

**ANNUAL REPORT ON SCIENTIFIC, AND SCIENTIFIC  
ORGANIZATIONAL ACTIVITY OF THE DEPARTMENT OF  
"EQUATIONS OF MATHEMATICAL PHYSICS" OF INSTITUTE OF  
MATHEMATICS AND MECHANICS OF NAS OF AZERBAIJAN FOR  
THE YEAR OF 2019**

In the department of "Equations of Mathematical Physics" 14 workers, 8 of whom are research workers. Of them 2 **doctors of sciences, professors:**

1. Akhundov Adalat Ya. – chief research associate, (full time).
2. Mammadov Farman I. – chief research associate, (full time).

**5 doctors of philosophy in mathematics:**

3. Guliyev Abdurrahim F. – head of department, leading research associate, (full time).
4. Bagirov Shirmail H. – leading research associate, ass. prof., (a part time).
5. Mammadov Elchin M. – senior research associate, ass. prof., (full time).
6. Shukurova Shahla Yu. – senior research associate, (full time).
7. Hasanova Aynur H. – senior research associate, ass. prof., (full time).

**1 kandidat for a degru:**

8. Mammadli Sayali M. – junior research associate, (full time).

**6 laboratory assistants:**

9. Mustafayeva Lala M. – laboratory assistant, (full time).
10. Abdullayeva Aydan J. – laboratory assistant, (full time).
11. Shafiyeva Aynur F. – laboratory assistant, (a part time).
12. Asadli Afaq A. – laboratory assistant, (a part time).
13. Gasimov Cesaret C. – laboratory assistant, (a part time).
14. Aliyev Azer A. – laboratory assistant, (a part time).

**I. SCIENTIFIC PART.**

**In 2019, according to the approved plan, the department conducts 6 research works on the topic "Unambiguous solutions of problems of mathematical physics and qualitative properties of solutions"**

**Work 1: "Regularity of boundary points with respect to the first boundary value problem for second-order parabolic equations".**

**Executor: head of department A.F. Guliyev**

In the reporting period, in special domains, a two-sided equivalent estimation was obtained for a fundamental solution of the heat equation. Applying the result obtained, a growth theorem is proved, which reflects the qualitative property of the solution in the trapezoidal region. Based on the growth theorem, a new proof of the Wiener criterion for the regularity of the boundary point with respect to the Dirichlet problem for the heat equation is obtained.

**Published papers:**

1. Quliyev A.F., *Bounds for the fundamental solution of the heat equation in special domains*. An International Workshop dedicated to the 80<sup>th</sup> anniversary of an academician Mirabbas Geogja oğlu Gasymov. Spectral Theory and its Applications. Baku, 2019, pp. 76-77.
2. Abdurrahim F. Quliyev, *A new proof of Wiener's criterion for the heat equation*. International Scientific Conference on Operators, Functions and Systems of Mathematical Physics, Khazar University, Baku, 2019, pp. 42-43.
3. A. Quliyev, *The sufficient condition for the regularity of boundary point with respect to the Dirichlet problem for the parabolic equations second order*. International conference dedicated to the 60-th anniversary of the Institute of Mathematics and Mechanics on Modern Problems of Mathematics and Mechanics, Baku, 2019, pp. 214-216.
4. Ə. Quliyev, *test toplusu "Riyaziyyat" – DIM – "Abituriyent" – 2019, part I*, publishing house "Polygraphic Production", 280 p.

**Work 2: "On an inverse problem for an elliptic equation with nonlinear initial data".**

**Executor: prof. A.Ya. Akhundov.**

During the reporting period, the inverse problem of determining the unknown function on the right side of the system of linear elliptic equations with a nonlinear boundary condition is investigated.

#### **Published papers:**

1. Akhundov A. Ya., Habibova A. Sh., *The inverse problem for parabolic equation in a domain with moving boundary*. International Workshop dedicated to the 80<sup>th</sup> anniversary of an academician Mirabbas Geogja oğlu Gasymov, Spectral Theory and its applications, Baku, 2019, pp. 29-31.
2. Axundov Ədalət, Həbibova A., *Hiperbolik tip istilikkeçirmə tənliyi üçün bir tərs məsələ haqqında*. Materials of the Republican scientific-practical conference "Ways to apply scientific innovations in the educational process", devoted to the 96th anniversary of national leader Heydar Aliyev. Lankaran, 2019, p.16.
3. Akhundov A. Ya., Habibova A. Sh., *The inverse problem for hyperbolic equation in a domain with moving boundary*. XXXIV International Conference problems of Decision making under uncertainties, 2019, Lvov.
4. A.Ya. Akhundov, A.Sh. Habibova, *The inverse problem for parabolic equation in a domain with moving boundary*. International conference dedicated to the 60-th anniversary of the Institute of Mathematics and Mechanics on Modern Problems of Mathematics and Mechanics, Baku, 2019, pp. 79-80.

#### **Work 3: "Qualitative properties of non-uniformly degenerate differential equations with growth condition".**

**Executor: prof. F.I. Mammadov, Sh.Yu. Shukurova, S.M. Mammadli.**

During the reporting period, Sobolev-Poincare-type inequality is proved. In addition, the problem of the existence of a "strong" solution for semi-elliptic equations with discontinuous coefficients is investigated. The Dirichlet problem for a second-order semi-linear elliptic equation with discontinuous coefficients in the main part and satisfying the Cordes condition is also considered. When these conditions are satisfied and the norm  $L_2(\Omega)$  is sufficiently small, the function  $f(x)$  on the right-hand side shows the existence in the class  $W_2'^2(\Omega)$  of at least one solution of the Dirichlet problem for the equation in question.

### Published papers:

1. Farman Mamedov, Sayali Mammadli, Yashar Shukurov, *On compact and bounded embedding in variable exponent Sobolev spaces and its applications*. Arabian Journal of Mathematics, 2019, pp. 1-14. (WoS, Scopus) DOI:10.1007/s40065-01900268-8  
<https://www.researchgate.net/publication/335783820> **On compact and bounded embedding in variable exponent Sobolev spaces and its applications**
2. F.I. Mamedov, N. Mammadzade, L.E. Persson, *A new fractional order Poincare inequality with weights*. Math.Inequality and Application, 2019. (WoS, Scopus)
3. Mamedov F.I. *A steady flow of viscous compressible liquid over the vertical wellbore*. 2<sup>nd</sup> International Conference on “Operators, Functions, and Systems of Mathematical Physics Commenced at Khazar University, 10-14 June, 2019, Baku, Azerbaijan, Invited speaker on topics (<http://khazar.org/en/news/4265>)
4. Mamedov F.I. *A variational view on the bottomhole zone and layer geometry impact to the productivity of wells*. 2<sup>nd</sup> International Conference on Mathematical Advances and Applications, MAY, 3-5, 2019, Yildiz Technical University, Istanbul, TURKEY, Invited speaker on topics (<https://icomaa2019.com/scientific-programme/>)
5. Mamedov F.I. and Amanova N.R. *On Harnack’s inequality for some class of non-uniformly degenerated elliptic equations*. 2<sup>nd</sup> International Conference on Mathematical Advances and Applications, MAY, 3-5, 2019, Yildiz Technical University, Istanbul, TURKEY, p.15 (<https://icomaa2019.com/wp-content/uploads/2019/05/ICOMAA-2019-ABSTRACT-BOOK.pdf>).
6. Zeren Y., Mamedov F. and F. Shirin, *A variable exponent boundedness of the Steklov operator*. 2<sup>nd</sup> International Conference on Mathematical Advances and Applications, MAY, 3-5, 2019, Yildiz Technical University, Istanbul, TURKEY, p.94.  
(<https://icomaa2019.com/wp-content/uploads/2019/05/ICOMAA-2019-ABSTRACT-BOOK.pdf>).
7. Farman I.Mamedov and Shahla Yu.Salmanova, *On strong solvability of the Dirichlet problem for semilinear elliptic equations with discontinues coefficients*. Proceedings of the Institute of Mathematics and Mechanics, NASA.

8. Shahla Yu.Salmanova. *The existence of solution of the Dirichlet problem for semilinear elliptic equations*. Republican conference on “Actual problems of mathematics and mechanics” dedicated to the 96th anniversary of the birth of national leader Heydar Aliyev, Baku, pp. 171-172.
9. Salmanova Sh.Yu. *On the existence of solution of the solution of the Dirichlet problem for semilinear elliptic equations*. International Workshop dedicated to the 80<sup>th</sup> anniversary of an academician Mirabbas Geogja oğlu Gasymov, Spectral Theory and its applications, Baku, 2019, pp.159-161.
- 10.F.I. Mamedov, V.A. Mammadova, Y. Shukurov, *A Phragmen-Lindelöf type theorem for the elliptic equations with small coefficients in unbounded domains*. International conference dedicated to the 60-th anniversary of the Institute of Mathematics and Mechanics on Modern Problems of Mathematics and Mechanics, Baku, 2019, pp. 354-356.
- 11.Sh.Yu. Salmanova (Shukurova), *The Dirichlet problem of seminilinear elliptic equations*. International conference dedicated to the 60-th anniversary of the Institute of Mathematics and Mechanics on Modern Problems of Mathematics and Mechanics, Baku, 2019, pp. 453-454.
- 12.S. Mammadli, *A decay condition for small coefficients of elliptic equations for uniqueness in cone condition unbounded domains*. International conference dedicated to the 60-th anniversary of the Institute of Mathematics and Mechanics on Modern Problems of Mathematics and Mechanics, Baku, 2019, pp. 329-331.

**Work 4: ”Existence of global solutions of semi-linear elliptic and parabolic equations with singular coefficients”.**

**Executor: ass. prof. Sh.H. Bagirov.**

In the outer infinite domain of the ball, a semi-linear parabolic equation with a biharmonic operator in the main part is considered and, in the case of imposing certain conditions on the ball’s boundary, the existence of a global solution is investigated. In addition, an exact sufficient condition was found to ensure the absence of a solution. We also consider a system of measurable weakly coupled parabolic equations with bounded coefficients in an infinite cylindrical domain, the basis of which is the outer part of the ball, and the problem of the existence of a global solution is investigated. An exact sufficient condition is found that ensures the absence of such solutions.

**Published papers:**

1. Багыров Ш.Г. *Отсутствие глобальных решений полулинейного параболического уравнения с бигармоническим оператором в главной части.* Вестник БГУ, 2019 N.3.
2. Багыров Ш. Г., Гулиева К. А. *Отсутствие глобальных решений слабо связанной системы полулинейных параболических уравнений второго порядка,* East European Scientific Journal, 9 (49), 2019, part 3, pp. 67-73.
3. Багыров Ш. Г., Гулиева К. А. *Отсутствие глобальных решений слабо связанной системы полулинейных параболических уравнений второго порядка.* Collected articles XXX International Scientific Conference, Crimean Autumn Mathematical School-Symposium on spectral and evolutionary problems, pp. 153-154.
4. Bagirov Sh.H. *Absence of a global solution of a semilinear parabolic equation with a biharmonic operator in the principal part.* International Workshop dedicated to the 80<sup>th</sup> anniversary of an academician Mirabbas Geogja oğlu Gasymov, Spectral Theory and its applications, Baku, 2019, pp. 53-56.
5. Bağırov Ş.H., Məmmədova B.R., *Yüksək tərtib adi diferensial bərabərsizliyin global həllinin yoxluğu.* Republican conference on “Actual problems of mathematics and mechanics” dedicated to the 96th anniversary of the birth of national leader Heydar Aliyev, Baku, pp. 23.
6. Bağırov Ş.H., Qasımova X.Ə., *Şarın xaricində yarım xətti parabolik tənliyin müsbət global həllinin varlığı.* Republican conference on “Actual problems of mathematics and mechanics” dedicated to the 96th anniversary of the birth of national leader Heydar Aliyev, Baku, pp. 23-24.
7. Sh.G. Bagirov, M.C. Aliyev, *The absence of global solutions to a semilinear parabolic equation with a biharmonic operator in the main part.* International conference dedicated to the 60-th anniversary of the Institute of Mathematics and Mechanics on Modern Problems of Mathematics and Mechanics, Baku, 2019, pp. 151-152.

**Work 5: ” Investigation of the qualitative properties of solutions of one class of pseudo-hyperbolic type equations with a nonlinear boundary condition”.**

**Executor: ass. prof. E.M. Mammadov.**

During the reporting period, for the fourth-order pseudo-hyperbolic equation with a nonlinear boundary condition, the stabilization problem with respect to  $t$  was studied and, based on the conditions imposed on the nonlinear functions

included in the equation and the boundary condition, the solution was stabilized. In addition, the problem of solution blow up for a finite period of time for a third-order equation with nonlinearity in the main part is investigated.

#### **Published papers:**

1. Mamedov E.M. *On behavior of solution for nonlinear pseudohyperbolic equation of fourth order with linear and nonlinear boundary conditions*. An international Workshop dedicated to the 80th anniversary of an academician Mirabbas Googja ogly Gasimov, Baku, 2019, pp. 103-104.
2. Мамедов Э.М. *Об одной нелинейной задаче для псевдогиперболического уравнения четвертого порядка*. Republican conference on “Actual problems of mathematics and mechanics” dedicated to the 96th anniversary of the birth of national leader Heydar Aliyev, Baku, pp. 110-111.
3. E.M. Mamedov, *On behavior of solution for nonlinear problem*, International conference dedicated to the 60-th anniversary of the Institute of Mathematics and Mechanics on Modern Problems of Mathematics and Mechanics, Baku, 2019, pp. 331-333.

#### **Work 6: ”Existence of a solution to one inverse problem for a semilinear parabolic equation”.**

**Executor: ass. prof. A.H. Hasanova.**

The work is devoted to the study of an approximate solution of the inverse problem by the method of successive approximations for a semilinear equation of parabolic type under the nonlinear Neumann boundary condition. The convergence theorem of the approximate solution to the exact solution is proved, and the convergence rate of the method of successive approximations proposed for the approximate solution of the problem is estimated. In addition, the problem under consideration is reduced to an equivalent problem – to a system of integral equations, and the existence of an integral (generalized) solution to this problem is investigated.

#### **Published papers:**

1. Tamilla Həsənova, Aynur Həsənova. *Yenilik hissi ilə yaşayan alim*. “Elm” newspaper, Baku, 2019, 11 January, № 1 (1215), p. 6.
2. Гасанова А. Г. *О существовании решения обратной задачи для уравнения параболического типа*. Collected articles VIII International

Scientific Conference “Mathematics. Education. Culture”, Togliatti, 2019, pp. 281-282.

3. Mərdanov M., Həsənova A. *Nüfuzlu elmi jurnallara məqalə hazırlamağın yolları*. “Azerbaijan Journal of Educational Studies”. (2018), № 4 (685), pp. 95-106. (Published in 2019).

[https://journal.edu.az/files/2018/Misir\\_Mardanov\\_Aynur\\_Hasanova.pdf](https://journal.edu.az/files/2018/Misir_Mardanov_Aynur_Hasanova.pdf)

4. Mərdanov M., Həsənova A. *Elmin inkişafında elmmetriyanın rolu*. “Azerbaijan Journal of Educational Studies”. (2019), № 2 (687), pp. 129–152.

[http://journal.edu.az/files/Misir\\_Mardanov\\_Azerbaijan\\_Journal\\_of\\_Educational\\_Studies.pdf](http://journal.edu.az/files/Misir_Mardanov_Azerbaijan_Journal_of_Educational_Studies.pdf)

5. A. Hasanova, *On the existence of a generalized solution of the inverse problem for equation of parabolic type*. International conference dedicated to the 60-th anniversary of the Institute of Mathematics and Mechanics on Modern Problems of Mathematics and Mechanics, Baku, 2019, pp. 235-237.

### Scientific work of the undergraduate of the department Shafiyeva Aynur:

1. Shafiyeva A.F. *On the Cauchy formula for functions in the Morry-Hardy class*. XIX Republican scientific conference of undergraduates, Sumgait, 2019, p. 50.

2. A. Shafiyeva, *Restoration of source function in system of parabolic equations*. International conference dedicated to the 60-th anniversary of the Institute of Mathematics and Mechanics on Modern Problems of Mathematics and Mechanics, Baku, 2019, pp. 459-461.

## II. ORGANIZATIONAL ACTIVITY.

Head of the department, Abdurrahim Guliyev lectures to the masters of the Institute of Mathematics and Mechanics on the subject "Modern problems of mathematics". Head of the department Abdurrahim Guliyev works as a teacher at Baku State University and in lyceum No.1 with a physical and mathematical bias.



Head of the department, Abdurragim Guliyev, one of the co-authors of the collection of test items in mathematics – “Abituriyent” – 2019, Part I (280 pages), published by Polygraphic Production, was a reviewer of



mathematics textbooks compiled on the basis of a new curriculum, is the scientific editor of the manual for the teacher to the textbook in mathematics for 8th grade, published in Russian.

Chief research associate of the department prof. Adalat Akhundov is a member of Scientific Council, vice-chairman of Dissertation Board, a member of the editorial staff of the journal «PROCEEDINGS» of Baku University for girls. Professor Adalat Akhundov lectures to the masters of the Institute of Mathematics and Mechanics in the specialties "Differential Equations" and "Equations of Mathematical Physics", works as a professor at Lankaran State University.

Chief research associate of the department prof. Farman Mammadov is a member of the Expert Council of the HAC, a member of editorial board of Azerbaijan and foreign journals, a reviewer of the journal of «Mathematical Reviews of American Mathematical Society».

The leading researcher of the department, associate professor Shirmail Bagirov lectures to the masters of the Institute of Mathematics and Mechanics on the subject “Nonlinear differential equations”, works as an associate professor at Baku State University.

Leading research associates of the department Abdurrahim Guliyev – scientific secretary, ass. prof. Shirmail Bagirov and senior research associate, ass. prof. Aynur Hasanova are the member of the Scientific Subject Seminar.

The senior researcher of the department, ass. prof. Elchin Mammadov is a member of the commission for control of the IMM trade union organization, works as a teacher at Baku State University.

A senior research of the department, ass. prof. Aynur Hasanova fellow is a member of a working group set up to use the Thomson Reuters Web of Science network and gather information.

Employees of the department A.F. Guliyev, A.Ya. Akhundov, F.I. Mammadov, Sh.H. Bagirov, E.M. Mammadov gave scientific reviews on dissertations, as well as were official opponents of dissertations.

Aynur Hasanova, a department employee, is the scientific editor of the teacher's manual for mathematics textbook for 4 classes, published in Azerbaijani and Russian, and the editor of mathematics textbook for 4 classes. The employee of the department, Aynur Hasanova, is one of the executors of the project “Optimization and application of oil refining methods with a gas lift and deep pump” of the Scientific Fund of the State Oil Company of the Republic of

Azerbaijan (SOCAR) (the project will be implemented within one year from 2020).

The head of the department, Abdurrahim Guliyev and Professor Farman Mammadov continuing their cooperation with Turkish scientists, expanded their scientific ties. Also, Professor Farman Mammadov continues to cooperate with Italian scientists.

Employees of the department, led by Abdurragim Guliyev, are working on the "English-Azerbaijani-Russian" dictionary of mathematical terms.

During the week, with the participation of employees and undergraduates of the department, seminars in English are held.

Every week, on Wednesdays, under the leadership of department head Abdurragim Guliyev, and on Mondays, under the leadership of Farman Mammadov, the seminar traditionally carries out its work department on the topic "Qualitative properties of differential equations".

### **KONFERENCES**

1. Head of the Department, Abdurragim Guliyev and Chief research associate of the department Professor Farman Mammadov (as a plenary speaker) took part in the International Scientific Conference entitled "Operators, Functions and Systems of Mathematical Physics", which was held on June 10-14, 2019 in Khazar University in Baku.
2. Professor Adalat Akhundov, a department employee, participated as a plenary speaker in the XXXIV International Scientific Conference entitled "Problems of Decision making under uncertainties", which was held in 2019 in Lviv.
3. Professor Adalat Akhundov, a department employee, took part in the Republican Scientific and Practical Conference on the theme "The unity of science, education and production at the stage of modern development", dedicated to the 96th anniversary of the birth of national leader Heydar Aliyev, held in 2019 at Lankaran State University.
4. Employees of the department Adalat Akhundov, Shirmail Bagirov, Elchin Mammadov, Shakhla Shukurova took part in the Republican conference on the topic "Actual problems of mathematics and mechanics" dedicated to the 96th anniversary of the birth of national leader Heydar Aliyev, held in 2019 at Baku State University.

5. Employees of the department Abdurragim Guliyev, Adalat Akhundov, Shirmail Bagirov, Elchin Mammadov, Shakhla Shukurova attended a conference dedicated to the 80th birthday of academician Mirrabas Gasimov, which was held in 2019 at the Institute of Mathematics and Mechanics.
6. Employees of the department Abdurragim Guliyev, Adalat Akhundov, Shirmail Bagirov, Elchin Mammadov, Shakhla Shukurova, Ainur Hasanova, Sayaly Mammadli, Ainur Shafieva took part in the International Scientific Conference on the topic "Contemporary Problems of Mathematics and Mechanics" dedicated to the 60th anniversary of the Institute of Mathematics and Mechanics ANAS.
7. Master student of the department Aynur Shafiyeva took part in the XIX Republican conference for undergraduates held in 2019 in the city of Sumgait.

**Thus, in 2019, employees of the department published 37 scientific papers, of which 5 scientific papers (3 papers abroad, 2 included in journals from the Web of Science and Scopus list), 3 – popular science articles, 28 abstracts (6 abroad), 1 collections of test items.**

**Head of department:**

**Ph. D. Abdurrahim Guliyev**