

Few-Body Systems Group (Sector 11) at BLTP, JINR

2010 Annual Activity Report

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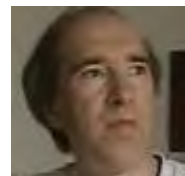
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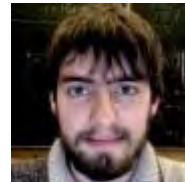
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2 Main results

Within the previously developed Dubna-Mainz-Taipei meson-exchange model [KS1], the singularity structure of the πN scattering amplitudes has been investigated [KS2]. For all partial waves up to F waves and c.m. energies up to $W \sim 2$ GeV, the T -matrix poles have been calculated by three different techniques: analytic continuation into the complex energy plane, speed-plot and the regularization method. For all 4-star resonances, a perfect agreement between the analytic continuation and the regularization method has been found. Resonance poles are also found for resonances that are not so well established, but in these cases the pole positions and residues obtained by analytic continuation can substantially differ from the results predicted by the speed-plot and regularization methods.

- [KS1] G. Y. Chen, S. S. Kamalov, S. N. Yang, D. Drechsel, and L. Tiator, “Nucleon resonances in πN scattering up to energies $\sqrt{s} < 2.0$ GeV,” *Phys. Rev. C* **76**, 035206 (2007) (11 pages).
- [KS2] L. Tiator, S. S. Kamalov *et al.*, “Singularity structure of the πN scattering amplitude in a meson-exchange model up to energies $W \leq 2.0$ GeV,” *Phys. Rev. C* **82**, 055203 (2010) (12 pages).

Faddeev differential equations in total angular momentum representation are used for numerical study of the Helium trimer systems [KE1]. An illustration of using a quantum three-body code is being prepared for public release [KE2]. The code is based on iterative solving of the three-dimensional Faddeev equations. The code is easy to use and allows users to perform highly-accurate calculations of quantum three-body systems. The previously known results for He_3 ground state are well reproduced by the code.

- [KE1] E. A. Kolganova, “Helium trimer in the framework of Faddeev approach” *Phys. Part. Nucl.* **41**, 1108–1110 (2010).
- [KE2] E. A. Kolganova, V. Roudnev, and M. Cavagnero, “Solution of three-dimensional Faddeev equations: Ultracold Helium trimer calculations with a public quantum three-body code”, in: *Proc. 2nd South Africa - JINR Symposium “Models and Methods in Few- and Many-Body Systems”*, edited by F. Simkovic, ISBN-978-5-9530-0264-6, pp. 32–40 (2010); arXiv:1010.1404.

The universal low-energy properties of two-component three-body systems have been studied for different configuration-space dimensions [MA]. A set of binding energies, the bound-state numbers, and the characteristics of the low-energy $(2 + 1)$ -scattering were presented; isotopic dependences of the rotational-vibrational spectrum and scattering characteristics have been given.

- [MA] O. I. Kartavtsev and A. V. Malykh, “Universal properties of ultra-cold two-component three-body systems”, *Vestnik of St. Petersburg State University. Series 4: Physics and Chemistry* **3**, 121-125 (2010) (Russian).

Confinement-induced resonances (IRs) have been observed in strongly interacting quantum-gas systems with tunable interactions for one- and two-dimensional geometry [MV]. Atom-atom scattering is substantially modified when the s-wave scattering length approaches the length scale associated with the tight transversal confinement, leading to characteristic loss and heating signatures. Furthermore, a splitting of the CIR has been observed upon introducing an anisotropy for the transversal confinement. With increasing anisotropy additional resonances appear. It was found that, in the limit of a two-dimensional system, that one resonance persists.

[MV] E. Haller, M. J. Mark, R. Hart, J. G. Danzl, L. Reichsöllner, V. S. Melezhik, P. Schmelcher, and H.-Ch. Nägerl, “Confinement-induced resonances in low-dimensional quantum systems”, *Phys. Rev. Lett.* **104**, 153203-1–4 (2010).

Given a self-adjoint involution J on a Hilbert space \mathfrak{H} , a J -self-adjoint operator $L = A + V$ on \mathfrak{H} has been considered in [AMT] under the assumption that A is a possibly unbounded self-adjoint operator commuting with J and V a bounded J -self-adjoint operator anti-commuting with J . Optimal estimates are established for the position of the spectrum of L with respect to the spectrum of A and norm bounds are obtained on the operator angles between maximal uniformly definite reducing subspaces of the unperturbed operator A and the perturbed operator L . All the bounds are given in terms of the norm of V and the distances between pairs of disjoint spectral sets associated with the operator L and/or the operator A . As an example, the quantum harmonic oscillator under a \mathcal{PT} -symmetric perturbation is discussed. The sharp norm bounds obtained for the operator angles generalize the celebrated Davis-Kahan trigonometric theorems to the case of J -self-adjoint perturbations.

[AMT] S. Albeverio, A. K. Motovilov, and C. Tretter, “Bounds on the spectrum and reducing subspaces of a J -self-adjoint operator”, *Indiana University Mathematics Journal* **59:5**, 1737–1776 (2010).

A new approach for treatment of three charged particles has been proposed [BN]. A new approach for treatment of three charged particles has been proposed. Within this approach, a finite rank approximation is used for the angular part of the total Coulomb potential, which results in a system of one-dimensional coupled integral equations. Preliminary numerical results for three-body atomic and molecular systems like H^- , He , $p\bar{p}\mu$, and some others are presented.

[BN] V. B. Belyaev and A. A. Naumkin, “A new method of description of three-particle Coulombic systems”, in: *Proc. 2nd South Africa - JINR Symposium “Models and Methods in Few- and Many-Body Systems”*, edited by F. Simkovic, ISBN-978-5-9530-0264-6, pp. 62–68 (2010); *arXiv:1012.3327*.

3 Publications

3.1 Journal publications

1. S. Albeverio, A. K. Motovilov, and C. Tretter, “Bounds on the spectrum and reducing subspaces of a J -self-adjoint operator”, *Indiana University Mathematics Journal* **59:5**, 1737–1776 (2010).
2. S. I. Fedotov, O. I. Kartavtsev, and A. V. Malykh, “Consistent alpha-cluster description of the $^{12}\text{C}(0_2^+)$ ‘Hoyle’ resonance”, *JETP Letters* **92, 10**, 715-719 (2010).
3. E. Haller, M. J. Mark, R. Hart, J. G. Danzl, L. Reichsöllner, V. S. Melezhik, P. Schmelcher, and H.-Ch. Nägerl, “Confinement-induced resonances in low-dimensional quantum systems”, *Phys. Rev. Lett.* **104**, 153203-1–4 (2010).
4. O. I. Kartavtsev and A. V. Malykh, “Universal properties of ultra-cold two-component three-body systems”, *Vestnik of St. Petersburg State University. Series 4: Physics and Chemistry* **3**, 121-125 (2010) (Russian).
5. E. A. Kolganova, “Helium trimer in the framework of Faddeev approach” *Phys. Part. Nucl.* **41**, 1108–1110 (2010).
6. A. V. Matveenko, H. Fukuda, and E. O. Alt, “Definition of free hyperradial dynamics for the three-body problem”, *Phys. Part. Nucl.* **41**, 1115–1118 (2010).
7. V. V. Pupyshev, “Structure of wave functions of three-body systems nearly the triple collision point”, *Vestnik of St. Petersburg State University. Series 4: Physics and Chemistry* **3**, 105-111 (2010) (Russian).
8. L. Tiator, S. S. Kamalov *et al.*, “Singularity structure of the πN scattering amplitude in a meson-exchange model up to energies $W \leq 2.0$ GeV,” *Phys. Rev. C* **82**, 055203 (2010) (12 pages).

3.2 Articles in paper collections/conference proceedings

1. V. B. Belyaev and A. A. Naumkin, “A new method of description of three-particle Coulombic systems”, in: *Proc. 2nd South Africa - JINR Symposium “Models and Methods in Few- and Many-Body Systems”*, edited by F. Simkovic, ISBN-978-5-9530-0264-6, pp. 62–68 (2010); *arXiv:1012.3327*.
2. V. B. Belyaev, W. Sandhas, and I. I. Shlyk, “Meson-nuclear clusters in the few-body approaches”, *EPJ Web of Conferences* **3**, 03033(4) (2010).
3. E. A. Kolganova, V. Roudnev, and M. Cavagnero, “Solution of three-dimensional Faddeev equations: Ultracold Helium trimer calculations with a public quantum three-body code”, in: *Proc. 2nd South Africa - JINR Symposium “Models and Methods in Few- and Many-Body Systems”*, edited by F. Simkovic, ISBN-978-5-9530-0264-6, pp. 32–40 (2010); *arXiv:1010.1404*.

4. N. Markovska, J. Pop-Jordanov, and E. Solov'ev, "Quantum resonance effects and solar cell efficiency", Ch. 05 in: *"Physics of Nanostructured Solar Cells"*, Eds. V. Badescu and M. Paulescu, ISBN: 978-1-60876-110-4, Nova Publishers, N. Y., 2010, pp. 133–143.
5. V. S. Melezhik, "Confinement-induced resonances in low-dimensional quantum systems", in: *JINR NEWS, Dubna, 2010, No. 3*, pp.11-12.
6. S. A. Sofianos, R. M. Adam, and V. B. Belyaev, "A few-body method for many-body systems", in: *Proc. 2nd South Africa - JINR Symposium "Models and Methods in Few- and Many-Body Systems"*, edited by F. Simkovic, ISBN-978-5-9530-0264-6, pp. 41–51 (2010).

3.3 Articles accepted for publication

1. S. Albeverio and A. K. Motovilov, "Operator integrals with respect to a spectral measure and solutions to some operator equations", *Proc. Moscow Math. Soc.* (accepted for publication).
2. V. B. Belyaev and A. A. Naumkin, "Approximate treatment of 3-body Coulomb systems. Discrete spectrum", *Few-Body Systems* (accepted for publication).

3.4 Preprints and data bases

1. S. Albeverio and A. K. Motovilov, "The a priori Tan Θ Theorem for spectral subspaces", *arXiv:1012.1569*.
2. E. A. Solov'ev, "Classical approach in quantum physics", *arXiv:1003.4387*.
3. E. A. Solov'ev, "On foundations of quantum physics", *arXiv:1001.2683*.

3.5 Conference presentations

1. V. B. Belyaev, "Some aspects of few-body physics in astrophysics", [VIIIth Winter School on Theoretical Physics "From Nuclear Physics to Astrophysics and Cosmology"](#) (January 31 – February 7, 2010, Dubna, Russia), invited lectures.
2. V. B. Belyaev, [A. A. Naumkin](#) "A new method of description of three-particle Coulombic systems", [2nd South Africa - JINR Symposium "Models and Methods in Few- and Many-Body Systems"](#) (September 8 – 10, 2010, Dubna, Russia), oral presentation.
3. [V. B. Belyaev](#) and [A. A. Naumkin](#), "Approximate treatment of three-body Coulomb systems", [21st European Conference on Few-Body Problems in Physics](#) (August 29 – September 03, 2010, Salamanka, Spain), session talk.
4. [V. B. Belyaev](#) and [A. A. Naumkin](#), "New treatment of Coulomb three-body system", [Spring School of South African Institute of Physics](#) (September 28 – 30, 2010, Pretoria, South Africa), oral presentation.

5. V. B. Belyaev and A. A. Naumkin, “Finite-dimensional approximation of the angular part of potential in the three-body Coulomb problem”, Symposium “Quantum resonances in Nuclear, Molecular and Solid State Physics” (September 22 – 26, 2010, Pretoria, South Africa), oral presentation.
6. V. B. Belyaev, W. Sandhas, and I. I. Shlyk, “New nuclear clusters”, [Nucleon-Nucleon Interaction and Nuclear Many-Body Problem](#) (November 18 – 27, 2010, Mumbai, India), invited talk.
7. S. I. Fedotov, O. I. Kartavtsev, and A. V. Malykh, “Consistent alpha-cluster description of the $^{12}\text{C}(0_2^+)$ state”, Programme Advisory Committee for Nuclear Physics, 31th Meeting (25 – 26 January, 2010, Dubna, Russia), poster.
8. S. I. Fedotov, O. I. Kartavtsev, and A. V. Malykh, “Structure and width of the $^{12}\text{C}(0_2^+)$ (Hoyle) state in the alpha-cluster model” [CAS - BLTP JINR Joint Workshop “Nuclear theory”](#) (June 28 - July 4, 2010, Dubna, Russia), invited talk.
9. O. I. Kartavtsev, A. V. Malykh, and S. A. Sofianos, “Three two-component particles with zero-range interactions under one-dimensional confinement”, [2nd South Africa - JINR Symposium “Models and Methods in Few- and Many-Body Systems”](#) (September 8-10, 2010, Dubna, Russia), invited talk.
10. E. A. Kolganova, “Solution of three-dimensional Faddeev equation on example of ultracold Helium trimer”, [Humboldt Kolleg / XIV International Conference on Symmetry Methods in Physics \(SYMPHYS-XIV\)](#) (Tsakhkadzor, Armenia, August 16-22 2010), oral presentation.
11. E. A. Kolganova, “Exzellenz verbindet - be part of a worldwide network”, [Humboldt Kolleg / XIV International Conference on Symmetry Methods in Physics \(SYMPHYS-XIV\)](#) (Tsakhkadzor, Armenia, August 16 – 22 2010), invited talk.
12. E. A. Kolganova, “Three-atomic systems in framework of three-dimensional Faddeev equations”, [Advanced Studies Institute: Symmetries and Spin \(SPIN-Praha-2010\)](#) (July 18 - July 24, 2010, Prague, Czech Republic), oral presentation.
13. E. A. Kolganova, A. K. Motovilov, and W. Sandhas, “Efimov Properties of three-atomic systems”, [Humboldt Kolleg “Mathematics and life sciences: possibilities, inter-lacements and limits”](#) (August 5 – 8, 2010, Kyiv, Ukraine), invited talk.
14. E. A. Kolganova, V. Roudnev, and M. Cavagnero, “Three-body systems within three-dimensional Faddeev equations”, [2nd South Africa - JINR symposium “Models and Methods in Few- and Many-Body Systems”](#) (September 8 – 10, 2010, Dubna, Russia), invited talk.
15. A. A. Korobitsin and E. A. Kolganova, “Three-body systems in the framework of Faddeev equations”, International Workshop and Summer school ‘Quo vadis Bose-Einstein condensation?’ (August 2 - 20, 2010, Max-Planck-Institut für Physik komplexer Systeme, Dresden, Germany), poster.

16. V. S. Melezhik, “Few-body physics of ultracold atoms and molecules in confined geometry”, [VIIIth Winter School on Theoretical Physics “From Nuclear Physics to Astrophysics and Cosmology”](#) (January 31 – February 7, 2010, Dubna, Russia), invited lectures.
17. [V. S. Melezhik](#) and P. Schmelcher “Collision induced transitions of confined atoms in waveguides: molecule formation and confinement-induced resonances” [ECAMP10, 10th European Conference on Atoms, Molecules and Photons](#) (4 – 9 July 2010, Salamanca, Spain), poster.
18. A. K. Motovilov, “Efimov effect in three-body problem”, [VIIIth Winter School on Theoretical Physics “From Nuclear Physics to Astrophysics and Cosmology”](#) (January 31 – February 7, 2010, Dubna, Russia), invited lectures.
19. A. K. Motovilov, “Bounds on variation of reducing subspaces under J -self-adjoint perturbations”, [The 21st International Workshop on Operator Theory and its Applications](#) (July 12 – 16, 2010, Berlin, Germany), session talk.
20. H.-Ch. Nägerl, E. Haller, M. J. Mark, R. Hart, J. G. Danzl, L. Reichsöllner, V. S. Melezhik, P. Schmelcher, A. Klinger, O. Kriegelsteiner, M. Rabie, G. Pupillo, and M. Dalmonde, “[Strongly-interacting quantum gases in one-dimensional geometry](#)”, [Frontiers of Ultracold Atoms and Molecules](#) (October 11 – 15, 2010, Santa Barbara, USA), invited talk.
21. I. I. Shlyk, “The possibility of the existence of new meson-nuclear few body systems”, Seminar “Training of young scientists from CIS” (December 22, 2010, Dubna, Russia), oral presentation.
22. E. A. Solov’ev, “Ionization of atoms by ultrastrong electric pulses: From symmetric to fully asymmetric momentum distribution”, Workshop “Theory Workshop” (June 11 - 13, 2010, Klein Quassow, Germany), oral presentation.
23. E. A. Solov’ev, “On foundations of quantum physics”, BLTP Laboratory Seminar (February 4, 2010, BLTP, JINR, Dubna), seminar talk.

4 Visits

4.1 Conferences, schools

1. V. B. Belyaev, [Nucleon-Nucleon Interaction and Nuclear Many-Body Problem](#) (November 18 – 27, 2010, Mumbai, India).
2. V. B. Belyaev, [21st European Conference on Few-Body Problems in Physics](#) (August 29 – September 03, 2010, Salamanka, Spain).
3. V. B. Belyaev, Spring School of South African Institute of Physics (September 28 – 30, 2010, Pretoria, South Africa).
4. V. B. Belyaev, Symposium “Quantum resonances in Nuclear, Molecular and Solid State Physics” (September 22 – 26, 2010, Pretoria, South Africa).

5. E. A. Kolganova, Humboldt Kolleg / XIV International Conference on Symmetry Methods in Physics (SYMPHYS-XIV) (August 16 – 22, 2010, Tsakhkadzor, Armenia).
6. E. A. Kolganova, Humboldt Kolleg “Mathematics and life sciences: possibilities, interlacements and limits” (August 5 – 8, 2010, Kiev, Ukraine).
7. E. A. Kolganova, Advanced Studies Institute: Symmetries and Spin (SPIN-Praha-2010), (July 18 – July 24, 2010, Prague, Czech Republic).
8. A. A. Korobitsin, International Workshop and Summer school ‘Quo vadis Bose-Einstein condensation?’ (August 2 – 15, 2010, Dresden, Germany).
9. V. S. Melezhik, 10th European Conference on Atoms, Molecules and Photons (July 4 – 9, 2010, Salamanca, Spain).
10. A. K. Motovilov, The 21st International Workshop on Operator Theory and its Applications (July 12 – 16, 2010, Berlin, Germany).
11. E. A. Solov’ev, Workshop “Theory Workshop” (June 11 – 13, 2010, Klein Quassow, Germany).

4.2 Collaboration visits

1. V. B. Belyaev, Physics Institute, Bonn University, Bonn, Germany, 20.12.2009–11.01.2010.
2. S. S. Kamalov, Institute of Nuclear Physics, Mainz University, Mainz, Germany, 03.03.2010–31.03.2010.
3. S. S. Kamalov, Institute of Nuclear Physics, Mainz University, Mainz, Germany, 05.07.2010–31.07.2010.
4. E. A. Kolganova, Physics Institute, Bonn University, Bonn, Germany, 24.03.2010–01.04.2010.
5. E. A. Kolganova, Institute of Nuclear Physics, Řež, Czech Republic, 16.07.2010–28.07.2010.
6. A. V. Matveenکو, Institute of Physics, Mainz University, Mainz, Germany, 18.10.2010–01.11.2010.
7. V. S. Melezhik, Center of Quantum Optics, Physics Department, University of Hamburg, Hamburg, Germany, 29.06.2010–08.08.2010.
8. A. K. Motovilov, Institute for Applied Mathematics, Bonn University, Bonn, Germany, 13.01.2010–04.02.2010.
9. A. K. Motovilov, Institute for Applied Mathematics, Bonn University, Bonn, Germany, 03.07.2010–25.07.2010.

10. E. A. Soloviev, Freie Universität, Berlin, Germany, 04.06.2010-18.06.2010.
11. I. I. Shlyk, Physics Institute, Bonn University, Bonn, Germany, 22.02.2010-08.03.2010.
12. I. I. Shlyk, Physics Institute of National Academy of Sciences, Minsk, Belarus 26.01.2010-30.01.2010.

5 Visitors

1. Michel Fabre de la Ripelle, Institute de Physique Nucleaire, Orsay, France, 28.06.2010–07.07.2010.
2. Nina Shevchenko, Institute of Nuclear Physics, Řež, Czech Republic, 12.10.2010–26.10.2010.
3. Dmitry Petrov, Laboratoire Physique Théorique et Modèles Statistique, Université Paris Sud, CNRS, Orsay, France, 11.06.2010.
4. János Révai, Research Institute for Nuclear and Particle Physics, Budapest, Hungary, 15.09.2010–12.12.2010.
5. Vladimir Roudnev, Kentucky University, Lexington, USA, 22.12.2010–24.12.2010.

6 Teaching

1. V. B. Belyaev: adviser of of A.Naumkin, Ph. D. student of Moscow State University, Moscow.
2. V. B. Belyaev: Lecture course “Nuclear Astrophysics” at Dubna University, Dubna.
3. E. A. Kolganova: Diploma adviser of A. Korobotsin, student of Dubna University, Dubna.
4. E. A. Kolganova: Diploma adviser of E. Kaneva, student of Dubna University, Dubna.
5. E. A. Kolganova: Diploma adviser of A. Nedelkin, student of Dubna University, Dubna.
6. E. A. Kolganova: Dozent of the Dubna University, lecture course “Mathematical modeling and numerical methods” (February–June and September–December 2010).
7. V. S. Melezhik: Professor of the Dubna University, lecture course “General physics”(all the academic year), lecture course “History and methodology of physics” (September–December 2010), lecture course “Modern problems of quantum physics” (September–December 2010).

8. V. S. Melezhik: Ph. D. Thesis co-adviser of Panagiotis Yannakeas, Ph. D. student at Institute of Laser Physics, University of Hamburg, Hamburg, Germany.
9. V. S. Melezhik: Diploma (master thesis) adviser of Yu. Loginova, student of Dubna University, Dubna.
10. V. S. Melezhik: Diploma (bachelors diploma) adviser of O. Koval and E. Koval, students of Dubna University, Dubna.
11. A. K. Motovilov: Professor of the Dubna University, lecture course and seminars on calculus for 1st year students (all the academic year 2009/2010), lectures and seminars on the course “Scattering theory for few-body systems” for 6th year students (September – December 2010).

7 Organizational activity

1. V. B. Belyaev: Member of the BLTP Scientific Council.
2. V. B. Belyaev: Member of the BLTP NTS.
3. V. B. Belyaev: Chairman of the Council for conferring of bachelor and magister degrees at the Faculty of Physics, Veliky Novgorod State University, Veliky Novgorod.
4. V. B. Belyaev: Member of Advisory Committee of the [21th European Conference on Few-Body Problems in Physics](#) (29 August - 3 September 2010, Salamanka, Spain).
5. E. A. Kolganova: Scientific Secretary of the Council for conferring of bachelor and magister degrees at the Theoretical Physics Department, Dubna University.
6. E. A. Kolganova: Co-chairman [Humboldt Kolleg / XIV International Conference on Symmetry Methods in Physics \(SYMPHYS-XIV\)](#) (16 – 22 August 2010, Tsakhkadzor, Armenia).
7. E. A. Kolganova: Member of Organizing Committee, [Advanced Studies Institute on Symmetries and Spin](#) (18 – 24 July 2010, Prague, Czech Republic).
8. E. A. Kolganova: Member of Organizing Committee, [Round Table 2 Italy - Russia@Dubna on Space Physics, and Biology](#) (19 – 23 December 2010, Dubna, Russia).
9. E. A. Kolganova: Member of Organizing Committee, [6th International Workshop on Critical Point and Onset of Deconfinement](#) (23 – 29 August 2010, Dubna, Russia).
10. E. A. Kolganova: Member of Organizing Committee, [HIC for FAIR Workshop and School Dense QCD phases in Heavy-Ion Collisions](#) (21 August 4 September 2010, Dubna, Russia).
11. E. A. Kolganova: Co-chairman, [VIII Winter School on Theoretical Physics “From Nuclear Physics to Astrophysics and Cosmology”](#) (31 January - 7 February 2010, Dubna, Russia).

12. E. A. Kolganova: Member of Organizing Committee, [International Summer School on Modern Mathematical Physics](#) (5 – 15 September 2010, Dubna, Russia).
13. E. A. Kolganova: Support of the [BLTP Website](#).
14. A. V. Malykh: Scientific Secretary, [2nd South Africa - JINR Symposium “Models and Methods in Few- and Many-Body Systems”](#) (8 – 10 September 2010, Dubna, Russia).
15. A. V. Malykh: Scientific Secretary, [International Workshop “Bogoliubov Readings”](#) (22 – 25 September 2010, Dubna, Russia).
16. A. V. Malykh: Secretary of the [Sector 11 seminar](#).
17. V. S. Melezhik: Member of the D. Sc. Panel of LIT JINR.
18. V. S. Melezhik: Member of the Program Committee of the International Conference “Mathematical Modeling and Computational Physics 2011” (4 – 8 July 2011, High Tatra Mountains, Slovakia).
19. V. S. Melezhik: Member of the BLTP Expert commission.
20. A. K. Motovilov: Member of Editorial Board of the “[Few-Body Systems](#)” journal.
21. A. K. Motovilov: Member of the BLTP NTS.
22. V. V. Pupyshev: Secretary of the BLTP Commission for Ph.D. (C.Sc) examinations.