Aoki（青木一生 教授）

Title：Asymptotic and Numerical Methods in Kinetic Theory of Gases

Organizers：吳恭儉教授

Place：成功大學 數學系 3F會議室

Date：（1） 8月16日（11:00~12:00, 13:30~14:30）

（2） 8月23日（11:00~12:00, 13:30~14:30）

（3） 8月30日（11:00~12:00, 13:30~14:30）

Abstracts：

Part 1:

The first half of this part is devoted to a brief introduction to kinetic theory of gases, which contains a summary of the Boltzmann equation and its basic properties, the boundary conditions, etc. Then, we consider the free-molecular gas (or the Knudsen gas), i.e., a gas which is so rarefied that the collisions between gas molecules can be neglected

(that is, the mean free path of the gas molecules is infinitely long compared with the characteristic length of the system). We present an exact solution that describes the effect of boundary temperature in a quite general situation.

Part 2:

In this part, we consider the near continuum regime (or near the fluid-dynamic limit), i.e., the case where the mean free path is small compared with the characteristic length. We show the outline of the formal asymptotic analysis of the steady boundary-value problem of the Boltzmann equation that provides the fluid-dynamic type equations, their boundary conditions of slip type, and the kinetic correction to fluid-dynamic solutions in the vicinity of the boundary (the Knudsen layer) systematically. A special emphasis is put on the case in which the fluid-dynamic limit thus obtained is not covered by the conventional fluid dynamics (the ghost effect). The slip boundary conditions for the compressible Navier-Stokes equations are also discussed.

Part 3:

Finally, we consider the general case where the mean free path is of the same order of magnitude as the characteristic length (the transition regime). In this case, the basic tool for solving the Boltzmann equation is a numerical method. Roughly speaking, there are two kinds of approach: One is stochastic (Monte Carlo methods) and the other is deterministic (discrete-velocity methods, finite-volume methods, etc.). Here, we discuss some deterministic methods with special interest in capturing the propagation of discontinuities in the velocity distribution function induced by a convex body or discontinuous boundary data.