Nuclear Fusion and Radiation

Midterm 2 - Content (Meetings 13-14 & 17-23)

Eugenio Schuster

schuster@lehigh.edu
Mechanical Engineering and Mechanics
Lehigh University

Lecture 6

- Approaches to plasma confinement
- Inertial confinement
  - Lawson criterion: $(nr)_L \sim 10^{26} \frac{\#}{m^2}$, $(\rho r)_L \sim 0.042 \frac{g}{cm^2}$
- Magnetic confinement
  - Motion equation for charged particle in magnetic field
    - + Work by magnetic force on charged particle is zero
    - + Circular motion $\rightarrow$ Larmor (gyromagnetic) radius
  - Total motion = circular ($\perp$ to $\bar{B}$) + translation ($\parallel$ to $\bar{B}$) motions$\rightarrow$helical path
  - Plasma diamagnetism
  - Definition of β. Relationship with fusion power P_f.
- Open configuration
  - Solenoid
  - Mirror: Energy/magnetic-momentum conservation

Lecture 7

- Closed configuration
  - Toroidal magnetic field equation from Ampere's Law
  - B_t gradient $\rightarrow$ charge separation, particle drift
  - Solution: rotational transform by adding B_p
  - Equations for ι and q
- Tokamak
  - Faraday's Law $\rightarrow$ Transformer action
  - Poloidal magnetic field equation from Ampere's Law
  - Definitions of β_t and β_p. Relationship equation.
  - Equation for β-q relationship
  - Limits on β and q
  - Need for auxiliary heating/non-inductive current drive
  - Spatially averaged quantities. Reactor design.

Lecture 8

- Radioactivity. Decay diagrams.
- Radioactive decay law. Definition of λ.
- Half life $T_{1/2}$. Radioactive decay law in terms of $T_{1/2}$.
- Probabilities of decay/no-decay $\rightarrow$ PDF $\rightarrow$ Average decay time T_{av}.
- Activity. Equation. Units. Calculation of λ from activity.
- Dating
  - Measuring decay of parent ($C-14$ Dating)
  - Measuring buildup of stable daughter without/with $N(0)$
- Transient Analysis
- Radioactive decays (Q calculation, E distribution)
  - γ decay
  - α decay
  - β^- decay