Subject card

Subject name and code	Quantum Field Theory in Curved Specetime, PG_00202443					
Field of study	Physics					
Date of commencement of studies	October 2025		Academic year of realisation of subject		2025/2026	
Education level	Master’s studies		Subject group		Obligatory subject group in the field of study Optional subject group	
Mode of study	full-time studies		Mode of delivery		at the university	
Year of study	1		Language of instruction		English	
Semester of study	2		ECTS credits		5.0	
Learning profile	academic		Assessment form		credit	
Conducting unit	Zakład Oddziaływań Fundamentalnych, Grawitacji i Kosmologii -> Institute of Theoretical Physics and Astrophysics -> Faculty of Mathematics, Physics and Informatics -> Rector					
Name and surname of lecturer (lecturers)	Subject supervisor		dr Denis Dobkowski-Ryłko			
	Teachers					
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	30.0	0.0	0.0	0.0	60
	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	60	0.0	65.0	125	
Subject objectives	The aim of the course is to introduce students to the fundamental concepts and techniques of quantum field theory in curved spacetime. The course covers the quantization of scalar fields in curved spacetime, the analysis of particle detectors, cosmological particle creation, Hawking radiation, and the Unruh effect.					

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[FIZMU2_U05] has the ability to synthesize methods and ideas from various areas of physics and other exact and natural sciences; is able to notice that even distant phenomena are described by similar models	Possesses the ability to synthesize methods and ideas from various areas of theoretical physics as well as other exact and natural sciences; is able to recognize that seemingly distant physical phenomena, including processes in quantum field theory in curved spacetime, can be described using similar mathematical and theoretical models.	[SU3] text preparation/written work
	[FIZMU2_U12] is able to use English in the field of physics, mathematics and computer science, in accordance with the requirements set out for level B2+ of the Common European Framework of Reference for Languages, to the extent that allows them to independently complete their education and communicate with specialists in the same or related specialisation	Is able to use English in the field of theoretical physics at a level that allows for independent advancement of knowledge and communication with specialists in quantum field theory in curved spacetime or related areas of theoretical physics and cosmology.	[SU3] text preparation/written work [SU4] test/exam - oral or written
	[FIZMU2_U06] is able to adapt the knowledge and methodology of physics, as well as the applied experimental and theoretical methods to related scientific disciplines	Is able to adapt knowledge and methodology from theoretical physics, as well as the theoretical methods used in quantum field theory in curved spacetime, to research in quantum cosmology and quantum gravity.	[SU3] text preparation/written work
	[FIZMU2_K02] is aware of the conclusive role of experiment in the verification of physical theories; is aware of the scientific method in the accumulation of knowledge	Is aware of the crucial role of experiment and observation in the verification of physical theories, including testing the predictions of quantum field theory in curved spacetime; understands the existence and importance of the scientific method in the collection and verification of scientific knowledge.	[SK4] test/exam - oral or written
	[FIZMU2_K01] knows the limitations of his own knowledge and skills; can formulate questions precisely; understands the need for further education and other	Is aware of the limitations of their own knowledge and skills in the field of quantum field theory in curved spacetime; is able to formulate precise questions regarding theoretical and experimental issues; understands the need for further self-education and for supporting the education of others in theoretical physics and cosmology.	[SK3] text preparation/written work
	[FIZMU2_U10] is able to popularize science within their specialty or related areas of physics	Is able to popularize science in the field of quantum field theory in curved spacetime and in related areas of theoretical physics and cosmology.	[SU3] text preparation/written work
	[FIZMU2_U11] is able to determine the directions of further improvement of knowledge and skills (including self-education) in the field of the selected specialization and beyond it	Is able to identify directions for further development of knowledge and skills, including self-education, in the field of quantum field theory in curved spacetime and in related areas of theoretical physics and cosmology.	[SU3] text preparation/written work
	[FIZMU2_W06] has knowledge of the current directions of development of physics and fundamental dilemmas of modern civilization	Possesses knowledge of current research directions in theoretical physics, particularly in the field of quantum field theory in curved spacetime and its applications in cosmology and gravitational physics.	[SW4] test/exam - oral or written
	[FIZMU2_K05] understands the need to popularize knowledge in the field of physics, including the latest scientific and technological achievements	Understands the need to popularize knowledge in the field of quantum field theory in curved spacetime, including the latest scientific and technological achievements in theoretical physics and cosmology.	[SK3] text preparation/written work

<table>
<tr><td>Subject contents</td><td colspan="3">Quantum field theory in Minkowski spacetime

Scalar field quantization

Particle detectors

Cosmological particle creation

Conformal vacuum

Hawking radiation in Vaidya Spacetime

Radiation in Rindler space: Unruh effect</td></tr>
<tr><td>Prerequisites and co-requisites</td><td colspan="3">Passed Field theory</td></tr>
<tr><td rowspan="3">Assessment methods and criteria</td><td>Subject passing criteria</td><td>Passing threshold</td><td>Percentage of the final grade</td></tr>
<tr><td>Test</td><td>51.0%</td><td>60.0%</td></tr>
<tr><td>Homework</td><td>51.0%</td><td>40.0%</td></tr>
<tr><td rowspan="3">Recommended reading</td><td>Basic literature</td><td colspan="2">A. Fabbri, J. Navarro-Salas, Modeling Black Hole Evaporation

N. D. Birrell, P.C.W. Davies, Quantum Fields in Curved Space</td></tr>
<tr><td>Supplementary literature</td><td colspan="2">R.M. Wald, Quantum Field Theory in Curved Spacetime and Black Hole Thermodynamics</td></tr>
<tr><td>eResources addresses</td><td colspan="2"></td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td colspan="3"></td></tr>
<tr><td>Work placement</td><td colspan="3">Not applicable</td></tr>
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