PHYS-425 **Quantum physics III**

Yazyev Oleg

Cursus	Sem.	Type
Ing.-phys	MA1, MA3	Opt.
Photonics minor	H	Opt.
Physicien	MA1, MA3	Opt.

Language of teaching	English
Credits	5
Session	Winter
Semester	Fall
Exam	Oral
Workload	150h
Weeks	14
Hours	**4 weekly**
Courses	2 weekly
Exercises	2 weekly
Number of positions	

Summary

To introduce several advanced topics in quantum physics, including semiclassical approximation, path integral, scattering theory, and relativistic quantum mechanics

Content

1. Transition from quantum physics to classical mechanics: the coherent states and the Ehrenfest theorem.

2. Semiclassical approximation in quantum mechanics: general form of the semiclassical wave function and matching conditions at turning points.

3. One-dimensional problems in semiclassical approximation: Bohr-Sommerfeld quantisation condition and the Planck formula, tunnelling probability through a potential barrier, lifetime of a metastable state, splitting of the energy levels in a double-well potential.

4. Path integral representation of quantum mechanics: Schrodinger equation from path integral, physical interpretation of the path integral and the principle of minimal action, Euclidean path integral and statistical physics, "instanton" and "bounce".

5. Scattering theory: cross-section, Moller operators and S-matrix, Green's functions and the scattering amplitude, the T-matrix and the Lippmann-Schwinger formula, perturbation theory for amplitudes and the Born approximation, scattering amplitude via stationary scattering states.

6. Relativistic quantum mechanics: the Dirac equation and its non-relativistic limit - the Pauli equation.

Learning Prerequisites

Required courses

Quantum physics I, II

Teaching methods

Ex cathedra and exercises

Assessment methods

oral exam (100%)

Resources

Bibliography

C. Cohen-Tannoudji, B. Diu, F. Laloe, Quantum Mechanics
L. D. Landau and E. M. Lifshitz, Quantum mechanics: non-relativistic theory
R. P. Feynman, A. R. Hibbs, Quantum Mechanics and Path Integrals
J. R. Taylor, Scattering Theory: The Quantum Theory of Nonrelativistic Collisions
J. D. Bjorken, S. D. Drell, Relativistic Quantum Mechanics
A. Messiah, Quantum Mechanics

Ressources en bibliothèque

- J. D. Bjorken, S. D. Drell, Relativistic Quantum Mechanics
- (Ebook) L. D. Landau and E. M. Lifshitz, Quantum mechanics: non-relativistic theory
- C. Cohen-Tannoudji, B. Diu, F. Laloe, Quantum Mechanics
- R. P. Feynman, A. R. Hibbs, Quantum Mechan
- J. R. Taylor, Scattering Theory: The Quantum Theory of Nonrelativistic Collisions
- A. Messiah, Quantum Mechanics
- L. D. Landau and E. M. Lifshitz, Quantum mechanics: non-relativistic theory

Prerequisite for

Quantum Physics IV