

## 218A - 7 Big Ideas

Here we list 7 'big ideas' in plasma physics from 218A.

- i.) **Coulomb force as long range**
  - a.) screening,  $\lambda_D$ ,  $n\lambda_D^3 > 1$  for plasma
  - b.) difference from hard sphere gas
  - c.) infrared divergence – Coulomb logarithm
  - d.) basic transport coefficients
  
- ii.) **Waves and Instabilities**
  - a.) plasma, ion-acoustic, EM
  - b.) Wave Energy Theorem
  - c.) Negative Energy Waves, Instabilities, Fast/Slow Wave System
  - d.) Two Stream Instability, Beam-Plasma System
  - e.) Jeans Instability – Gas, Plasma
  
- iii.) **Kinetics**
  - a.) Vlasov Equation from BBGKY
  - b.) Landau Damping
  - c.) Physics of Landau Damping
  - d.) Landau Growth, B-O-T instability
  
- iv.) **Near Thermal Equilibrium**
  - a.) Fluctuation-Dissipation Theorem, Brownian Motion
  - b.) Test Particle Model, Discreteness Emission
  - c.) Equilibrium Fluctuation Spectrum, Role of Screening
  
- v.) **Transport and Relaxation Near Equilibrium**
  - a.) Diffusion, Central Limit Theorem, Fokker-Planck Eqn. – Basic Theory
  - b.) Boltzmann Eqn. + small momentum transfer  $\rightarrow$  Landau Collision Operator
  - c.) Screened Landau Operator, Resolution of Infrared Cut-Off
  - d.) Rosenbluth Potentials, Calculation of Transport Coefficients
  - e.) Dreicer Field, Runaways
  
- vi.) **Mean Field Theory for Instabilities**
  - a.) Quasi-Linear Equations
  - b.) Relation to Stochasticity, Time Scales
  - c.)  $\tau_{ac}$  vs  $\tau_b$ , validity of unperturbed orbits
  - d.) Energy-Momentum Theorems
  - e.) Bump-on-Tail Saturation
  - f.) Anomalous Resistivity

vii.) **Introduction to Nonlinear Plasma Processes**

- a.) Role of nonlinear process in saturation, OV of nonlinear processes, limitations of quasilinear theory
- b.) Navier-Stokes Turbulence ala' K41, Energy Flux dominated system, Basic Laws, Cascade and Dissipation, Particle Dispersion
- c.) Langmuir Turbulence I: Disparate Scale Interaction, Zakharov Eqns. as Envelope Equations, Adiabatic Theory, Transfer and Decay Criterion, Energetics
- d.) Langmuir Turbulence II: Collapse and Singularity Formation