

## Curriculum vitae

### PERSONAL INFORMATION

Family name, First name: LOEBL MARTIN  
Nationality: Czech Republic  
URL for web site: <http://kam.mff.cuni.cz/~loebl>

### EMPLOYMENT

1989- present: Department of Applied Mathematics KAM MFF UK, Faculty of Mathematics and Physics, Charles University Prague, Czech Republic  
From 2007 Head of the Optimization group of KAM MFF UK  
From 2008 Full Professor  
From 2015 Head of the Department of Applied Mathematics KAM MFF UK.

### FELLOWSHIPS AND AWARDS

1986 Prize of the Czechoslovak Academy of Sciences (for a joint paper with J. Matousek)  
1990 International Meeting of Young Computer Scientists (IMYCS) award  
1990 – 1991 Humboldt Research Fellow, Forschungsinstitut für Diskrete Mathematik, Universität Bonn, Germany (12 months)  
1993 Postdoctoral Fellow, DIMACS, Rutgers University, U.S.A.  
1994 – 1995 NSERC Canada International Fellow, University of Waterloo, Canada  
2018 **Member of the Learned Society of the Czech Republic**

### STAYS ABROAD

Long: Georgia Institute of Technology, Atlanta, U.S.A. 2000 – 2001.  
Short: Budapest, Technion Haifa, Paris 6, Paris 7, Poincaré Institute Paris, Bordeaux, Nancy, Rome, Pavia, Barcelona, Berlin, Bielefeld, Hamburg, Koeln, Oxford, Cambridge, Warwick, Royal Holloway, Sao Paulo, Buenos Aires, Santiago, Waterloo, Vancouver, Princeton, Berkeley, Stanford, Los Alamos National Laboratory, Rutgers University, Atlanta, Columbia University.

### SUPERVISION OF GRADUATE STUDENTS AND POSTDOCTORAL FELLOWS

Supervisor of 9 Ph.D. Students (6 Czechs, 2 Chileans, 1 Iranian, 7 finished, 7 have academic jobs):

Marek Janata (2005)

Ondrej Pankrac (2006) Assistant Professor Charles University Prague <http://iuuk.mff.cuni.cz/~pangrac/>

Jan Vondrak (2007) Associate Professor Stanford University U.S.A. <http://theory.stanford.edu/~jvondrak/>

Hossein Teimoori (2010) Kashani University Iran <http://ghiasodin.academia.edu/HosseinTeimooriFaal>

Jirka Fink (2011) Assistant Professor Charles University Prague <https://kam.mff.cuni.cz/~fink/>

Jose Zamora (2013) Assistant Professor Universidad Andres Bello Chile <http://mat-unab.cl/~jzamora/>

Pavel Rytir (2013) Lecturer Czech Technical University [cs.felk.cvut.cz/en/people/rytirpav](https://cs.felk.cvut.cz/en/people/rytirpav)

Andrea Jimenez (2012) I was co-supervisor of Andrea's doctoral thesis Universidad de Chile; Universidad de Valparaiso Chile <http://ajimenez.cimfav.cl/>

Jakub Cerny started 2017

Supervisor of 2 postdoctoral fellows (1 British, 1 Spanish) in the Czech Republic:

Anna DeMier (2006) Associate Professor UPC Barcelona <https://mat-web.upc.edu/people/anna.de.mier/>

Iain Moffatt (2006) Royal Holloway University of London <http://www.personal.rhul.ac.uk/uxah/001/>

For more information see my Ten years track-record.

### RESPONSIBILITIES, COMMISSIONS OF TRUST

European Commission, REA scientific evaluator for FP7 and H2020.

2012 - 2016 member of the panel of Informatics of the Grant agency of Czech Republic GACR.

Prize of Jirka Matousek <http://kam.mff.cuni.cz/cenajm.html> I introduced this prize in 2015 for excellent doctoral students in memory of our colleague Jirka Matousek.

Member of hiring and reviewing committees in Argentina, Brazil, Chile, Czech Republic, Germany.  
Reviewer for grant agencies in Argentina, Brazil, Chile, Germany, Israel, Switzerland, U.S.A.

## PUBLICATIONS

Coauthor of 35+ journal publications since 2000 (70+ total), for details see my web page. A sample of older papers:

A. Galluccio, M. Loeb, J. Vondrak, A New Algorithm for the Ising Problem: Partition Function for Finite Lattice Graphs, *Physical Review Letters* **84**, 5924-5927 (2000).

M. Kiwi, M. Loeb, J. Matousek, Expected Length of the Longest Common Subsequence For Large Alphabets, *Advances in Mathematics* **197** 2005.

S. Garoufalidis, M. Loeb, [Random Walks and the Colored Jones Function](#) *Combinatorica* 25/6 2005

S. Garoufalidis, M. Loeb, A non-commutative formula for the Colored Jones Function, *Math. Annalen* 336, 2006.

M. Loeb, Chromatic Polynomial, q-Binomial Counting and Colored Jones Function, *Advances in Mathematics* 211-2, 2007.

## PATENTS

U.S.A. patent number 08856940 (2015) Information Concealing. For details see my Ten years track-record.

## BOOKS

Martin Loeb, *Discrete Mathematics in Statistical Physics*, ISBN 978-3-834-89329-1(Print) 978-3-528-03219-7(Online), Vieweg+Teubner Verlag (2010); **10K chapter downloads**, see Bookmetrix <http://www.bookmetrix.com/detail/book/3a9f6abb-d87d-4e2d-a2dd-852cd6e687ca#downloads>

M. Klazar, J. Kratochvil, M. Loeb, R.Thomas, P. Valtr (eds) *Topics in Discrete Mathematics: Dedicated to Jarik Nešetřil on the Occasion of his 60th birthday*, ISBN 978-3-540-33700-3, Springer Verlag, Series Algorithms and Combinatorics (2006); received **Prize of Rector of Charles University**.

M. Loeb, J. Nešetřil, R. Thomas (eds) *A Journey Through Discrete Mathematics: A Tribute to Jiri Matousek* ISBN 978-3-319-44479-6 Springer Verlag; received **Prize of Dean of MFF of Charles University 2018**.

## Horizon 2020 MSCA FUNDING

I am the coordinator of the H2020 MSCA-RISE cooperative staff exchange project called Combinatorial Structures and Processes (CoSP) accepted for funding in 2018. The partners are Charles University (Czechia), CNRS (France), Technion (Israel), Los Alamos National Security (U.S.A.), Princeton University (U.S.A.), Rutgers University (U.S.A.) and Simon Fraser University (Canada).

## MAJOR COLLABORATIONS

I started my academic career with research in graph theory and algorithms. My master thesis was related to discrete optimisation and my doctoral thesis focused on combinatorial functions growing extremely fast; this is related to unprovability in Finite Set Theory. With **Jirka Matousek** and **Jarik Nešetřil** (my supervisor) we achieved several interesting results (see e.g. *Proceeding of AMS* 116,3 (1992)). My first paper with **Ron Aharoni** is from the field of infinite combinatorics.

I started working on matching theory with **Svatopluk Poljak**. In a series of papers we characterized complexity of subgraph packing, solving a problem posed by Lovasz (see e.g. *Journal of Combinatorial Theory-B* 59,1 (1993)).

In a joint paper with **Paul Erdos**, **Zoltan Furedi** and **Vera Sos** (*Studia Sci. Math. Hungar.* 30 (1995)) we studied the discrepancy of hypergraphs and introduced the extensively studied **Loeb-Komlos-Sos Conjecture** (see paragraph on Diana Piguet in my Ten years track-record).

My view of mathematics changed in the second half of the 1990's when I read a seminal paper of Kasteleyn which started the theory of Kasteleyn orientations. In spring 2016 in Berkeley I attended a lecture of Valiant, and he spoke equally enthusiastically about the same Kasteleyn's paper. With **Anna Galluccio** we proved the formula conjectured by Kasteleyn in the beginning of sixties (the Arf-invariant formula; see the discussion and references in the Extended Synopsis). Our method was implemented by **Jan Vondrak** (see paragraph on Jan Vondrak in my Ten years track-record).

A problem from informatics let me to study repeats in DNA with **Lukas Kencl** and **Jenny Blamey** (see PATENTS in my Ten years track-record). I find the problem of DNA repeats fascinating. See *Advances in Mathematics* 197 (2005) (with **Marcos Kiwi** and Jirka Matousek) for my earlier result motivated by bioinformatics.

Next period 2008—2019 is described below in more detail.

From 2019, I am interested in the discrete optimisation again. With Jirka Fink and Petra Pelikanova we optimised the winter road maintenance plans in the Plzen region of the Czech Republic. From 2020, I coordinate a multidisciplinary project motivated by the pandemics to design a distribution system for crises.

**Selected publications 2008-2019 (ordered thematically, the full list is in my web page).**

**M. Loeb, I. Moffatt, The chromatic polynomial of fatgraphs and its categorification, *Advances in Mathematics* 217, 2008.** This is the main result from Iain Moffatt's stay in Prague. We discovered new algebraic connections of the graph polynomials of embedded graphs and the Jones polynomial of knots. This work's suggested explorations of graphs are still quite open.

**M. Klazar, M. Loeb, I. Moffatt, The Potts model and chromatic functions of graphs, *Annales de l'Institut Henri Poincaré D (Combinatorics, Physics and their Interactions), European Mathematical Society* 1(1) 47- 60 (2014).**

This work confirms one of important suggestions of paper d.: that the Potts partition function with a magnetic field contribution is as strong as the strongest studied graph polynomials. It is plausible that with simple preprocessing such Potts partition function can distinguish non-isomorphic graphs.

**M, Loeb, J.-S. Sereni, Isomorphism of weighted trees and Stanley's isomorphism conjecture for caterpillars, *Annales de l'Institut Henri Poincaré D (Combinatorics, Physics and their Interactions), European Mathematical Society* 2019.** This paper, a follow-up to d. and 2., constitutes an initial result towards one of the goals of the proposal. It proves the extensively studied Stanley's isomorphism conjecture for the class of special trees called caterpillars. This special case was investigated since the formulation of the conjecture in the 1990's.

**M. Loeb, L. Zdeborova, The 3D Dimer and Ising Problems Revisited, *European J. Combinatorics* 29/3, 2008.** The paper simplifies and generalises my previous work on applications of the Kasteleyn method to the 3-dimensional Ising problem (one of the main objectives of this proposal). Lenka Zdeborova, now in Institute de Physique Theoretique, Saclay, France, was a bright physics student in Prague. We keep speaking with Lenka about mathematics, physics and informatics; we jointly organise the Czech Workshop on Complex Systems, see my CV. Lenka is one of external collaborators of the project.

**M. Loeb, [Binary linear codes via 4D discrete Ihara-Selberg function](#), *Annales de l'Institut Henri Poincaré D (Combinatorics, Physics and their Interactions), European Mathematical Society* (2019).** This paper is one of the main reasons to write this proposal: it provides a formula how to express the weight enumerator of an arbitrary binary linear code as a single infinite product. In particular, this paper opens up a fundamentally new way to study the logarithm of the Ising partition function for 3D cubic lattices. This new approach generalises the formula of R. Feynman from the beginning of 60's from the cycle space of the planar graphs to general binary linear codes.

**M. Loeb, P. Somberg, Discrete Dirac Operators, Critical Embeddings and Ihara-Selberg Functions, *The Electronic Journal of Combinatorics* 22, 1 (2015).** In 2007 I learned about the work of Cimasoni and Reshetikhin on the Arf-invariant formula, and of Mercat on discrete analytic functions. Kenyon defined discrete Dirac operators on critical planar graphs and observed that the dimer partition function is determined by the local geometric information of a critical planar embedding. I became fascinated by attempts of Cimasoni to extend the results of Kenyon to the graphs critically embedded on a surface of genus bigger than zero. I realised that one needs to use the theory of Kac-Ward-Feynman-Sherman based on products and rotations (see 5.; an extension of this theory is a main theme of this proposal). At that time, these results were forgotten. I explained them in Prague to Somberg, Cimasoni and Masbaum and it resulted in several papers of Cimasoni and also our paper.

**M. Loeb, G. Masbaum, On the optimality of the Arf invariant formula for graph polynomials, *Advances in Mathematics* 226 (2011).** We continued to discuss mathematics with Gregor Masbaum and we managed to prove Norine's conjecture for the Ising partition function. This result provides an exponential complexity lower bound in a very restricted but commonly used model of computation. I was invited to speak about the result by communities across fields. The paper is involved but the arguments are well understood. I believe this may be one of my most important results.

**E. Berger, K. Choromanski, M. Chudnovsky, J. Fox, M. Loeb, A. Scott, P. Seymour, S. Thomasse, *Tournaments and colouring, J.Comb.Theory, Ser.B* 103(1) 1- 20 (2013).** This is my recent work on colourings in the structural graph theory.

**R. Aharoni, M. Loeb, The Odd Case of Rota's Bases Conjecture, *Advances in Mathematics* 282 (2015)**

**427-442.** I heard from Aharoni about the Rota's bases conjecture, that it is implied (for each even size) by the Alon-Tarsi conjecture, and a beautiful enumeration proof of this fact by Onn. I found a non-commutative generalization of Onn's proof, and it was the beginning of our joint work. This paper contains proof of 'half of Alon-Tarsi conjecture'. One objective in this research area has been to understand the List coloring conjecture. In the course of our work with Ron a group formed including Berger, Chudnovsky, Kotlar and Ziv, which extensively collaborates.

**R. Aharoni, N. Alon, E. Berger, M. Chudnovsky, D. Kotlar, M. Loeb, R. Ziv** [Fair representation by independent sets](#) in: **A Journey Through Discrete Mathematics: A Tribute to Jiri Matousek, Springer (2017)**. This is my recent work in structural graph theory and the topological methods. The considerations of this work will contribute to the part of the project on the List coloring conjecture.

#### **PATENTS**

J. Blamey, L. Kencl, M. Loeb: Information concealing, **Czech** patent number 301799 (2010).

J. Blamey, L. Kencl, M. Loeb: Information concealing, **U.S.A.** patent number 08856940 (2015).

Protection of sensitive content is crucial for extensive information sharing. The patents concern information concealing to enable information sharing, by introduction and maintenance of repeats. The patented claims are from Informatics and Structure of DNA.

#### **MAJOR CONTRIBUTION TO EARLY CAREERS OF EXCELLENT RESEARCHERS**

**Jan Vondrak**, Associate Professor, Stanford University <http://theory.stanford.edu/~jvondrak/>

Jan wrote his master thesis (1999) resulting in influential papers [GLV1, GLV2] under my supervision. After obtaining his master degree Jan completed doctoral studies at MIT (2005, supervisor M.X. Goemans). After the doctorate at MIT Jan completed his doctoral studies at Charles University in 2007 under my supervision. Jan is interested in optimization of submodular functions, approximation algorithms, algorithmic game theory and probabilistic combinatorics. We have 3 joint papers related to algorithmic and computational aspects of the theory of Kasteleyn orientations. We regularly discuss mathematics.

**Jirka Fink**, Assistant Professor, Charles University <https://kam.mff.cuni.cz/~fink/>

Jirka wrote his master thesis and doctoral thesis (2011) in applied discrete mathematics under my supervision. After obtaining the doctorate Jirka continued to do applications and scientific computation in his postdocs and he is becoming a leader in this field.

**Diana Piquet**, Researcher, Czech Academy of Sciences <http://uivty.cs.cas.cz/~piquet/>

Diana wrote her doctoral thesis in 2008. Her supervisor was Jarik Nesetril and I contributed in a major way to Diana's supervision. Her thesis was on the **Loeb- Komlos- Sos Conjecture** mentioned in my CV. This has been a leading topic of Diana's research. A group of researchers including Jan Hladky, Maya Stein, Julia Bottcher and Peter Allen established around her. Diana won prestigious fellowships, and she is clearly established at the frontiers of research in graph theory worldwide.

**Iain Moffatt**, Royal Holloway University of London <http://www.personal.rhul.ac.uk/uxah/001/>

Iain did his postdoc with me in 2006 and since then we have completed 3 publications. It is clear from Iain's achievements that he established himself as a leader in the community of graph polynomials.