

DOCTORAL SCHOOL OF PHYSICS

Discipline: Science

Form of education: Doctor of Philosophy (PhD) training

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 Free credits (max. credits: 6/semester)

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/2/081 Weak interaction
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/2/137 Strong interaction at low energies
 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/SZ Free credits (max. credits: 6/semester)

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/3/019** Modelling traffic in communication networks
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: Bioacoustics
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, no repetition
- 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/SZ Free credits (max. credits: 6/semester)

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 Free credits (max. credits: 6/semester)

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 kredit, gyakorlat, választható, nem ismételhető
- 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 kredit, egyéni kutatás, választható, nem ismételhető
- FIZ/5/015 [040]** Infrared Astronomy I
6 credits, theory, optional, no repetition
- FIZ/5/016 [068]** Infrared Astronomy II. GY
6 kredit, gyakorlat, választható, nem ismételhető
- FIZ/5/017 [076]** Chapters from modern astronomy and cosmology
6 kredit, előadás, választható, nem ismételhető
- 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 kredit, előadás, választható, nem ismételhető
- 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 kredit, előadás, választható, nem ismételtető
- 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 kredit, gyakorlat, választható, nem ismételtető
- 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 kredit, gyakorlat, választható, nem ismételhető
- 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]** Lineár and nonlinear MHD waves
6 kredit, előadás, választható, nem ismételhető
- FIZ/5/055 [082]** Solar System plasma physics
6 kredit, előadás, választható, nem ismételhető
- 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 kredit, gyakorlat, választható, nem ismételhető
- FIZ/5/059 [135]** Space weather and space climate
6 credits, theory, optional, no repetition

FIZ/SZ Free credits (max. credits: 6/semester)

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 amorph 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.