

References

The following abbreviations stand for titles of some Russian journals:

AT *Avtomatika i Telemekhanika* Automatics and Telemechanics.

DAS *Doklady Akademii Nauk* Doklady of the Academy of Sciences.

FAA *Funkzionalny Analiz i ego Primeneniya* Functional Analysis and its Applications.

PIT *Problemy peredatchi Informatzii* Problems of Information Transmission.

TPA *Teoria Veroyatnostei i ego Primeneniya* Theory of Probability and its Applications.

- 1 Averintsev, M. B. (1975). Gibbsian description of random variables, condition probabilities of which may turn into zero. *PIT* **11**, 4, 86–9 (in Russian).
- 2 Beliaev Yu. K., Gromak, Yu. I. and Malyshev, V. A. (1969). On invariant random Boolean fields. *Matematicheskie Zametki* **6**, 5, 555–66 (in Russian).
- 3 Bramson, M. and Griffeath, D. (1979). Renormalizing the 3-dimensional voter model. *Ann. Probab.* **7**, 418–32.
- 4 Chomsky, N. and Miller, G. A. (1958). Finite state languages. *Information and Control* **1**, 91–112.
- 5 Con, J. T. and Griffeath, D. (1983). Critical clustering in the two-dimensional voter model. In: Hô, K. and Prokhorov, J. V. *Probability Theory and Mathematical Statistics. Proceedings, 1982* (Lecture Notes in Mathematics, 1021), Springer, 59–68.
- 6 Dawson D. A. (1973). Information flow in discrete Markov systems. *J. Appl. Prob.* **10**, 1, 63–83.

- 7 Dawson D. A. (1975). Synchronous and asynchronous reversible Markov systems. *Canad. Math. Bull.* **17**, 5, 633–49.
- 8 Dawson D. A. (1975). Information flow in graphs. *Stochastic Processes and Applications* **3**, 137–51.
- 9 Dobrushin, R. L. (1968) Description of a random field with its conditional probabilities and conditions of its regularity. *TPA* **13**, 2, 201–29 (in Russian).
- 10 Dobrushin, R. L. (1968). Gibbsian random fields for lattice systems with pairwise interactions. *FAA* **2**, 4, 292–301.
- 11 Dobrushin, R. L. (1968). The problem of uniqueness of a Gibbsian random field and the problem of phase transition. *FAA* **2**, 4, 302–19.
- 12 Dobrushin, R. L. (1971). Markov processes with a large number of locally interacting components—existence of a limit process and its ergodicity. *PIT* **7**, 2, 149–94.
- 13 Dobrushin, R. L. (1971). Markov processes with many locally interacting components – the reversible case and some generalizations. *PIT* **7**, 3, 235–41.
- 14 Dobrushin, R. L., Piatetski-Shapiro, I. I. and Vasiliev, N. B. (1969). Markov processes in an infinite product of discrete spaces. *Proceedings of the Soviet-Japanese Symposium in Probability Theory*. Novosibirsk, pp. 3–29 (in Russian).
- 15 Dobrushin, R. L. and Pirogov, S. A. (1976). Theory of random fields. *Proc. 1975 IEEE-USSR Joint Workshop on Information Theory*, IEEE, pp. 39–49.
- 16 Durrett, R. (1979). An infinite particle system with additive interactions. *Adv. Appl. Probab.* **11**, 355–83.
- 17 Durrett, R. (1984). Oriented percolation in two dimensions. *Ann. Probab.* **12**, 4, 999–1040.
- 18 Durrett, R. and Griffeath, D. (1983). Supercritical contact processes on \mathbb{Z} . *Ann. Probab.* **11**, 1, 1–15.
- 19 Feller, W. (1970–1). *An Introduction to Probability Theory and its Applications*. Wiley New York.
- 20 Freiwald, R. V. (1974). Limit computations on probabilistic machines. A theory of algorithms and programs. *Proceedings of the Latvian Univ.* **210**, 1, Riga, 32–47 (in Russian).
- 21 Gács, P. (1986). Reliable computation with cellular automata. *Journal of Computer and System Sciences* **32**, 3, 201–8.
- 22 Gács, P., Kurdyumov, G. L. and Levin, L. A. (1978). One-dimensional Homogeneous media which erode finite islands. *PIT* **14**, 3, 92–6 (in Russian).
- 23 Galperin, G. A. (1976). Homogeneous nets of automata with monotone local interaction *PIT* **12**, 4, 74–87 (in Russian).
- 24 Galperin, G. A. (1976). Homogeneous local monotone operators with memory. *DAS* **228**, 2, 277–80 (in Russian).

- 25 Galperin, G. A. (1977). Homogeneous local monotone operators with memory. In: *Interacting Markov Processes and their Application in Biology*, Pushchino (in Russian).
- 26 Gantmaher, F. R. (1959). *The Theory of Matrices*. Chelsea, New York.
- 27 Gelfand, I. M., Piatetski-Shapiro, I. I. and Tsetlin, M. L. (1963). On homogeneous games and games of automata, *DAS* **152**, 4 (in Russian).
- 28 Gray, L. (1982). The positive rates problem for attractive nearest-neighbor spin systems on \mathbb{Z} . *Z. Wahrsch. und Verw. Gebiete* **61**, 389–404.
- 29 Gray, L. (1986). Duality for general attractive spin systems, with applications in one dimension. *Ann. Probab.* **14**, 2, 371–96.
- 30 Gray, L. and Griffeath, D. (1982). A stability criterion for attractive nearest-neighbor spin systems on \mathbb{Z} . *Ann. Probab.* **10**, 67–85.
- 31 Griffeath, D. (1978). *Coupling Methods for Markov Processes*. Studies in Probability and Ergodic Theory: Advances in Mathematics, Supplementary Studies, Vol. 2, pp. 1–43. Academic Press, New York.
- 32 Griffeath, D. (1979). *Additive and Cancellative Interacting Particle Systems*. (Lecture Notes in Mathematics, 724), Springer.
- 33 Griffeath, D. (1983). The binary contact path process. *Ann. Probab.* **11**, 3, 692–705.
- 34 Griffiths, R. B. (1972). Rigorous results and theorems. In: *Phase Transitions and Critical Phenomena*, Vol. 1, C. Domb and M. S. Green (eds), pp. 7–109. Academic Press, London.
- 35 Harris, T. E. (1976). On a class of set-valued Markov processes. *Ann. Probab.* **4**, 1, 175–94.
- 36 Harris, T. E. (1978). Additive set-valued Markov processes and graphical methods. *Ann. Probab.* **6**, 3, 355–78.
- 37 Holley, R. (1971). Free energy in a Markovian model of a lattice spin system. *Comm. Math. Phys.* **23**, 87–99.
- 38 Holley, R. (1972). An ergodic theorem for interacting with attractive interactions. *Z. Wahrsch. und Verw. Gebiete*, **24**, 4, 325–34.
- 39 Holley, R. and Liggett, T. (1975). Ergodic theorems for weakly interacting systems and the voter model. *Ann. Prob.* **3**, 4, 643–63.
- 40 Kemeny, J. G., Knapp, A. W. and Snell, J. L. (1976). *Denumerable Markov Chains*. Springer, New York, chapter 12.
- 41 Kesten, H. (1982). *Percolation Theory for Mathematicians*. Birkhäuser, Boston.
- 42 Kozlov, O. K. and Vasilyev, N. B. (1980). Reversible Markov chains with local interaction. *Adv. Probab.* **6**, 451–69.
- 43 Kurdyumov, G. L. (1978). An example of a nonergodic homogeneous one-dimensional random medium with positive transi-

- tion probabilities. *DAS* **19**, 1, 211–14.
- 44 Kurdyumov, G. L. (1978). An algorithm-theoretic method in studying homogeneous random networks. In: Dobrushin, R. L., Kryukov, V. I. and Toom, A. L. (eds.) *Locally Interacting Systems and their Application in Biology*. (Lecture Notes in Mathematics, 653), Springer, pp. 37–55.
- 45 Kurdyumov, G. L. (1980). An algorithm-theoretic method for the study of homogeneous random networks. *Adv. Probab.* **6**, 471–504.
- 46 De Leeuw, K., Moore, E. F., Shannon, C. E. and Shapiro, N. (1956). Computing on stochastic Turing machines. In: *Automata Studies*, C. E. Shannon and J. McCarthy (eds.) Princeton Univ. Press, Princeton, NJ.
- 47 Leontovich, A. M. and Vaserstein, L. N. (1970). On invariant measures of some Markov operators which describe a homogeneous random medium. *PIT* **6**, 1, 71–80 (in Russian).
- 48 Liggett, T. M. (1985). *Interacting Particle Systems*. Springer.
- 49 Malyshev, V. A. and Minlos, R. A. (1985). *Gibbsian Random Fields. The Method of Cluster Decompositions*. Nauka, Moscow (in Russian).
- 50 Martirosjan, D. G. (1975). Uniqueness of limit Gibbsian distributions for confused Ising model. *Theoretical and Mathematical Physics* **22**, 3, 335–342 (in Russian).
- 51 Minlos, R. A. and Sinai Ya. G. (1968). The phenomenon of separation of phases with low temperatures in some lattice models of gas, II. *Proceedings of the Moscow Mathematical Society* **19**, 113–78 (in Russian).
- 52 Mityushin, L. G. (1970). Non-ergodicity of homogeneous threshold nets with small self-excitement. *PIT* **6**, 3, 99–103 (in Russian).
- 53 Mityushin, L. G. (1975). On some multi-dimensional systems of automata, related with the percolation problem. *PIT* **11**, 3 (in Russian).
- 54 Mityushin, L. G. (1976). Some results on percolation problems. *Proceedings of IV International Symposium on Information Theory, part I*. Moscow and Leningrad, pp. 103–4 (in Russian).
- 55 Mityushin, L. G., Piatetski-Shapiro, I. I., Toom, A. L. and Vasilyev, N. B. (1973). Stavskaya operators. Preprint 12 of the Institute of Applied Mathematics of Academy of Sciences of the USSR (in Russian).
- 56 Moore, E. F. and Shannon, C. E. (1956). Reliable circuits using less reliable relays. *J. of Franklin Institute* **262**.
- 57 Petri, N. V. (1979). The unsolvability of the problem of discerning of annuling iterative nets. In: *Researches in the Theory of Algorithms and Mathematical Logic*. Nauka, Moscow (in Russian).
- 58 Petrovskaya, M. B., Piatetski-Shapiro, I. I. and Vasilyev, N. B.

- (1969). Modelling of voting with random errors. *AT* 10, 103–7 (in Russian).
- 59 Piatetski-Shapiro, I. I. and Vasilyev, N. B. (1971). On classification of one-dimensional homogeneous media. *PIT* 7, 4, 82–90 (in Russian).
- 60 Pirogov, S. A. (1975). Coexistence of phases for lattice models with several types of particles. *Izvestia of the Academy of Sciences of the USSR, Mathematical Series* 39, 6, 1404–33 (in Russian).
- 61 Pirogov, S. A. (1986). Cluster decompositions for automata systems. *PIT* 22, 4, 60–6.
- 62 Pirogov, S. A. and Sinai, Ya. G. (1975–6). Phase diagrams of classical lattice systems. *Theoretical and Mathematical Physics* 25, 3, 358–69; 26, 1, 61–76.
- 63 Pirogov, S. A. and Sinai, Ya. G. (1974). Phase transitions of the first order for small perturbations of the Ising model. *FAA* 8, 1, 25–31.
- 64 Plesnevich, G. S. (1968). Comparison of two concepts of computing on homogeneous iterative automata. *The Conference on Automata Theory and Artificial Intellect, Tashkent, Abstracts of Communications*, Computing Center of the USSR Academy of Sciences, Moscow.
- 65 Preston, C. J. (1976). *Random Fields*. (Lecture Notes in Mathematics, 534), Springer.
- 66 Rockafellar, R. T. (1970). *Convex Analysis*. Princeton Univ. Press, Princeton, NJ.
- 67 Rozonoer, L. I. (1969). On random logical networks I, II, III. *AT* 5, 137–47; 6, 99–109; 7, 127–36 (in Russian).
- 68 Schormann, H. H. (1987). A new proof of the complete convergence theorem for contact processes in several dimensions with large infection parameter. *Ann. Probab.* 15, 1, 382–7.
- 69 Shabat, B. V. (1976). *Introduction to Complex Analysis*, Part II. Nauka, Moscow (in Russian).
- 70 Shmukler, Yu. (1971). The voting problem with random error. *DAS* 196, 4, 789–92 (in Russian).
- 71 Shnirman, M. G. (1968). On the problem of ergodicity of a Markov chain with infinite set of states. *Problemy Kibernetiki* 20, 115–24 (in Russian).
- 72 Shnirman, M. G. (1978). On non-uniqueness in some homogeneous networks. In: Dobrushin, R. L., Kryukov, V. I. and Toom, A. L. (eds.) *Locally Interacting Systems and their Application in Biology*. (Lecture Notes in Mathematics, 653), Springer, pp. 31–6.
- 73 Sinai, Ya. G. (1982). *Theory of Phase Transitions: Rigorous Results*. Pergamon International Series in Natural Philosophy, 108. Pergamon Press, Oxford.

- 74 Spitzer, F. (1976). *Random Fields*. (Lecture Notes in Mathematics, 534), Springer.
- 75 Stavskaya, O. N. (1973). Gibbsian invariant measures for Markov chains on finite lattices with local interaction. *Mathematicheski Sbornik* **92**, 3, 402–19 (in Russian).
- 76 Stavskaya, O. N. (1978). Markov fields as invariant states for local processes. In: Dobrushin, R. L. Kryukov, V. I. and Toom, A. L. (eds.) *Locally Interacting Systems and their Application in Biology*. (Lecture Notes in Mathematics, 653, Springer, pp. 2, 113–21).
- 77 Stavskaya, O. N. (1976). Invariant Bernoulli measures for Markov processes with local interaction. *Proceedings of the Fourth International Symposium on Information Theory* part I. Moscow and Leningrad, 127–9 (in Russian).
- 78 Stavskaya, O. N. and Piatetski-Shapiro, I. I. (1971). On homogeneous nets of spontaneously active elements. *Systems Theory Res.* **20**, 75–88.
- 79 Stockmeyer, L. (1974). The complexity of solution problems in automata theory and logic. Project MAC, MIT.
- 80 Strook D. (1978). *Lectures on Infinite Interacting Systems*. Kyoto Univ. Lectures in Mathematics, Vol. 11.
- 81 Sullivan, W. G. (1975). Markov processes for random fields. *Communications of the Dublin Institute for Advanced Studies*, Series A, no. 23.
- 82 Sullivan, W. G. (1976). Specific information gain for interacting Markov processes. *Z. Wahrscheinlichkeit und Verw. Gebiete* **37**, 77–90.
- 83 Toom, A. L. (1972). Non-ergodicity in homogeneous random media. *Verojatnostnye Metody Issledovanija* (collection of papers), Moscow Univ., issue 41, 34–42 (in Russian).
- 84 Toom, A. L. (1972). On invariant measures in nonergodic random media, ibid, 43–51 (in Russian).
- 85 Toom, A. L. (1968). A family of homogeneous nets of formal neurons. *DAS* **9**, 1338–41.
- 86 Toom, A. L. (1974). Nonergodic multidimensional systems of automata. *PIT* **10**, 239–46.
- 87 Toom, A. L. (1976). Monotonic binary cellular automata. *PIT* **12**, 33–7.
- 88 Toom, A. L. (1976). Unstable multicomponent systems. *PIT* **12**, 220–5.
- 89 Toom, A. L. (1978). Monotonic evolutions in real spaces. In: Dobrushin, R. L., Kryukov, V. I. and Toom, A. L. (eds.) *Locally Interacting Systems and their Application in Biology*. (Lecture Notes in Mathematics, 653), Springer, pp. 1–14.
- 90 Toom, A. L. (1979). Stable and attractive trajectories in multi-component systems. *Adv. Probab.* **6**, 549–75.

- 91 Bishir, J. (1963). A lower bound for the critical probability in the one-quadrant oriented-atom percolation process. *Journ. of the Royal St. Soc., Ser. B*, **25**, 2, 401–4.
- 92 Toom, A. L. and Mityushin, L. G. (1976). Two results on non-computability for one-dimensional tessellation automata. *PIT* **12**, 2, 69–75 (in Russian).
- 93 Tsetlin, M. L. (1973). *Automaton Theory and Modeling of Biological Systems*. Mathematics in Science and Engineering, 102, Academic Press, New York and London.
- 94 Tsirelson, B. S. (1976). Non-homogeneous local interaction can produce ‘far-range order’ in a one-dimensional system. *TPA* **21**, 3, 681–3.
- 95 Tsirelson, B. S. (1978). Reliable information storage in a system of locally interacting unreliable elements. In: Dobrushin, R. L., Kryukov, V. I. and Toom, A. L. (eds.) *Locally Interacting Systems and their Application in Biology*. (Lecture Notes in Mathematics, 653), Springer, pp. 15–30.
- 96 Vaserstein, L. N. (1969). Markov processes over denumerable products of spaces, describing large systems of automata. *PIT* **5**, 3, 47–52.
- 97 Vasilyev, A. V. (1975). Investigation of the stationary probability of one Markov system of interactions. *PIT* **11**, 4, 109–12 (in Russian).
- 98 Vasilyev, N. B. (1969). Limit behavior of one random medium. *PIT* **5**, 57–62.
- 99 Vasilyev, N. B. (1978). Bernoulli and Markov stationary measures in discrete local interactions. In: Dobrushin, R. L., Kryukov, V. I. and Toom, A. L. (eds.) *Locally Interacting Systems and their Application in Biology*. (Lecture Notes in Mathematics, 653), Springer, pp. 99–112.
- 100 Vasilyev, N. B. (1970). Correlation equations for the stationary measure of one Markov chain. *TPA* **15**, 3, 536–41.

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