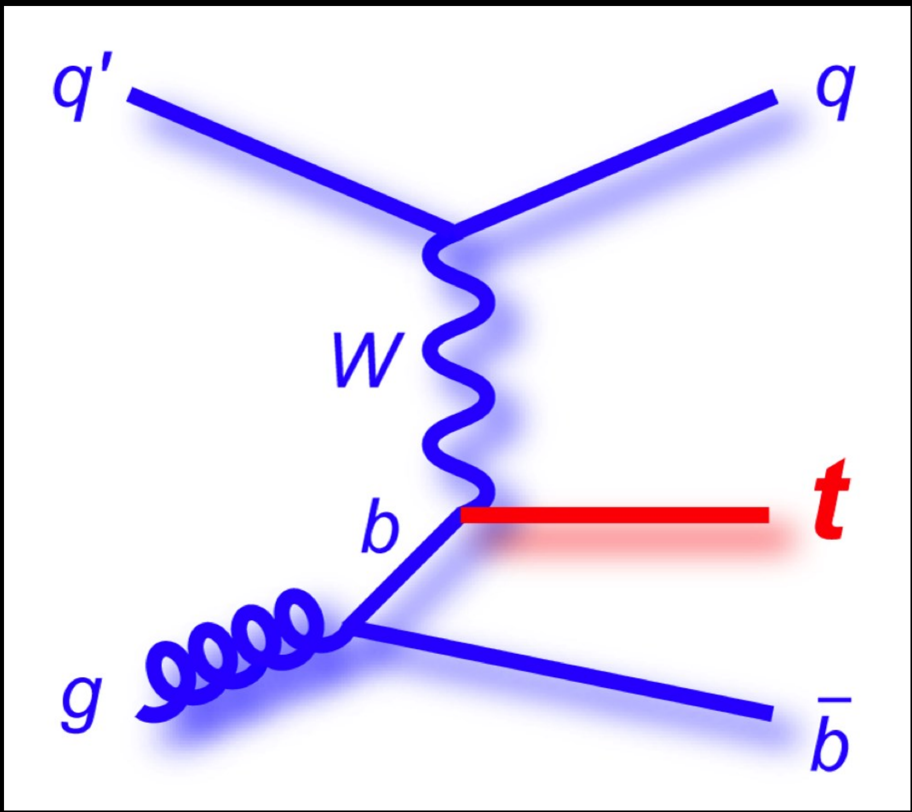
University of Glasgow | School of Physics & Astronomy



PHYS5014 PHYS5014: Relativistic Quantum Fields

Course Information Guide

1 Course Details

PHYS5014 Relativistic Quantum Fields is an M-level Physics course, composed of 18 lectures and 2 full class tutorials, all given in Semester 1. The course is compulsory for Theoretical Physics

Lecturer: Dr Sophie Renner, Rm 534, Kelvin Building, sophie.renner@glasgow.ac.uk

Time and place: Normally: Wednesdays and Fridays 11:00 – 12 noon
Wednesdays: Adam Smith Building rm 281
Fridays: James Watt South Building rm 811
NOTE: there may be exceptions or last minute room changes, please keep an eye on your timetabling app.

Recommended Text: An Introduction to Quantum Field Theory, Peskin and Schroeder (Perseus books) or Quantum Field Theory, Srednicki (CUP).

Course notes and Question Sheets will be made available on Moodle.

2 Assessment

The course will be assessed via an examination in the April/May diet. It provides 10 M-level credits.

3 Required Knowledge

This is an introductory course in relativistic quantum mechanics and quantum field theory. Students are expected to have completed a course in nonrelativistic Quantum Mechanics, covering solution of Schrodinger's equation in multiple space dimensions and time-independent and time-dependent perturbation theory.

4 Intended Learning Outcomes

By the end of the course, students will be able to demonstrate a knowledge and broad understanding of relativistic quantum mechanics and Quantum Field Theory. They should be able to draw Feynman diagrams for a variety of processes in theories such as φ^4 and Quantum Electrodynamics, and evaluate them.

5 Course Outline

5.1 Review

Review of relativistic conventions, Lorentz transformations, and basic quantum mechanics. The Schrödinger and Heisenberg pictures.

5.2 Classical Field Theory

The Klein-Gordon equation and its solutions. The Lagrangian and Hamiltonian formalisms. Symmetries and Noether's Theorem.

5.3 Free Scalar Fields

Canonical quantization and the simple harmonic oscillator. Quantization of the Klein-Gordon field. The vacuum and normal ordering. Particle excitations and multi-particle states. The Feynman propagator and Greens functions.

5.4 Interacting Scalar Fields

Interactions in the Lagrangian and irrelevant operators. ϕ^4 theory. The interaction picture. Time ordering, the S-matrix and Wick's Theorem. Feynman diagrams. Scattering amplitudes.

5.5 The Dirac Equation

The Dirac Equation and its solutions. Negative energy states, Dirac's hole theory and interpretation. Angular momentum and intrinsic spin. Helicity of massless particles. The Dirac Equation under a Lorentz transformations.

5.6 Quantum Electrodynamics

Review Maxwell's Equations in covariant form. Gauge transformations for the photon field. The global U(1) symmetry of the Dirac equation, the insistence on a local symmetry and the covariant derivative. Quantization of the (interacting) Dirac field. The Feynman rules of QED. Some simple scattering processes.