

Module title		Abbreviation
Quantum Mechanics		11-T-Q-152-m01
Module coordinator		Module offered by
Managing Director of the Institute of Theoretical Physics and Astrophysics		Faculty of Physics and Astronomy
ECTS	Method of grading	Only after succ. compl. of module(s)
8	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	Admission prerequisite to assessment: completion of exercises (approx. 13 exercise sheets per semester). Students who successfully completed approx. 50% of exercises will qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the semester.
Contents		
<p>1. History and basics: Limits of classical physics; fundamental historical experiments; from classical physics to quantum mechanics (QM);</p> <p>2. Wave function and Schrödinger equation (SG): SG for free particles; superposition; probability distribution for pulse measurement; correspondence principles: postulates of QM; Ehrenfest theorem; continuity equation; stationary solutions of SG</p> <p>3. Formalisation of QM: Eigenvalue equations; Physical significance of the eigenvalues of an operator; state space and Dirac notation; representations in state space; tensor products of state spaces;</p> <p>4. Postulates of QM (and their interpretation): State; measurement; chronological development; energy-time uncertainty;</p> <p>5. One-Dimensional problems: The harmonic oscillator; potential level; potential barrier; potential well; symmetry properties;</p> <p>6. Spin-1/2 systems I: Theoretical description in Dirac notation; Spin 1/2 in the homogeneous magnetic field; two-level systems (qubits);</p> <p>7. Angular momentum: Commutation and rotations; eigenvalues of the angular momentum operators (abstract); solution of the eigenvalue equation in polar coordinates (concrete);</p> <p>8. Central potential - hydrogen atom: Bonding states in 3D; Coulomb potential;</p> <p>9. Motion in an electromagnetic field: Hamiltonian; Normal Zeeman effect; canonical and kinetic momentum; Gauge transformation; Aharonov-Bohm effect; Schrödinger, Heisenberg and interaction representation; motion of a free electron in a magnetic field;</p> <p>10. Spin-1/2 systems II: Formulation using angular momentum algebra;</p> <p>11. Addition of angular momenta;</p> <p>12. Approximation methods: Stationary perturbation theory (with examples); variational method; WKB method; time-dependent perturbation theory;</p> <p>13. Atoms with several electrons: Identical particles; Helium atom; Hartree and Hartree-Fock approximation; atomic structure and Hund's rules</p>		
Intended learning outcomes		
The students have gained first experiences concerning the working methods of Theoretical Physics. They are familiar with the principles of quantum theory. They are able to apply the acquired mathematical methods and techniques to simple problems of quantum theory and to interpret the results. They have especially acquired knowledge of advanced mathematical concepts.		
Courses (type, number of weekly contact hours, language — if other than German)		
V (4) + Ü (2) Module taught in: Ü: German or English		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)		
written examination (approx. 120 minutes) Language of assessment: German and/or English		

Allocation of places

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Additional information

Registration: If a student registers for the exercises and obtains the qualification for admission to assessment, this will be considered a declaration of will to seek admission to assessment pursuant to Section 20 Subsection 3 Sentence 4 ASPO (general academic and examination regulations). If the module coordinators subsequently find that the student has obtained the qualification for admission to assessment, they will put the student's registration for assessment into effect. Only those students that meet the respective prerequisites can successfully register for an assessment. Students who did not register for an assessment or whose registration for an assessment was not put into effect will not be admitted to the respective assessment. If a student takes an assessment to which he/she has not been admitted, the grade achieved in this assessment will not be considered.

Workload

240 h

Teaching cycle

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Referred to in LPO I (examination regulations for teaching-degree programmes)

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Module appears in

Bachelor' degree (1 major) Mathematics (2015)
 Bachelor' degree (1 major) Physics (2015)
 Bachelor' degree (1 major) Mathematical Physics (2015)
 Bachelor' degree (1 major) Computational Mathematics (2015)
 Bachelor's degree (1 major, 1 minor) Physics (Minor, 2015)
 Bachelor' degree (1 major) Physics (2020)
 Bachelor' degree (1 major) Mathematical Physics (2020)
 Bachelor's degree (1 major, 1 minor) Physics (Minor, 2020)
 Bachelor' degree (1 major) Mathematics (2023)
 exchange program Physics (2023)