ISSN 0965-5425, Computational Mathematics and Mathematical Physics, 2010, Vol. 50, No. 1, pp. 1–6. © Pleiades Publishing, Ltd., 2010.
Original Russian Text © K.V. Brushlinskii, V.G. Zhukov, M.K. Kerimov, 2010, published in Zhurnal Vychislitel'noi Matematiki i Matematicheskoi Fiziki, 2010, Vol. 50, No. 1, pp. 3–9.

On the 80th Birthday of Academician Sergei Konstantinovich Godunov

K. V. Brushlinskii, V. G. Zhukov, and M. K. Kerimov

Dorodnicyn Computing Center, Russian Academy of Sciences, ul. Vavilova 40, Moscow, 119333 Russia

e-mail: comp_mat@ccas.ru

Received September 4, 2009

DOI: 10.1134/S096554251001001X

An outstanding Russian mathematician and dynamicist, Academician of the Russian Academy of Sciences (RAS) Sergei Konstantinovich Godunov has celebrated his 80th birthday. In the scientific community, Godunov is known as one of the founders of modern computational mathematics (Godunov-type difference schemes). In mechanics and mathematical physics, he is famous for his prominent works concerning fluid and gas dynamics and continuum mechanics. Among the mathematicians, Godunov is also known as a founder of new research techniques for computational algebra. While a second-year student at the Faculty of Mechanics and Mathematics of Moscow State University (MSU), Godunov made a serious contribution to the geometric number theory, extending B.N. Delaunay and H. Minkowski's results. Presented by Academician I.M. Vinogradov, this work was published in the prestigious academic journal *Doklady of the USSR Academy of Sciences* in 1948. At the age of 80, Godunov looks energetic and takes an active part in scientific and public activities. Though living and working in Novosibirsk, he frequently visits Moscow; the long distance between these cities is not an obstacle to his vigorous research activities. His

students and colleagues who continue to work at the Keldysh Institute of Applied Mathematics of the RAS after his move to Novosibirsk consider him a regular employee. He continues to keep in touch with this institute.

Godunov was born on July 17, 1929, into the family of Konstantin Dmitrievich Godunov, a Soviet stratonaut and designer of airships, who was famous for his height record flight on the USSR-1 stratosphere balloon of his own design in 1934. Possibly, under the influence of his father's occupation, Godunov attended the first Moscow school of Air Force and graduated in 1946. K.D. Godunov's family was also known for another mathematician, Elena Konstantinovna Godunova, who has an inequality named after her. As a school student, Godunov attended a math circle and participated in MSU olympiads, exhibiting keen interest in mathematics and remarkable mathematical aptitude. This was noticed by the school authority, so after leaving school, Godunov was encouraged to enroll at the MSU Faculty of Mechanics and Mathematics. At MSU, he rapidly progressed under the guidance of remarkable Soviet researchers and educators, such as Corresponding Member Delaunay and Academician I.G. Petrovskii. Starting in his second year, Godunov was engaged in serious research under Professors Delaunay and won Stalin scholarship.

In 1951, Godunov graduated with distinction from the MSU Faculty of Mechanics and Mathematics with a specialty in mathematics and started his postgraduate study at the Steklov Institute of Mathematics (MIAN). Simultaneously, he joined the MIAN Computational Bureau. In 1953, the Bureau became part of the new MIAN Department of Applied Mathematics created by Academician Keldysh. In 1966, the department was rearranged into the Institute of Applied Mathematics (IAM) of the USSR Academy of Sciences (AS), which was named after Academician Keldysh after his death in 1978. Until 1969 Godunov worked at IAM as a junior and, then, senior researcher and, from 1966, he headed the Department of Computational Gas Dynamics.

Along with several related organizations, such as the Computing Center of the USSR AS, the Institute of Fine Mechanics and Computer Technology, and Sobolev's Laboratory, the Institute of Applied Mathematics was created to address a new defense-related direction, namely, the mathematical simulation and computations associated with atomic projects and space missions. Research in this direction was led by outstanding mathematicians, Academicians Keldysh, A.N. Tikhonov, and I.M. Gelfand, who collected a team of young researchers and inspired a responsible creative research climate at IAM, which is still preserved in our difficult times. Prominent physicists, such as I.V. Kurchatov, Yu.B. Khariton, Ya.B. Zel'dovich, I.E. Tamm, A.D. Sakharov, and E.I. Zababakhin, regularly attended the IAM and took part in the formulation of problems and discussions of results. In that period, the work was primarily focused on numerical gasdynamic simulations. This at first glance simple formulation hid numerous problems, the overcoming of which led to the creation of modern computational mathematics and new chapters in continuum mechanics and in the theory of differential equations. In parallel, electronic computers were created. In 1954–1955 they took over computations, which were previously performed by a large team of staff armed with arithmometers and Mercedes desktop calculators. One of the first USSR computers (Strela) was installed at IAM. Another computer (BESM-1) was installed at the Institute of Fine Mechanics and Computer Technology of the USSR AS, which is now named after Academician S.A. Lebedev, a notable expert in computer creation. The latter machine was also available to users from IAM.

The central place in computational mathematics as applied to the numerical solution of differential equations is occupied by the theory of difference schemes, which means the development, analysis, and implementation of numerical methods for solving equations of mathematical physics. After the derivatives are approximated by difference relations, the differential equation transforms into a system of many algebraic equations.

Young university graduates, which constituted the core of the IAM research team, quickly became experienced specialists, commanding new scientific areas and directly participating in their creation. Starting from his first years at the institute, Godunov was among the first and best researchers due to his talent, deep knowledge of mathematics, practical skills, hard work, and passion for research.

His name soon became widely known in our country and abroad due to his celebrated difference scheme intended for computing discontinuous solutions of gas dynamics problems by the shock-capturing method. The ideas behind Godunov's scheme are the preservation of the monotonicity of base solution elements (which is implemented via solving Riemann problems at cell interfaces) and the conservativeness condition, which means that the difference analogues of conservation laws hold in each cell.

The scheme was developed at IAM, where a large amount of draft and trial computations was executed by N.M. Zueva and V.V. Paleichik. The development and implementation of this scheme was summarized in Godunov's candidate dissertation. It was defended at the Steklov Institute of Mathematics in 1954 and led to a thoughtful discussion with the participation of outstanding mathematicians Vinogradov, Petro-

vskii, Keldysh, M.A. Lavrent'ev, Sobolev, Gelfand on the requirements and standards for dissertations defended in the new fundamental discipline of computational mathematics. Godunov's scheme was not published until 1959. This publication is still referred to by many experts in difference schemes in our country and abroad. Godunov's current view of this subject and related issues were addressed in his talk "Reminiscences about Difference Schemes," which was published in Novosibirsk in 1997.

Later, other difference methods for computing discontinuous solutions were developed in the world. They can be somewhat simpler or more efficient and ensure a higher resolution of discontinuities. However, all of them are underlain by the same idea, namely, by the preservation of solution monotonicity. For this reason, they are naturally called Godunov-type difference schemes.

The necessity of industrial computations led to the creation of the new scientific discipline of computational mathematics. Its formation and spread were greatly influenced by Godunov and V.S. Ryaben'kii's monograph *The Theory of Difference Schemes: An Introduction*, which was published in 1962. For the first time in the Russian scientific literature, topical theoretical questions were combined with practical guidelines on difference methods as applied to the numerical solution of problems. A revised and extended edition of this book was issued in 1973 and 1977. This book resulted from hard work on the systematization of available numerical experience and its analysis, and it was preceded by a number of authors' theoretical publications concerning its concept. In the book, the foundations of the theory are illustrated by solving model problems with simple linear partial differential equations.

More complicated yet important problems concerning the computation of discontinuous solutions to quasilinear equations and problems with several spatial variables were summarized in the 1976 monograph *Numerical Solution of Multidimensional Gas Dynamic Problems*, which Godunov coauthored with A.V. Zabrodin, M.Ya. Ivanov, A.N. Kraiko, and G.P. Prokopov. In addition to traditional subjects of nuclear physics, the importance of two-dimensional problems was associated with the rapidly developing area of computational aerodynamics as applied to flying vehicles.

It is well known that applied and fundamental disciplines are closely related, interact with each other, and supplement each other. Accordingly, Godunov's applied and industrial works motivated his permanent deep interest in theoretical problems related to differential equations and continuum mechanics. In the late 1950s, he proved the uniqueness of solutions to the gas dynamics equations and constructed well-known counterexamples to Gelfand's too optimistic hypotheses concerning the possibility of simple uniqueness theorems for discontinuous solutions of quasilinear equations in the general case.

Later, Godunov stated and partially solved problems on the place of continuum mechanics equations in the theory of hyperbolic equations, on the generalization of the concept of entropy and the law of its growth, and on thermodynamic relations. These works were presented in his doctoral dissertation, which was defended at IAM in 1965. Together with later advances, these works were covered in his two monographs published in 1978 and 1998.

Godunov singled out and studied new aspects of computational linear algebra that are important in the solution of problems with a large number of unknowns. He constructed an example in which the eigenvalues of a non-self-adjoint matrix depend unexpectedly strongly on its elements. This example was used as a starting point for developing the concept of the ε-spectrum of a matrix and for determining the relation of the ε-spectrum to the stability of difference schemes, Lyapunov stability theory, and other areas of mathematics. The results of his long-time work in this field were presented in two monographs issued in 1997 and 2002.

Starting in early years, Godunov's research was accompanied by training activities at the MSU Faculty of Mechanics and Mathematics. He prepared and repeatedly taught an original course on partial differential equations, which was published as a textbook in 1971 and 1979.

The Moscow period of Godunov's life was finished in 1969, when he was invited by Academician Lavrent'ev to move to Novosibirsk and work for the Siberian Branch of the Academy of Sciences. Nevertheless, he has maintained scientific and friendly contacts with his former colleagues at IAM, which resulted in new joint publications. Godunov also keeps in touch with the MSU Faculty of Mechanics and Mathematics, where he was brilliantly educated as a student.

In Novosibirsk, Godunov worked as a laboratory head at the Computing Center (now the Institute of Computational Mathematics and Mathematical Geophysics of the RAS Siberian Branch. Since 1980, he has been working at the Institute of Mathematics (now named after Sobolev) of the RAS Siberian Branch, holding the positions of department head, deputy director, acting director (1981–1986), and nowadays adviser of the RAS. He also continues his training activities, holding a part-time position of professor at Novosibirsk State University (NGU). Since 1977, he has headed the Department of Differential Equations.

At NGU, Godunov gave lectures on continuum mechanics, equations of mathematical physics, approximation techniques, differential equations, numerical methods of linear algebra, and modern aspects of linear algebra. He also taught courses on the theory of hyperbolic systems and nonlinear elasticity equations.

Godunov trained numerous students who have become notable scientists and work in numerous research centers in Russian and abroad. He continues vigorous research, involving colleagues and new students in his work. His seminar "Mathematics in Applications" held at the Sobolev Institute of Mathematics has been widely known for a long time among the experts in various fundamental and applied disciplines in Russia and abroad.

In our age of narrow specialization, Academician Godunov is a vivid example of a scholar who is equally successful in the creation of scientific theories and in their applications. He has made major contributions to the theory of continued fractions, differential equations, difference schemes, linear algebra, gas dynamics, and continuum mechanics and the list goes on. A distinctive feature of Godunov's works is their incredible depth. They played a key role in the formation and evolution of applied branches, such as the well-posedness theory of boundary value problems for differential equations, continuum mechanics, difference schemes, numerical methods of linear algebra, algorithms for gasdynamic simulations and metal viscoelastic strain computation, and guaranteed accuracy of computer calculations.

For the accomplishments of Government's special tasks and the solution of important problems concerning new defensive technology, Godunov was awarded the Lenin Prize (1959) and received the Order of Red Banner of Labor (1956, 1957), the Order of the Honor Badge (1954, 1981), the commemorative Medal for Labor Valor in commemoration of the 100th birthday of V.I. Lenin (1970), and the Medal for Veteran of Labor (1996). For his works concerning the study of effects accompanying explosion welding, Godunov was awarded the A.N. Krylov Prize of the USSR Academy of Sciences (1972). For his book *Elements of Continuum Mechanics*, he received the M.A. Lavrent'ev Prize of the RAS (1993).

In 1966, Godunov was awarded the degree of doctor of physics and mathematics for his research works. In 1976, he became Corresponding Member of the USSR Academy of Sciences in the Department of Mathematics. In 1994, he was elected Academician of the Russian Academy of Sciences. Godunov is a honored doctor of the University of Michigan, USA (1997). He received the Medal "For Merits for Novosibirsk Oblast" (2004) and the Prize of the Academician Lavrent'ev Foundation for his outstanding contribution to fundamental mathematics and applications (2005). The worldwide recognition of Godunov's outstanding merits was manifested by two international conferences devoted to his methods. One conference was held in the United States under the name *Godunov's Method for Dynamics: Current Applications and Future Developments* (Ann-Arbor, May 1–3, 1997). The other was held in the UK under the title *Godunov's Methods: Theory and Applications* (Oxford, October 12–22, 1999). An international conference dedicated to Godunov's 80th birthday was recently held in Novosibirsk.

Godunov is the author of more than 300 scientific works, including 16 monographs.

For many years, Godunov has been an active editorial board member of this journal, which published numerous works concerning Godunov-type difference schemes and other results associated with his name. Despite the long distance from the editorial board, Godunov diligently carries out his duties as an editorial board member. Due to his work as a benevolent expert, many young authors were encouraged on their way to big science. For many years, the first two authors of this article have been involved in joint scientific work with Godunov, while the third author visited, together with him, lectures of outstanding mathematicians at MSU. He remembers Godunov as the youngest student and now works together with him preparing current issues of a well-known journal on computational mathematics. All of this paper's authors, the editorial board, and the staff members warmly congratulate Godunov on the 80th anniversary of his birthday and wish him many happy years of creative work and good health.

The comlete list of Godunov's work can be found in the book *Sergei Konstantinovich Godunov*: *Bibliographic Index* (Inst. Mat. Sib. Otd. Ross. Akad. Nauk, Novosibirsk, 2009).

Below is a list of Godunov's basic publications.

BOOKS AND MONOGRAPHS

1. *The Theory of Difference Schemes: An Introduction* (Fizmatlit, Moscow, 1962; North-Holland, Amsterdam, 1964) (with V.S. Ryaben'kii).
2. *Equations of Mathematical Physics* (Nauka, Moscow, 1971) [in Russian].
3. *Numerical Solution of Multidimensional Gas Dynamic Problems* (Nauka, Moscow, 1976) (with A. V. Zabrodin, M. Ya. Ivanov, A. N. Kraiko, and G. P. Prokopov) [in Russian].
4. *Elements of Continuum Mechanics* (Nauka, Moscow, 1978) [in Russian].

5. *Guaranteed Accuracy of Solutions to Systems of Linear Equations* (Nauka, Novosibirsk, 1992) (with A. G. Antonov, O. P. Kirilyuk, and V. I. Kostin) [in Russian].
6. *Guaranteed Accuracy in Numerical Linear Algebra* (Kluwer, Dordrecht, 1993) (with A. Antonov, O. Kirilyuk, and V. Kostin).
7. *Ordinary Differential Equations with Constant Coefficients*, Vol. 1: *Boundary Value Problems* (Novosibirsk. Gos. Univ., Novosibirsk, 1994) [in Russian].
8. *Modern Aspects of Linear Algebra* (Nauchnaya Kniga, Novosibirsk, 1997) [in Russian].
9. *Modern Aspects of Linear Algebra* (Am. Math. Soc., Providence, 1997) (Transl. Math. Monogr., Vol. 175).
10. *Ordinary Differential Equations with Constant Coefficients* (Am. Math. Soc., Providence, 1997) (Trans. Math. Monogr., Vol. 169).
11. *Lectures on Modern Aspects of Linear Algebra* (Nauchnaya Kniga, Novosibirsk, 2002) [in Russian].
12. *Elements of Continuum Mechanics and Conservation Laws* (Kluwer Academic/Plenum, 2003) (with E. Romenskii).

ARTICLES

1. "On the Minkowski Problem," Dokl. Akad. Nauk SSSR **59**, 1525–1528 (1945).
2. "On the Uniqueness of Solutions to Fluid Dynamic Equations," Mat. Sb. Nov. Ser. **40**, 467–478 (1956).
3. "Difference Method for Shock Wave Computation," Usp. Mat. Nauk **12** (1), 176–177 (1957).
4. "Difference Schemes for Multidimensional Problems," Dokl. Akad. Nauk SSSR **115**, 431–433 (1957) (with K. A. Bagrinovskii).
5. "Difference Method for the Numerical Computation of Discontinuous Solutions of Fluid Dynamics Equations," Mat. Sb. **47**, 276–306 (1959).
6. "Thermodynamics of Gases and Differential Equations," Usp. Mat. Nauk **14** (5), 171–174 (1959).
7. "On the Concept of Weak Solution," Dokl. Akad. Nauk SSSR **134**, 1279–1282 (1960).
8. "On the Nonuniqueness of "Smearing" Discontinuities in Solutions of Quasilinear Systems," Dokl. Akad. Nauk SSSR **136**, 272–273 (1961).
9. "On the Numerical Solution of Boundary Value Problems for Systems of Linear Ordinary Differential Equations," Usp. Mat. Nauk **16** (3), 171–174 (1961).
10. "Example of Nonuniqueness for a Nonlinear Parabolic System," Dokl. Akad. Nauk SSSR **136**, 1281–1282 (1961).
11. "On Nonuniqueness for Parabolic Systems," Dokl. Akad. Nauk SSSR **145**, 498–500 (1962).
12. "Problem of Weak Solutions in the Theory of Quasilinear Equations and Gas Dynamics," Usp. Mat. Nauk **17** (3), 47–158 (1962).
13. "Spectral Stability Criteria for Boundary Value Problems for Non-Self-Adjoint Difference Equations," Usp. Mat. Nauk **18** (3), 3–14 (1963) (with V. S. Ryaben'kii).
14. "Variational Approach to the Solution of Large Systems of Linear Equations Arising in Strongly Elliptic Systems" (Inst. Prikl. Mat. Akad. Nauk SSSR, Moscow, 1968) (with G. P. Prokopov).
15. "Vladimirov Functional Expressed in Terms of Spherical Harmonics in Tensor Form (P_3-Approximation), Zh. Vychisl. Mat. Mat. Fiz. **8**, 824–841 (1968) (with I. A. Adamskaya and G. P. Prokopov).
16. "On the Convergence of Simulated Method of Steepest Descent in Eigenvalue Computation," *Partial Differential Equations: Proceedings of Symposium Dedicated to the 60th Birthday of Academician S.L. Sobolev* (Nauka, Moscow, 1970), pp. 77–80 (with V. V. Ogneva and G. P. Prokopov).
17. "On Discrete Models of the Boltzmann Kinetic Equation," Usp. Mat. Nauk **26** (3), 3–51 (1971) (with U. M. Sultangazin).
18. "On the Dissipativeness of Vladimirov's Boundary Conditions for Symmetric System of the Spherical Harmonics Method," Zh. Vychisl. Mat. Mat. Fiz. **11**, 688–704 (1971) (with U. M. Sultangazin).
19. "Energy Integral as Applied to the Error Estimation of Approximate Eigenvalues," Zh. Vychisl. Mat. Mat. Fiz. **11**, 1322–1326 (1971).
20. "The Use of Moving Grids in Gasdynamic Computation," Zh. Vychisl. Mat. Mat. Fiz. **12**, 429–440 (1972) (with G. P. Prokopov).
21. "The Use of a Class of Quasiconformal Mappings for Grid Generation in Domains with Curved Boundaries," Zh. Vychisl. Mat. Mat. Fiz. **15**, 1499–1511 (1975) (with P. P. Belinskii, Yu. B. Ivanova, and I. K. Yanenko).
22. "Reduction of a Hyperbolic Equation to a Symmetric Hyperbolic System in the Case of Two Spatial Variables," Sib. Mat. Zh. **21** (6), 3–20 (1980) (with V. I. Kostin).
23. "Green's Matrix of a Boundary Value Problem for Ordinary Differential Equations," Usp. Mat. Nauk **39** (1), 39–76 (1984) (with V. M. Gordienko).
24. "Computation of Positive Definite Solutions of the Lyapunov Equation," Tr. Inst. Mat. Sib. Otd. Akad. Nauk SSSR **6**, 17–38 (1985) (with A. Ya. Bulgakov).

25. “Taking into Account the Computational Errors in a Variant of the Conjugate Gradient Method,” Tr. Inst. Mat. Sib. Otd. Akad. Nauk SSSR **6**, 38–55 (1985) (with A. Ya. Bulgakov).

26. “Computation of an Eigenvector of a Symmetric Tridiagonal Matrix,” Sib. Mat. Zh. **26** (5), 71–85 (1985) (with V. I. Kostin and A. D. Minchenko).

27. “The Problem of Dichotomy of a Matrix Spectrum,” Sib. Mat. Zh. **27** (5), 24–37 (1986).

28. “Circular Dichotomy of a Matrix Spectrum,” Sib. Mat. Zh. **29** (5), 59–70 (1988) (with A. Ya. Bulgakov).

29. “Singular Values of the Boundary Value Problem on a Half-Line for a Linear System of Ordinary Differential Equations,” Sib. Mat. Zh. **30** (4), 5–12 (1989) (with V. M. Gordienko).

30. “Criteria for Convergence of Orthogonal Power Methods in Spectral Analysis of Matrices,” Tr. Inst. Mat. Sib. Otd. Akad. Nauk SSSR **15**, 4–12 (1989).

31. “Stability of Iterates of Symplectic Transformations,” Sib. Mat. Zh. **30** (1), 70–81 (1989).

32. “Grid Generation in Complex Domains with the Help of Quasiconformal Mappings,” Tr. Inst. Mat. Sib. Otd. Akad. Nauk SSSR **18**, 75–83 (1990) (with E. I. Romenskii and G. A. Chumakov).

33. “Norms of Solutions to Matrix Lourie–Riccati Equations as Performance Criteria for Stabilizability and Detectability,” Tr. Inst. Mat. Sib. Otd. Ross. Akad. Nauk **22**, 3–22 (1992).

34. “An Estimate for Green’s Matrix of a Hamiltonian System in the Optimal Control Problem,” Sib. Mat. Zh. **34** (4), 70–80 (1993).

35. “Hausdorff Sets of Matrices and an Estimate for the Angle between Invariant Subspaces,” Sib. Mat. Zh. **36**, 531–533 (1995) (with V. M. Gordienko).

36. “Spectrum Dichotomy and a Stability Criterion for Sectorial Operators,” Sib. Mat. Zh. **36**, 1328–1335 (1995).

37. “Systems of Thermodynamically Consistent Laws of Conservation Invariant under Rotations,” Sib. Mat. Zh. **37**, 790–806 (1996) (with T. Yu. Mikhailova and E. I. Romanenko).

38. “Bounds for the Principal and Stiff Components Based on the Integral Performance Criterion for Dichotomy,” Zh. Vychisl. Mat. Mat. Fiz. **40**, 35–42 (2000) [Comput. Math. Math. Phys. **40**, 32–39 (2000)] (with Yu. M. Nechepurenko).

39. “On the Annular Separation of a Matrix Spectrum,” Zh. Vychisl. Mat. Mat. Fiz. **40**, 980–985 (2000) (with Yu. M. Nechepurenko) [Comput. Math. Math. Phys. **40**, 939–944 (2000)].

40. “Numerical Determination of a Canonical Form of a Symplectic Matrix,” Sib. Mat. Zh. **42**, 749–770 (2001) (with M. Sadkane).

41. “Bounds for the Convergence Rate of Newton’s Method for Calculating Invariant Subspaces,” Zh. Vychisl. Mat. Mat. Fiz. **42**, 771–779 (2002) [Comput. Math. Math. Phys. **42**, 427–441 (2002)] (with Yu. M. Nechepurenko).

42. “On the Ideas Underlying Grid Generation Methods,” Zh. Vychisl. Mat. Mat. Fiz. **43**, 787–789 (2003) [Comput. Math. Math. Phys. **43**, 751–753 (2003)].

43. “The Clebsch–Gordan Coefficients with Respect to Various Bases for Unitary and Orthogonal Representations of SU(2) and SO(3),” Sib. Mat. Zh. **45**, 540–557 (2004) (with V. M. Gordienko).

44. “A Method for Calculating Invariant Subspaces of Symmetric Hyperbolic Equations,” Zh. Vychisl. Mat. Mat. Fiz. **46**, 1019–1031 (2006) [Comput. Math. Math. Phys. **46**, 971–982 (2006)] (with V. T. Zhukov and O. B. Feodoritova).

45. “On the Difference Approximations of Overdetermined Hyperbolic Equations of Classical Mathematical Physics,” Zh. Vychisl. Mat. Mat. Fiz. **47**, 445–459 (2007) [Comput. Math. Math. Phys. **47**, 427–441 (2007)] (with D. P. Babii, V. T. Zhukov, and O. B. Feodoritova).

46. “Symmetrization of the Nonlinear System of Gas Dynamics Equations,” Sib. Mat. Zh. **49**, 1046–1053 (2008) (with I. M. Peshkov).

47. “Symmetric Equations in the Nonlinear Elasticity Theory,” Zh. Vychisl. Mat. Mat. Fiz. **48**, 1034–1055 (2008) [Comput. Math. Math. Phys. **48**, 975–995 (2008)] (with I. M. Peshkov).

48. “On a Special Basis of Approximate Eigenvectors with Local Supports for an Isolated Narrow Cluster of Eigenvalues of a Symmetric Tridiagonal Matrix,” Zh. Vychisl. Mat. Mat. Fiz. **48**, 1156–1166 (2008) [Comput. Math. Math. Phys. **48**, 1089–1099 (2008)] (with A. N. Malyshev).