Quantum physics - course description

General information

Course name	Quantum physics
Course ID	13.2-WF-FizD-QP-S17
Faculty	Faculty of Physics and Astronomy
Field of study	Physics
Education profile	academic
Level of studies	Second-cycle studies leading to MS degree
Beginning semester	winter term 2020/2021

Course information

Semester	1
ECTS credits to win	6
Course type	obligatory
Teaching language	english
Author of syllabus	• prof. dr hab. Piotr Rozmej

Classes forms

The class form	Hours per semester (full-time)	Hours per week (full-time)	Hours per semester (part-time)	Hours per week (part-time)	Form of assignment
Lecture	30	2	-	-	Exam
Class	30	2	-	-	Credit with grade

Aim of the course

To teach the student advanced methods of quantum mechanics. To teach approximation methods and give foundations for relativisitc quantum mechanics

Prerequisites

Knowledge of first course of quantum mechanics

Scope

- Postulates of quantum mechanics – recollection.
- Approximate methods:
- Perturbation theory (time independent). Non-degenerate case. Interpretation of Stern-Gerlach effect and Zeeman effect. Degenerate case. Stark effect.
- Variational principle and variational method. Many-body problem of interacting particles. Mean field approach, self-consistent method.
- Symmetries and conservation laws:
- Unitary transforamations. General formulation.
- Translations and conservation of momentum.
- Rotations and conservation of angular momentum.
- Translations in time and conservation of energy.
- Space inversion and parity conservation.
- Second quantization, occupation number representation. Creation and anihilation operators for fermions.
- Occupation number representation. Creation and anihilation operators for bosons.
- Elements of relativistic quantum mechanics:
- Klein-Gordon equation.
- Dirac equation.
- Free electron motion in Dirac theory. Negative energy states.
- Magnetic moment of electron.
- Spin.
- Hydrogen atom in Dirac theory.
- Universal properties of wave packet dynamics in bounded systems.
- Fermi and Bose statistics

Teaching methods

Lectures on problems and discussions. Oral practice, in which students solve tasks.

Learning outcomes and methods of theirs verification

Outcome description	Outcome symbols	Methods of verification	The class form

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Student is able to link symmetries of the quantum system with particular conservation laws.	• K2_U06	• a discussion • a test • an exam - oral, descriptive, test and other	• Lecture • Class
Student derives conclusions from particular postulates of quantum mechanics.	• K2_W02	• a discussion • a test • an exam - oral, descriptive, test and other	• Lecture • Class
Applies several approximate methods.	• K2_W02	• a discussion • a test • an exam - oral, descriptive, test and other	• Lecture • Class
Is familiar with different representations of physical operator.	• K2_W04	• a discussion • a test • an exam - oral, descriptive, test and other	• Lecture • Class
Is aware of relativistic effects (like spin of fermions) present in quantum systems.	• K2_W06	• a discussion • a test • an exam - oral, descriptive, test and other	• Lecture • Class

Assignment conditions

LECTURE: A course credit for the lectures is obtained by taking a final exam composed of tasks of varying degrees of difficulty.
CLASS: During the classes the preparation of the students will be checked as well as their understanding of the lecture content at the time of the lectures.
To obtain a course credit for the exercises 50% of the maximum number of points will be required, which can be achieved through two cumulative tests. A student who achieves at least 10% of the maximum points and who does not exceed the class absence limit has the right to a resit test of the entire material before the examination date. The result of the exam is also affected by class participation and preparation for the class.
Entrance to the exam requires prior accreditation of the course exercises.

Recommended reading

[1] P. Rozmej, Lecture Notes, pdf file, delivered to students.
[2] St. Szpikowski, Elementy mechaniki kwantowej, Wyd. UMCS, 1999.

Further reading

[1] I. Białynicki-Birula, M. Cieplak, J. Kamiński, Theory of quanta, PWN, Warszawa 2001.
[2] A. L. Schiff, Quantum mechanics, PWN, Warszawa 1987.

Notes

Modified by dr hab. Piotr Lubiński, prof. UZ (last modification: 09-06-2020 16:59)