Prof. Liu Chen's NCU Lectures Fall, 2023

(I) Title (tentative): Essentials of Tokamak Plasma Physics.

(II) Class room: S4 – 202 10/3, 10/17, 10/24, 12/5 (time: 10:00 – 11:30)

S4 – 204 10/5, 10/12, 10/19, 12/7 (time: 14:00 – 15:30)

(III) Lecture hours: Twice per week. Each lecture about 90 minutes.

(IV) Outlines of Topics

1. Brief introduction: History, progress, etc.
2. Tokamak magnetic field geometry: Vector representations, magnetic surfaces, safety factor, etc.
3. Singe charged particle motion: Adiabatic invariant, guiding center motion, circulating and trapped particle , action angle variables.
4. Ideal magnetohydrodynamic (MHD) description: Derivations and approximations.
5. Ideal MHD -equilibrium: Grad-Shafranov equation, low-beta circular tokamak.
6. Ideal MHD- stability: Energy principle and its applications, internal kink mode.
7. Ideal MHD- ballooning instability: Ballooning-mode representation, eigenmode equation and instability threshold.
8. Linear gyrokinetic theory-linear gyrokinetic equations: Electrostatic and electromagnetic perturbations.
9. Linear gyrokinetic theory applications-microscopic instabilities: Ion-temperature-gradient and trapped-electron modes.
10. Shear Alfven waves (SAWs) in tokamak: Continuous spectrum and discrete Alfven eigenmodes.
11. Excitations of SAWs by energetic particles: Wave-particle resonance in tokamak, toroidal Alfven eigenmode, and fishbone modes.

(V) Possible future topics (including by guest lecturers): Neoclassical transport, nonlinear gyrokinetic theory, quasi-linear theory, collisionless transport, nonlinear wave-particle Interactions, nonlinear wave-wave interactions, etc.