

## TOPICS

### A.) Basics of Ideal MHD

- i.) MHD equations and their meaning
- ii.) Freezing-in law: Formulation, Proof, Application
- iii.) Energy and Momentum Conservation Relations
- iv.) Linear Waves in MHD: General Calculation, Specific Cases, Friedrichs Diagram

### B.) Introduction to Non-Ideal MHD

- i.) Local Non-Ideal Behavior: Sweet-Parker Reconnection: Basic Scalings
- ii.) Global Non-Ideal Behavior (2D): Prandtl-Batchelor Theorem, PV Homogenization, Flux Expulsion
- iii.) Basic concepts of Fluid and MHD Turbulent Cascades
- iv.) Magnetic Helicity and Basic Concepts of Taylor Relaxation

### C.) Ideal MHD Stability Theory

- i.) Formulation of MHD Energy Principle
- ii.) Structure of MHD Energy Principle and Basic Paradigmatic Examples
  - a.) Rayleigh-Benard Instability
  - b.) Rayleigh-Taylor Instability
  - c.) Interchange Instability
  - d.) Line-Tying and Magnetic Shear: Suydam Criterion
- iii.) Magnetic Instabilities
  - a.) Sausage Mode and hydro analogue
  - b.) Kink Mode

### D.) Resistive MHD Stability, Magnetic Resonances, Stochastic Fields

- i.) Basic Ideas of Resonances, Reduced MHD, Resistive Modes, etc.
- ii.) Resistive Interchange
- iii.) Tearing and Magnetic Island Evolution
- iv.) Review of Quasilinear Theory
- v.) Stochastic Magnetic Fields and Transport
- vi.) Taylor Relaxation, Revisited
- vii.) Basic Ideas of Mean Field Electrodynamics for MHD
- viii.) A Look at the RFP

### E.) Beyond MHD

- i.) Non-Ideal Ohm's Law
- ii.) Review of Drifts
- iii.) Formulating Resistive-Drift Fluid Models
- iv.) Hasegawa-Wakatani, Hasegawa-Mima Systems
- v.) Drift Waves, Instabilities, Energetics
- vi.) Mean Field Evolution: Transport and Zonal Modes
- vii.) Langmuir Turbulence: Paradigm for Secondary Structure Formation
- viii.) Dynamics of Zonal Flow Formation