University of Gdańsk

Subject card

Subject name and code	Molecular Physics , PG_00182578						
Field of study	Physics						
Date of commencement of studies	October 2026		Academic year of realisation of subject	2027/2028			
Education level	Bachelor's studies		Subject group	Obligatory subject group in the field of study Optional subject group Subject group related to scientific research in the field of study			
Mode of study	full-time studies		Mode of delivery	at the university			
Year of study	2		Language of instruction	Polish			
Semester of study	4		ECTS credits	4.0			
Learning profile	academic		Assessment form	credit			
Conducting unit	Faculty of Mathematics, Physics and Informatics -> Rector						
Name and surname of lecturer (lecturers)	Subject supervisor		dr hab. Ryszard Drozdowski, prof. UG				
	Teachers						
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	15.0	0.0	0.0	0.0	45
	E-learning hours included: 0.0						
Learning activity and number of study hours	Learning activity	Participation in didactic classes included in study plan		Participation in consultation hours	Self-study	SUM	
	Number of study hours	45		0.0	55.0	100	
Subject objectives	The aim of the lecture is to learn the quantum-mechanical description of two- and polyatomic molecules, and to realize that molecules are the building blocks of very complex structures of dead and living matter.						

Learning outcomes

Course outcome	Subject outcome	Method of verification
[FIZL3_U09] can extrapolate the results obtained in the terrestrial laboratory to describe phenomena in the Universe	The student is able to use knowledge of molecular physics to interpret the results of laboratory experiments and extrapolate them to describe phenomena related to the structure, spectra and interactions of molecules in astrophysical and cosmological systems.	[SU1] oral statement/conversation/ discussion [SU2] presentation/project/paper/ report [SU3] text preparation/written work
[FIZL3_W01] has advanced knowledge of physical concepts, principles and theories, understands their historical development and significance not only for physics, but also for other exact and natural sciences and cognition of the world; knows and understands fundamental dilemmas of the civilization	The student will know: - the operating principles of advanced spectroscopic equipment - how to select advanced spectroscopic methods for measuring the energy level structure of molecules - how to apply spectroscopic methods to analyze the structure of molecules - how to apply selected atomic and molecular spectroscopy methods to study various physical phenomena - how to apply molecular spectroscopic methods in biology, medicine, and other areas of human activity.	[SW1] oral statement/ conversation/discussion [SW3] text preparation/written work
[FIZL3_W10] has advanced knowledge of the elementary components of matter and the types of fundamental interactions between them, of the manifestations of these interactions in phenomena occurring on various scales from subatomic to astronomical, knows the time and energy scales associated with these phenomena	The student knows: – the concepts of quantum mechanics, – advanced models for describing the structure of atoms and molecules, – a description of the spontaneous and stimulated emission process, – the effect of an electric field on molecules and interatomic interactions, – the effect of a magnetic field on molecules and interatomic interactions, – the mechanism of formation of diatomic and polyatomic molecules, – types of molecular spectra, – approximate quantum mechanical methods for describing molecules. – methods for analyzing spectra,	[SW1] oral statement/ conversation/discussion [SW3] text preparation/written work

Subject contents

Diatomic and polyatomic molecules - wave functions and energy level structure of molecules - the Schrödinger equation and the Born-Oppenheimer approximation. Methods for solving the Schrödinger equation - the molecular orbital method, the LCAO MO (Linear Combination of Atomic Orbitals) method, the valence bond method, and the variational method. Description and classification of orbitals in diatomic homonuclear and heteronuclear molecules, and in polyatomic molecules. Types of bonds between atoms in molecules. Characterization of molecular spectra - electronic, vibrational, rotational, and Raman spectra. Spectral band intensities - the Franck-Condon principle.

Prerequisites and co-requisites

Knowledge of quantum mechanics and atomic physics.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
class activity/discussion	0.0%	25.0%
written study of a given problem	51.0%	75.0%

Recommended reading	Basic literature	Z. Kęcki, Podstawy spektroskopii molekularnej, Wydawnictwo Naukowe PWN Warszawa 1998 J. Sadlej, Spektroskopia molekularna, WNT 2002 H. Haken, H.C. Wolf, "Fizyka molekularna z elementami chemii kwantowej", PWN Warszawa 1998 W. Kołos Chemia kwantowa PWN 1978 R. Eisberg, R. Resnick, "Fizyka kwantowa atomów, cząsteczek, ciał stałych, jąder i cząstek elementarnych", PWN Warszawa 1983 J. Ginter, "Wstęp do fizyki atomu, cząsteczki i ciała stałego", PWN Warszawa 1986
	Supplementary literature	Z. Leś, Podstawy fizyki atomu, PWN SA 2015 H. Haken, H.C. Wolf, "Atomy i kwanty, wprowadzenie do spektroskopii atomowej", PWN Warszawa 1997 L. I. Schiff, "Mechanika kwantowa", PWN Warszawa 1987 L. I. Liboff, "Wstęp do mechaniki kwantowej", PWN Warszawa 1987
	eResources addresses	
Example issues/ example questions/ tasks being completed	not applicable	
Work placement	Not applicable	

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