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Mini-Course in Kinetic Theory

by

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Lecture 1: Incompressible Navier-Stokes limit of the Boltzmann equation

Abstract : We will demonstrate the (formal) asymptotic expansion of the Boltzmann equation for small Knudsen number that yeilds the incompressible Navier-Stokes set of equations in the conventional fluid dynamics [1]. The key is the so-called diffusive scaling. The derived continuity and momentum equations are indeed identical to those of the incompressible NS set and can be solved independently from the energy equation. However, the energy equation exhibits the compressibility and accordingly applying the incompressibility in the energy equation is not consistent. This resembles the feature in small Mach number expansion of the compressible NS set of equations in the viscous conservation law. The talk is based on Sone's monograph on Moleular Gas Dynamics [1].

Lecture 2: Single droplet or bubble and its stability: Kinetic theory and dynamical system approaches

Abstract : Steady solutions of a single droplet or bubble in the van der Waals fluid are investigated on the basis of the kinetic model equation that has been recently proposed by Miyauchi et al. [Gas Dynamics with Applications in Industry and Life Sciences (Springer, Cham, 2023), pp. 19-39]. Under the thermal equilibrium condition and isotropic assumption with respect to the origin of the coordinates, the kinetic equation is reduced to an ordinary differential equation for the density, which can be regarded as a low-dimensional dynamical system. The possible density distribution is studied as a flow in the low-dimensional phase space. It is clarified that a single droplet or bubble can be understood as a flow that goes into a fixed point and that the flow is qualitatively different in the unstable and metastable parameter regions. The features of the obtained density distributions in individual regions are also clarified. Finally, the stability of those solutions is studied by direct numerical experiments of the kinetic equation. The talk is based on the joint work with Takumu Miyauchi [2].

References:

[1] Y. Sone, Molecular Gas Dynamics (Birkhauser, Boston, 2007), Sec. 3.7.2. https://doi.org/10.1007/978-0-8176-4573-1
[2] T. Miyauchi and S. Takata, Phys. Rev. E 110, 025102 (2004). https://doi.org/10.1103/PhysRevE.110.025102

Lecture 1:	
Date :	November 21, 2024 (Thursday)
Time :	10:00am – 12:00pm (Hong Kong SAR)
Venue:	Room 222, 2/F, Lady Shaw Building, The Chinese University of Hong Kong, Shatin
Lecture 2:	
Date :	November 22, 2024 (Friday)
Time :	10:00am – 12:00pm (Hong Kong SAR)
Venue:	Room 219, 2/F, Lady Shaw Building, The Chinese University of Hong Kong, Shatin

All are Welcome