Curriculum Vitae

1.Full name and date

- Vehkalahti, Roope Iikanpoika
- gender: Male
- date of writing the CV: 2.9.2015

2.Date and place of birth, nationality, current residence

- date and place of birth: born in Pori, Finland on January 17th 1977.
- citizenship: Finnish
- current residence: Finland
- married with two children

3. Education and degrees awarded

- PhD from mathematics, University of Turku, 22.5. 2008. The field of the doctoral thesis "Class Field Theoretic Methods in the Design of Lattice Signal Constellations" is algebraic coding theory.
- MSc from mathematics, University of Turku, 4.9. 2003, was accepted with the grade *laudatur* (excellent).

4. Linguistic skills

- Finnish: Mother tongue
- English: Excellent
- Swedish: Good

5.Current position

- On grant from Finnish Cultural Foundations, University of Turku, Finland 1.12.2014–
- Research career phase: Independent researcher

6.Previous work experience

- Post-doctoral research fellow, Academy of Finland/University of Turku, Finland, 1.9.2011-31.11.2014.
- Invited guest, Swiss Federal Institute of Technology at Lausanne (EPFL), 18.4.2011–16.4.2012
- Post-doctoral researcher in the project "Applications of Class Field Theory in Present and Future Multi-Antenna Communications" at the Department of Mathematics, University of Turku, Finland, 1. 7. 2009-31.8.2011.
- Several positions at the Department of Mathematics, University of Turku Finland, 1.7.2003-30.6.2009
- Paternal leaves: 28.8-10.9.2012, 21.05.2013 - 02.07.2013, 1.10–31.10.2013, 9.8.2014–29.8.2014.

7.Research funding as well as leadership and supervision

- Emil Aaltonen Foundation 9000 euro (2008).
- Finnish Cultural Foundation, Varsinais-Suomi regional fund 10000 euro (2008).
- Post-doctoral project from Academy of Finland (grant 252457) 266 327 euro (2011).
- Finnish Cultural Foundation, 26000 euro (2014).
- Wrote parts (concerning done and planned research) of application for following project: Applications of Class Field Theory in Present and Future Multi - Antenna Communications 01.01.2010 - 31.12.2012, 443 000 euro, Academy of Finland.
- Wrote parts (concerning done and planned research) of the application for the following project: "Applications of Class Field Theory in Present and Future Multi-Antenna Communications", 200 000 euro (2008), Emil Aaltonen Foundation.
- Graduate student: Toni Ernvall 2011-2015, supervised together with Jyrki Lahtonen, University of Turku and Camilla Hollanti, Aalto University.

8.Merits in teaching and pedagogical competence

- Master student: Cyril Becker, EPFL, 2012, master thesis, supervised together with Eva Bayer.

9. Other academic merits

- Referee for scientific and scholarly journals: Transactions on Information Theory, Transactions on Wireless Communication, Designs, Codes and Cryptography, Advances in Mathematics of Communication, Applicable Algebra and Engineering and several proceedings of major conferences.
- Acted as chair for session "MIMO 3" in 2010 IEEE Int. Symp. Inf. Theory and its Appl., Taichung, Taiwan, Oct 2010.

Relatively recent research visits:

- Professor Eva Bayer, Swiss Federal Institute of Technology at Lausanne (EPFL), Chair of Algebra and Geometry, 18.4.2011–16.4.2012.
- Professor Jean-Claude Belfiore, Telecom ParisTech (former ENST), France 19.3–23.3.2012.
- Professor Bharath Sethuraman, University of California, 16.5-23.5.2015.

Recent international visitors (acting as the main host):

- Dr Piotr Maciak, Swiss Federal Institute of Technology at Lausanne (EPFL), Lausanne, Switzerland, 15.-22.1.2013.
- Dr Laura Luzzi, ENSEA, Paris, France, 11.-17.3.2013.
- Dr Wittawat Kositwattanarerk, Nanyang Technological University, Sinagpore, 20.-26.4.2013.
- Dr Laura Luzzi, ENSEA, Paris, France, 11.-17.3.2014.
- Dr Laura Luzzi, ENSEA, Paris, France, 8.4.2015.-4.5.2015.
- Frequent speaker in the best information theory conferences, such as IEEE International Symposium on Information Theory and IEEE Information Theory Workshops.

Invited talks

- "Bounding error with algebra and ergodic theory", Fourth Finnish-Estonian Mathematical Colloquium, 2014.
- "Measuring the Growth of Inverse Determinants Sums of a Family of Quasi-Orthogonal Codes", International Zurich Seminar on Communications 2014.
- "Capacity and geometry of numbers in fading channels", IEEE IWSDA 2015, 7th International Workshop on Signal Design and its Applications in Communications, Indian Institute of Science, Bengaluru, India.

Invited talks kept by others, based on joint works

- "Connections Between Fading Channel Coding and Analytic Number Theory", 2013 IEEE Taiwan/Hong Kong Joint Workshop on Information Theory and Communications, kept by Francis Lu.
- "Dense MIMO Matrix Lattices and Class Field Theoretic Themes in Their Construction", Information Theory Workshop, Bergen, Norway, 2007, kept by J. Lahtonen.
- "Dense MIMO Matrix Lattices - A Meeting Point for Class Field Theory and Invariant Theory", 17th International Symposium on Applied Algebra, Algebraic Algorithms and Error-Correcting Codes, 2007, kept by J. Lahtonen.

Scientific and societal impact of research

- Few codes I have developed have been suggested for the (DVB) Next Generation Handheld (NGH) systems consortium's call for technologies.

Publications

Articles in Journals and in refereed conference proceedings (with major component that has not appeared in journal article)

- L.Luzzi and R.Vehkalahti, "Almost universal codes achieving ergodic MIMO capacity within a constant gap", **submitted** to *IEEE Trans. Inf. Theory.*
- R. Vehkalahti, "Remarks on criteria for achieving the optimal diversity-multiplexing gain trade-off ", **to be submitted** to *IEEE Trans. Inf. Theory.*
- T. Ernvall, J.Lahtonen, H.-F. Lu and R.Vehkalahti "An error event sensitive trade-off between rate and coding gain in MIMO MAC, **to appear** in *IEEE Trans. Inf. Theory.*
- R. Vehkalahti and L. Luzzi, "Number field lattices achieve Gaussian and Rayleigh channel capacity within a constant gap", in Proc. 2015 IEEE Int. Symp. Inform. Theory, Hong Kong, 2015.
- L.Luzzi and R. Vehkalahti, "Division algebra codes achieve MIMO block fading channel capacity within a constant gap", in Proc. 2015 IEEE Int. Symp. Inform. Theory, Hong Kong, 2015.
- B. Linowitz, M. Satriano and R. Vehkalahti, "A non-commutative analogue of the Odlyzko bounds and bounds on performance for space-time lattice codes", *IEEE Trans. Inf. Theory*, vol. 61, pp.1971– 1984, April 2015.
- R.Vehkalahti and L.Luzzi, "Measuring the Growth of Inverse Determinants Sums of a Family of Quasi-Orthogonal Codes", Proc. International Zurich Seminar on Communications, Zurich, 2014.
- R.Vehkalahti, W. Kositwattanarerk, and F. Oggier, Constructions A From Number Fields and Division Algebras, in Proc. 2014 IEEE Int. Symp. Inform. Theory (ISIT), Hawaii, USA, 2014.
- R. Vehkalahti, L. Luzzi and J.-C. Belfiore, Shifted inverse determinant sums and new bounds for the DMT of space-time lattice codes, in Proc. 2014 IEEE Int. Symp. Inform. Theory (ISIT), Hawaii, USA, 2014.
- R.Vehkalahti, H.-F. Lu, L.Luzzi, "Inverse Determinant Sums and Connections Between Fading Channel Information Theory and Algebra", *IEEE Trans. Inf. Theory*, vol 59, pp. 6060–6082, September 2013.
- L. Luzzi and R. Vehkalahti, A new design criterion for spherically-shaped division algebra-based space-time codes, Proc. 2013 IEEE Inform. Theory Workshop (ITW), Seville, Spain, Sept. 2013.
- R. Vehkalahti, Camilla Hollanti and Frédérique Oggier, "Fast-Decodable Asymmetric Space-Time Codes from Division Algebras" *IEEE Trans. Inf. Theory*, vol. 58, pp. 2362–2385, April 2012.
- R. Vehkalahti and C. Hollanti, Reducing complexity with less than minimum delay space-time lattice codes, in Proc. 2011 IEEE Inform. Theory Workshop (ITW), Paraty, Brazil, Oct. 2011.
- C. Hollanti, R. Vehkalahti, and Y. Nasser, Algebraic hybrid satellite-terrestrial space-time codes for digital broadcasting, in SFN, 2011 IEEE Workshop on Signal Processing Systems (SIPS), Beirut, Lebanon, 2011.
- R. Vehkalahti and H.-f. Lu, An algebraic look into MAC-DMT of lattice space-time codes, in Proc. IEEE Int. Symp. Inform. Theory (ISIT), St. Petersburg, Russia, 2011.
- H.-F. Lu, C. Hollanti, R. Vehkalahti, and J. Lahtonen, "DMT optimal code constructions for multiuser MIMO channel",*IEEE Trans. Inf. Theory*, vol. 57, pp. 3594–3617, June 2011.
- R. Vehkalahti, C. Hollanti, H.-F. Lu and J. Lahtonen, "Some Simple Observations on MISO codes", in Proc. 2010 IEEE Int. Symp. Inf. Theory and its Appl., Taichung, Taiwan, Oct 2010.
- R. Vehkalahti, "The Coding Gain of Real Matrix Lattices: Bounds and Existence Results", *IEEE Trans. Inf. Theory*, vol 56, pp. 4359– 4366, Sept. 2010.
- R. Vehkalahti, "Some Simple Observations on Lattice Codes, in Proc. 2009 IEEE Inf. Theory Workshop, Taormina, Italy, Oct. 2009.
- R. Vehkalahti, "Some Properties of Alamouti-Like Miso Codes, in Proc. 2009 IEEE Int. Symp. Inform. Theory, Seoul, South Korea, Jul. 2009.
- C. Hollanti, H.-F. Lu, and R. Vehkalahti, "An Algebraic Tool for Obtaining Conditional Non-Vanishing Determinants, in Proc. 2009 IEEE Int. Symp. Inform. Theory, Seoul, South Korea, Jul. 2009.
- R. Vehkalahti, C. Hollanti, J. Lahtonen and K. Ranto "On the Densest MIMO Lattices from Cyclic Division Algebras", *IEEE Trans. Inf. Theory*, vol 55, no 8, August 2009.
- H.-F. Lu, R. Vehkalahti, C. Hollanti, J. Lahtonen, Y. Hong, and E. Viterbo, "New Space-Time

Code Constructions for Two-User Multiple Access Channels", *IEEE J. on Special Topics in Signal Processing: Managing Complexity in Multi-user MIMO Systems*, pp. 939–957 Dec. 2009.

- C. Hollanti, J. Lahtonen, K. Ranto, R. Vehkalahti, and E. Viterbo, "On the Algebraic Structure of the Silver Code: A 2x2 Perfect Space-Time Code with Non-Vanishing Determinant, in Proc. 2008 IEEE Inf. Theory Workshop, Porto, Portugal, May 2008.
- J. Lahtonen and R. Vehkalahti, "Dense Mimo Matrix Lattices - a Meeting Point for Class Field Theory and Invariant Theory, in Proc. Applied Algebra, Algebraic Algorithms, and Error Correcting Codes (AAECC-17), Bangalore, India, 2007.
- J. Lahtonen, K. Ranto and R. Vehkalahti, "3-Designs from All Z4-Goethals-Like Codes with Block Size 7 and 8", *Finite Fields and Their Applications*, 13(4) pp. 815-827, 2007.

Articles in refereed conference proceedings that have later appeared as part of a journal article

- T. Ernvall and R. Vehkalahti, Construction of MIMO MAC Codes Achieving the Pigeon Hole Bound, in Proc. 2012 IEEE Int. Symp. Inform. Theory (ISIT), Boston, USA, 2012.
- R. Vehkalahti and L. Luzzi, Connecting DMT of Division Algebra Space-Time Codes and Point Counting in Lie Groups, in Proc. 2012 IEEE Int. Symp. Inform. Theory (ISIT), Boston USA.
- R. Vehkalahti and H.-f. Lu, Diversity-multiplexing Gain Tradeoff: a Tool in Algebra?, in Proc. 2011 IEEE Inform. Theory Workshop (ITW), Paraty, Brazil, Oct. 2011.
- R. Vehkalahti and C. Hollanti, A General Framework for Constructing Fast-Decodable Asymmetric Space-Time Codes, in Proc. IEEE Int. Symp. Inform. Theory (ISIT), St. Petersburg, Russia, 2011.
- T. Jokela, C. Hollanti, J. Lahtonen, R. Vehkalahti, and J. Paavola, Performance evaluation of 4x2 MIMO schemes for mobile broadcasting, in Proc. 2011 IEEE Int. Symp. on Broadband Multimedia Systems and Broadcasting, Germany, 2011.
- R.Vehkalahti, C. Hollanti ja H. Lahtonen, " A Family of Cyclic Division Algebra Based Fast-Decodable 4×2 Space-Time Block Codes",in Proc. 2010 IEEE Int. Symp. Inf. Theory and its Appl., Taichung, Taiwan, Oct 2010
- F. Oggier, C. Hollanti, and R. Vehkalahti, " An Algebraic MIDO-MISO Code Construction", in Proc. 2010 International conference on signal processing and communications (SPCOM 2010), Bangalore, India, July 2010.
- F. Oggier, R. Vehkalahti, and C. Hollanti, "Fast-decodable MIDO codes from crossed product algebras", in Proc. 2010 IEEE Int. Symp. Inform. Theory (ISIT), Austin, TX, June 2010.
- H.-F. Lu, J. Lahtonen, R. Vehkalahti, and C. Hollanti, "Remarks on the Criteria of Constructing Mac-dmt Optimal Codes", in Proc. 2010 IEEE Inform. Theory Workshop, Cairo, Egypt, 2010.
- J. Lahtonen, R. Vehkalahti, H. F. Lu, C. Hollanti, and E. Viterbo, "On the Decay of the Determinants of Multiuser Mimo Lattice Codes", in Proc. 2009 IEEE Inform. Theory Workshop, Cairo, Egypt, 2010.
- R. Vehkalahti, "Constructing Optimal Division Algebras for Space-Time Coding, in Proc. 2007 IEEE Inform. Theory Workshop, Solstrand, Norway, Jul. 2007.
- J. Lahtonen, K. Ranto, R. Vehkalahti, "3-Designs from Z4-Goethals-like codes and variants of cyclotomic polynomials, In International Workshop of Coding and Cryptography, pp. 425-434, March 14-18, 2005, Bergen, Norway. Coding and Cryptography, Springer LNCS 3969, pp. 55-68, 2006.
- C. Hollanti, J. Lahtonen, K. Ranto, and R. Vehkalahti, "Optimal Matrix Lattices for MIMO Codes From Division Algebras, in Proc. 2006 IEEE Int. Symp. Inform. Theory, Seattle, WA, Jul. 2006.

Thesis

G4 R. Vehkalahti, "Class Field Theoretic Methods in the Design of Lattice Signal Constellations", Ph.D. thesis, University of Turku, 2008, available at https://oa.doria.fi/handle/10024/36604

Other

D1 C. Hollanti and R. Vehkalahti, "Aika, avaruus ja algebrat tiedonsiirrossa", Arkhimedes pp. 14-22, June 2009.
A popularized article explaining relations between modern communication and algebraic structures in the Finnish magazine for mathematicians and physicists.

D1 R. Vehkalahti,"Jokke Häsän ja Johanna Rämön kirja Johdatus abstraktiin algebraan keskustelee ja motivoi", Arkhimedes pp. 38-39, May 2012.
A review of a Finnish algebra book in the Finnish magazine for mathematicians and physicists