ICPY473 Nuclear Physics-Keys

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1 Nuclear phenomenology

- Bateman equation, and condition for transient equilibrium decay

2 Deuterium

- Quantum mechanics of finite spherical potential well for deuterium

3 Nuclear models

- Shell structure of rigid spherical potential well + spin-orbit coupling
- Fermi gas model, derivation of Fermi energy
- Liquid drop model, meaning of terms within Bethe-Weizsacker formula

4 Nuclear decays

- Gamow theory of alpha emission, decay rate and half-life time
- Fermi theory of beta emission, Fermi golden rule and beta spectrum

5 Nuclear reactions

- Reaction cross section of direct nuclear reaction
- Fission and fusion, thermonuclear reactions on the Sun

6 Nuclear radiations

- interaction of photon with matter and half-value thickness
- interaction of charged particle with matter and range of particle
- absorption dose in rad, and rem and sievert

7 Relativistic kinematics

- 4-momentum and its Lorentz transformation
- one-to-two particle decay kinematics, i.e., in CM-frame and LAB-frame

8 Particle classification with additional quantum numbers

- isospin I, baryon number B, lepton number L, strangeness S, Charmness C, bottomness B', and topness T
- hypercharge Y =S+C+B'+T, Gell-Mann Nishijima formula $Q = I_3 + \frac{1}{2}Y$

9 Deep inelastic scattering and parton

- characteristic of elastic and inelastic e-p scattering
- DIS kinematics
- parton model

10 Quark models of hadrons

- SU(2) and SU(3) symmetries in QM and their algebras
- SU(2) models of mesons and baryons
- SU(3) models of mesons and baryons

11 Standard model of particles

- standard model particles
- gauge symmetry and gauge field theory of fundamental interactions
- Feynman diagrams

12 Electromagnetic and weak interactions

- diagrams of EM interaction by photon exchange
- diagrams of weak interactions by $W^{\pm}$ and Z^0 exchange

13 Strong interaction

- diagrams of strong interaction by gluon exchange
- kaon decays
- mass matrix and kaon oscillations

14 Discrete symmetries and quark mixing

- parity-P, charge conjugation-C, and time reversal-T symmetries
- CP-violation in beta emission

15 Neutrinos

- neutrino masses
- neutrinos oscillation

16 New physics after the LHC

- higher precision physics meet the mass hierarchy problem
- supersymmetry extension
- go to extra dimensions