

## Topics

### I) Kinetic Theory

- i) Foundations from Dynamical Systems Theory
- ii) Boltzmann Equation from BBGKY truncation via diluteness
- iii) H-Theorem via Detailed Balance and Molecular Chaos; Macroscopic Irreversibility from Chaos and Micro-Reversibility
- iv) Fluid Equations: Moments of Boltzmann Equation which express Conservation Laws
- v) Computing Transport Coefficients via Chapman-Enskog expansion
- vi) Onsager Symmetry of the Transport Matrix from Micro-Irreversibility

### II) Statistical Dynamics I

- i) Noisy Particle Dynamics: Langevin Equation, Noise and Brownian Motion; Test Particle Model for Equilibrium Spectra
- ii) Fluctuation-Dissipation Balance
- iii) Dynamical Model of a Heat Bath
- iv) From Particle Motion to PDFs: Markov Processes, Chapman-Kolmogorov Equation, Fokker-Planck Theory and its limitations. Glimpse of Non-standard Kinetics
- v) Basic Applications of Fokker-Planck Theory
  - Brownian Particle
  - Sedimentation
  - Logistic System with Multiplicative Noise, Aspects of Population Evolution
  - Stratonovich and Ito formulations

### III) Linear Response and Fluctuation Theory

- i) Kubo formulae, which link transport coefficients to equilibrium correlations
- ii) Diffusion obtained from Cumulant Expansion
- iii) Hydrodynamics revisited: Conservation, Response and Susceptibility, Diffusion; Connection to Correlation Function
- iv) Classical and Quantum Fluctuation – Dissipation Theory

**IV) Statistical Dynamics II**

- i) Master equation, relation to Chapman-Kolmogorov, Fokker-Planck; examples: Diffusion, Radioactive Decay
- ii) Reaction Rate Problems: Kramers Problem, First Passage, Brownian Motors
- iii) Emergence by Aggregation
  - Smoluchowski Theory of Coagulation
  - General Theory of Aggregation
  - Gelation, Finite Time Singularity
- iv) More on the Master Equation
  - Biomolecular Chemical Reactions
  - Quantum Master Equation
  - Quantum Dynamics, Dephasing

**V) Toward Renormalization**

- i) Thinning D-o-f's by Projection: Zwanzig-Mori Method
- ii) 'Burgulence' and Eddy Viscosity
- iii) Adiabatic Theory and Quasi-Particle Models

**VI) Special Topics**

- i) Foraging beyond Fokker-Planck: A Brief Introduction to CTRW and Fractional Kinetics
- ii) Coarsening: Non-Conservative and Conservative Dynamics
- iii) Population Dynamics