

Physics 226: Particles & Symmetries

Based on A17 & A18 as taught by Steve Sharpe

Overview

This course aims to introduce you to the wonderful world of nuclear and particle physics and to provide you with some of the tools needed to understand and analyze the dynamics and decays of relativistic particles. Three major tools are (i) facility with special relativity, (ii) determining the consequences of symmetries and (iii) making order-of-magnitude estimates.

Evaluation

Quizzes (Poll Everywhere) in about 60% classes, weekly graded homeworks, one midterm and one final exam.

Texts

1. **Required:** Lecture notes by L. Yaffe (available as pdf file)
2. **Recommended:** *"Introduction to Relativity,"* John Kogut
3. **Recommended:** *"Introduction to Nuclear and Particle Physics,"* A. Das and T. Ferbel

Topics by week (11 weeks since in Autumn)

1. Recap of Galilean Relativity; introduction to Special Relativity; time dilation and length contraction.
2. Spacetime diagrams, 4-vectors, Lorentz transformations, inner products and invariant separation.
3. Timelike, spacelike & lightlike separations; causality & maximum speed; relativistic velocity addition; Introduction to relativistic dynamics; frame-invariant formulation of rel. dynamics: 4-velocity, 4-momentum.
4. Natural units; application of 4-momentum conservation in collisions; 4-force and example of constant acceleration; plane waves, 4-vector wavenumber, and relativistic Doppler effect.
5. Overview of known particles and forces; nuclei; neutron decay and nuclear decays;
6. Atomic mass units; more examples of nuclear decays. **Review. Midterm.**
7. Introduction to the particle zoo (photon, leptons, quarks); quark model, color confinement, mesons & baryons, flavor symmetries & conservation. **Holiday.**
8. Review of spin in QM; spin-flavor wavefunctions of light mesons & baryons; strong & EM decays of mesons
9. Strong & EM decays of baryons; Isospin symmetry. **Holiday.**
10. Applications of isospin. Discrete symmetries: parity, charge conjugation, time reversal & G parity.
11. Cross sections, luminosity & scattering; weak decays & scattering. **Review.**