Introduction to Mathematical Theory for Many Particle System

DONGHYUN LEE (POSTECH)

Abstract.

Interacting particle system (such as gas, fluid, plasma, etc) is very important physical system. Under hypothesis of continuum mechanics, it can be analyzed mathematically by various partial differential equation models. There are two big branches depending on our view points : mesoscopic description (PDE for probability density function) and macroscopic one (PDE for velocty). In this short lecture series, we study basic mathematical theory for two fundamental equations that describe fluid and gas : Navier-Stokes equation and Boltzmann equation, respectively. Moreover, using basic energy method and functional analysis, we study asymptotic behaviors for some simple cases.

- Class 1 : Many particle system : Introduction to Navier-Stokes and Boltzmann equations
- Class 2 : Basic mathematical tools : L^p, Sobolev spaces, and functional inequalities
- Class 3 : Energy estimate and asymptotic behavior analysis of many particle system.

References.

- L. C. Evans, *Partial Differential Equation 2nd Ed*, AMS
- C. Villani, *A review of mathematical topics in collisional kinetic theory*, lecture note

Projects

- Poincare inequality and diffusion of Navier-Stokes equations.
- Coercivity of linearized Boltzmann equation.
- Duhamel's principle and pointwise estimate of the Boltzmann equation.
- Mixing of free transport and Landau damping.