

**SEMI-ANNUAL REPORT OF 2018 ON SCIENTIFIC, AND SCIENTIFIC
ORGANIZATIONAL ACTIVITY OF THE DEPARTMENT OF
“EQUATIONS OF MATHEMATICAL PHYSICS” OF INSTITUTE OF
MATHEMATICS AND MECHANICS OF ANAS**

In the department of "Equations of Mathematical Physics" 13 workers, 11 of whom are research workers. Of them 3 **doctors of sciences, professors, including one member of ANAS:**

1. Huseynov Rauf V. – head of department, chief research associate, corr-member of ANAS, (full time).
2. Akhundov Adalat Ya. – chief research associate, (a part time).
3. Mammadov Farman I. – chief research associate, (a part time).

7 doctors of philosophy in mathematics:

4. Guliyev Abdurrahim F. – leading research associate, (full time).
5. Bagirov Shirmail H. – leading research associate, assistant professor, (a part time).
6. Aliyev Mushfig J. – leading research associate, assistant professor, (full time).
7. Mammadov Elchin M. – senior research associate, (full time).
8. Shukurova Shahla Yu. – senior research associate, (full time).
9. Ismailova Sakina H. – senior research associate, (full time).
10. Hasanova Aynur H. – senior research associate, (full time).

1 kandidat for a degru:

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

2 laboratory assistants:

12. Mustafayeva Lala M. – laboratory assistant, (full time).
13. Abdullayeva Aydan J. – laboratory assistant, (a part time).

I. SCIENTIFIC PART.

In 2018, according to the approved plan, the department conducts 11 research works on the topic "Unambiguous solutions of problems of mathematical physics and qualitative properties of solutions."

Work 1: "Investigation of the negative spectrum of quasi-elliptic operators".

Executor: corr-member of ANAS, prof. R.V. Huseynov.

During the reporting period, the spectrum for elliptic and some quasi-elliptic equations of high order was investigated. In particular, analogues of the stationary

Schrödinger operator of high order are studied. In this case, a negative spectrum was considered for different types of differential operator and a given potential $Q(x)$. We investigated what necessary conditions must be imposed on the potential, that the negative spectrum be finite and infinite.

Work 2: "An approximate solution of an inverse problem for a semilinear elliptic equation".

Executor: prof. A.Ya. Akhundov.

The inverse problem of determining the unknown coefficients on the right-hand side of the system of elliptic equations is investigated. The problem is solved by the method of successive approximations, the convergence of the approximate solution to the exact solution is proved, with the speed of the geometric series, the theorem on the existence, uniqueness, and stability of the solution is proved.

Published papers:

1. Axundov Ə., Paşayev N. Bir tərs məsələnin ümumiləşmiş həllinin varlığı haqqında. *Ümummilli lider Heydər Əliyevin anadan olmasının 95-ci il döniümünə həsr olunmuş "Müasir inkişaf mərhələsində elm, təhsil və istehsalatın vəhdəti" adlı Respublika Elmi-praktik Konfransı, Lənkəran Dövlət Universiteti, 7-8 may, 2018.*
2. Ахундов А., Селимханов Б. Определение коэффициентов в правой части системы эллиптических уравнений. *Ümummilli lider Heydər Əliyevin anadan olmasının 95-ci il döniümünə həsr olunmuş "Müasir inkişaf mərhələsində elm, təhsil və istehsalatın vəhdəti" adlı Respublika Elmi-praktik Konfransı, Lənkəran Dövlət Universiteti, 7-8 may, 2018.*

Work 3: "Integral inequalities of Hardy-Sobolev-Poincaré type and their application. Qualitative properties of nonuniformly degenerate elliptic and parabolic partial differential equations".

Executor: prof. F.I. Mammadov.

During the reporting period, one class of unevenly degenerate elliptic equations was investigated. Qualitative properties of the solutions of these equations are studied. An a priori estimate of the Holder norm for these solutions is proved.

Published papers:

1. F. Mammadov. "On qualitative properties of some class elliptic equations with nonuniformly degeneration". *ICOMAA, Istanbul, 11-13 May, 2018*.
2. F. Mammadov. "On study of regularity properties for some class elliptic equations with nonuniformly degeneration". *Operators, Functions and Systems of Mathematical Physics International Conference, Khazar University, Baku, 21-24 May, 2018*.
3. Farman Mamedov, Yashar Shukurov. [A Sawyer-type sufficient condition for the weighted Poincaré inequality](#). *Positivity, 2018, v. 22, № 3, pp. 687–699*.

Work 4: "Some qualitative properties of solutions of second-order parabolic equations of a non-divergent structure".

Executor: A.F. Guliyev.

For a Weierstrass-type nucleus in the paraboloid domain, where the parabolic equations have supersolutions, two-sided equivalent estimates were obtained using the value of the nucleus at the pole. Applying these results, we obtain a growth theorem for solutions of second-order parabolic equations.

Published papers:

1. Guliyev A.F. The Estimates of Functions Type of Weirstrass Kernel in Special Domains. *ICOMAA, Istanbul, 11-13 May, 2018*.
2. Guliyev A.F. The broth Teorem for Positive Solitions of the Heat. *Operators, Functions and Systems of Mathematical Physics International Conference, Khazar University, Baku, 21-24 May, 2018*.
3. Guliyev A.F. (həmmüəlliflərlə birgə) "Riyaziyyat" 10-cu sinif. *Test toplusu, 2018*.
4. Guliyev A.F. (həmmüəlliflərlə birgə) "Riyaziyyat" 7-ci sinif. *Dərslik, 2018, (çapdadır)*.
5. Guliyev A.F. (həmmüəlliflərlə birgə) "Riyaziyyat" 11-ci sinif. *Dərslik, 2018, (çapdadır)*.

Work 5: "Elliptic and parabolic equations with a singular potential and the absence of a global solution of a system of semilinear equations in the exterior domain".

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

The problem of the existence in the outer region of global solutions of semilinear elliptic and parabolic equations is studied. The problem of the absence of positive global solutions in the outer sphere of the ball is investigated, and sufficient conditions are found for which solutions do not exist. By the example it was shown that the found conditions are exact. We also considered a system of semilinear

elliptic equations with a singular potential, with a biharmonic operator in the principal part, and we found an exact estimate for the absence of a positive global solution of this system. Next, we studied the absence in the cylindrical domain, the base of which is the outer part of the ball, of positive global solutions of second-order semilinear parabolic equations and a system of semilinear parabolic equations with periodic coefficients in time, and in this case exact sufficient conditions are found for which global solutions do not exist.

Published papers:

1. Ш.Г. Багыров. Отсутствие решений полулинейного бигармонического уравнения с сингулярным потенциалом. *Математические заметки*, 103 (1) (2018), с. 27-37.
2. Shirmayil G. Bagirov. [On Non-Existence of Positive Periodic Solution for Second Order Semilinear Parabolic Equation](#). *Azerbaijan Journal of Mathematics*, 8 (2) (2018) (*çapdadır*).
3. Shirmayil Bagirov. Nonexistence of global solutions to the system of semilinear parabolic equations with biharmonic operator and singular potential. *Electronic Journal of Differential Equations*, 2018 (9) (2018), pp. 1-13.

Work 6: "The boundedness of the Hardy operator in Lebesgue spaces with variable exponent, its application to the qualitative properties of elliptic and parabolic equations".

Executor: ass. prof. M.J. Aliyev.

The existence in the outer region of global solutions of semilinear parabolic and elliptic equations was investigated. The absence of positive global solutions of a system of second-order semilinear parabolic equations with periodic coefficients in time was studied in the cylindrical domain whose base is the outer part of the ball, and exact sufficient conditions are found for which global solutions do not exist. By the example it was shown that the found conditions are exact.

Work 7: "Investigation of the qualitative properties of solutions of a class of nonlinear equations of pseudo-hyperbolic type".

Executor: E.M. Mammadov.

During the reporting period, for the wave equation with strong dissipation and with a nonlinear boundary condition, the stabilization problem with respect to t was investigated.

Over a finite period of time, taking into account certain conditions imposed on the nonlinear functions given in the equation and boundary conditions, the destruction of the solution is investigated. In this direction, research continues.

Published papers:

Мамедов Э.М. О поведении решений смешанной задачи для нелинейного волнового уравнения с сильной диссипацией. *Ümummilli lider Heydər Əliyevin anadan olmasının 95-ci il döniümünə həsr olunmuş "Riyaziyyat və Mexanikanın aktual problemləri" adlı Respublika Konfransı, Bakı Dövlət Universiteti, Bakı, 17-18 May, 2018, səh. 160-162.*

Work 8: "Investigation of the solution of the boundary value problem for a parabolic equation in a symmetric-geometric domain".

Executor: Sh.Yu. Shukurova.

During the reporting period, the following task was considered:

$$\sum_{i,j=1}^n a_{ij}(x) u_{x_i x_j} + g(x, u) = f(x), \quad x \in \Omega, \quad (1)$$

$$u|_{\partial\Omega} = 0. \quad (2)$$

Here, the coefficients $a_{ij}(x)$, $i, j = 1, 2, \dots, n$ satisfy the conditions of uniform ellipticity and Cordes, $g(x, u)$ is a Caratheodory function satisfying the following condition: $|g(x)| \leq b_0 |u|^q$, $b_0 > 0$.

The existence of a strong solution of problem (1) – (2) in the space $W_p^2(\Omega)$ is shown.

Work 9: "Strong solvability of the mixed boundary value problem for second-order parabolic equations of a non-divergent structure in the Sobolev's spaces".

Executor: S.H. Ismailova.

During the reporting period, the existence of a solution of the mixed boundary value problem for parabolic second-order equations of a non-divergent structure in Sobolev's spaces was investigated. Here, the Cordes's condition is imposed on the coefficients of the principal part of the parabolic equation, and the condition of belonging to the corresponding Lebesgue spaces is imposed on small coefficients.

For quasilinear second-order parabolic equations of a nondivergence structure with discontinuous coefficients, we consider a mixed boundary value problem. Taking into account the stated conditions, strong solvability of the problem under consideration in the domain $\tilde{W}_p^{2,1}(Q_T)$ is investigated.

Work 10: "An approximate solution of an inverse problem for a semilinear parabolic equation".

Executor: A.H. Hasanova.

In the paper, the method of successive approximations is used to study the approximate solution of an inverse problem for a second-order semilinear parabolic equation with a nonlinear Neumann boundary condition. A theorem on the convergence of an approximate solution to an exact solution is proved, and the rate of convergence of the proposed method of successive approximations is estimated.

Also, by the method of successive approximations, an approximate solution of the inverse problem of determining unknown coefficients for a system of parabolic equations of reaction-diffusion type in a bounded domain in the case of the third boundary condition and additional integral information was investigated, and the existence of a generalized solution of the inverse problem was proved.

Published papers:

1. Adalat Ya. Akhundov, Aynur Hasanova. [On the existence of a solution of the inverse problem for a system of parabolic equations](#). *Proceedings of the Institute of Mathematics and Mechanics, National Academy of Sciences of Azerbaijan*, 44 (1) (2018), pp. 81-89.
2. M.Ə. Şahverdiyev, A.H. Həsənova, L.R. Əliyeva, S.Ə. Həsənova. Riyazi analiz. Sıralar nəzəriyyəsinin elementləri. *Dəs vəsaiti (III hissə)*, Bakı, 2018, 144 s.

Work 11: "Integral inequalities of Hardy-Sobolev-Poincaré type and their application."

Executor: S.M. Mammadli.

During the reporting period, questions of the existence and uniqueness of the solution of the Dirichlet problem were studied using Poincare-Sobolev type inequalities obtained for differential equations with a variable exponent.

II. ORGANIZATIONAL ACTIVITY.

Thad of the department, corr. member of ANAS, prof. Rauf Huseynov is a member of Scientific Council, Dissertation Board and a member of editorial staff of scientific journals «TRANSACTIONS» and «PROCEEDINGS» of ANAS. Professor Rauf Huseynov lectures to the masters of the Institute of Mathematics and Mechanics on the subject "Modern problems of mathematics".

Cheif 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 Adalyat Akhundov lectures to the masters of the Institute of Mathematics and Mechanics in the specialties "Differential Equations" and "Equations of Mathematical Physics".

Cheif research associate of the department prof. Farman Mammadov is a member of the Expert Commission of HCC, a member of editorval board of Azerbaijan and foreign journals, a reviewer of the journal of «Mathematical Reviews of American Mathematical Society».

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

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

The employee of the department Abdurrahim Guliyev (in co-authorship) became the winner of the tender conducted for the implementation of the draft textbook on mathematics for the 11th grade, compiled on the basis of a new curriculum. Also, Abdurrahim Guliyev is one of the co-authors of the collection of test assignments in mathematics for the 10th grades of secondary schools of the country, compiled for the first time under a new curriculum and a textbook on mathematics for the 7th grade.

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

Leading researcher of the department, Associate Professor Sh. Bagirov, in the general seminar of the Institute June 13, 2018 made a report on the topic "Lack of global positive solutions of loosely coupled systems of semilinear parabolic equations with periodic coefficients in time".

Every week on Wednesdays, under the guidance of member corr. ANAS, prof. R.W. Huseynov traditionally carries out its work the seminar of the department on the topic "Qualitative properties of differential equations".

KONFERENCES

1. Employees of the department Professor Farman Mammadov and Abdurrahim Guliyev took part in the International Scientific Conference ICOMAA, which was held May 11-13, 2018 in Turkey in the city of Istanbul and delivered plenary reports.
2. Employees of the department Professor Farman Mammadov (with a plenary report) and Abdurrahim Guliyev took part in the International Scientific Conference on “Operators, Functions and Systems of Mathematical Physics” dedicated to the 70th anniversary of Hamlet Isakhanli held May 21-24, 2018 in Baku at the Khazar University.
3. The employee of the department, Professor Adalat Akhundov, took part in the Republican Scientific and Practical Conference on the theme “Unity of science, education and production at the stage of modern development”, dedicated to the 95th anniversary of the birth of the national leader Heydar Aliyev, held May 7-8, 2018 in the Lenkoran State University.
4. Employee of the department Elchin Mammadov took part in the Republican conference on “Actual problems of mathematics and mechanics” dedicated to the 95th anniversary of the birth of national leader Heydar Aliyev, held May 17-18, 2018 in Baku State University.

Thus, for the first half of 2018, collaborators of the department published 4 papers (3 papers included in the journals from the list of Thomson Reuters), 7 abstracts, 2 textbooks; 1 papers and 2 textbooks in print, 7 papers are submitted for publication.

Head of department:

**corr-member of ANAS,
d.f.-m.s., prof. R.V. Huseynov.**