

# Quantum Dynamics

Programme course

6 credits

Kvantdynamik

TFYA28

Valid from: 2017 Spring semester

**Determined by** Board of Studies for Electrical Engineering, Physics and Mathematics

Date determined 2017-01-25

**Replaced by** TFYT06

# Main field of study

Applied Physics, Physics

**Course level** 

Second cycle

#### Advancement level

A1X

#### Course offered for

- Physics and Nanoscience, Master's Programme
- Applied Physics and Electrical Engineering International, M Sc in Engineering
- Applied Physics and Electrical Engineering, M Sc in Engineering
- Materials Science and Nanotechnology, Master's programme

### Entry requirements

Note: Admission requirements for non-programme students usually also include admission requirements for the programme and threshold requirements for progression within the programme, or corresponding.

#### Prerequisites

Quantum Mechanics, Modern physics

# Intended learning outcomes

The main aim of the course is to give an exposition of the advanced concepts of quantum mechanics such as time-dependent perturbation theory, theory of many-particle systems, scattering theory, quantization of electromagnetic field and elements of relativistic quantum theory. After studying this course students should know:

- how to solve problems using such tools as state vectors and evolution operators, Schrödinger, Heisenberg and Dirac picture, non-pure states and density matrices
- the theory behind second quantization and some basic many-body systems
- the elements of scattering theory, quantization of electromagnetic field and relativistic quantum theory



#### Course content

Introduction and repetition. Wave packets. Group and phase velocity x-, p-, and N-representation. Change of bases. Closure. Spectral decomposition of operators. Unitary operators and trace. The evolution operator and its time-evolution. Schrödinger, Heisenberg and Dirac pictures. Time-dependent perturbation theory. Fermi's golden rule. Density operator. Pure and mixed states. Addition of angular momentum. Many particle systems. Hartree equations. Hartree-Fock equations. Density functional theory and the Kohn-Sham equations. Transport in two-dimensional semiconductor heterostructures. Second quantization or occupation number formalism. Tight-binding model and Hubbard model Scattering theory. Quantization of electromagnetic field. Interaction of matter with the light.Introduction to relativistic quantum mechanics. Klein-Gordon and Dirac equations. EPR-paradox and Bell's theorems.

# Teaching and working methods

The course presented in the form of big seminars with theory and solution of problems

# Examination

UPG1 Hand-in exercises and oral presentation 6 credits U, 3, 4, 5

#### Grades

Four-grade scale, LiU, U, 3, 4, 5

### Other information

Supplementary courses: Relativistic Quantum Mechanics, Particle Physics

#### Department

Institutionen för fysik, kemi och biologi

# Director of Studies or equivalent

Magnus Johansson

Examiner Iryna Yakimenko



# Course website and other links

http://www.ifm.liu.se/undergrad/fysikgtu/coursepage.html? selection=all&sort=kk

#### **Education components**

Preliminary scheduled hours: 64 h Recommended self-study hours: 96 h

# Course literature

#### **Additional literature**

Compendia

I.I. Yakymenko, Lecture Notes in Quantum Dynamics

Other



# **Common rules**

Regulations (apply to LiU in its entirety)

The university is a government agency whose operations are regulated by legislation and ordinances, which include the Higher Education Act and the Higher Education Ordinance. In addition to legislation and ordinances, operations are subject to several policy documents. The Linköping University rule book collects currently valid decisions of a regulatory nature taken by the university board, the vice-chancellor and faculty/department boards.

LiU's rule book for education at first-cycle and second-cycle levels is available at http://styrdokument.liu.se/Regelsamling/Innehall/Utbildning\_pa\_grund-\_och\_avancerad\_niva.

