**Physics 200B** **Mechanics II** **Winter 2015**

**Topics**

**A.) More Mechanics – Nonlinear Oscillators, Changing Variables in Hamiltonian Mechanics, Introduction to Nonlinear Dynamics**

i.) Nonlinear Oscillators
- a.) Ponderomotive Force
- b.) Parametric Instability
- c.) Poincare-Lindstet Perturbation Theory for Nonlinear Oscillators
- d.) Driven Nonlinear Oscillators and Mode Jumping
- e.) Van-der-Pol Oscillator

ii.) Canonical Formalism
- a.) Hamilton-Jacobi Theory, Principle Maupertuis, Applications to Eikonal Theory
- b.) Changing Variables in Hamiltonian Mechanics → Canonical Transformations (Review)
- c.) Underlying Theory → Poincare-Cartan Invariant, Symplectic Systems
- d.) Action-Angle Variables → Symmetry and Canonical Structure
- e.) Using the Formalism → Adiabatic Invariants, Applications to Charged Particle Motion
- f.) Adiabatic Theory for Waves, Quasi-Particle Formulation

ii.) Overview of Hamiltonian Chaos
- a.) Hamiltonian Maps, Systems → Integrability
- 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 → 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)
- f.) Resolution of H-Theorem and Recurrence

ii.) Linear Response Theory and Transport
- a.) Transport as a Linear Response Problem → Onsager Matrix and Symmetry
- b.) From Boltzmann → Euler and Navier-Stokes: Deriving Fluid Equations from Kinetic
- e.) Basic Ideas of Fluctuations, Response, Correlation
- d.) Off-diagonal Effects: Chemotaxis, Pinches
- e.) Calculating Transport Coefficients → Chapman-Enskog Expansion
- f.) Fluctuation-Dissipation Theorem

iii.) Introduction to Hydrodynamics
- a.) Fundamentals of Hydrodynamics
- b.) Hydrodynamic Modes
- c.) Introduction to Instabilities