10587-719(8) Quantum Mechanics C
(Functional Integral Formulation) (1½l, 1½p)

2018

Course summary:

Discrete and continuous stochastic processes, diffusion and Brownian motion, functional calculus, Feynman-Kac theorem, propagators and their functional integral representation, free particle and harmonic oscillator, determinants, correlation functions and generating functionals, perturbation theory and saddle point approximation.

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:

This course teaches the student the path integral formulation of quantum mechanics and path integrals as objects in their own right. The student is equipped with basic tools such as conditional probabilities and multidimensional gaussian distributions. The saddle point approximation and perturbative expansions provide more advanced tools to evaluate path integrals.

Lecturer:

Prof H.C. Eggers
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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 Prof KK Müller-Nedebock
kkmn@physics.sun.ac.za.

Course content:

The foundations of path integrals are first studied for classical stochastic processes for discrete timesteps. The possibility and limitations of taking the continuum limit are set out. Functional calculus and the Feynman-Kac theorem lay the foundation for application of path integrals in both classical and quantum mechanical settings. The quantum mechanical propagator and its functional integral representation is derived and evaluated for harmonic oscillator and free particle cases. Correlation functions and the generating functional are introduced and calculated in simple cases. A rudimentary introduction to perturbation theory and the saddle point approximation completes the course.

Practical (Tutorials):

Weekly tutorials

Study material:

Lecture notes are provided, and reference material is placed on reserve in the departmental library.

Assessment:

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

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

Availability of marks:
2 weeks following assessment

Calculation of mark:
Homework/other assignments 50%, tests 50%

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