Physics 431: Particle and Nuclear Physics  Spring, 20

Prof. R. Shrock, office: 6-111, tel. 632-7986, email:

Prerequisites: PHY 308 (quantum physics); it is also assumed that students have taken courses including PHY 251 (modern physics).

Course requirements: homework, midterm, and final exam

First meeting time/place: Tue. Jan. 24, 2017, 8:30 AM, Room TBA; office hr. TBA

The main textbook is D. Griffiths, Introduction to Elementary Particles (2010). Another book is C. Quigg, Gauge Theories of the Strong, Electromagnetic, and Weak Interactions: also use information from various websites.

This is a senior-level undergraduate course on particle and nuclear physics covering topic following list:

- Basic properties and interactions of elementary particles
- Early history of discoveries of elementary particles and connection with nuclear ph;
- Relativistic kinematics, calculation of scattering cross sections and decay rates
- Dirac equation, gamma matrices
- Introduction to quantum field theory, Lagrangians, and use of Feynman diagrams f calculations
- Accelerators and particle detectors
- Symmetries, groups, and conservation laws; SU(2) and spin; chiral and vectorial “f
- Concept of gauge invariance, gauge interactions: abelian (QED) and non-abelian (\n- Electromagnetic interactions and properties of elementary particles
- Weak interactions and beta decay, Fermi current-current theory and applications to
- Construction of a unified electroweak SU(2) × U(1)Y gauge theory; role of spontar breaking; vector boson masses and couplings; observation of W and Z; Higgs mech observation; other tests, including muon g − 2
- Fermion couplings and masses; Cabibbo-Kobayashi-Maskawa quark mixing matrix; Glashow-Iliopoulos-Maiani mechanism; \n\n- Quantum chromodynamics with SU(3) color gauge group, including early indicatio inelastic scattering and asymptotic freedom, quarkonium, heavy quarks c, b, t; jets. chiral symmetry breaking; residual strong interactions between hadrons; scattering
- Properties of nuclei as bound states of nucleons: masses, radii, stability considerati decays; β, γ, α decays; nuclear reactions; models for nuclei; fission and nuclear pow nuclei.
- Neutrino masses and lepton mixing as evidence of physics beyond the SM; types of terms, models of neutrino masses, searches for neutrino masses in nuclear and part neutrinoless double beta decay, theory and experiments on solar and atmospheric r accelerator neutrino experiments, reactor antineutrino experiments