

Topics

- A.) More Mechanics (Changing Variables in Hamiltonian Mechanics; Introduction to Nonlinear Dynamics)**
- i.) Nonlinear Oscillators
 - a.) Parametric Instability
 - b.) Poincare-Lindstedt Perturbation Theory for Nonlinear Oscillators
 - c.) Driven Nonlinear Oscillators and Mode Jumping
 - d.) Van-der-Pol Oscillator (Time Allowing)
 - ii.) Canonical Formalism
 - a.) Hamiltonian Structure \rightarrow Poisson Brackets
 - b.) Changing Variables in Hamiltonian Mechanics \rightarrow Canonical Transformations
 - c.) Underlying Theory \rightarrow Poincare-Cartan Invariant, Symplectic Systems
 - d.) Action-Angle Variables \rightarrow Symmetry and Canonical Structure
 - e.) Using the Formalism \rightarrow Adiabatic Invariants, Applications to Charged Particle Motion
 - f.) Adiabatic Theory for Waves, Quasi-Particle Formulation (Time Allowing)
 - iii.) Overview of Hamiltonian Chaos (Time Allowing)
 - a.) Hamiltonian Maps
 - b.) Perturbation Theory and Small Denominators
 - c.) KAM Theorem, Fate of Resonant Tori
 - d.) Standard Map and Stochasticity, Lyapunov Exponent
 - e.) Island Overlap, Chirikov Criterion
- B.) Kinetic Theory and Hydrodynamics (From Liouville to Boltzmann to Navier-Stokes)**
- i.) Boltzmann Equation
 - a.) Concepts of Entropy: Kolmogorov, Information Theory, Thermodynamic
 - b.) From Liouville \rightarrow Boltzmann: BBGKY Hierarchy and its truncation
 - c.) Boltzmann Equation and Collision Operator
 - d.) H-Theorem: Proof and Meaning
 - e.) Dynamical Foundations of Principle of Molecular Chaos (Time Allowing)
 - ii.) Linear Response Theory and Transport
 - a.) Basic Ideas of Fluctuations, Response, Correlation
 - b.) Fluctuation-Dissipation Theorem
 - c.) Transport as a Linear Response Problem \rightarrow Onsager Matrix and Symmetry
 - d.) Calculating Transport Coefficients \rightarrow Chapman-Enskog Expansion
 - e.) Off-diagonal Effects: Chemotaxis, Pinches
 - iii.) Introduction to Hydrodynamics
 - a.) From Boltzmann \rightarrow Euler and Navier-Stokes: Deriving Fluid Equations from Kinetic
 - b.) Fundamental Ideas of Hydrodynamics
 - c.) Hydrodynamic Modes
 - d.) Heat and Mass Transport in Fluids