



Editorial

Preface: Levon Khachatryan's legacy in extremal combinatorics



In Yerevan, Armenia, June 2–3, 2014, the National Academy of Sciences of Armenia jointly with the American University of Armenia organized a memorial workshop on extremal combinatorics, cryptography, and coding theory dedicated to the 60th anniversary of the birth of the great mathematician Levon Khachatryan.

Professor Khachatryan started his academic career at the Institute for Problems of Informatics and Automation of National Academy of Sciences of Armenia. From 1991 until his untimely passing in 2002, he worked for the University of Bielefeld, Germany, where his talent flourished working with Professor Rudolf Ahlswede. Professor Khachatryan's most remarkable results include solutions to problems in extremal combinatorics posed by Paul Erdős over 40 years ago. These problems had attracted the attention of many top scientists in combinatorics and number theory.

The workshop well represented the wide areas of research of Levon Khachatryan in combinatorics and theoretical computer science. The speakers not only recalled his mathematical results and showed important recent consequences of these works, but recounted their personal memories of this nice, modest genius, who passed away so early.

The present collection is based on this workshop in Professor Khachatryan's memory. It tries to cover the areas he worked on. Its goal is to pay tribute to our unforgettable colleague and friend.



Levon Khachatryan 1954–2002



Levon Khachatryan with Paul Erdős and Rudolf Ahlswede at Bielefeld University 1995

Bibliography of Publications by Levon Khachatryan

1981

- [1] Equidistant, codes and equidistant permutation arrays, J. Problemi Peredachi Informatsii, No. 4, 116–119, 1981. (in Russian, abstract in English)
- [2] Pseudo-random arrays, 8-th Conference on Coding Theory and Information Transmission, Kuibyshev, USSR, 1981, (in Russian).

1982

- [3] Arrays with “window” property, J. Dokladi Akademii Nauk Armenia SSR, v. 74, 51–55, 1982, (in Russian, abstract in English).

1984

[4] Sequential diagnosis of computing networks, (with D. Gevorkian and R. Oglakchian), 9th. All-Union Workshop On Computing Networks, iss. 3.1, Moscow, 160–162, 1984, (in Russian).

1985

[5] One step diagnosis of computing networks, (with D. Gevorkian and R. Oglakchian), 10th. All-Union Workshop on Computing Networks, iss. 1, Tbilisi-Moscow, 201–206, 1985, (in Russian)

1986

[6] Sequential diagnosis in closely connected computing networks, (with D. Gevorkian and R. Oglakchian), 11th. All-Union Workshop on Computing Networks, iss. 1, Riga-Moscow, 269–273, 1986, (in Russian).

[7] Diagnostic capability of large computing networks, (with D. Gevorkian and R. Oglakchian), Proc. of the 1-st joint Colloquium on Coding Theory between Academy of Sciences of Armenia and Osaka University, 38–40, 1986.

[8] On a method of construction of De Bruijn sequences, (with H. Hakopian), Proc. of the 1-st joint Colloquium on Coding Theory between Armenian Academy of Sciences and Osaka University, 96–98, 1986.

[9] The method of word synchronization in alphabetic codes for the digital transmission systems, (with G. Khachatrian and G. Markarian), Trans. of the 10-th Prague Conf. on Inf. Th., Vol. B, 37–41, Prague 1986.

1987

[10] Lower estimate of the number of the diagnosed modules for a class of computing networks, (with D. Gevorkian and R. Oglakchian), 12-th All-Union Workshop on Computing Networks, iss. 3, Odessa-Moscow. 123–126. 1987, (in Russian).

[11] The method of block synchronization in alphabetic codes for the digital transmission systems, (with G. Khachatrian and G. Markarian), J. Radiotekhnika, No. 3, 56–60, 1987, (in Russian, abstract in English).

1989

[12] Minimum broadcast trees, (with H. Haroutunian), 17-th All-Union Workshop on Computing Networks, Minsk-Moscow, 1989, (in Russian).

1990

[13] Construction of new classes of minimal broadcast networks, (with H. Haroutunian), Proc. of Third International Colloquium on coding Theory. Dilijan, 69–72, October 1990.

[14] New methods of construction of De Bruijn sequences, Proc. of Third Inter. Coll. on Coding Theory, Dilijan, 103–126, 1990.

1991

[15] On optimal broadcast graphs, (with H. Haroutunian), Proc. of IV International Colloquium on Coding Theory, Dilijan, 65–72, 1991.

[16] Construction of (t_1, t_2) -tolerant codes, Proc. of IV Inter. Colloquium on Coding Theory, Dilijan, 1–7, 1991.

1992

[17] Construction of new classes of minimal broadcasting networks, (with H. Haroutunian), Akad. Nauk Armenii Dokl, 93, No 4, 159–162, 1992, (in Russian.)

[18] The methods of construction of De Bruijn sequences and arrays with window property, J. Discretnaja matematika, No. 4, 62–78, Moscow, 1991. (in Russian) English translation in Discrete Math. Appl., No. 6, 607–622, 2, 1992.

[19] Sharp bounds for cloud-antichains of length two, (with R. Ahlswede), Preprint 92- 012, SFB 343, “Diskrete Strukturen in der Mathematik” Univeristät Bielefeld.

1993

[20] The Lower bound of the quadratic spans of De Bruijn sequences, J. Designs, Codes and Cryptography, No. 3, 29–32, 1993.

[21] Construction of skew-tolerant and skew-detecting codes, (with M. Blaum and J. Bruck), IEEE Trans. on Inform. Theory, Vol. 39, No. 5, 1751–1757, September 1993.

1994

[22] The maximal length of cloud-antichains, (with R. Ahlswede), Discrete Mathematics, Vol. 131, 9–15, 1994.

[23] Messy broadcasting in networks, (with R. Ahlswede and H. Haroutunian), Special volume in honor of J.L. Massey on occasion of his 60th birthday. Communications and Cryptography (Two sides of one tapestry), editors R.E. Blahut, D.J. Costello, U. Maurer, T. Mittelholzer, Kluwer Acad. Publ., 13-24, 1994.

[24] On extremal sets without coprimes, (with R. Ahlswede), Acta Arithmetica LXVI 1, 89-99, 1994.

1995

[25] Towards characterizing equality in correlation inequalities, (with R. Ahlswede), Preprint 93-027, SFB 343 "Diskrete Strukturen in der Mathematik" Universität Bielefeld, European J. of Combinatorics 16, 315-328, 1995.

[26] Density inequalities for sets of multiples, (with R. Ahlswede), Preprint 93-049, SFB 343 "Diskrete Strukturen in der Mathematik" Universität Bielefeld, J. of Number Theory 55, No. 2, 170-180, 1995.

[27] Maximal sets of numbers not containing $k+1$ pairwise coprime integers, (with R. Ahlswede), Preprint 94-080, SFB 343 "Diskrete Strukturen in der Mathematik" Universität Bielefeld, Acta Arithmetica LXX II, 1, 77-100, 1995.

1996

[28] Optimal pairs of incomparable clouds in multisets, (with R. Ahlswede), Graphs and Combinatorics 12, 97-137, 1996.

[29] Classical results on primitive and recent results on cross-primitive sequences, (with R. Ahlswede), The Mathematics of P. Erdős, Vol. I, R.L. Graham and J. Nešetřil, ed., Algorithms and Combinatorics B, Springer Verlag, Berlin/Heidelberg/New York, 104-116, 1996.

[30] Fault-tolerant minimum broadcast networks, (with R. Ahlswede, L. Gargano and H. Haroutunian), Networks, Vol. 27, No. 4, 1293-1307, 1996.

[31] Sets of integers with pairwise common divisor and a factor from a specified set of primes, (with R. Ahlswede), Acta Arithmetica LXX V 3, 259-276, 1996.

[32] Sets of integers and quasi-integers with pairwise common divisor, (with R. Ahlswede), Acta Arithmetica LXXIV 2, 141-153, 1996.

[33] A counterexample to Aharoni's "Strongly maximal matching" conjecture, (with R. Ahlswede), included in "Report on work in progress in combinatorial extremal theory" Ergänzungsreihe des SFB 343 "Diskrete Strukturen in der Mathematik" Universität Bielefeld, Nr. 95-004, Discrete Mathematics 149, 289, 1996. [34] The complete nontrivial-intersection theorem for systems of finite sets, (with R. Ahlswede), J. Combinatorial Theory, Series A, 76, 121-138, 1996.

[35] Contributions to the diagnosis of computing networks, (with D. Gevorgian and R. Oglakchian), (survey on the not available papers in russian), Ergänzungsreihe des SFB 343 "Diskrete Strukturen in der Mathematik" Nr. 96-004, Universität Bielefeld.

[36] Report on Work in Progress in Combinatorial Extremal Theory, Shadows, AZ-Identities, Matching, (with R. Ahlswede, N. Cai, N. Dahn, D. Daykin and T. D. Thu), Ergänzungsreihe des SFB 343 "Diskrete Strukturen in der Mathematik" Nr. 95-004, Universität Bielefeld,

[37] Some properties of fix-free codes, (with R. Ahlswede and B. Balkenhol), Proceedings First INTAS International Seminar on Coding Theory and Combinatorics 1996, Tshahkadzor, Armenia, 20-33, 6-11 October 1996.

1997

[38] The complete intersection theorem for systems of finite sets, (with R. Ahlswede), European J. Combinatorics, 18, 125-136, 1997.

[39] Counterexample to the Frankl-Pach conjecture for uniform, dense families, (with R. Ahlswede), Combinatorica, 17 (2), 299-301, 1997.

[40] Number theoretic correlation inequalities for Dirichlet densities, (with R. Ahlswede), J. Number Theory, Vol. 63, No. 1, 34-46, 1997.

1998

[41] The diametric theorem in Hamming spaces — optimal anticodes, (with R. Ahlswede), Proceedings First INTAS International Seminar on Coding Theory and Combinatorics 1996, Thahkadzor, Armenia, 1-19, 6-11 October 1996, Advances in Applied Mathematics 20, 429-449, 1998.

[42] The intersection theorem for direct products, (with R. Ahlswede and H. Aydinian), European Journal of Combinatorics 19, 649-661, 1998.

1999

[43] A pushing-pulling method: new proofs of intersection theorems, (with R. Ahlswede), Combinatorica 19 (1), 1-15, 1999.

[44] On the counting function for primitive sets of integers, (with R. Ahlswede and A. Sárközy), *J. Number Theory* 79, 330–344, 1999.

[45] On the quotient sequence of sequences of integers, (with R. Ahlswede and A. Sárközy), *Acta Arithmetica*, XCI.2, 117–132, 1999.

2000

[46] Splitting properties in partially ordered sets and set systems, (with R. Ahlswede), *Numbers, Information and Complexity*, Special volume in honour of R. Ahlswede on occasion of his 60th birthday, editors I. Althöfer, N. Cai, G. Dueck, L. Khachatryan, M. Pinsker, A. Sárközy, I. Wegener and Z. Zhang, Kluwer Acad. Publ., Boston, Dordrecht, London, 29–44.

[47] On prefix-free and suffix-free sequences of integers, (with R. Ahlswede and A. Sárközy), *Numbers, Information and Complexity*, Special volume in honour of R. Ahlswede on occasion of his 60th birthday, editors I. Althöfer, N. Cai, G. Dueck, L. Khachatryan, M. Pinsker, A. Sárközy, I. Wegener and Z. Zhang, Kluwer Acad. Publ., Boston, Dordrecht, London, 1–16.

[48] A diametric theorem for edges, (with R. Ahlswede), *J. Comb. Theory Series A* 92, 1–16.

2001

[49] On perfect codes and related concepts, (with R. Ahlswede and H. Aydinian), *Designs, Codes and Cryptography*, 22, 221–237 (2001).

[50] Extremal problems under dimension constraints, (with R. Ahlswede, H.K. Aydinian) *Electronic Notes in Discrete Mathematics* 10, 154–156 (2001).

[51] On primitive sets of squarefree integers, (with R. Ahlswede and A. Sárközy), *Periodica Mathematica Hungarica* Vol. 42 (1–2), 99–115 (2001).

2002

[52] The t -intersection Problem in the Truncated Boolean Lattice, (with R. Ahlswede, C. Bey, K. Engel), *European Journal Combinatorics*. 23(5), 471–487 (2002). [53] Unidirectional error control codes and related combinatorial problems, (with R. Ahlswede and H. Aydinian), in *Proceedings of Eight International workshop on Algebraic and Combinatorial Coding Theory*, 8–14 September, Tsarskoe Selo, Russia, 6–9.

2003

[54] Maximum Number of Constant Weight Vertices of the Unit n -Cube Contained in a k -Dimensional Subspace, (with R. Ahlswede and H. Aydinian), *Combinatorica*, Vol. 23(1): 5–22 (2003).

[55] Forbidden $(0,1)$ -Vectors in Hyperplanes of R_n : The Restricted Case, (with R. Ahlswede and H. Aydinian), *Designs, Codes Cryptography*, 29 (1–3), 17–28 (2003).

[56] Cone Dependence—A Basic Combinatorial Concept, (with R. Ahlswede), *Designs, Codes Cryptography*, 29(1–3), 29–40 (2003).

[57] Extremal problems under dimension constraints, (with R. Ahlswede and H. Aydinian), *Discrete Mathematics, Discrete Mathematics*, Special issue: EuroComb'01—Edited by J. Nešetřil, M. Noy and O. Serra, Vol. 273, No. 13, 9–21 (2003).

[58] Maximal antichains under dimension constraints, (with R. Ahlswede and H. Aydinian), *Discrete Mathematics*, Special issue: EuroComb'01—Edited by J. Nešetřil, M. Noy and O. Serra, Vol. 273, No. 13, 23–29 (2003).

[59] More about shifting techniques, (with R. Ahlswede and H. Aydinian), *European Journal of Combinatorics* 24(5), 551–556 (2003).

[60] A complexity measure for families of binary sequences, (with R. Ahlswede, C. Mauduit, A. Sárközy), *Periodica Mathematica Hungarica*, Vol. 46(2), 107–118 (2003).

2004

[61] On Shadows Of Intersecting Families, (with R. Ahlswede and H. Aydinian), *Combinatorica* 24(4), 555–566 (2004).

[62] On Bohman's conjecture related to a sum packing problem of Erdős, (with R. Ahlswede and H. Aydinian), *Proceedings of the American Mathematical Society*, Vol. 132, No. 5, 1257–1265.

[63] On the density of primitive sets, (with R. Ahlswede and A. Sárközy), *J. Number Theory* 109, 319–361.

2005

[64] Katona's Intersection Theorem: Four Proofs, (with R. Ahlswede), *Combinatorica* 25(1), 105–110 (2005).

- [65] Forbidden $(0, 1)$ -vectors in Hyperplanes of R^n : The unrestricted case, (with R. Ahlswede and H. Aydinian), Designs, Codes and Cryptography 37(1), 151–167 (2005).
- [66] On attractive and friendly sets in sequence spaces, (with R. Ahlswede), Electronic Notes in Discrete Mathematics 21: 193–198 (2005).

2006

- [67] Intersection theorems under dimension constraints, part I: the restricted case and part II: the unrestricted case, (with R. Ahlswede and H. Aydinian), J. Comb. Theory, Series A 113(3): 483–519 (2006).
- [68] On Attractive and Friendly Sets in Sequence Spaces, (with R. Ahlswede), GTIT-C 2006: 955–970.
- [69] On q -ary codes correcting all unidirectional errors of a limited magnitude, (with R. Ahlswede, H. Aydinian, Ludo M. G. M. Tolhuizen), Extended abstract in Proceedings of the International workshop on Algebraic and Combinatorial Coding Theory (ACCT), Kranevo, Bulgaria, June 19–25, 2004. Full text in *bool Codes, Polynomials, and Numbers, Selected work of Rom R. Varshamov and some of his students and colleagues dedicated to the memory of Academician Rom R. Varshamov*, 41–61, 2009.

Zoltán Füredi
Gyula O.H. Katona