

MINISTRY OF SCIENCE AND HIGHER EDUCATION OF THE RUSSIAN FEDERATION
Federal State Autonomous Educational Institution of
Higher Education

"Ural Federal University named after the First President of Russia B.N. Yeltsin"

Institute of Natural Sciences and Mathematics

APPROVED BY
Vice-Rector for Research
A.V. Germanenko

« »

2023 г.

**PROGRAM OF SCIENTIFIC RESEARCH ACTIVITIES AND PREPARATION OF A
DISSERTATION**

List of information about the program of the discipline	Credentials
Postgraduate Program Space physics, astronomy	Code PP 1.3.1.
Group of specialties Physical sciences	Код 1.3.
Federal State requirements (FSR)	Order of the Ministry of Science and Higher Education of the Russian Federation № 951 dated 20.10.2021.
Self-approved requirements (SAR)	Order "On the implementation of the "Requirements for the development and implementation of training programs for scientific and scientific-pedagogical personnel in the graduate school of Ur-FU" dated 31.03.2022 №315/03

Yekaterinburg
2023

The program was compiled by the authors:

№	Full name	Academic degree, Academic Title	Position	Affiliation
1	Anton I. Vasyunin	PhD	Associate Professor	Department of Astronomy, Geodesy, Ecology and Envi- ronmental Monitoring of the Institute of Natural Sciences and Mathematics
2	Eduard D. Kuznetsov	Dr. Sci., Associate Professor	Head of Department	Department of Astronomy, Geodesy, Ecology and Envi- ronmental Monitoring of the Institute of Natural Sciences and Mathematics
3	Anton F. Seleznev	Dr. Sci.	Associate Professor	Department of Astronomy, Geodesy, Ecology and Envi- ronmental Monitoring of the Institute of Natural Sciences and Mathematics
4	Andrei M. Sobolev	PhD, Senior Researcher	Leading Researcher	Kourovka Astronomical Ob- servatory, Institute of Natural Sciences and Mathematics

Recommended by:

Educational and methodological board of Institute of Natural Sciences and Mathematics

Head of the Educational and Methodological board of
the Institute of Natural Sciences and Mathematics
Record № 1 от 19.01.2023 г.


E. S. Buyanova

Agreed by:

Head of academic staff training department


E.A. Butrina

1. GENERAL CHARACTERISTICS OF THE PROGRAM OF SCIENTIFIC RESEARCH ACTIVITIES AND PREPARATION OF A DISSERTATION

1.1. Annotation

The program “Scientific research activity and preparation of a dissertation” was developed taking into account independently approved requirements and the order of the rector “On the introduction of the “Requirements for the development and implementation of training programs for scientific and scientific-pedagogical personnel in the graduate school of Ur-FU” No. 315/03 dated 31.03. 2022 and is included in Block 3 "Variable part" of the curricula of postgraduate programs.

The goals:

- preparation of a graduate student for independent work as a research scientist, the formation of his worldview as a professional scientist, the formation and improvement of the skills of independent research work, including the formulation and correction of a scientific problem, work with various sources of scientific and technical information;
- conducting original scientific research independently and as part of a scientific team, discussing scientific activities in the process of free discussion in a professional environment, preparing for the publication of the results of scientific activities, as well as writing and preparing a dissertation for the degree of candidate of sciences.

The content of scientific research activity is determined in accordance with the theme of the scientific qualification work (dissertation).

The main tasks of the scientific research work of graduate students are:

- formation of a system of knowledge, skills in the field of planning, organization and phased conduct of research activities;
- acquisition of skills in working with bibliographic reference books, compiling scientific bibliographic lists, using bibliographic descriptions in scientific papers;
- development of information and analytical skills in the field of working with electronic databases of domestic and foreign library collections;
- formation and development of skills and abilities in terms of applying research methods to solve the planned tasks of research activities;
- formation and development of skills in designing and implementing integrated studies;
- formation and development of skills and abilities of scientific and experimental work with an empirical research base in accordance with the chosen topic of scientific and qualification work (dissertation);
- mastering the methods of observation, experiment and modeling;
- acquisition of skills of collective scientific work, productive interaction with other scientific groups (divisions) and researchers;
- formation of skills and abilities in the field of scientific communications, public discussion of the results of research activities, improvement of the professional and communicative culture of the future teacher-researcher;
- formation of skills to draw up reporting documentation, scientific qualification work (thesis), scientific report in accordance with existing requirements.

The research activity of a postgraduate student is carried out under the guidance of a supervisor, both in the classroom and in extracurricular forms. It is carried out in the form of the implementation of a research project carried out by a graduate student within the approved topic of a PhD dissertation.

Research activities of graduate students include the following forms:

- performing independent scientific research on the chosen topic of the dissertation;
- scientific publications in accordance with the requirements of the Higher Attestation Commission of the Ministry of Science and Higher Education of the Russian Federation, the UrFU

Attestation Council;

- participation in scientific conferences, writing the dissertation text;
- performance of specific non-standard tasks of a research nature during the period of research practice, research activities and preparation of a dissertation for the degree of candidate of sciences.

Research activity is an active form of conducting research activities by a graduate student, designed to:

- to develop the skills and competencies of research and information-analytical work in the process of preparing a dissertation;

- to make research and information-analytical work a permanent and systematic element of scientific and pedagogical activity;

- to include graduate students in the active life of the scientific and expert community.

The following can be counted as scientific research works of graduate students:

- participation of a postgraduate student in research grants and other research projects;
- participation of a graduate student in academic mobility programs;
- participation of graduate students in the performance of work in the creative community within the framework of state, interuniversity or intrauniversity grants;
- state registration of intellectual activity (inventions, utility models, industrial designs, breeding achievements, topologies of integrated circuits, trademarks and service marks, etc.);
- participation of graduate students in open competitions for the best scientific work (provision of scientific, research papers, which are independently performed research on topical issues of technical sciences), conducted by orders of federal and regional executive authorities.

1.2. The language of the program is English.

1.3. Planned results of scientific research

Research activities are aimed at the formation of competencies by postgraduate students:

- the ability to critically analyze and evaluate modern scientific achievements, generate new ideas in solving research and practical problems, including in interdisciplinary areas;
- the ability to design and carry out comprehensive research, including interdisciplinary ones, based on a holistic systemic scientific worldview using knowledge in the field of the history and philosophy of science;
- willingness to participate in the work of Russian and international research teams to solve scientific and educational problems;
- willingness to use modern methods and technologies of scientific communication in the native and foreign languages;
- the ability to follow ethical standards in professional activities;
- the ability to plan and solve problems of one's own professional and personal development;
- the ability to operate with modern methods of theoretical analysis and computer simulation in the study of complex systems and objects in the field of space physics and astronomy;
- the ability and willingness to use in practice the integrated knowledge of natural sciences, general professionally oriented and special disciplines to understand the problems of space physics and astronomy;
- the ability and willingness to perform computational-theoretical and experimental research as a leading performer using computer technology;
- the ability and readiness to conduct a patent search on research topics, prepare materials for obtaining patents, analyze, systematize and generalize information from global computer networks;
- ability and willingness to process the results of research work, draw up scientific and technical reports, prepare scientific articles and reports for publication;
- the ability and willingness to develop technical specifications and programs for carrying out theoretical and experimental work;
- ability and willingness to develop measures for the implementation of the developed projects and programs;

- the ability and willingness to manage the work of a team of performers, to participate in the planning of scientific research;
- readiness for teaching activities in the main educational programs of higher education;
- the ability and willingness to demonstrate a systematic understanding of the current state and problems of the chosen (professional) branch of scientific knowledge;
- the ability and willingness to conduct research in the chosen (professional) branch of scientific knowledge using modern methods and technologies;
- readiness to identify, develop issues using a scientific approach, conduct and implement research results in a selected (professional) branch of scientific knowledge;
- ability to analyze, process and present scientific and professional information;
- the ability and willingness to make a scientific contribution to the development of the chosen (professional) branch of scientific knowledge as a result of scientific research;
- the ability to critically analyze, evaluate and develop new ideas in the chosen (professional) branch of scientific knowledge, related fields;
- the ability and willingness to share accumulated knowledge and experience with colleagues, scientific communities, in educational institutions of higher education, additional professional education;
- the ability and willingness for career growth in academic or professional activities in the context of technological, social and cultural progress in a society based on knowledge.

During the period of scientific research and the preparation of a dissertation, a graduate student must master the methods and techniques of organizing scientific research on the processes of a professional field to solve problems in education, science and the social sphere, learn how to analyze, interpret the results and present them in the form of scientific articles.

As a result of the implementation of scientific research activities and the preparation of a dissertation, a postgraduate student must demonstrate the following results:

Knowledge:

- methods, techniques, technologies of scientific communication;
- the main achievements and trends in the development of the relevant subject and scientific field and its relationship with other sciences;
- modern approaches to modeling scientific activity;
- the basics of scientific and methodological work in higher education;
- the procedure for organizing, planning, conducting and supporting scientific activities using the latest technologies;
- bases of scientific culture and skill;
- basic principles, methods and forms of organization of the scientific process at the university;
- methods for monitoring and evaluating the quality of scientific results;

Skills:

- use scientific technologies, methods and techniques of scientific communication;
- to use modern technical means when presenting the results of scientific research;
- the basics of the use of computer technology and information technology in scientific communication;
- engage in scientific activities in a scientific team;

Mastering (to demonstrate skills and experience):

- possession of methods of using technical means when presenting the results of scientific research;
- possession of the technique of oral and written scientific speech;
- registration of the results of scientific research using modern computer technologies;
- possession of a methodology for self-assessment and self-analysis of the results and effectiveness of scientific research.

In the process of participating in research seminars, a postgraduate student must demonstrate:

- the ability to review and analyze scientific literature, the choice of direction (corrections, if necessary) of scientific research;
- be able and demonstrate the skills of conducting scientific research: collecting empirical and analytical material and its theoretical generalization; advancement of scientific hypotheses, their development into theoretical systems and substantiation;
- skills of public scientific discussion and presentation of the results of scientific research, preparation and writing of scientific papers.

1.4. Content of the discipline

№	Types of educational work	Volume of discipline		Distribution of the volume of discipline by semester (hours)							
		Total hours	Incl. contact work (hours)*	1	2	3	4	5	6	7	8
1.	Individual work of graduate students, including all types of current attestation	7812	32	828	828	1080	1080	1080	972	1080	864
2.	Midterm assessment	Test		T	T	T	T	T	T	T	T
3.	Total volume according to the curriculum, hours	7812	32	828	828	1080	1080	1080	972	1080	864
4.	Total volume according to the curriculum, credit points	217		23	23	30	30	30	27	30	24

2. CONTENT OF RESEARCH ACTIVITIES AND DISSERTATION PREPARATION

2.1. Volume and content of research work of graduate students

№	Sections	Content
1	Section I. Statement and correction of the scientific problem solved in the dissertation	Identification of the object and method of scientific research. Drawing up a plan for the research activities of a graduate student and the implementation of a dissertation for the degree of candidate of sciences. Literature search methods: use of library catalogs and indexes, abstract journals, automated search tools, review of periodical literature.
2	Section II. Work with sources of scientific and technical information	Review and analysis of information on the topic of dissertation research: review, reference, abstract. Preparation of an analytical review of scientific, technical and patent literature on the topic of the dissertation.
3	Section III. Conducting independent scientific research	Theoretical part of the research. Practical part of the research. Equipment: experimental installations, instruments, equipment, software. Stages and methods of conducting theoretical, experimental research or computer simulation. Parameters controlled during research. Criteria for evaluating the effectiveness of the investigated process object, device. Processing of research results and their analysis.

4	Section IV. Preparation of presentations and reports on the results of scientific research at scientific seminars, conferences	Technologies for preparing speech materials, the structure and style of presentations depending on the target audience and the duration of the speech.
5	Section V. Preparation of publications based on research results in peer-reviewed scientific journals, recommended by the Higher Attestation Commission of Russia and the UrFU Attestation Council for the publication of dissertation	Preparation of a scientific publication: theses of reports, an article in a journal, a monograph. The structure of the theses of the report, articles, monographs. Presentations with reports at seminars, scientific conferences, symposiums, meetings.
6	Section VI. Preparation of applications and reports for competitions for conducting research activities on the topic of the dissertation	Applying for a grant. Description of the project: methodology used; materials and research methods; the conditions under which the project will be carried out; a list of activities necessary to achieve the goals; plan and technology for the implementation of each event; mechanism for the implementation of the project as a whole. Expected results; publications that will be made in the course of the project; the possibility of using the results of the project.
7	Semester and annual attestation	Semi-annual and annual attestation according to individual plans at the departments and the Academic Council of the corresponding institute of UrFU.

2.2. Individual work of graduate students

Sections	Content	Amount of study time, credit points/hour
Section I	Working with literature, databases, drawing up a work plan	12 / 432
Section II	Working with literature, preparation of an analytical review of scientific, technical and patent literature	36 / 1296
Section III	Conducting the theoretical and practical part of the study, processing the research results and their analysis	92 / 3312
Section IV	Preparation of reports and presentations	12 / 432
Section V	Writing scientific publications	30 / 1080
Section VI	Writing applications and reports on competitions for conducting research activity	23 / 828
Section VII	Preparation of reports for attestation	12 / 432

Within the limits of the total laboriousness, the distribution of the labor intensity of certain types of research and development work for each year of study is not regulated. Within the framework of the individual curriculum of a postgraduate student, agreed with the supervisor and approved by the head of the department, it is possible to redistribute the labor intensity of certain types of scientific research work of a postgraduate student within the labor intensity of each year of study.

3. FUND OF EVALUATION FACILITIES FOR CURRENT AND INTERIM ATTESTATION

3.1. EVALUATION CRITERIA

The criteria approved by the department are used to evaluate the achievements of graduate students for each control and evaluation event. The system of assessment criteria is based on three levels of mastering the components of competencies: threshold, advanced, high.

Competency components	Signs of the level of mastering the components of competencies		
	threshold	advanced	high
Knowledge	A graduate student demonstrates knowledge-acquaintance, knowledge-copy: recognizes objects, phenomena and concepts, finds differences in them, shows knowledge of sources of information, can independently reproduce actions on knowledge by independently reproducing and applying information.	A graduate student demonstrates analytical knowledge: he confidently reproduces and understands the acquired knowledge, assigns it to one or another classification group, independently systematizes it, establishes relationships between them, and applies it productively in familiar situations.	A graduate student can independently extract new knowledge from the outside world, creatively use it to make decisions in new and non-standard situations.
Skills	A graduate student is able to correctly perform prescribed actions according to an instruction, an algorithm in a known situation, independently performs actions to solve typical problems that require a choice from among known methods, in a predictably changing situation	A graduate student is able to independently perform actions (techniques, operations) to solve non-standard tasks that require a choice based on a combination of known methods in an unpredictably changing situation	A graduate student is able to independently perform actions related to solving research problems, demonstrates the creative use of skills (technologies)
Personal qualities	A graduate student has a low motivation for learning activities, shows an indifferent, irresponsible attitude to learning, assigned work	The graduate student has a pronounced motivation for learning activities, demonstrates a positive attitude towards learning and future work, and is active.	The graduate student has a developed motivation for educational and labor activity, shows perseverance and enthusiasm, diligence, independence, creative approach.

3.2. Evaluation tools for ongoing attestation

Attestation is carried out in the form of annual reports of the postgraduate student at the meetings of the department.

3.3. Evaluation tools for intermediate attestation

Scientific reports on the topic of published articles and dissertations.

Examination of the dissertation after its writing.

Discussion of the dissertation at a meeting of the department and recommendation for defense.

4. EDUCATIONAL AND INFORMATION SUPPORT

4.1. Recommended literature

4.1.1. The main literature on the topic of scientific research

1. Tamhane, A. C. Statistical Analysis of Designed Experiments: Theory and Applications. 1 ed.; Wiley- Interscience: 2009; p 720.
2. Herzog, M. H.; Francis, G.; Clarke, A. Understanding Statistics and Experimental Design. Springer Cham: 2019; p 142.
3. Booth, W. C.; Colomb, G. G.; Williams, J. M.; Bizup, J.; Fitzgerald, W. T. The Craft of Research. 4 ed.; University of Chicago Press: 2016; p 336.
4. Thomas, G. How to Do Your Research Project: A Guide for Students. 4 ed.; SAGE Publications Ltd: 2022; p 368.
5. Silvia, P. J. How to Write a Lot: A Practical Guide to Productive Academic Writing. 2 ed.; American Psychological Association: 2018; p 110.
6. Bright Wilson Jr., E. An Introduction to Scientific Research. Dover Publications: 1991; p 400.
7. Dunleavy, P. Authoring a PhD: How to Plan, Draft, Write and Finish a Doctoral Thesis or Dissertation. Red Globe Press: 2003; p 297.
8. Schimel, J. Writing Science: How to Write Papers That Get Cited and Proposals That Get Funded. Oxford University Press: 2011; p 221.
9. McCarthy, P.; Hatcher, C. Presentation Skills: The Essential Guide for Students (Study Skills). 1 ed.; SAGE Publications Ltd: 2002; p 228.
10. Morgan, S.; Whitener, B. Speaking about Science: A Manual for Creating Clear Presentations led.; Cambridge University Press: 2006; p 138.
11. Moon-Earth-Sun: The oldest three-body problem.
<http://sites.apam.columbia.edu/courses/ap1601y/Moon-Earth-Sin%20RMP.70.589.pdf>
12. Introduction to Space Physics. https://mcgoodwin.net/pages/spacephysics_ess471.pdf
13. Astrometry. http://ircamera.as.arizona.edu/Astr_518/astrometry_2016.pdf
14. Introduction to Astrometry. [https://pholus.mtk.nao.ac.jp/~toshio/education/Astrometry\(Notes-BW\).pdf](https://pholus.mtk.nao.ac.jp/~toshio/education/Astrometry(Notes-BW).pdf)
15. Astronomy2e. <https://openstax.org/details/books/astronomy-2e>
16. Introduction to Optical Telescopes.
<https://rwoconne.github.io/rwoclass/ast1230/telescopes.html>
17. Large Optical Telescopes. <https://vdoc.pub/documents/the-design-and-construction-of-large-optical-telescopes-6171ci7f13i0>
18. Basics of Radio Astronomy.
https://www2.jpl.nasa.gov/radioastronomy/radioastronomy_all.pdf
19. Review of Neutrino Astronomy. <https://arxiv.org/pdf/astro-ph/0204527.pdf>

4.1.2. Additional literature

1. Creswell, J. W. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. 2 ed.; SAGE Publications, Inc: 2002; p 272.
2. Bell, J. Doing Your Research Project (Open Up Study Skills). 5 ed.; Open University Press: 2010; p 296.
3. Christensen, L.; Johnson, R.; Turner, L. Research Methods, Design, and Analysis. 12 ed.; Pearson: 2014;p 552.

4.1.3. Periodicals

Original articles and monographs on the subject of the work, recommended by the head of the research activity.

4.2. Electronic educational resources

not provided

4.3. Databases, information and reference and search systems

1. Zonal Scientific Library <http://library.urfu.ru/>
2. Library catalogs <http://library.urfu.ru/about/department/catalog/rescatalog/>
3. Electronic catalog <http://library.urfu.ru/resources/ec/>

4. Resources <http://library.urfu.ru/resources>
5. Search <http://library.urfu.ru/search>;
6. Electronic resources by subscription.
7. Russian electronic scientific library: <http://www.elibrary.ru>
8. Search engines for publications of domestic and foreign scientific publications: <http://www.sciencedirect.com>, <http://www.ingentaconnect.com>
9. Astrophysical Data System, http://adsabs.harvard.edu/abstract_service.html
10. Astronet, <http://www.astronet.ru>
11. VisieR Data Sastem, <http://vizier.u-strasbg.fr/viz-bin/VizieR>
12. Astrochemistry Data System KIDA, <http://kida.obs.u-bordeaux1.fr/>

4.4. Software

1. Microsoft office (Word, Excel, Power point)
2. Google Chrome
3. Adobe Reader
4. Software package GILDAS: <http://www.iram.fr/IRAMFR/GILDAS/>
5. Software package IRAF: <http://iraf.noao.edu/>
6. Software package SAOImage DS9: <http://ds9.si.edu/site/Home.html>
7. Software package OrbFit: <http://adams.dm.unipi.it/~orbmain/orbfit/>
8. Publishing system MiKTeX: <https://miktex.org>

5. LOGISTICS AND TECHNICAL SUPPORT OF THE DISCIPLINE

5.1. Information on the provision of specialized and laboratory equipment

To carry out scientific research and prepare a dissertation for the degree of Candidate of Science by postgraduate students, the Ural Federal University has special rooms for group and individual consultations, current control and intermediate certification, as well as scientific laboratories for research, rooms for independent work and facilities for storage and preventive maintenance of equipment.

The graduate student has the opportunity to use the equipment in the Ural Center for Collective Use "Modern Nanotechnologies" of the Ural Federal University.