

DOCTORAL SCHOOL OF PHYSICS LIST OF COURSES

Discipline: Science

Form of education: Doctor of Philosophy (PhD) training

Effective from: 2026/27 academic year

Objectives: acquire the academic degree training and the skills necessary in research, development, innovation, and higher-level education

Length of training: 8 semesters

Training type: regular school

Financing: state-sponsored or tuition-fee based

Entrance requirements: MSc and a successful entrance exam

Language requirements: a type „C” secondary (or equivalent) English language exam recognized by the state

Training phases: First two years (period I): 120 ECTS credits, finished with a complex exam

Last two years (period II): 120 ECTS credits, finished with an absolutionarium

Number of ECTS credits required: 240

Modules of ECTS credits:

Programs I-III and V: study credits (48), research credits in the first two years (72), in the last two years (120)

Program IV (Physics education): study credits (80), research credits in the first two years (52), in the last two years (120)

Person responsible for the training: Dr. Gergely Palla professor of physics, head of the PhD school

TRAINING MODULE

Program I: Materials Science and Solid State Physics

Head of the program: Dr. István Groma

FIZ/1/001 Nanophase metals

6 credit, theory, optional, no repetition

FIZ/1/004 The finite element method and applications in material science

6 credit, theory, optional, no repetition

FIZ/1/005 Liquid crystals, polymers

6 credit, theory, optional, no repetition

FIZ/1/006 Pattern formation in complex systems

6 credit, theory, optional, no repetition

FIZ/1/009 Micro- and nanotechnology I.

6 credit, theory, optional, no repetition

FIZ/1/014 Analytical electron microscopy

6 credit, theory, optional, no repetition

FIZ/1/015 Physical materials science I.

6 credit, theory, optional, no repetition

FIZ/1/016 Physical materials science II.
6 credit, theory, optional, no repetition

FIZ/1/018 Nuclear solid state physics I.
6 credit, theory, optional, no repetition

FIZ/1/019 Nuclear solid state physics II.
6 credit, theory, optional, no repetition

FIZ/1/021 Transmission electron microscopy and electron diffraction
6 credit, theory, optional, no repetition

FIZ/1/022 Advanced Material Physics
6 credit, theory, optional, no repetition

FIZ/1/023 Solid state theory
6 credit, theory, optional, no repetition

FIZ/1/024 Lattice defects I.
6 credit, theory, optional, no repetition

FIZ/1/025 Lattice defects II.
6 credit, theory, optional, no repetition

FIZ/1/029 Solid state research I.
6 credit, theory, optional, no repetition

FIZ/1/030 Solid state research II.
6 credit, theory, optional, no repetition

FIZ/1/031 Technology of materials (intensive course)
6 credit, theory, optional, no repetition

FIZ/1/032 Nanomagnetism
6 credit, theory, optional, no repetition

FIZ/1/036 Composite materials
6 credit, theory, optional, no repetition

FIZ/1/037 Amorphous alloys
6 credit, theory, optional, no repetition

FIZ/1/038 Diffraction methods in Materials Science I.
6 credit, theory, optional, no repetition

FIZ/1/039 Diffraction methods in Materials Science II.
6 credit, theory, optional, no repetition

FIZ/1/040 Bulk nanostructured materials
6 credit, theory, optional, no repetition

FIZ/1/041 Quantum bits in solids
6 credit, theory, optional, no repetition

FIZ/1/042 Topological insulators I.
6 credit, theory, optional, no repetition

FIZ/1/043 Topological insulators II.
6 credit, theory, optional, no repetition

FIZ/1/044 Micro and nanotechnology II.
6 credit, theory, optional, no repetition

FIZ/1/045 Low temperature plasma physics
6 credit, theory, optional, no repetition

FIZ/1,3/013 Quantum chaos in mesoscopic systems
6 credits, theory, optional, no repetition

FIZ/1,3/015 Carbon Nanostructures
6 credits, theory, optional, no repetition

FIZ/1,3/016 Macromolecules
6 credits, theory, optional, no repetition

FIZ/1,3/020 Experimental methods in solid state physics I.
6 credit, theory, optional, no repetition

FIZ/1,3/022 Mesoscopic superconductors
6 credits, theory, optional, no repetition

FIZ/1,3/023 Physics of mesoscopic systems II.
6 credits, theory, optional, no repetition

FIZ/1,3/025 Trapped atomic systems
6 credits, theory, optional, no repetition

FIZ/1,3/028 Computer simulations in statistical physics
6 credits, theory, optional, no repetition

FIZ/1,3/032 Phase transitions
6 credits, theory, optional, no repetition

FIZ/1,3/035 Many-body problem I.
6 credits, theory, optional, no repetition

FIZ/1,3/040 Mesoscopic Systems I.
6 credits, theory, optional, no repetition

FIZ/1,3/041 Trapped atomic systems II.
6 credits, theory, optional, no repetition

FIZ/1,3/042 Cooling and trapping of neutral atoms
6 credits, theory, optional, no repetition

FIZ/1,3/050 Many-body problem II.
6 credit, theory, optional, no repetition

FIZ/1,3/052 Experimental methods in solid state physics II.
6 credit, theory, optional, no repetition

FIZ/1,3/054 Universality classes in non-equilibrium systems
6 credits, theory, optional, no repetition

FIZ/1,3/060 Quantum information theory
6 credits, theory, optional, no repetition

FIZ/1,3/062 Superconductivity
6 credits, theory, optional, no repetition

FIZ/1,3/065 Synchrotron radiation and applications
6 credits, theory, optional, no repetition

FIZ/1,3/066 Theories of open quantum systems
6 credits, theory, optional, no repetition

FIZ/1,3/068 Green's functions in nanophysics
6 credits, theory, optional, no repetition

FIZ/1,3/073 Group theory in solid state research
6 credits, theory, optional, no repetition

FIZ/1,3/074 Introduction to superconductivity
6 credits, theory, optional, no repetition

FIZ/1,3/076 Entanglement in quantum many-body systems
6 credits, theory, optional, no repetition

FIZ/1,3/079 Stochastic processes
6 credits, theory, optional, no repetition

FIZ/1,3/082 Dynamical phenomena in soft materials
6 credits, theory, optional, no repetition

FIZ/1,3/083 Advanced neutron techniques of material characterization
6 credits, theory, optional, no repetition

FIZ/SZ/3

Free credits; 3 credits, practice, optional, repeatable

FIZ/SZ/6

Free credits; 6 credits, practice, optional, no repetition

FIZ/VB Final report credits (maximum 60 credits at the end of the 6th semester and maximum 30 credits at the end of the 7th semester)

Research module

FIZ/S1-S4/K18 Guided research work (1., 2., 3., 4. semester)

18 credit, research, optional, repeatable (4 times)

FIZ/S5-S8/K5 Guided research work (5., 6., 7., 8. semester)

5 credit, research, optional, repeatable (4 times)

FIZ/S5-S8/K10 Guided research work (5., 6., 7., 8. semester)

10 credit, research, optional, repeatable (4 times)

FIZ/S5-S8/K15 Guided research work (5., 6., 7., 8. semester)

15 credit, research, optional, repeatable (4 times)

Teaching module (max. credits: 4/semester)

FIZ/OKT/2 Teaching activity

2 credits, practice, optional, can be repeated

FIZ/OKT/4 Teaching activity

4 credits, practice, optional, can be repeated

Program II: Particle and Nuclear Physics

Head of the program: Dr. Zoltán Trócsányi

FIZ/2/001 Advanced field theory

6 credit, theory, optional, no repetition

FIZ/2/002 Standard model

6 credit, theory, optional, no repetition

FIZ/2/003 Beyond the standard model

6 credit, theory, optional, no repetition

FIZ/2/004 Experimental methods of particle physics II

6 credit, theory, optional, no repetition

FIZ/2/005 String Theory I

6 credit, theory, optional, no repetition

FIZ/2/007 Lattice field theory I.

6 credit, theory, optional, no repetition

FIZ/2/008 Solitons and instantons I.

6 credit, theory, optional, no repetition

FIZ/2/009 Solitons and instantons II.

6 credit, theory, optional, no repetition

FIZ/2/015 Inflationary cosmology

6 credit, theory, optional, no repetition
FIZ/2/016 Finite temperature quantum field theory and astrophysical applications
6 credit, theory, optional, no repetition
FIZ/2/017 Discrete gauge symmetries
6 credit, theory, optional, no repetition
FIZ/2/018 Conform field theories
6 credit, theory, optional, no repetition
FIZ/2/019 Field theories with boundaries
6 credit, theory, optional, no repetition
FIZ/2/020 Algebraic field theory I.
6 credit, theory, optional, no repetition
FIZ/2/021 Introduction to general relativity I.
6 credit, theory, optional, no repetition
FIZ/2/022 Experimental methods of nuclear physics
6 credit, theory, optional, no repetition
FIZ/2/023 Jet physics in hadron hadron and in heavy ion collisions
6 credit, theory, optional, no repetition
FIZ/2/024 The phase diagram of strongly interacting matter
6 credit, theory, optional, no repetition
FIZ/2/043 Introduction to supersymmetry
6 credit, theory, optional, no repetition
FIZ/2/049 Experimental high energy physics: data analysis
6 credit, theory, optional, no repetition
FIZ/2/050 Perturbative conformal field theory
6 credit, theory, optional, no repetition
FIZ/2/052 Algebraic field theory II.
6 credit, theory, optional, no repetition
FIZ/2/053 String theory II.
6 credit, theory, optional, no repetition
FIZ/2/054 String Theory III.
6 credit, theory, optional, no repetition
FIZ/2/055 Lattice field theory II.
6 credit, theory, optional, no repetition
FIZ/2/057 Introduction to general relativity II.
6 credit, theory, optional, no repetition
FIZ/2/077 Introduction to Quantum Integrable Models
6 credit, theory, optional, no repetition
FIZ/2/078 The algebraic Bethe Ansatz and its applications
6 credit, theory, optional, no repetition
FIZ/2/083 Quantum chromodynamics
6 credit, theory, optional, no repetition
FIZ/2/084 Integrable field theories
6 credit, theory, optional, no repetition
FIZ/2/086 Solitons and instantons III.
6 credit, theory, optional, no repetition
FIZ/2/094 High energy heavy ion physics and the perfect quark fluid
6 credit, theory, optional, no repetition
FIZ/2/104 Integrable methods in gauge/gravity duality I
6 credit, theory, optional, no repetition
FIZ/2/109 Integrability methods in gauge/gravity duality

6 credit, theory, optional, no repetition
FIZ/2/110 Statistical field theory
6 credit, theory, optional, no repetition

FIZ/2/113 Quantum world
6 credit, theory, optional, no repetition
FIZ/2/117 Selected chapters from experimental high energy physics
6 credit, theory, optional, no repetition
FIZ/2/132 Particle Astrophysics
6 credits, theory, optional, no repetition
FIZ/2/136 Nuclear physics with radioactive beams
6 credit, theory, optional, no repetition
FIZ/2/138 Experimental methods in particle physics
6 credit, theory, optional, no repetition
FIZ/2/139 Neutrino Physics
6 credit, theory, optional, no repetition
FIZ/2/140 Methods of Computing Feynman integrals
6 credit, theory, optional, no repetition
FIZ/2/141 Lie group in physics
6 credit, theory, optional, no repetition
FIZ/2/142 Renormalization
6 credit, theory, optional, no repetition
FIZ/2/143 Open quantum field theories and renormalization group
6 credit, theory, optional, no repetition

FIZ/2/144 Hadron physics at low energies
9 credit, theory, optional, no repetition

FIZ/SZ/3
Free credits; 3 credits, practice, optional, repeatable

FIZ/SZ/6
Free credits; 6 credits, practice, optional, no repetition

FIZ/VB Final report credits (maximum 60 credits at the end of the 6th semester and maximum 30 credits at the end of the 7th semester)

Research module

FIZ/S1-S4/K18 Guided research work (1., 2., 3., 4. semester)
18 credit, research, optional, repeatable (4 times)
FIZ/S5-S8/K5 Guided research work (5., 6., 7., 8. semester)
5 credit, research, optional, repeatable (4 times)
FIZ/S5-S8/K10 Guided research work (5., 6., 7., 8. semester)
10 credit, research, optional, repeatable (4 times)

FIZ/S5-S8/K15 Guided research work (5., 6., 7., 8. semester)
15 credit, research, optional, repeatable (4 times)

Teaching module (max. credits: 4/semester)

FIZ/OKT/2 Teaching activity
2 credits, practice, optional, can be repeated

FIZ/OKT/4 Teaching activity
4 credits, practice, optional, can be repeated

Program III: Statistical Physics, Biological Physics and Physics of Quantum Systems

Head of the program: Dr. Gábor Horváth

- FIZ/3/003** Statistical physics of biological systems
6 credit, theory, optional, no repetition
- FIZ/3/004** Fractal growth
6 credit, theory, optional, no repetition
- FIZ/3/005** Theoretical evolutionary biology
6 credit, theory, optional, no repetition
- FIZ/3/008** Pattern formation in complex systems
6 credit, theory, optional, no repetition
- FIZ/3/009** Liquid crystals and polymers
6 credit, theory, optional, no repetition
- FIZ/3/010** Sensory biophysics
6 credit, theory, optional, no repetition
- FIZ/1,3/013** Quantum chaos in mesoscopic systems
6 credit, theory, optional, no repetition
- FIZ/1,3/015** Carbon Nanostructures
6 credit, theory, optional, no repetition
- FIZ/1,3/016** Macromolecules
6 credit, theory, optional, no repetition
- FIZ/3/017** Physics of environmental flows
6 credit, theory, optional, no repetition
- FIZ/3/018** Application of chaos theory
6 credit, theory, optional, no repetition
- FIZ/1,3/020** Experimental methods in solid state physics I.
6 credit, theory, optional, no repetition
- FIZ/3/021** Statistical physics of polymers and membranes
6 credit, theory, optional, no repetition
- FIZ/1,3/022** Mesoscopic superconductors
6 credit, theory, optional, no repetition
- FIZ/1,3/023** Physics of mesoscopic systems II.
6 credit, theory, optional, no repetition
- FIZ/1,3/025** Trapped atomic systems
6 credit, theory, optional, no repetition

FIZ/3/027 Extreme statistics and their applications
6 credit, theory, optional, no repetition

FIZ/1,3/028 Computer simulations in statistical physics
6 credit, theory, optional, no repetition

FIZ/3/029 Introduction to quantum optics
6 credit, theory, optional, no repetition

FIZ/3/030 Coherent control of quantum systems
6 credit, theory, optional, no repetition

FIZ/1,3/032 Phase transitions
6 credit, theory, optional, no repetition

FIZ/3/033 Non-equilibrium statistical physics
6 credit, theory, optional, no repetition

FIZ/3/034 Mathematical methods in quantum chemistry I.
6 credit, theory, optional, no repetition

FIZ/1,3/035 Many-body problem I.
6 credit, theory, optional, no repetition

FIZ/3/037 Environmental fluid hydrodynamics II. EA
6 credit, theory, optional, no repetition

FIZ/3/039 Statistical properties of chaos
6 credit, theory, optional, no repetition

FIZ/1,3/040 Mesoscopic Systems I.
6 credit, theory, optional, no repetition

FIZ/1,3/041 Trapped atomic systems II.
6 credit, theory, optional, no repetition

FIZ/1,3/042 Cooling and trapping of neutral atoms
6 credit, theory, optional, no repetition

FIZ/3/044 New experiments in quantum mechanics
6 credits, theory, optional, no repetition

FIZ/3/045 Sensory biophysics II
6 credit, theory, optional, no repetition

FIZ/3/048 Dynamical critical phenomena
6 credit, theory, optional, no repetition

FIZ/1,3/050 Many-body problem II.
6 credit, theory, optional, no repetition

FIZ/3/051 Fundamentals of the Physics of Solids II.
6 credit, theory, optional, no repetition

FIZ/1,3/052 Experimental methods in solid state physics II.
6 credit, theory, optional, no repetition

FIZ/1,3/054 Universality classes in non-equilibrium systems
6 credit, theory, optional, no repetition

FIZ/3/055 Systems biology: quantitative analysis of intracellular signal transduction networks
6 credit, theory, optional, no repetition

FIZ/3/056 Quantitative models of mechanisms in developmental biology
6 credit, theory, optional, no repetition

FIZ/3/059 Evolutionary game theory
6 credit, theory, optional, no repetition

FIZ/1,3/060 Quantum information theory
6 credit, theory, optional, no repetition

FIZ/1,3/062 Superconductivity
6 credit, theory, optional, no repetition

FIZ/3/063 Graphs in bioinformatics
6 credit, theory, optional, no repetition

FIZ/3/064 Clustering with networks
6 credit, theory, optional, no repetition

FIZ/1,3/065 Synchrotron radiation and applications
6 credit, theory, optional, no repetition

FIZ/1,3/066 Theories of open quantum systems
6 credit, theory, optional, no repetition

FIZ/1,3/068 Green's functions in nanophysics
6 credit, theory, optional, no repetition

FIZ/3/070 Quantum electrodynamics in resonator
6 credit, theory, optional, no repetition

FIZ/3/071 Molecular and biophysical mechanisms of cell motion
6 credit, theory, optional, no repetition

FIZ/1,3/073 Group theory in solid state research
6 credit, theory, optional, no repetition

FIZ/1,3/074 Introduction to superconductivity
6 credit, theory, optional, no repetition

FIZ/3/075 Extremes, Records, and Order-Statistics in Nature
6 credit, theory, optional, no repetition

FIZ/1,3/076 Entanglement in quantum many-body systems
6 credit, theory, optional, no repetition

FIZ/3/077 Imaging techniques in modern biology
6 credit, theory, optional, no repetition

FIZ/3/078 Fronts and Patterns
6 credit, theory, optional, no repetition

FIZ/1,3/079 Stochastic processes
6 credit, theory, optional, no repetition

FIZ/3/082 Preclinical models in cancer research
6 credit, theory, optional, no repetition

FIZ/3/083 Python programming and networks
6 credit, theory, optional, no repetition

FIZ/1,3/083 Advanced neutron techniques of material characterization
6 credits, theory, optional, no repetition

FIZ/3/084 Data mining and machine learning
6 credits, theory and practice, optional, no repetition

FIZ/3/085 Data exploration and visualisation
6 credits, theory and practice, optional, no repetition

FIZ/3/086 Data Models and Databases in Science
6 credits, theory and practice, optional, no repetition

FIZ/3/087 Data science computer lab
6 credits, practice, optional, no repetition

FIZ/3/088 Advanced statistics and modelling
6 credits, theory and practice, optional, no repetition

FIZ/3/089 Deep learning and machine learning in natural sciences
6 credits, theory optional, no repetition

FIZ/3/090 Scientific modelling computer lab

- 6 credits, practice, optional, no repetition
FIZ/3/091 Computational Studies of Electron Systems
 6 credits, practice, optional, no repetition
- FIZ/3/092** New results in machine learning
 6 credits, theory and practice, optional, repeatable (4 times)
- FIZ/3/093** Advanced machine learning lab
 6 credits, theory and practice, optional, no repetition
- FIZ/3/094** X-ray and YUV physics and spectroscopy
 6 credits, theory, optional, no repetition
- FIZ/3/095** Electromagnetic waves in plasmas
 6 credits, theory, optional, no repetition
- FIZ/3/096** Foundations of Quantum Mechanics
 6 credits, theory, optional, no repetition
- FIZ/3/097** Classical and Quantum Optimization
 6 credits, theory, optional, no repetition
- FIZ/3/098** Environmental biophysics
 6 credits, theory, optional, no repetition
- FIZ/3/099** Data-driven health
 6 credits, theory, optional, no repetition
- FIZ/3/100** Quantum computer science
 6 credits, theory, optional, no repetition
- FIZ/3/101** Artificial intelligence techniques in robotics
 6 credits, theory, optional, no repetition
- FIZ/3/102** Quantum Reservoir Computing in Artificial Intelligence
 6 credits, theory, optional, no repetition

FIZ/SZ/3

Free credits; 3 credits, practice, optional, repeatable

FIZ/SZ/6

Free credits; 6 credits, practice, optional, no repetition

FIZ/VB Final report credits (maximum 60 credits at the end of the 6th semester and maximum 30 credits at the end of the 7th semester)

Research module

FIZ/S1-S4/K18 Guided research work (1., 2., 3., 4. semester)

18 credit, research, optional, repeatable (4 times)

FIZ/S5-S8/K5 Guided research work (5., 6., 7., 8. semester)

5 credit, research, optional, repeatable (4 times)

FIZ/S5-S8/K10 Guided research work (5., 6., 7., 8. semester)

10 credit, research, optional, repeatable (4 times)

FIZ/S5-S8/K15 Guided research work (5., 6., 7., 8. semester)
15 credit, research, optional, repeatable (4 times)

Teaching module (max. credits: 4/semester)

FIZ/OKT/2 Teaching activity

2 credits, practice, optional, can be repeated

FIZ/OKT/4 Teaching activity

4 credits, practice, optional, can be repeated

Program IV: Physics Education

Head of the program: Dr. Nguyen Quang Chinh

FIZ/T/001 Physics education I

5 credit, theory, optional, no repetition

FIZ/T/002 Foundation of the theory of relativity

5 credit, theory, optional, no repetition

FIZ/T/003 Physics of environmental flows

5 credit, theory, optional, no repetition

FIZ/T/005 Chaotic mechanics

5 credit, theory, optional, no repetition

FIZ/T/006 Versatile use of computers in physics education

5 credit, theory, optional, no repetition

FIZ/T/007 Physics of elementary particles

5 credit, theory, optional, no repetition

FIZ/T/009 Physics education II (Classical physics, electromagnetism, optics)

5 credit, theory, optional, no repetition

FIZ/T/010 Physics education III (Modern physics: atomic physics, molecular and nuclear physics)

5 credit, theory, optional, no repetition

FIZ/T/011 Physics education IV (Modern physics: statistical physics, relativity, material science, nonlinear phenomena)

5 credit, theory, optional, no repetition

FIZ/T/013 Historically relevant experiments of Physics

5 credit, theory, optional, no repetition

FIZ/T/016 Energetics and environment

5 credit, theory, optional, no repetition

FIZ/T/020 Cooperative phenomena, interdisciplinary aspects

5 credit, theory, optional, no repetition

FIZ/T/021 Physics in biology

5 credit, theory, optional, no repetition

FIZ/T/022 Physics in chemistry

5 credit, theory, optional, no repetition

FIZ/T/023 Recent results in astronomy and space science

5 credit, theory, optional, no repetition

FIZ/T/024 Plausible quantum theory

5 credit, theory, optional, no repetition

FIZ/SZ/3

Free credits; 3 credits, practice, optional, repeatable

FIZ/SZ/6

Free credits; 6 credits, practice, optional, no repetition

FIZ/VB Final report credits (maximum 60 credits at the end of the 6th semester and maximum 30 credits at the end of the 7th semester)

Research module

FIZ/T/S1/K4 Guided research work (1. semester)

4 credit, research, optional, non-repeatable

FIZ/T/S2-S4/K16 Guided research work (2., 3., 4. semester)

16 credit, research, optional, repeatable (3 times)

FIZ/S5-S8/K5 Guided research work (5., 6., 7., 8. semester)

5 credit, research, optional, repeatable (4 times)

FIZ/S5-S8/K10 Guided research work (5., 6., 7., 8. semester)

10 credit, research, optional, repeatable (4 times)

FIZ/S5-S8/K15 Guided research work (5., 6., 7., 8. semester)

15 credit, research, optional, repeatable (4 times)

Teaching module (max. credits: 4/semester)

FIZ/OKT/2 Teaching activity

2 credits, practice, optional, can be repeated

FIZ/OKT/4 Teaching activity

4 credits, practice, optional, can be repeated

Program V: Astronomy and Space Physics

Head of the program: Dr. Kristóf Petrovay

FIZ/5/001 [034] Observational methods in astrophysics

6 credits, theory, optional, no repetition

FIZ/5/002 [129] Astronomy with ESO instrumentation

6 credits, theory, optional, no repetition

FIZ/5/003 [026] Astrostatistics I.

6 credits, theory, optional, no repetition

FIZ/5/004 [059] Astrostatistics II.

6 credits, theory, optional, no repetition

FIZ/5/005 [075] Working with astronomical databases

6 credits, practice, optional, no repetition

FIZ/5/006 [119] Data mining in astronomy

6 credits, theory, optional, no repetition

FIZ/5/007 [031] Advanced information technology in astronomy I.

6 credits, theory, optional, no repetition

- FIZ/5/008 [064]** Advanced information technology in astronomy II.
6 credits, theory, optional, no repetition
- FIZ/5/009 [032]** Radio astronomy I.
6 credits, theory, optional, no repetition
- FIZ/5/010 [065]** Radio astronomy II.
6 credits, theory, optional, no repetition
- FIZ/5/011 [038]** Astrophysical turbulence, dynamos and reconnection 1. LCT
6 credits, theory, optional, no repetition
- FIZ/5/012 [067]** Astrophysical turbulence, dynamos and reconnection II. LCT
6 credits, theory, optional, no repetition
- FIZ/5/013 [039]** Astronomy from space I.
6 credits, theory, optional, no repetition
- FIZ/5/014 [072]** Astronomy from space II.
6 credits individual research, optional, repeatable
- FIZ/5/015 [040] Infrared Astronomy I**
6 credits, theory, optional, no repetition
- FIZ/5/016 [068]** Infrared Astronomy II. GY
6 credits, practice, optional, no repetition
- FIZ/5/017 [076]** Chapters from modern astronomy and cosmology
6 credits, theory, optional, no repetition
- FIZ/5/018 [107]** N-body simulations in astrophysics and cosmology
6 credits, theory, optional, no repetition
- FIZ/5/019 [126]** Cosmology
6 credits, theory, optional, no repetition
- FIZ/5/020 [074]** The distant universe
6 credits, theory, optional, no repetition
- FIZ/5/021 [127]** Gravitational wave astrophysics
6 credits, theory, optional, no repetition
- FIZ/5/022 [118]** High energy astrophysics
6 credits, theory, optional, no repetition
- FIZ/5/023 [122]** The physics of black holes
6 credits, theory, optional, no repetition
- FIZ/5/024 [123]** Selected chapters from the study of the structure of compact stars
6 credits, theory, optional, no repetition
- FIZ/5/025 [080]** The structure of compact stars
6 credits, theory, optional, no repetition
- FIZ/5/026 [121]** Active galactic nuclei
6 credits, theory, optional, no repetition
- FIZ/5/027 [027]** Dynamics of stellar systems I.
6 credits, theory, optional, no repetition
- FIZ/5/028 [060]** Dynamics of stellar systems II.
6 credits, theory, optional, no repetition
- FIZ/5/029 [120]** Stellar and galaxy populations
6 credits, theory, optional, no repetition
- FIZ/5/030 [037]** Current research results in interstellar matter and star formation I.
6 credits, theory, optional, no repetition
- FIZ/5/031 [025]** The physics of interstellar matter I.
6 credits, theory, optional, no repetition
- FIZ/5/032 [058]** The physics of interstellar matter II.
6 credits, theory, optional, no repetition

- FIZ/5/033 [070]** Accretion processes in star formation
6 credits, practice, optional, no repetition
- FIZ/5/034 [093]** Light variations in young stellar objects
6 credits, theory, optional, no repetition
- FIZ/5/035 [033]** Stellar activity – active stars I.
6 credits, theory, optional, no repetition
- FIZ/5/036 [066]** Stellar activity – active stars II.
6 credits, theory, optional, no repetition
- FIZ/5/037 [115]** Pulsating variables and their observation I.
6 credits, theory, optional, no repetition
- FIZ/5/038 [116]** Pulsating variables and their observation II.
6 credits, theory, optional, no repetition
- FIZ/5/039 [114]** Pulsation theory
6 credits, theory, optional, no repetition
- FIZ/5/040 [101]** Exoplanetary research
6 credits, theory, optional, no repetition
- FIZ/5/041 [099]** Chapter sfrom the theory and observations of multiple stellar and planetary systems I.
6 credits, theory, optional, no repetition
- FIZ/5/042 [100]** Chapter sfrom the theory and observations of multiple stellar and planetary systems II.
6 credits, theory, optional, no repetition
- FIZ/5/043 [130]** (Exo)planetary atmospheres seminar I.
6 credits, theory, optional, no repetition
- FIZ/5/044 [131]** (Exo)planetary atmospheres seminar II.
6 credits, theory, optional, no repetition
- FIZ/5/045 [103]** The formation of planets and planetary systems
6 credits, theory, optional, no repetition
- FIZ/5/046 [098]** Small and microscopic Solar System bodies
6 credits, theory, optional, no repetition
- FIZ/5/047 [133]** At the edge of the Solar System 1
6 credits, theory, optional, no repetition
- FIZ/5/048 [134]** At the edge of the Solar System 2
6 credits, theory, optional, no repetition
- FIZ/5/049 [102]** Dwarf planets in the Solar System
6 credits, theory, optional, no repetition
- FIZ/5/050 [105]** Chaos detection methods in Hamiltonian systems. - Applications in celestial mechanics
6 credits, practice, optional, no repetition
- FIZ/5/051 [029]** Perturbation methods in celestial mechanics I.
6 credits, theory, optional, no repetition
- FIZ/5/052 [062]** Perturbation methods in celestial mechanics II.
6 credits, theory, optional, no repetition
- FIZ/5/053 [125]** Chapters from modern celestial mechanics
6 credits, theory, optional, no repetition
- FIZ/5/054 [073]** Lineáar and nonlinear MHD waves
6 credits, theory, optional, no repetition
- FIZ/5/055 [082]** Solar System plasma physics
6 credits, theory, optional, no repetition
- FIZ/5/056 [095]** Physics of the heliosphere

6 credits, theory, optional, no repetition
FIZ/5/057 [128] Solar physics

6 credits, theory, optional, no repetition
FIZ/5/058 [071] Physics of the solar atmosphere

6 credits, practice, optional, no repetition
FIZ/5/059 [135] Space weather and space climate
6 credits, theory, optional, no repetition

FIZ/5/060 Advances in exoplanet research
6 credits, theory, optional, no repetition

FIZ/5/061 Nuclear astrophysics
6 credit, theory, optional, no repetition

FIZ/SZ/3
Free credits; 3 credits, practice, optional, repeatable

FIZ/SZ/6
Free credits; 6 credits, practice, optional, no repetition

FIZ/VB Final report credits (maximum 60 credits at the end of the 6th semester and maximum 30 credits at the end of the 7th semester)

Research module

FIZ/S1-S4/K18 Guided research work (1., 2., 3., 4. semester)
18 credit, research, optional, repeatable (4 times)

FIZ/S5-S8/K5 Guided research work (5., 6., 7., 8. semester)
5 credit, research, optional, repeatable (4 times)

FIZ/S5-S8/K10 Guided research work (5., 6., 7., 8. semester)
10 credit, research, optional, repeatable (4 times)

FIZ/S5-S8/K15 Guided research work (5., 6., 7., 8. semester)
15 credit, research, optional, repeatable (4 times)

Teaching module (max. credits: 4/semester)

FIZ/OKT/2 Teaching activity
2 credits, practice, optional, can be repeated

FIZ/OKT/4 Teaching activity
4 credits, practice, optional, can be repeated

List of complex examination topics

In Programs I-III and V one can choose the *main topics* from the following list:

Astrophysics, Space Physics and Planetary Systems, Biophysics, Material science, Quantum mechanics, Atomic and molecular physics, Nuclear physics, Optics, Particle Physics, Statistical physics, Solid state physics, Network theory,

In Program IV the main topic is Physics education.

Secondary topics in Programs I-III and V (all optional):

Solar Physics, Physics of the Solar System, Celestial mechanics, Galactic astronomy, Stellar astrophysics, Physics of the interstellar medium, Extragalactic astronomy, Cosmology, High energy astrophysics, Physics of exoplanets and exoplanetary systems, Signal processing. Data-intensive and machine learning methods. Molecular biophysics, Bioinformatics, Methods of physics in biology, Evolution theory, Environmental physics, Mathematical foundations of relativistic quantum theory, Renormalization and the renormalization group, Optical and particle spectroscopy, Plasma physics, Heavy ion physics, Reactor physics and radiation protection, Applications of nuclear methods, Theory of gravitation, Quantum information, Experimental quantum mechanics, Quantum optics and lasers, Quantum electrodynamics, Low energy hadron physics and nonperturbative quantum chromodynamics, Quantum chromodynamics, Phenomena and theory of electroweak interaction, Experimental methods and data processing in particle physics, Chaotic systems, Growth phenomena and pattern formation, Phase transitions and critical phenomena, Computational methods in statistical physics, Hydrodynamics, Defects in metals and insulators, Mechanical properties of solids, Experimental methods in solid state research and material science, Liquid crystals, Magnetic properties of condensed matter, Optical properties of condensed matter, Many-body problem, Mesoscopic electron systems, Carbon nanostructures, **Topological insulators**, Computational methods in material science and solid state physics, Physics of amorphous materials and nanostructures, Physics of membranes and macromolecules; Nuclear astrophysics; Standard model of particle interactions; Beyond the standard model; Particle astrophysics

Secondary topics in Program IV can be chosen by merging two topics of the following list:

Historically relevant experiments of Physics, Foundation of the theory of relativity Plausible quantum theory, Physics of elementary particles, Energetics and environment, Physics of environmental flows, Chaotic mechanics, Versatile use of computers in physics education, Cooperative phenomena, interdisciplinary aspects, Physics in biology, Physics in chemistry, Recent results in astronomy and space science.

Evaluation and control

Fulfilment of the requirements of a given course is evaluated and recorded in the transcript by the lecturer on a five-point scale (1-2-3-4-5, 1: failed .. 5: excellent). Research activities are evaluated and recorded in the transcript by the supervisor on a three-point scale (excellent – acceptable – failed). Credits are approved by the program directors. Outstanding research achievements, proved by scientific publications, books or book chapters, can be honoured by a maximum of 60 ECTS credits. A request for such credits should be submitted by the student and approved by the Council of the PhD School.