

MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

Yuriy Fedkovych Chernivtsi National University

Name of higher education institution

EDUCATIONAL AND SCIENTIFIC PROGRAM

«Physics and Astronomy»

Level of higher education: third

for educational and scientific degree: Doctor of Philosophy

specialty 104 «Physics and Astronomy»

Name of the field of knowledge 10 «Natural Sciences»

APPROVED

BY THE ACADEMIC COUNCIL

Chairman of the Academic Council

_____/Petryshyn R.I./

(protocol № __ from " __ " _____ 2021)

Entered into force by order

from " __ " _____ 2021 by № _____

Chernivtsi, 2021

LETTER OF APPROVAL
of the Educational and Scientific Program

" DEVELOPED "

by Working Group

prof. Angelsky O.V.,
prof. Holovatsky V.A.,
prof. Gudyma Iu.V.,
prof. Zenkova C.Yu.,
prof. Kramar V.M.,
prof. Maksimyak P.P.,
prof. Tkach M.V.,
prof. Ushenko A.G.,
Dr. Sc. (Phys.-Math.) Borcha M.D.

Head of the Working Group
_____ V.A. Holovatsky
«27» August 2021

" APPROVED "

at a meeting of the Department of Theoretical Physics
and Computer Modeling, protocol № ____
from «__» _____ 2021
Head of the Department _____ M.V. Tkach

at the meeting of the Department of Information Technologies
and Computer Physics, protocol № ____
від «__» _____ 2021 р.
Head of the Department _____ M.D. Borcha

at the meeting of the Department of Optics, Publishing
and Printing, protocol № ____
from «__» _____ 2021
Head of the Department _____ A.G. Ushenko

at the meeting of Correlation Optics Department,
protocol № ____
from «__» _____ 2021
Head of the Department _____ P.P. Maksimyak

at the meeting of the Department of Professional and Techno-
logical Education and General Physics, protocol № ____
from «__» _____ 2021
Head of the Department _____ V.M. Kramar

" APPROVED "

by Academic Council of the Institute of Physical,
Technical and Computer Sciences
protocol № _8_ from «27» August 2021
Chairman of the Academic Council of the Institute
_____ Angelsky O.V.

" AGREED "

Head of Educational Department
of Yuriy Fedkovych ChNU
_____ Ya.D. Harabazhiv
«__» _____ 2021

" RECOMMENDED "

by Scientific and Methodological Commission of the Academic Council
of Yuri Fedkovych ChNU

Protocol № ____ from «__» _____ 2021

Chairman of the University Commission _____ Martyniuk O.V.

(version from «__» _____ 20____, approved by the decision _____)

PREFACE

Developed by a Working Group consisting of:

Surname, name, middle name of head and members of project team	Job title, place of work	The name of the institution that the teacher graduated from, year, specialty, qualification in accordance with the document of higher education*	Academic degree, code and name of scientific specialty dissertation topic, academic title, according to which department (specialty) assigned	Experience of scientific-pedagogical and/or scientific work	Information on scientific activity (main publications in the field, scientific research work, participation in conferences and seminars, work with graduate and doctoral students, management of scientific work of students)	Information on teacher professional development (name of the institution, type of document, subject, date of issue)
Head of the project team						
Holovatsky Volodymyr Anatoliyovych	Professor of the Department of Theoretical Physics and Computer Modeling of IPTCS of Yuriy Fedkovych Chernivtsi National University	Chernivtsi State University, specialty – Physics, qualification – physicist, teacher	Dr. Sc. (Phys.-Math.) diploma ДД №002062, HAC of Ukraine from 12.12.01, specialty 01.04.02 – Theoretical Physics, dissertation topic «Interaction of quasiparticles in complex semiconductor nanoheterostructures», professor of the Department of Theoretical Physics certificate 12IIP №004878 from 21.06.07.	35 years	<p>According to the SCOPUS scientometric database published 37 papers, total number of references 294, Hirsch index - 10 (as of August 25, 2021) https://www.scopus.com/authid/detail.uri?authorId=6507899727</p> <p>Textbooks and manuals</p> <ol style="list-style-type: none"> 1. V.A. Holovatsky. Electrodynamics: a study guide. – Chernivtsi, ChNU, 2011. - 280 p. 2. Holovatsky V.A. Computer algebra system Mathematica 5. - Chernivtsi: Ruta, 2008. – 352 p. <p>Major publications (for the last 3 years)</p> <ol style="list-style-type: none"> 1. Holovatsky V.A., Chubrey M.V., Voitsekhivska O.M. Effect of electric field on photoionisation cross-section of impurity in multilayered quantum dot, Superlattice&Microstructures, - V. 145. - 2020. - P.106642. 2. V. Holovatsky, M. Yakhnevych, M. Chubrey. Influence of magnetic field and non-central impurity on the energy spectrum of an electron in a spherical multilayer nanosystem // Journal of Nano- and Electronic Physics. – 2019.– Vol.11.– № 1.– 01007: 1-5. 3. Holovatsky V. Effect of magnetic field and donor impurity on electron spectrum in spherical core-shell quantum dots / V. Holovatsky, O. Voitsekhivska, M. Yakhnevych // Superlattice and Microstructure. – V. 116. – 2018. – P. 1 – 9. 4. Holovatsky V. Joint effect of electric and magnetic field on electron energy spectrum in spherical nanostructure ZnS/CdSe/ZnS / V. Holovatsky, I. Holovatsky, M. Yakhnevych // Physica E: Low-dimensional Systems and Nanostructures. – V. 104. – 2018. – P. 58 – 63. <p>Member of Specialized Academic Council Д 76.051.01 at ChNU. Supervisor of scientific works of students and graduate students. Under the supervision of Holovatsky V.A. 3 candidate dissertations</p>	Professional development on the Coursera platform from 16.03.2020 to 30.06.2020, “Python programming language” 180 hours, 9 diplomas of the mastered courses. Internship report.

					were completed and successfully defended.	
Project team members						
Angelsky Oleg Vyacheslavovich	Director of the Institute of Physical, Technical and Computer Sciences of Yuriy Fedkovych Chernivtsi National University Honored Worker of Science and Technology of Ukraine	Chernivtsi State University, 1979 Diploma with honors GII № 044203 on specialty «Optical devices and spectroscopy», awarded the qualification of specialist - engineer-physicist-optician	Dr. Sc. (Phys.-Math.) specialty 01.04.05 – Optics, Laser Physics. «Correlation characteristics of scattered radiation and diagnostics of random phase objects». Diploma ДТ № 006493 March 1, 1991 Professor of the Department of Correlation Optics certificate ІП № 010275 October 23, 1991	40 years	According to the SCOPUS scientometric database published 267 papers, total number of references 4394, Hirsch index 51 (as of 25.08.2021) https://www.scopus.com/authid/detail.uri?authorId=7005472269 1. OV Angelsky, AY Bekshaev, SG Hanson, CY Zenkova, I. I Mokhun and Jun Zheng (2020) , Structured Light: Ideas and Concepts. Front. Phys. 8:114. 26 pages doi: 10.3389/fphy.2020.00114 2. O. V. Angelsky , C. Yu Zenkova , S. G. Hanson and Jun Zheng, Extraordinary Manifestation of Evanescent Wave in Biomedical Application, Front. Phys., (2020) 3. Introduction to Singular Correlation Optics, Editor(s): O.Angelsky, 252 p., 2019 4. O. V. Angelsky, P. P. Maksimyak, C. Yu. Zenkova, A.P.Maksimyak, S. G. Hanson, D.D.Ivanskyi “Peculiarities of control of erythrocytes moving in an evanescent field “ J. of Biomedical Optics, 24(5), 055002 (2019). 5. Angelsky, O. V.; Bekshaev, A. Ya.; Maksimyak, P. P.; Maksimyak, A. P.; Hanson, S. G., Low-temperature laser-stimulated controllable generation of micro-bubbles in a water suspension of absorptive colloid particles , Optics Express 26(11) 13995-14009 (2018) Supervision of scientific work of graduate students and students, Supervisor of numerous scientific research projects. Under the supervision of Angelsky O.V. 10 candidate's and 5 doctoral dissertations were defended.	Internship in accordance with order №784 dated 23.10.2019, Taizhou Research Institute of Zhejiang University, Taizhou, China
Gudyma Yuriy Vasyliovich	Professor of the Department of Professional and Technological Education and General Physics of IPTCS of Yuriy Fedkovych Chernivtsi National University	Chernivtsi State University, specialty – Physics, qualification – physicist, teacher	Dr. Sc. (Phys.-Math.) diploma ДД №006117, HAC of Ukraine from 11.10.07, specialty 01.04.07 – Physics of Solid State, dissertation topic «"Kinetics of formation of nonequilibrium states and structures in solid-state systems», professor of General Physics Department,	23 years (scientific-pedagogical) and 10 years (scientific)	According to the SCOPUS scientometric database published 70 papers, total number of references 394, Hirsch index 13 (as of 25.08.2021) https://www.scopus.com/authid/detail.uri?authorId=7003377566 Major publications for the last 3 years: 1. Gudyma, A., Gudyma, I. 1D spin-crossover molecular chain with degenerate states, Journal of Applied Physics, 2021, 129(12), 123905 2. Gudyma Iu. Maksymov A., Polonska K. Cooperative Phenomena in Spin-Crossover Molecular Crystals, Nanochemistry, Biotechnology, Nanomaterials, and Their Applications / edited by O. Fesenko, L. Yatsenko. Springer Proceedings in Physics 214 – Cham: Springer International	Internship in accordance with order №621– OII from 01.09.2016, Pavlo Josef Šafárik University of Košice, Slovak Republic

			certificate 12ПП №007910 from 17.05.12		<p>Publishing AG, 2018. – Chapter 27. – P. 427-441</p> <p>3. Gudyma Iu, Maksymov A., The cooperativity in 3D spin-crossover nanocrystals with ferromagnetic and antiferromagnetic surface, Applied Surface Science – 2019. – V. 483. – P.779-784.</p> <p>4. Gudyma Iu. Boboshko K., Boukheddaden K. Reentrant behavior of magnetic ordered phase in spin-crossover solids with quenched disordered ligand field, Physics Letters A 384 (2020) 126677 (6 pages)</p> <p>Supervise the scientific work of students and graduate students. Under the supervision of Gudyma Iu.V. 2 PhD theses are defended.</p>	
Zenkova Claudia Yuriyivna	Professor of the Department of Optics, Publishing and Printing, professor, IPTCS of Yuriy Fedkovych Chernivtsi National University	Yuriy Fedkovych Chernivtsi State University, diploma with honor KJIN№900211 in specialty Optical and Optoelectronic systems, awarded the qualification of specialist - engineer-optician-researcher	<p>Dr. Sc. (Phys.-Math.) Specialty 01.04.05 – Optics, Laser Physics, Diploma ДД №003733 from September 23, 2014.</p> <p>Dissertation topic: Energy flows and polarization-correlation transformations in optical fields and polarization-sensitive environments.</p> <p>Professor of the Department of Optics, Publishing and Printing, Certificate АП №000335 from March 20, 2018</p>		<p>According to the SCOPUS scientometric database published 100 papers, total number of references 1518, Hirsch index 24 (as of 25.08.2021)</p> <p>https://www.scopus.com/authid/detail.uri?authorId=6507576429</p> <p>Textbooks and manuals</p> <p>1.Introduction to Applied Optics, Textbook, Compiled by C.Yu. Zenkova, Chernivtsi, 148p., 2020</p> <p>2. Fundamentals of materials science. Applications in optics, information technology and printing, Compilers: Zenkova C.Yu., Ryabiy P.A., Chernivtsi, 2017.</p> <p>Scientific articles for 2020:</p> <p>1.Angelsky OV, Bekshaev AY, Hanson SG, Zenkova CY, Mokhun I. I and Jun Zheng, Structured Light: Ideas and Concepts. Front. Phys. 8:114. 26 pages, (2020)</p> <p>2.Oleg V. Angelsky , Claudia Yu Zenkova , Steen G. Hanson and Jun Zheng, Extraordinary Manifestation of Evanescent Wave in Biomedical Application, ORIGINAL RESEARCH ARTICLE, Front. Phys., (2020)</p> <p>3. P.P. Maksymyak, C.Yu. Zenkova, V.M. Tkachuk, Carbon Nanoparticles. Production, properties, perspectives of use, PHYSICS AND CHEMISTRY OF SOLID STATE, V. 21, N 1 p. 13-18, (2020).</p> <p>Supervision of scientific work of graduate students and students, supervisor of Research Topic 36-813 «Investigation of the action of energy flows on micro and nanoparticles in complex optical fields» (2020-2022);</p> <p>Under the supervision of Zenkova C.Yu. 3 PhD theses are defended</p>	Internship in accordance with order №703- from 23.10.2019, Taizhou Research Institute of Zhejiang University, Taizhou, China
Kramar Valeriy Maksymovych	Head of the Department of Professional and Technological Education and General Physics	Chernivtsi State University of the Order of the Red Banner of Labor, 1978	<p>Dr. Sc. (Phys.-Math.) diploma ДД №008538, HAC of Ukraine from 01.07.2010</p> <p>specialty 01.04.10 – Physics of Semiconductors</p>	38 years	<p>Published scientific papers in the amount of 161, 41 of which are in the scientometric database SCOPUS (total number of references 49), Hirsch index 4 (as of 05.06.2021)</p> <p>https://www.scopus.com/authid/detail.uri?authorId=6602084035</p>	Chernivtsi branch of IPMS of NAS of Ukraine, Department of layered crystals, 01-22.07.2016, certificate of

	of IPTCS of Yuriy Fedkovych Chernivtsi National University	specialty – Physics, qualification – physicist, teacher of physics	and dielectrics, dissertation topic: «Theory of spectra of quasi-particles in massive and quasi-two-dimensional semiconductor crystal structures», professor of the Department of Professional and Technological Education and General Physics, certificate 12IIP №009469 from 03.04.2014.		<p>1. Physical practice. – Part. 2. Electricity and magnetism: textbook/ Compiled by: V.M. Kramar, O.P. Croytor. – Chernivtsi, Yu. Fedkovich Chernivtsi. Nat. Univ., 2018. – 120 p.</p> <p>2. Kramar V.M. An analytical method for investigations of acoustic phonons spectra in semiconductor ultrathin flat films / Derevyanchuk A.V., Lutsiuk Yu.V., Kramar V.M. // Proc. SPIE. – 2020. – 11369. – P. 113691D1-5.</p> <p>3. Kramar V.M. Portable automati-zed measuring system for nonin-vasive contactless medical diag-nostics of physiological divergen-ces and inflammations / Belov M.Ye., Dudko O.G., Kramar V.M., Shayko-Shaykovskiy O.G. // Proc. SPIE. – 2020. – 11369. – P.113691U1-4.</p> <p>4. Kramar V.M. Internal optical bi-stability of quasi-two-dimensional semiconductor nanohetero-structures /Derevyanchuk O.V., Kramar N.K., Kramar V.M. // Proc. SPIE. – 2018. – 10612. – P.106120N(6 p.).</p> <p>5. Kramar V.M. Dependence of optical absorption spectra of the flat double nanoheterostructures Al_{1-x}GaxN/GaN/Al_{1-x}GaxN from their thickness and concentration / Derevyanchuk O.V., Kondryuk D.V., Kramar V.M. // Proc. SPIE. – 2018. – 10612. – P. 1061219(6 p.).</p> <p>6. Kramar V.M. New possibilities of complex "Termodyn" application for contactless remote diagnostics in medical practice / Belov M.Ye., Shayko-Shaykovskiy O.G., Makhrova Ye.G., Kramar V.M.,et.al// Proc. SPIE. – 2018. – 10612. – P. 106121D.</p> <p>Member of the Specialized Scientific Councils: Д 76.051.01 at Yuri Fedkovych ChNU; Д 76.244.01 at the Institute of Thermoelectricity of NAS and MES of Ukraine.</p> <p>Editor of the journal "Thermoelectrics"; member of the Organizing Committee of International Conferences on Correlation Optics "CorrOpt" (Chernivtsi, Ukraine, 2005-2019)</p> <p>Supervisor of scientific works of students, graduate students and applicants for scientific degrees, who reported at conferences, competitions of scientific works (diploma of the 3rd degree, 2020). Under the supervision of Kramar V.M. 3 candidate dissertations were completed and successfully defended.</p>	internship №2C from 22.07.2016.
Maksimyak Petro Petrovich	Head of the Department of Correlation Optics of Yuriy Fedkovych Chernivtsi National University	Chernivtsi State University, 1979. Optical instruments and spectroscopy. Engineer-physicist-optician.	Dr. Sc. (Phys.-Math.) in specialty 01.04.05 – Optics, Laser Physics. «Statistical and stochastic characteristics	40 years	<p>According to the SCOPUS scientometric database published 177 papers, total number of references 1665, Hirsch index 21 (as of 25.08.2021)</p> <p>https://www.scopus.com/authid/detail.uri?authorId=7003787152</p> <p>Major publications (for the last 3 years):</p> <p>1. Maksimyak, P.P., Zenkova, C.Y., Tkachuk, V.M., Carbon</p>	Certificate of professional development CIIK 02070921/004442-19, issued on 02.04.2019. Educational

			<p>of the scattered coherent radiation field and their diagnostic use». Diploma ДД № 002063, 2001.</p> <p>Professor of the Department of Correlation Optics, certificate ИП № 003447, 2015.</p>	<p>nanoparticles. Production, properties, perspectives of use Physics and Chemistry of Solid State, 2020, 21(1), pp. 13–18</p> <p>2. O. V. Angelsky, P. P. Maksymyak, C. Yu. Zenkova, S. G. Hanson, B. Guo, and Z. Chen, “Applications of Correlation Singular Optics,” in Introduction to Singular Correlation Optics, O. V. Angelsky, Ed., SPIE Press, Bellingham, Washington, pp. 159–236 (2019).</p> <p>3. V.V.Ivashko, O. V. Angelsky, P. P. Maksymyak “Monte Carlo modeling of ferromagnetism of nano-graphene monolayer within Ising model” Journal of Magnetism and Magnetic Materials V. 492, 165617 (2019)</p> <p>4. O. V. Angelsky, P. P. Maksymyak, C. Yu. Zenkova, A.P.Maksymyak, S. G. Hanson, D.D.Ivanskyi “Peculiarities of control of erythrocytes moving in an evanescent field “ J. of Biomedical Optics, 24(5), 055002 (2019).</p> <p>5. O. V. Angelsky, A. Ya. Bekshaev, P. P. Maksymyak, A. P. Maksymyak, and S. G. Hanson, "Low-temperature laser-stimulated controllable generation of micro-bubbles in a water suspension of absorptive colloid particles," Opt. Express 26, 13995-14009 (2018) IF=3,59</p> <p>Was the research supervisor of 3 research works, the responsible executor of 11 research works.</p> <p>Supervises the research work of students and graduate students. Under the supervision of Maksymyak P.P. 4 candidate theses were defended.</p>	<p>and methodical complex «Institute of Postgraduate Education» (EMC «IPE») of Igor Sikorsky KPI</p>
<p>Tkach Mykola Vasyliovych</p>	<p>Head of the Department of Theoretical Physics and Computer Modelling, professor of the Department of Theoretical Physics and Computer Modelling</p> <p>Honored Worker of Science and Technology of Ukraine Deputy Chairman</p>	<p>Chernivtsi State University, 1969, specialty – Physics, qualification – physics teacher</p>	<p>Doctor of Physical and Mathematical Sciences, diploma ФМ №003730 from 24.07.1987, specialty 01.04.02 – "Theoretical and Mathematical Physics", dissertation topic "Renormalization of the spectrum of quasiparticles interacting with phonons in semiconductors",</p> <p>professor of the Department of Theoretical Physics, certificate ИП №000699 from 10.10.1988.</p>	<p>According to the SCOPUS scientometric database published 129 papers, total number of references 435, Hirsch index 11 (as of 25.08.2021) https://www.scopus.com/authid/detail.uri?authorId=7004130726</p> <p>Major publications (for the last 3 years):</p> <p>1. Seti, J., Voitsekhivska, O., Vereshko, E., Tkach, M., Effect of interface phonons on the functioning of quantum cascade detectors operating in the far infrared range Applied Nanoscience (Switzerland), 2021</p> <p>2.M. Tkach, Ju.Seti, O.Voitsekhivska, V.Gutiv, E.Vereshko. Properties of Renormalized Spectrum of Interacting With Polarization Phonons Localized Quasiparticle With Degenerated Excited State // Molecular Crystals and Liquid Crystals. – 2020.</p> <p>3. M.Tkach, Ju.Seti, O.Voitsekhivska, V.Gutiv. Method of successive separation and summing of multiplicative diagrams of mass operator for the multi-level quasiparticle interacting with polarization phonons // Condensed Matter Physics. – 2019.– V. 22, № 3 – 33707: 1-15.</p>	<p>Chernivtsi branch of I.Frantsevich IPMS of NAS of Ukraine. Department of layered crystals, 08.02.2017 – 15.03.2017. (Order of ChNU №37 03.02.17), internship report.</p>

	of the Specialized Council for the defense of Doctoral Dissertations at ChNU Д76.051.01				<p>4. M. Tkach, Ju. Seti, O. Pytiuk, O. Voitsekhivska, V. Gutiv. Spectrum of localized three-level quasiparticle resonantly interacting with polarization phonons at cryogenic temperature // Applied Nanoscience. – 2019, P. 1-11.</p> <p>5. Tkach, M., Seti, J., Pytiuk, O., Voitsekhivska O. Renormalized spectrum of three-level localized quasiparticle interacting with polarization phonons at cryogenic temperature // J. Low Temp. Phys.– 2019, V. 195, P. 26 – 36.</p> <p>Supervision of scientific work of graduate students, doctoral students and students, head of research project.</p> <p>Under the supervision of Tkach M.V. 19 candidate and 5 doctoral dissertations were defended.</p>	
Ushenko Alexander Grigorovich	<p>Head of the Department of Optics, Publishing and Printing,</p> <p>professor, IPTCS of Yuriy Fedkovych Chernivtsi National University</p> <p>Honored Worker of Science and Technology of Ukraine</p>	<p>Chernivtsi State University, 1977, Diploma with honor B-II № 535861 in specialty «Optical instruments and spectroscopy», awarded the qualification of specialist - engineer-physicist-optician</p>	<p>Doctor of Physical and Mathematical Sciences, in specialty 01.04.05 – Optics, Laser Physics. «Laser polarimetry of light-scattering objects and media». Diploma ДД № 001902 July 1, 2001</p> <p>Professor of the Department of Correlation Optics, certificate ІІР № 002101 February 18, 2003</p>	42 years	<p>According to the SCOPUS scientometric database published 246 papers, total number of references 3041, Hirsch index 36 (as of 25.08.2021)</p> <p>https://www.scopus.com/authid/detail.uri?authorId=7004368950</p> <p>1. Peyvasteh, M., Dubolazov, A., Popov, A., Ushenko, A., Ushenko, Y., Two-point Stokes vector diagnostic approach for characterization of optically anisotropic biological tissues”, (2020) Journal of Physics D: Applied Physics, 53 (39), 395401.</p> <p>2. Ushenko, V.A., Sdobnov, A.Y., Mishalov, W.D., Dubolazov, A.V., Olar, O.V., Bachinskyi, V.T., Ushenko, A.G. et. al. “Biomedical applications of Jones-matrix tomography to polycrystalline films of biological fluids,” (2019) Journal of Innovative Optical Health Sciences, 12 (6), 1950017.</p> <p>3. Ushenko, A., Sdobnov, A., Dubolazov, A., Grytsiuk, M., Ushenko, Y., et. al. “Stokes-Correlometry Analysis of Biological Tissues with Polycrystalline Structure (2019) IEEE Journal of Selected Topics in Quantum Electronics, 25 (1), 8438957.</p> <p>4. Ushenko, V., Sdobnov, A., Syvokorovskaya, A., Dubolazov, A., Vanchulyak, O., Ushenko, A., Ushenko, Y., Gorsky, M., et. al, “3D Mueller-matrix diffusive tomography of polycrystalline blood films for cancer diagnosis,” (2018) Photonics, 5 (4), 54 .</p> <p>5. Ushenko, V.A., Dubolazov, A.V., Pidkamin, L.Y., Sakchnovsky, M.Y., Bodnar, A.B., Ushenko, Y.A., Ushenko, A.G., “Mapping of polycrystalline films of biological fluids utilizing the Jones-matrix formalism”, (2018) Laser Physics, 28 (2), 025602.</p> <p>Supervisor of scientific work of graduate students and students, head of research projects. Under the supervision of Ushenko A.G. 18 candidate and 2 doctoral dissertations were defended.</p>	<p>Professional development on program “Publishing and Printing”, ІІК02070921/00444 8-19, 2019</p>

**PROFILE OF THE EDUCATIONAL AND SCIENTIFIC PROGRAM
in specialty 104 "Physics and Astronomy"**

1 – General information	
Full name of the institution of higher education, as well as the structural unit in which the study is carried out	Yuriy Fedkovych Chernivtsi National University, Institute of Physical, Technical and Computer Sciences Department of Theoretical Physics and Computer Modeling Department of Information Technology and Computer Physics Correlation Optics Department Department of Optics, Publishing and Printing Department of Physics of Semiconductors and Nanostructures
Degree of higher education and the name of the qualification in the original language	third (educational and scientific) level Doctor of Philosophy in the field of Natural Sciences, majoring in Physics and Astronomy
The official name of the educational program	Physics and Astronomy
Short name	Physics
Type of diploma and scope of the program	Single degree, 43 ECTS credits for 4 academic years
Availability of accreditation	no
Cycle / level	NQF of Ukraine – level 8, FQ–EHEA – third cycle, EQF–LLL – level 8
Prerequisites	Availability of a master's degree
Language of instruction	Ukrainian
Validity of the educational and scientific program	Before the entry into force of the standard of higher education
Internet address of the description of the educational program	https://sites.google.com/chnu.edu.ua/104-phd/main
2 – Purpose of the educational program	
Training of creative highly qualified, integrated into the European and world scientific and educational space specialists in the degree of Doctor of Philosophy in the field of Natural Sciences in Physics and Astronomy, who have theoretical knowledge, skills, abilities and other competencies sufficient to produce new ideas, solve complex scientific problems capable of independent research, scientific-organizational, pedagogical-organizational and practical activities in the field of natural sciences, teaching work in higher educational institutions.	
3 – Characteristics of the educational program	
Subject area (field of knowledge) specialty / specialization	10 Natural Sciences 104 Physics and Astronomy
Orientation of the educational program	educational and scientific academic

Main focus of the program and specialization	Fundamental theoretical and experimental research in the field of natural sciences in the specialty 104 Physics and Astronomy using modern methods of computer modeling, which will have wide practical application.
Features and differences	<p>The educational component of the program is focused on the acquisition by graduate students of in-depth knowledge of the specialty, general scientific competencies, acquisition of universal research skills and presentation of their own research results orally and in writing, including in a foreign language.</p> <p>The scientific component of the program is based on the author's achievements of scientific supervisors.</p>
Program structure	The structure of the program provides for the implementation of educational and scientific components of the relevant specialization. The scientific component is performed during the entire period of study, is not interrupted by the educational component, session and practice. The content of each component of the program is focused on modern research in physics of the specialization, takes into account regional features of scientific and experimental base, based on current results, trends in scientific and practical state of physics in Ukraine and abroad.
4. Suitability of graduates for employment and further education	
Employment	<p>Graduates can work in such professions (according to the National Classification of Professions 003:2010):</p> <p>2111.1 Researchers (physics, astronomy) 2111.2 Physicists and astronomers 2131.1 Researchers (computer systems) 2139.1 Researchers (other areas of computing) 2139.2 Professionals in other areas of computing 2310.1 Professors and associate professors 2310.2 Other teachers of universities and higher education institutions Independent employment</p>
Further education	Further training at the doctoral level is possible in fields close to physics and computer science.
5. Teaching and assessment	
Teaching and learning	Supervisor support, support and advice from other colleagues from the research group, more experienced graduate students. Study of scientific methodology on the basis of various interactive courses offered by graduate school. Lecture courses, seminars, consultations, self-training, pedagogical practice, scientific work and individual consultations. Research method (performance of independent scientific research).

Assessment	Written and oral exams, seminars, practical and laboratory classes, projects, presentations, final certification, defense of the dissertation.
6. Program competencies	
Integral competence	Ability to solve complex problems in the field of professional and / or research and innovation activities, which involves a deep rethinking of existing and the creation of new holistic knowledge and / or professional practice.
General competencies	<p>GC1. Ability to abstract thinking, analysis and synthesis.</p> <p>GC2. Ability to search, process and critically analyze information from various sources, to be critical of one's own scientific achievements and the achievements of other researchers.</p> <p>GC3. Ability to work in an international scientific community.</p> <p>GC4. Ability to organize, plan and manage research projects.</p> <p>GC5. Ability to generate new ideas and apply knowledge in practical situations.</p> <p>GC6. Ability to use the latest information and communication technologies, specialized software in scientific and educational activities.</p> <p>GC7. Interpersonal communication skills related to the ability interact with other people and work in a team.</p> <p>GC8. Ability to work independently, initiate, organize and conduct comprehensive theoretical and experimental research.</p> <p>GC9. Ability to present orally and in writing and discuss the results of research and / or innovative developments in Ukrainian and English, including with experts in other fields.</p> <p>GC10. Ability to identify, pose and solve problems and conduct research at the appropriate level, plan and predict results.</p> <p>GC11. Ability to form a systematic scientific worldview, professional ethics and general cultural outlook.</p>
Professional competencies of the specialty	<p>PC1. Research abilities and competence to perform original research in the chosen field of physics and achieve scientific results that create new knowledge, paying special attention to current issues and using the latest scientific methods.</p> <p>PC2. Technological skills. Competence in the use of scientific equipment and technologies, calculation methods related to the selected field of research. Competence to analyze methodological problems that arise in solving research and practical problems, including in interdisciplinary areas.</p>

	<p>PC3. Competence to create and configure computer programs based on self-developed algorithms.</p> <p>PC4. Ability to analyze data. Competence to analyze research data, which can be significant and require the use of powerful computing resources.</p> <p>PC5. Ability to generate new ideas and solve complex problems in the chosen field of physical research.</p> <p>PC6. Ability to conduct basic and applied scientific research using modern experimental and theoretical methods.</p> <p>PC7. Awareness of the goals and objectives of modern physics and astronomy, the ability to solve problems and problems of an innovative nature in one of the branches of physics or astronomy.</p> <p>PC8. Ability to organize the educational process and conduct classes in physical and astronomical disciplines in higher educational institutions.</p> <p>PC9. Ability to apply modern methods of research of low-dimensional systems, mastery of the principles of structural construction of nanosystems.</p> <p>PC10. Ability to apply knowledge of theories to describe the physical properties of low-dimensional systems of different type.</p> <p>PC11. Ability to use knowledge and skills in the practical use of computer technology to study nanosystems.</p>
7. Program learning results	
Program learning results (PLR)	<p>PLR1. Ability to analyze and discuss scientific publications within one's own research issues and beyond.</p> <p>PLR2. Ability to carry out completed original research based on the use of modern methods of science.</p> <p>PLR3. Be able to perceive and process foreign language scientific texts on physics or astronomy from scientific sources containing the latest professional information, to make written and annotative translation of texts on physics or astronomy.</p> <p>PLR4. Ability to develop and present the results of research in scientific and popular science contexts, orally and in writing, in the form of scientific seminars, conferences.</p> <p>PLR5. Ability to prepare the results of own scientific research for the publication of scientific articles, monographs, educational literature.</p> <p>PLR6. Ability to conduct scientific discussions with specialists and non-specialists on research results, fundamental and applied problems of physics in Ukrainian and foreign</p>

languages, qualified to reflect the results of research in scientific publications in leading international scientific journals.

PLR7. Ability to process, analyze and summarize scientific and technical information, advanced domestic and foreign experience in professional activities, to present the results of their own research in a foreign language.

PLR8. Ability to lead specialized scientific seminars and conduct scientific discussions in accordance with professional ethics.

PLR9. Be able to use general scientific competencies to formulate and test a scientific hypothesis; to substantiate the conclusions, choosing the appropriate evidence, in particular the results of theoretical analysis, experimental research and and / or computer modeling, available literature data.

PLR10. Be able to develop and research physical, mathematical and computer models of processes and systems, effectively use them to gain new knowledge and / or create innovative products in physics and related interdisciplinary areas.

PLR11. Plan and perform experimental and / or theoretical research in physics and related interdisciplinary areas using modern scientific methods, critically analyze the results of their own research and the results of other researchers in the context of the whole set of modern knowledge on the research problem.

PLR12. Develop and implement research projects that provide an opportunity to rethink existing and create new holistic knowledge and solve significant scientific problems of physics in compliance with the norms of academic ethics.

PLR13. Deeply understand the general principles and methods of natural sciences, as well as the methodology of scientific research, apply them in their own research in the field of physics and teaching.

PLR14. Be able to review and search for information in specialized literature, using a variety of resources: journals, databases, online resources.

PLR15. Ability to use accounting information from Ukrainian and foreign archives, library catalogs and the latest ICT resources to locate sources and literature useful for their own research.

PLR16. Carry out the procedure of establishing the value of sources of scientific information through comparative analysis with other sources.

PLR17. Know the possibilities of different software environments for use in their own research.

8. Resource support for program implementation

Specific characteristics of staffing	<p>The Department of Theoretical Physics and Computer Modeling, the Department of Information Technologies and Computer Physics, the Department of Correlation Optics, the Department of Optics and Publishing and Printing, the Department of Semiconductor and Nanostructure Physics participate in the training of specialists.</p> <p>Staffing of the educational process is sufficient to provide training for specialists in this specialty and meets the Accreditation requirements for the provision of educational services in higher education.</p>
Specific characteristics of material and technical support	<p>To ensure the educational process, the educational and material base of the Institute of Physical, Technical and Computer Sciences is used, which has the necessary technical equipment and is satisfactorily staffed with computer equipment.</p> <p>Free Internet access is provided to ensure an effective learning process.</p>
Specific characteristics of information and educational and methodological support	<p>The University has access to the Web of Science and Scopus databases. A test subscription to the resources of world publishers of scientific periodicals and books is periodically made. In particular, in 2020 there is a subscription to Wiley and Springer. Providing textbooks, manuals, reference and other educational literature through the funds of the library and departments. Availability of an electronic resource of the educational institution, which contains educational and methodological materials on academic disciplines in the distance learning system Moodle. The Scientific Library of ChNU constantly subscribes to professional journals of physical and mathematical profile of Ukrainian publishers. And also has a large fund of educational and educational literature.</p>
9. Academic mobility	
National credit mobility	<p>Agreements on academic mobility have been concluded on the basis of bilateral agreements between Yu. Fedkovych ChNU and HEI and scientific institutions of Ukraine.</p>
International credit mobility	<p>Agreements on international academic mobility have been concluded on the basis of international and bilateral agreements between Yu. Fedkovych ChNU and educational and scientific institutions of the partner countries.</p>
Training of foreign applicants for higher education	<p>Training and admission of foreign applicants are carried out in accordance with the current legislation of Ukraine and the Rules of Admission to the Yuri Fedkovych ChNU.</p> <p>The language of instruction is Ukrainian.</p>

LIST OF COMPONENTS OF THE EDUCATIONAL AND SCIENTIFIC PROGRAM AND THEIR LOGICAL SEQUENCE

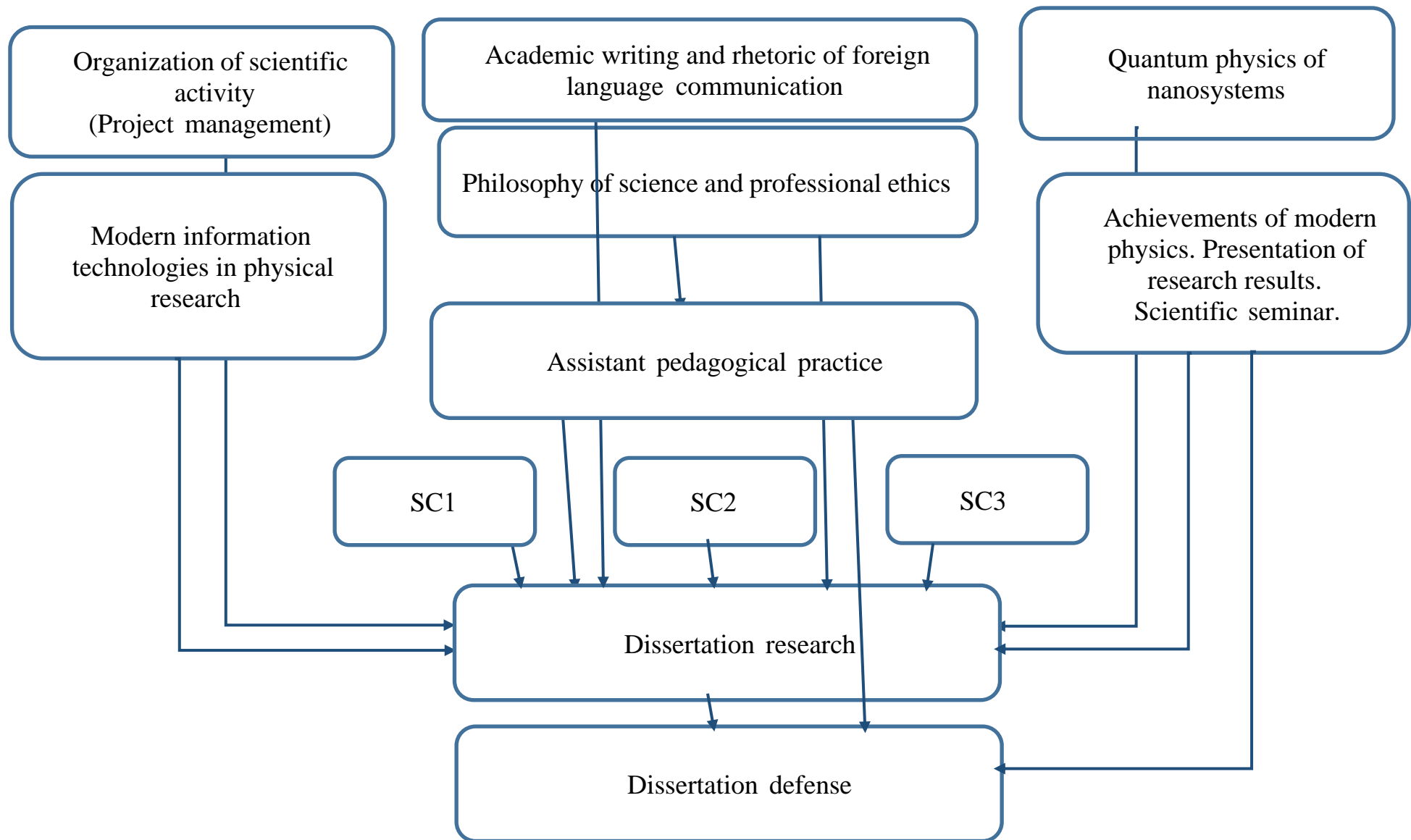
List of components of ESP

Code n/d	Components of the educational and scientific program (academic disciplines, practices, qualification work)	Num. of cred.	Form of final control
1	2	3	4
Mandatory components of ESP			
MC1	Philosophy of science and professional ethics	4	test
MC2	Academic writing and rhetoric of foreign language communication	6	test, exam
MC3	Organization of scientific activity (Project management)	3	test
MC4	Modern information technologies in physical research	4	test
MC5	Quantum physics of nanosystems	4	test
MC6	Achievements of modern physics. Presentation of research results. Scientific seminar.	4	test
MC7	Assistant pedagogical practice	6	test
Total amount of mandatory component of ESP		31	
Selective components of ESP			
(graduate student chooses 1 discipline from block 1 and 2 disciplines from block 2)			
Block 1			
SC1.1	Programming for research. Computational methods of nanostructure physics	4	exam
SC1.2	Surface physics and nanomaterials	4	exam
SC1.3	Latest technologies in semiconductor materials science	4	exam
SC1.4	Correlation optics	4	exam
SC1.5	Selected sections of quantum mechanics	4	exam
Block 2			
SC2.1	Methods of research of bulk and multilayer nanoscale crystalline systems	4	exam
SC2.2	Nanoprobe and ultra microscopy and modern methods of processing digital data arrays	4	exam
SC2.3	Modern methods of statistical physics	4	exam
SC2.4	Methods of topology in optics	4	exam
SC2.5	Automation of analytical transformations in computer algebra systems	4	exam
SC2.6	Laser polarimetry of polarization-inhomogeneous layers	4	exam
SC2.7	Modern approaches and methods of coherent polarization optics	4	exam
SC2.8	Applied application of Fourier and wavelet analysis in solid state physics	4	exam
SC2.9	Correlation and singular optics	4	exam
Total amount of selective components:		12	
TOTAL AMOUNT OF ESP		43	

11.2. STRUCTURAL-LOGICAL SCHEME OF ESP

First year of study		Second year of study		Third year of study		Fourth year of study	
1 semester	2 semester	3 semester	4 semester	5 semester	6 semester	7 semester	8 semester
Educational activities							
Mandatory component							
Philosophy and methodology of science	Assistant pedagogical practice	Assistant pedagogical practice					
Academic writing and rhetoric of foreign language communication							
Organization of scientific activity (Project management)	Achievements of modern physics. Presentation of research results. Scientific seminar.						
Modern information technologies in physical research	Quantum physics of nanosystems						
Selective component							
SC1	SC2						
	SC3						

Research work on the topic of the dissertation			
First year of study	Second year of study	Third year of study	Fourth year of study
Writing scientific articles	Writing scientific articles	Writing scientific articles	Completion of the dissertation
Participation in scientific conferences	Participation in scientific conferences	Participation in scientific conferences	Preliminary defense at the department. Public defense



MATRIX OF CORRESPONDENCE OF PROGRAM COMPETENCES TO ESP COMPONENTS

	MC1 Philosophy of science and professional ethics	MC2 Academic writing and rhetoric of foreign language communication	MC3 Org. of scientific activity (Project management)	MC4 Modern information technologies in physical research	MC5 Quantum physics of nanosystems	MC6 Achievements of modern physics. Presentation of research results. Scientific seminar.	MC7 Assistant pedagogical practice	SC1.1	SC1.2	SC1.3	SC1.4	SC1.5	SC2.1	SC2.2	SC2.3	SC2.4	SC2.5	SC2.6	SC2.7	SC2.8	SC2.9	SC2.10
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	22
GC1	+			+	+			+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
GC2	+					+																
GC3		+				+																
GC4			+																			
GC5	+					+		+	+	+	+	+	+	+	+	+		+	+	+	+	+
GC6				+	+			+									+					
GC7			+			+	+															
GC8				+	+	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
GC9	+	+				+	+															
GC10				+	+	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
GC11	+					+																
PC1				+	+	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PC2	+			+				+									+					
PC3				+				+									+					
PC4				+	+			+									+					
PC5					+	+			+	+	+	+	+	+	+	+		+	+	+	+	+
PC6	+				+	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PC7	+				+	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PC8						+	+															
PC9					+	+			+	+			+	+			+					
PC10					+	+		+	+	+			+	+			+					
PC11				+	+			+					+				+					

MATRIX OF PROVIDING PROGRAM LEARNING RESULTS WITH RELEVANT COMPONENTS OF THE EDUCATIONAL AND SCIENTIFIC PROGRAM

	MC1 Philosophy of science and professional ethics	MC2 Academic writing and rhetoric of foreign language communication	MC3 Org. of scientific activity (Project management)	MC4 Modern information technologies in physical research	MC5 Quantum physics of nanosystems	MC6 Achievements of modern physics. Presentation of research results. Scientific seminar.	MC7 Assistant pedagogical practice	SC1.1	SC1.2	SC1.3	SC1.4	SC1.5	SC2.1	SC2.2	SC2.3	SC2.4	SC2.5	SC2.6	SC2.7	SC2.8	SC2.9	SC2.10
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	22
PLR1						+																
PLR2					+			+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PLR3		+				+																
PLR4						+	+															
PLR5		+		+		+																
PLR6		+				+	+															
PLR7		+				+																
PLR8						+	+															
PLR9	+			+	+	+																
PLR10				+	+	+		+				+				+					+	
PLR11	+		+	+	+			+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PLR12	+		+																			
PLR13	+		+																			
PLR14				+		+																
PLR15				+		+																
PLR16				+		+																
PLR17				+	+			+								+				+		

