Russian Math. Surveys **58**:6 1245–1253 ©2003 RAS(DoM) and LMS
Uspekhi Mat. Nauk **58**:6 193–200 DOI 10.1070/RM2003v058n06ABEH000695

Arkadii L'vovich Onishchik (on his 70th birthday)

In November 2003 Professor Arkadii L'vovich Onishchik of Yaroslavl State University turned 70.

Onishchik was born in Moscow on 14 November 1933. In 1951 he entered the mechanics and mathematics department of Moscow State University. He was one of the leaders of his class, took an active part in department activities, led mathematical workshops for school students, and organized mathematical olympiads. His scientific advisor was E. B. Dynkin, the author of classical works on Lie group theory. Onishchik obtained his first results when he was still an undergraduate. Some of them were included in a long joint paper with Dynkin on the global structure of compact Lie groups, published in *Uspekhi Matematicheskikh Nauk* in 1955.

In 1956 Onishchik graduated from the university and entered graduate school, specializing in higher algebra. After finishing the graduate school program, he remained in the higher algebra section, at that time chaired by A. G. Kurosh.

In 1960 Onishchik defended his PhD thesis "On transitive Lie transformation groups", and in 1970 his DSc thesis "Compact homogeneous spaces and decompositions of Lie groups". In 1975 he became a professor at Yaroslavl University.

His first studies were investigations of the cohomology of loop spaces on topological spaces using the method of spectral sequences. He considered an important special case in which the cohomology algebra of the loop space $\Omega(X)$ can be determined from the cohomology algebra of the space X itself. Namely, suppose that $H^*(X)$ is a free anticommutative algebra of finite type, and let y_i, $i = 1, 2, \dots$, be its free generators. Then the theorem proved by Onishchik states that the algebra $H^*(\Omega(X))$ has a free system of generators x_i of degree $\deg(x_i) = \deg(y_i) - 1$. More precisely, the x_i form a basis of the space of transgressive elements in the cohomological spectral sequence of the fibre bundle of the path space over X, and x_i corresponds to y_i under the transgression. This result was preceded by a joint paper with F. I. Karpelevich, where it was assumed that all the y_i have odd degree, that is, $H^*(X)$ is an exterior algebra.

As an application, Onishchik computed the algebra $H^*(\Omega(M))$, where $M = G/U$ is a simply connected homogeneous space of a semisimple compact Lie group G. In particular, he proved that if the algebra $H^*(M)$ is a tensor product of algebras with one generator, then the algebra $H^*(\Omega(M))$ can be computed directly from

$H^*(M)$. This implies that if the algebra $H^*(M)$ is given, then either of the two algebras $H^*(G)$ and $H^*(U)$ can be found from the other. These results, published in 1958, marked the beginning of many years of research, which was summed up in his book *Topology of transitive transformation groups* (1995). We will return to the topology of homogeneous spaces a little later, but now we present a fundamental result, important for both complex analysis and the theory of algebraic groups of transformations, which Onishchik published in *Doklady Akad. Nauk SSSR* in 1960.

By that time, the methods of sheaf theory had made their way into the theory of functions of several complex variables, leading to an understanding of the role of Stein manifolds in complex analysis. Originally introduced by K. Stein as certain generalizations of domains of holomorphy, these manifolds turned out to form a natural class for which the theorems A and B proved in H. Cartan's seminar of 1951–1952 hold true. Due to the significance of the concept itself, the problem of describing Stein manifolds that are homogeneous with respect to the transitive Lie group of holomorphic transformations becomes especially important. This problem has not yet been fully solved even for complex Lie groups of transformations.

Onishchik's paper talks about Stein manifolds that are homogeneous with respect to reductive complex algebraic groups. Let $M = G/H$ be a complex homogeneous space of such a group G. Onishchik proved that (a) M is a Stein manifold if and only if the subgroup H is algebraic and reductive; (b) under this condition M has a structure of an affine complex algebraic manifold. At about the same time this theorem was independently proved by Y. Matsushima. As a byproduct, Onishchik obtained the following important result: if K is a compact group of linear transformations of a real vector space V, then the complexification G of the group K acts transitively on the complexification of the orbit of any point $v \in V$, and moreover, the stationary subgroup of v in G coincides with the complexification of its stationary subgroup in the group K. This result was later re-proved by A. Borel and Harish-Chandra and other authors.

Returning now to the topology of transitive groups of transformations, we consider first the problem of finding all decompositions of the form $G = G' \cdot G''$, where G is a connected compact Lie group and G' and G'' are connected compact subgroups of it. This problem is equivalent to the problem of finding closed connected subgroups of G that are transitive on homogeneous spaces of this group. The problem was completely solved by Onishchik in 1962. The following decompositions hold, some of which were known earlier:

$$SU_{2n} = Sp_n \cdot SU_{2n-1}\ (n \geq 2); \quad SO_7 = G_2 \cdot SO_6; \quad SO_7 = G_2 \cdot SO_5;$$
$$SO_{2n} = SO_{2n-1} \cdot SU_n\ (n \geq 4); \quad SO_{4n} = SO_{4n-1} \cdot Sp_n\ (n \geq 2);$$
$$SO_{16} = SO_{15} \cdot Spin_9; \quad SO_8 = SO_7 \cdot Spin_7.$$

The definitive answer is that, up to a local isomorphism and a rearrangement of factors, any non-trivial decomposition can be obtained from one of the above decompositions by a normal extension of the group G''. It is remarkable that this algebraic result was proved by investigating the topological properties of the decompositions. No one has yet found a purely algebraic proof.

The theorem on decompositions of compact Lie groups has a variety of applications. In particular, Onishchik has used it to find the automorphism groups of flag manifolds of simple complex Lie groups. He also applied the theorem to the computation of the isometry group of a Riemannian homogeneous space of a simple compact Lie group.

In the decomposition problem the Lie group is given, but its homogeneous space is not fixed. Conversely, one can ask which Lie groups act transitively on a given homogeneous space $M = G/H$. In the case where G and H are connected compact Lie groups, much progress has been made in the problem, and the most complete results are due to Onishchik. Its solution for homogeneous spaces requires the introduction of invariants that can be effectively computed from the given pair (G, H) but in fact depend only on M. Onishchik introduced an integer-valued invariant which he called the rank of a homogeneous space. Denote by P_G the space of primitive real cohomology classes of the group G. Then under the map $i^*\colon H^*(G,\mathbb{R}) \to H^*(H,\mathbb{R})$ induced by the embedding $i\colon H \hookrightarrow G$, we have $i^*(P_G) \subset P_H$. By definition, the rank $r(M)$ of the homogeneous space $M = G/H$ is equal to the dimension of the kernel of the map $i^*|_{P_G}$. We note that $r(G)$ is the rank of the group G in the usual sense, and $r(M) > 0$ if M has positive dimension. Onishchik obtained the formulae

$$r(M) = \sum_{k=0}^{\infty} \operatorname{rk} \pi_{2k+1}(M), \qquad h(M) := r(G) - r(H) = \sum_{k=0}^{\infty} (-1)^k \operatorname{rk} \pi_{k+1}(M),$$

which show that $h(M) \le r(M)$ and that both invariants depend only on M.

Onishchik found all simply connected compact homogeneous spaces of rank 1 and 2. His list of manifolds of rank 1 contains all spheres, complex and quaternion projective spaces, the octave (Cayley) projective plane, and a number of other manifolds. For each manifold he described all transitive actions of connected compact Lie groups. The results by D. Montgomery, H. Samelson, and A. Borel on transitive groups on spheres are contained in this theory as special cases. Another consequence of the theory is that two simply connected compact homogeneous spaces of rank 1 are homotopy equivalent if and only if they are diffeomorphic (this is not true for spaces of rank 2).

Suppose now that for some simply connected compact homogeneous space M we have a classification of connected compact transitive Lie transformation groups, and consider the question of carrying this classification over to non-compact groups. The problem in this generality was first stated, and largely solved, by Onishchik. To begin with, he proved the following theorem (the real analogue of J. Tits's theorem): if G is a connected Lie group, and $H \subset G$ is a closed subgroup such that the manifold $M = G/H$ is compact, then the normalizer $N(H^\circ)$ of the connected component H° of the identity of H contains a maximal connected triangular subgroup of G. From this theorem it follows that the commutator subgroup of the radical R of G is commutative. Moreover, if the manifold M is simply connected and $r(M) = 1$, then the radical itself is commutative. There are two possible cases: (i) $h(M) = 1$ and the dimension of R may be arbitrarily large (say, for an odd-dimensional sphere); (ii) $h(M) = 0$ and $R = \{e\}$, that is, G is semisimple (say, for an even-dimensional sphere). Using these results, Onishchik found all the connected semisimple Lie groups that act transitively on simply connected compact homogeneous spaces of rank 1, and established which of them can be extended to non-semisimple transformation groups. We present his list of non-compact simple Lie groups that act transitively on spheres S^n, $n \geq 2$. Up to a local isomorphism, they are

$$SO^\circ_{1,n+1},\ SU_{1,m}\ (n = 2m-1),\ Sp_{1,m}\ (n = 4m-1),\ FII\ (n = 15),\ SL_{n+1}(\mathbb{R}),$$
$$SL_m(\mathbb{C})\ (n = 2m-1),\quad Sp_{2m}(\mathbb{R})\ (n = 2m-1),\quad Sp_{2m}(\mathbb{C})\ (n = 4m-1),$$
$$SL_m(\mathbb{H})\ (n = 4m-1),\ \text{and the universal covering of the group } SL_3(\mathbb{R})\ (n = 3).$$

A description of all transitive groups on simply connected compact homogeneous spaces of rank greater than 1 is known only in isolated cases so far. For example, Onishchik made a list of connected transitive Lie transformation groups for real, complex, and quaternion Grassmann and Stiefel manifolds. These results have provided a basis for numerous investigations by other authors in geometry, topology, and algebra.

Onishchik has returned several times to the problem of decompositions of a Lie group into a product of two subgroups, a problem he solved for compact groups. In particular, he described all decompositions of connected reductive Lie groups into a product of two connected reductive subgroups. It turned out that this problem is equivalent to the problem of describing local decompositions. In other words, if G is a reductive group, F and H are reductive subgroups of it, and the orbit of F in G/H is open, then this orbit coincides with G/H. This result, later generalized by other authors, is of principal importance for the theory of algebraic transformation groups.

Onishchik was among the first mathematicians who began to apply the methods of non-Abelian cohomology theory to specific geometric problems. In particular, he generalized de Rham's theorem (for 1-forms) that there exist closed differential forms with given periods and that they are cohomologous. In this generalization the role of forms is played by zero-curvature connections in a given fibre bundle, and the role of periods by their holonomy groups.

Important finiteness theorems in the theory of invariants of compact Lie transformation groups are also due to Onishchik. Namely, let G be a compact Lie group acting on a compact manifold M, and E a vector G-bundle over M (all objects are of class C^∞). Denote by $C^\infty(M)_G$ and $C^\infty(M)^G$, respectively, the algebras of smooth spherical and invariant functions on M. Onishchik proved that the module of smooth invariant sections of E over the algebra $C^\infty(M)^G$ has finite type. He also proved that the algebra $C^\infty(M)_G$ admits a finite system of generators over $C^\infty(M)^G$.

A number of fairly recent papers by Onishchik are devoted to the theory of supermanifolds. In particular, he proved a theorem on rigidity of certain super-Grassmannians, proposed a new construction of non-split supermanifolds, and found conditions under which an analytic action of a Lie group lifts to a non-split supermanifold from its retract. In a joint paper with O. V. Platonova, he classified homogeneous and evenly homogeneous supermanifolds whose reduction is a projective space.

Onishchik began his pedagogical activity more than 40 years ago in the mechanics and mathematics department of Moscow University. At that time he and È. B. Vinberg organized a seminar on Lie groups which became a successor of

Dynkin's seminar. Over the subsequent years he has always been one of the leaders of this seminar, even after he moved to Yaroslavl University. Notes from the seminar of 1967/68 formed the basis for a book by Vinberg and Onishchik, *Seminar on Lie groups and algebraic groups* (1988), which became an invaluable source for graduate students and experts in this area.

Onishchik is a founder of the group-theoretic methods laboratory at Yaroslavl University. Since the very beginning of his work there he has regularly edited and published the collections of research papers *Geometricheskie metody v zadachakh analiza i algebry* (*Geometric methods in problems of analysis and algebra*) and *Voprosy teorii grupp i gomologicheskoi algebry* (*Problems in group theory and homological algebra*), which have become widely known due to the high level of the papers. These collections have received international recognition: many papers contained in them have been translated into English. Also, Onishchik is a member of the editorial boards of the journals *Annals of Global Analysis and Geometry* and *Transformation Groups*. As an editor he is distinguished by his high standards regarding the mathematical articles as well as by his considerate and tactful attitude towards their authors.

The high level of mathematics in the USSR would hardly have been possible without timely and high-quality translations of international mathematics literature into the Russian language. Onishchik regarded translation of books as a cultural mission, and not just as a secondary part-time job. Without doubt, the readers of the Russian editions of the books *Complex manifolds* by Chern and *Differential geometry and symmetric spaces* by Helgason and other books and papers translated by Onishchik greatly appreciated his mastery as a translator. For several years Onishchik was the librarian of the Moscow Mathematical Society, to the great advantage of readers.

Characteristic of Arkadii L'vovich are his professionalism, high culture, and broad interests, as well as good will, sympathy, and a wonderful sense of humour. These qualities have always attracted young people to him. During his years at Moscow and Yaroslavl Universities he has nurtured several generations of students, many of whom continue active research in mathematics and its applications or teach mathematics. They are ever grateful to their professor, who not only taught them mathematics but also showed them, by his own example, modestly and without many words, how to respect others.

We wish Arkadii L'vovich good health, new interesting mathematical results, and many years of life, as meaningful and fruitful as the part he has left behind.

D. N. Akhiezer, *È. B. Vinberg*, *V. V. Gorbatsevich*, *V. G. Durnev*,
R. Sulanke, *L. S. Kazarin*, *D. Leites*, *V. Serganova*, *V. M. Tikhomirov*

List of publications of A. L. Onishchik

[1] "On the orientability of analytic homogeneous manifolds", *Uspekhi Mat. Nauk* (N.S.) **8** (1953), 121–130. (Russian)

[2] "Compact global Lie groups", *Uspekhi Mat. Nauk* (N.S.) **10** (1955), 3–74; English transl., *Amer. Math. Soc. Transl.* (2) **21** (1962), 119–192 (with E. B. Dynkin).

[3] "Homology algebra of a space of paths", *Dokl. Akad. Nauk SSSR* **106** (1956), 967–969 (with F. I. Karpelevich). (Russian)

[4] "Spaces of paths and fibre bundles", *Dokl. Akad. Nauk SSSR* **110** (1956), 932–935. (Russian)

[5] "On the cohomology of spaces of paths", *Mat. Sb.* (N.S.) **44** (1958), 3–52; English transl., *Amer. Math. Soc. Transl.* (2) **25** (1963), 283–334.

[6] "Transitive groups of transformations of compact homogeneous spaces", *Dokl. Akad. Nauk SSSR* **124** (1959), 520–523. (Russian)

[7] "Inclusions between transitive compact transformation groups", *Dokl. Akad. Nauk SSSR* **129** (1959), 261–264. (Russian)

[8] "Complex hulls of compact homogeneous spaces", *Dokl. Akad. Nauk SSSR* **130** (1960), 726–729; English transl., *Soviet Math. Dokl.* **1** (1960), 88–91.

[9] "Transitive Lie transformation groups", PhD Thesis, Moskov. Gos. Univ., Moscow 1960. (Russian)

[10] "Compact Lie groups transitive on certain manifolds", *Dokl. Akad. Nauk SSSR* **135** (1960), 531–534; English transl., *Soviet Math. Dokl.* **1** (1960), 1288–1291.

[11] "Torsion of the special Lie groups", *Mat. Sb.* (N.S.) **51** (1960), 273–276; English transl., *Amer. Math. Soc. Transl.* (2) **50** (1966), 1–4.

[12] "Classification of fiber bundles", *Dokl. Akad. Nauk SSSR* **141** (1961), 803–806; English transl., *Soviet Math. Dokl.* **2** (1961), 1561–1564.

[13] "Inclusion relations between transitive compact transformation groups", *Trudy Moskov. Mat. Obshch.* **11** (1962), 199–242; English transl., *Amer. Math. Soc. Transl.* (2) **50** (1966), 5–58.

[14] "Semisimple decompositions of semisimple Lie algebras", *Dokl. Akad. Nauk SSSR* **149** (1963), 1033–1036; English transl., *Soviet Math. Dokl.* **4** (1963), 519–522.

[15] "Transitive compact transformation groups", *Mat. Sb.* (N.S.) **60** (1963), 447–485; English transl., *Amer. Math. Soc. Transl.* (2) **55** (1966), 153–194.

[16] "Connections with zero curvature and de Rham's theorem", *Dokl. Akad. Nauk SSSR* **159** (1964), 988–991; English transl., *Soviet Math. Dokl.* **5** (1964), 1654–1657.

[17] "Deformations of fibre bundles", *Dokl. Akad. Nauk SSSR* **161** (1965), 45–47; English transl., *Soviet Math. Dokl.* **6** (1965), 369–371.

[18] "Deformations of holomorphic fibre bundles", Contemporary Problems in the Theory of Analytic Functions, Nauka, Moscow 1966, pp. 236–239. (Russian)

[19] "Lie groups that are transitive on compact manifolds", *Mat. Sb.* (N.S.) **71** (1966), 483–494; English transl., *Amer. Math. Soc. Transl.* (2) **73** (1968), 59–72.

[20] "Lie groups that are transitive on compact manifolds. II", *Mat. Sb.* (N.S.) **74** (1967), 398–416; English transl., *Math. USSR Sb.* **3** (1967), 373–388.

[21] "Some concepts and applications of non-Abelian cohomology theory", *Trudy Moskov. Mat. Obshch.* **17** (1967), 45–88; English transl., *Trans. Moscow Math. Soc.* **17** (1967), 49–98.

[22] "Lie groups that are transitive on compact manifolds. III", *Mat. Sb.* (N.S.) **75** (1968), 255–263; English transl., *Math. USSR Sb.* **4** (1968), 233–240.

[23] "Homogeneous vector bundles", *Uspekhi Mat. Nauk* **24**:3 (1969), 231–232. (Russian)

[24] *Seminar on algebraic groups and Lie groups*, 1967/68, Izdat. Moskov. Univ., Moscow 1969 (with È. B. Vinberg). (Russian)

[25] "Decomposition of reductive Lie groups", *Mat. Sb.* (N.S.) **80** (1969), 553–599; English transl., *Math. USSR Sb.* **9** (1969), 515–554.

[26] "Lie groups that are transitive on Grassmann and Stiefel manifolds", *Mat. Sb.* (N.S.) **83** (1970), 407–428; English transl., *Math. USSR Sb.* **12** (1970), 405–427.

[27] "Compact homogeneous spaces and decompositions of Lie groups", DSc Thesis, Izdat. Moskov. Univ., Moscow 1970. (Russian)

[28] "Completely integrable equations on homogeneous spaces", *Mat. Zametki* **9** (1971), 365–373; English transl., *Math. Notes* **9** (1971), 211–215.

[29] "Meromorphic functions and complex line bundles on compact complex manifolds", Proc. 8th Math. Summer School, Kiev 1971, pp. 78–101. (Russian)

[30] "Certain topological invariants of homogeneous spaces", *Mat. Zametki* **12** (1972), 761–768; English transl., *Math. Notes* **12** (1972), 893–896.

[31] "Stein spaces", Algebra. Topology. Geometry (Itogi Nauki i Tekhniki), vol. 11, Akad. Nauk SSSR, Moscow 1974, pp. 125–151; English transl., *J. Soviet Math.* **4** (1975), 540–554.

[32] "Semidirect sums of Lie algebras", *Mat. Zametki* **18** (1975), 31-40; English transl., *Math. Notes* **18** (1975), 600–604 (with Yu. B. Khakimdzhanov).

[33] "Invariants and almost invariants of compact transformation groups", *Trudy Moskov. Mat. Obshch.* **35** (1976), 235–264; English transl., *Trans. Moscow Math. Soc.* **1979**, no. 1, 237–267.

[34] "Extensions of transitive transformation groups", *Izv. Vyssh. Uchebn. Zaved. Mat.* **1977**, no. 3, 53–65; correction: ibid. **1981**, no. 7, 88; English transl., *Soviet Math.* (Iz. VUZ) **21**:3 (1977), 42–51.

[35] "Transitive actions on Borel manifolds", Problems of Group Theory and Homological Algebra, Yaroslav. Gos. Univ., Yaroslavl 1977, pp. 143–155; English transl., *Selecta Math. Sovietica* **1** (1981), 161–167.

[36] *Algebra und Geometrie. Eine Einführung*, DVW, Berlin 1977, 1986 (with R. Sulanke).

[37] "Pseudoconvexity in the theory of complex spaces", Algebra. Topology. Geometry (Itogi Nauki i Tekhniki), vol. 15, Akad. Nauk SSSR, Moscow 1977, pp. 93–171; English transl., *J. Soviet Math.* **14** (1980), 1363–1407.

[38] *Elements of linear algebra and group theory*, Yaroslav. Gos. Univ., Yaroslavl 1978. (Russian)

[39] *Introduction to the theory of Lie groups and Lie algebras*, Yaroslav. Gos. Univ., Yaroslavl 1979. (Russian)

[40] "A remark on invariants of groups generated by reflections", Problems in Group Theory and Homological Algebra, Yaroslav. Gos. Univ., Yaroslavl 1979, pp. 138–141; English transl., *Selecta Math. Sovietica* **3** (1983/84), 239–241.

[41] "Classification of compact Lie groups", J. Adams, *Lectures on Lie groups*, Appendix to the Russian transl., Nauka, Moscow 1979, pp. 132–144. (Russian)

[42] *Linear algebra for biologists*, Yaroslav. Gos. Univ., Yaroslavl 1980 (with A. N. Rudakov). (Russian)

[43] "Totally geodesic submanifolds of symmetric spaces", Geometric Methods in Problems of Algebra and Analysis, Yaroslav. Gos. Univ., Yaroslavl 1980, pp. 64–85. (Russian)

[44] "On a class of subgroups of simple algebraic groups", Problems in Group Theory and Homological Algebra, Yaroslav. Gos. Univ., Yaroslavl 1981, pp. 93–103; English transl., *Selecta Math. Sovietica* **3** (1983/84), 243–252.

[45] "Parabolic factorizations of semisimple algebraic groups", *Math. Nachr.* **104** (1981), 315–329.

[46] "On inclusions between transitive algebraic groups", *Izv. Vyssh. Uchebn. Zaved. Mat.* **1982**, no. 2, 28–35; English transl., *Soviet Math.* (Iz. VUZ) **26**:2 (1982), 35–46.

[47] "Transitive semisimple Lie groups", Problems in Group Theory and Homological Algebra, Yaroslav. Gos. Univ., Yaroslavl 1983, pp. 128–129. (Russian)

[48] "Topology of some complex homogeneous spaces", Multidimensional Complex Analysis, Akad. Nauk SSSR Sibirsk. Otdel., Krasnoyarsk 1985, pp. 109–121; English transl., *Amer. Math. Soc. Transl.* (2) **146** (1990), 43–52.

[49] "Methods of sheaf theory and Stein spaces", Current Problems in Mathematics. Fundamental Directions (Itogi Nauki i Tekhniki), vol. 10, Akad. Nauk SSSR, Moscow 1986, pp. 5–73; English transl., Encyclopaedia Math. Sci., vol. 10 [Several Complex Variables IV], Springer-Verlag, Berlin–New York, 1990, pp. 1–61.

[50] "Transitive irreducible Lie superalgebras of vector fields", Deposited at VINITI 12/06/86, no. 4329-B, Yaroslav. Gos. Univ., Yaroslavl 1986. (Russian)

[51] "Reducible maximal subalgebras of certain classical Lie superalgebras", Problems in Group Theory and Homological Algebra, Yaroslav. Gos. Univ., Yaroslavl 1987, pp. 161–163 (with O. A. Zharov and V. A. Zolotarev). (Russian)

[52] *Algebra und Geometrie* 2. *Moduln und Algebren*, DVW, Berlin 1988 (with R. Sulanke).

[53] *Seminar on Lie groups and algebraic groups*, (based on [24]) Nauka, Moscow 1988; English transl., [61] (with È. B. Vinberg).

[54] *Lie groups and Lie algebras* I, Current Problems in Mathematics. Fundamental directions (Itogi Nauki i Tekhniki), vol. 20, Akad. Nauk SSSR, Moscow 1988; English transl., [69] (with È. B. Vinberg and V. V. Gorbatsevich).

[55] "Lie superalgebras of vector fields on splittable flag supermanifolds", *Dokl. Akad. Nauk SSSR* **300** (1988), 284–287; English transl., *Soviet Math. Dokl.* **37** (1988), 652–655 (with A. A. Serov).

[56] "On the centre of a transitive semisimple Lie group", *Ann. Global Anal. Geom.* **6**:3 (1988), 265–272.
[57] "Actions of Cartan type Lie superalgebras on certain supermanifolds", Problems in Group Theory and Homological Algebra, Yaroslav. Gos. Univ., Yaroslavl 1989, pp. 42–49. (Russian)
[58] "Cartan subalgebras in Lie superalgebras", Problems in Group Theory and Homological Algebra, Yaroslav. Gos. Univ., Yaroslavl 1989, pp. 99–104 (with V. A. Bunegina and T. N. Naumova). (Russian)
[59] "Homogeneous Stein spaces of reductive groups", G. Grauert and R. Remmert, *Theory of Stein spaces*, Appendix to Russian transl., Nauka, Moscow 1989, pp. 328–331. (Russian)
[60] *Lie groups and Lie algebras* III, Current Problems in Mathematics. Fundamental Directions (Itogi Nauki i Tekhniki), vol. 41, Akad. Nauk SSSR, Moscow 1990; English transl., [70] (with È. B. Vinberg and V. V. Gorbatsevich).
[61] *Lie groups and algebraic groups*, Springer-Verlag, Berlin 1990; English transl. of [53] (with E. B. Vinberg).
[62] "Lie superalgebras of vector fields", *Amer. Math. Soc. Transl. Ser.* (2) **148** (1991), 87–97.
[63] "Irreducible components of the exterior algebra over a space of matrices", Problems in Group Theory and Homological Algebra, Yaroslav. Gos. Univ., Yaroslavl 1992, pp. 136–139. (Russian)
[64] "A family of homogeneous supermanifolds", Problems in Group Theory and Homological Algebra, Yaroslav. Gos. Univ., Yaroslavl 1992, pp. 153–158 (with V. A. Bunegina). (Russian)
[65] "The group of isometries of a compact Riemannian homogeneous space", Differential Geometry and Its Applications (Eger, Hungary, 1989) (Colloq. Math. Soc. János Bolyai, vol. 56), North Holland, Amsterdam 1992, pp. 597–616.
[66] "Holomorphic vector fields on super-Grassmannians", Lie Groups, their Discrete Subgroups, and Invariant Theory (Advances in Soviet Mathematics, vol. 8), Amer. Math. Soc., Providence, RI 1992, pp. 113–129 (with A. A. Serov).
[67] "On the rigidity of super-Grassmannians", *Ann. Global Anal. Geom.* **11** (1993), 361–372.
[68] "Homogeneous supermanifolds associated with the complex projective line", preprint no. 33, Inst. Math. Univ. Oslo, Oslo 1993 (with V. A. Bunegina).
[69] *Lie groups and Lie algebras* I: *Foundations of Lie theory. Lie transformation groups*, Encyclopaedia Math. Sci., vol. 20, Springer-Verlag, Berlin 1993; English transl. of [54] (with V. V. Gorbatsevich and È. B. Vinberg).
[70] *Lie groups and Lie algebras* III: *Structure of Lie groups and Lie algebras*, Encyclopaedia Math. Sci., vol. 41, Springer-Verlag, Berlin 1994; English transl. of [60] (with È. B. Vinberg and V. V. Gorbatsevich).
[71] *Topology of transitive transformation groups*, J. A. Barth Verlag, Leipzig 1994.
[72] "Flag supermanifolds, their automorphisms and deformations", Sophus Lie Memorial Conference (Oslo, 1992)., Scand. Univ. Press, Oslo 1994, pp. 289–302.
[73] "Evgenii Borisovich Dynkin (on the occasion of his 70th birthday), *Uspekhi Mat. Nauk* **49**:4 (1994), 183–188; English transl., *Russian Math. Surveys* **49**:4 (1994), 183–191 (with N. D. Vvedenskaya, R. L. Dobrushin, and V. A. Uspenskii).
[74] "Two families of flag supermanifolds", *Differential Geom. Appl.* **4**:4 (1994), 329–360 (with V. A. Bunegina).
[75] "A spectral sequence for the tangent sheaf cohomology of a supermanifold", SFB 288, preprint no. 148, Technische Universität, Berlin 1994.
[76] *Seminar on Lie groups and algebraic groups*, 2nd ed., URSS, Moscow 1995 (with È. B. Vinberg). (Russian)
[77] "About derivations and vector-valued differential forms", Bericht no. 181, Inst. Math. Ruhr-Universität, Bochum 1995.
[78] "Cohomology of a tangent bundle of a complex supermanifold", Actual Problems of the Natural Sciences and Humanities. Mathematics, Informatics, Yaroslav. Gos. Univ., Yaroslavl 1995, pp. 44–46. (Russian)
[79] *Topology of transitive transformation groups*, Fizmatlit, Moscow 1995; Russian version of [71].

[80] On the work of E. B. Dynkin in the theory of Lie groups, *Amer. Math. Soc. Transl. Ser.* (2) **169** (1995), 1–13 (with F. I. Karpelevich and È. B. Vinberg).

[81] "Vector fields and deformations of isotropic super-Grassmannians of maximal type", *Amer. Math. Soc. Transl. Ser.* (2) **169** (1995), 75–90 (with A. A. Serov).

[82] "Complex homogeneous supermanifolds", Mathematics at Yaroslavl University, Yaroslav. Gos. Univ., Yaroslavl 1996, pp. 133–153. (Russian)

[83] "On isotropic super-Grassmannians of maximal type associated with an odd bilinear form", preprint no. 340, E. Schrödinger International Institute for Mathematical Physics, Vienna 1996 (with A. A. Serov).

[84] "A construction of non-split supermanifolds", preprint no. 361, E. Schrödinger International Institute for Mathematical Physics, Vienna 1996.

[85] "Homogeneous supermanifolds associated with the complex projective line", *J. Math. Sci.* (New York) **82**:4 (1996), 3503–3527 (with V. A. Bunegina).

[86] "Non-split supermanifolds associated with the cotangent bundle", Prépubl. Université de Poitiers, Départ. de Math., no. 109, Poitiers 1997.

[87] *Foundations of Lie theory and Lie transformation groups*, reprint of [69], Springer-Verlag, Berlin 1997 (with V. V. Gorbatsevich and È. B. Vinberg).

[88] "About derivations and vector-valued differential forms", *J. Math. Sci.* (New York) **90**:4 (1998), 2274–2286.

[89] "A spectral sequence for the tangent sheaf cohomology of a supermanifold", Lie Groups and Lie Algebras (Math. Appl., vol. 433), Kluwer, Dordrecht 1998, pp. 199–215.

[90] "Homogeneous supermanifolds associated with a complex projected space. I", *Mat. Sb.* **189**:2 (1998), 111–136; English transl., *Sb. Math.* **189** (1998), 265–289 (with O. V. Platonova).

[91] "Homogeneous supermanifolds associated with a complex projected space. II", *Mat. Sb.* **189**:3 (1998), 103–124; English transl., *Sb. Math.* **189** (1998), 421–441 (with O. V. Platonova).

[92] "A moduli problem related to complex supermanifolds", Algebra and Operator Theory (Proc. Colloquium, Tashkent, 1997), Kluwer, Dordrecht 1998, pp. 13–24.

[93] "A construction of non-split supermanifolds", *Ann. Global Anal. Geom.* **16**:4 (1998), 309–333.

[94] "On non-Abelian cochain complexes", Problems in Group Theory and Homological Algebra, Yaroslav. Univ., Yaroslavl 1998, pp. 171–197. (Russian)

[95] "Non-Abelian cohomology and supermanifolds", SFB 288, preprint 360, Technische Universität, Berlin 1998.

[96] "On the classification of complex analytic supermanifolds", *Lobachevskii J. Math.* (electronic) **4** (1999), 47–70.

[97] "On supermanifolds associated with the cotangent bundle", Lie Groups, Geometric Structures and Differential Equations—One Hundred Years after Sophus Lie (Kyoto/Nara, 1999) (Søurikaisekikenkyøusho Køokyøuroku, vol. 1150), RIMS, Kyoto 2000, pp. 45–53. (Japanese)

[98] "Lifting of holomorphic actions on complex supermanifolds", preprint 966, E. Schrödinger International Institute for Mathematical Physics, Vienna 2000.

[99] "Triangular de Rham cohomology of compact Kähler manifolds", *Mat. Sb.* **192**:2 (2001), 27–56; English transl., *Sb. Math.* **192** (2001), 187–214 (with A. Yu. Brudnyi).

[100] "Problems of the classification of complex supermanifolds", Mathematics at Yaroslavl University, Yaroslav. Gos. Univ., Yaroslavl 2001, pp. 7–33. (Russian)

[101] "Lifting of holomorphic actions on complex supermanifolds", Lie Groups, Geometric Structures and Differential Equations—One Hundred Years after Sophus Lie (Kyoto, 1999) (Adv. Stud. Pure Math., vol. 37), Math. Soc. Japan, Tokyo 2002, pp. 317–335.

Translated by NATALYA PLUZHNIKOV

Typeset by $\mathcal{A}\mathcal{M}\mathcal{S}$-TEX