13948 – 719 (8) Relativistic Quantum Mechanics
(1.5L, 1.5P)

2019

Course summary:

Relativistic dispersion relations and quantum mechanics. Klein Gordon equation, Klein paradox. Dirac equation and spin. Covariance of the Dirac wave-function, chirality. Minimal coupling. Nonrelativistic limit and Pauli equation. Relativistic treatment of the hydrogen atom. Maxwell equation as gauge theory. Radiation gauge.

Module relevance in programme:

This module introduces the tools of functional integration that are often used in the contexts of diffusion and quantum mechanics. We show how partial differential equations typical in quantum mechanics and statistical physics can be expressed as sums over paths. In so doing we establish a useful additional perspective and route for calculations on the Brownian motion covered in Physics 721 and the quantum mechanics of Physics 714. In particular, the course provides mathematical tools that are applicable to field theory (Physics 755).

Outcomes of course:

After successful completion of the module students will be able to establish wave-equations based on relativistic kinematics, relate orbital angular momentum and spin, understand Lorentz transformations of wave functions, find relativistic corrections to the hydrogen spectrum, describe the interactions of spins with magnetic fields,identify the constituents of hadrons and apply Greens function methods in simple systems.

Lecturer:

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Mentor:

The Department of Physics has appointed a staff member as mentor for each year of its physics programme to be available to students for consultation. Students should feel free to discuss general issues related to the physics programme or specific modules in the programme with the relevant mentor, in addition to usual consultations with their individual lecturers of modules.

The mentor for the Honours programme and its modules is Dr CM Steenkamp cmsteen@sun.ac.za

Course content:

Formal lectures

Klein-Gordon and Dirac equations; interpretation of solutions with negative energies; covariant notation. Symmetries of the Klein-Gordon and Dirac equations and their non-relativistic limits. Relativistic description of the hydrogen atom. Propagator theory (Greens functions). Transition amplitudes and cross-sections.

Practical (Tutorials):

Weekly tutorials

Study material:

Recommended textbooks: Bjorken and Drell: *Relativistic quantum mechanics*, Halzen and Martin: *Quarks and Leptons*
Further information can be traced at http://www.physics.sun.ac.za/~weigel/teach/rqm.html

Assessment:

Methods of Assessments
Continuous Evaluation. Homework assignments and two tests (one written and one oral).

Venue and time of assessment opportunities
See ***timetable*** on Physics home page

Availability of marks:
2 weeks following assessment

Calculation of mark:
Written test: 50/100, oral test 25/100, homework 25/100