Prof. Dr. Max-K. von Renesse

Curriculum Vitae

Scientific Profile & Vision

- **Research Areas:** Stochastic Analysis, Optimal Transport, Geometric Analysis
- **Research Perspective:** Geometric principles governing stochastic dynamics on probability spaces, especially in interacting systems.
- **Current Directions:** Optimal transport in geometric deep learning and mathematical foundations of artificial intelligence; measure-valued stochastic dynamics; singular interacting particle systems; entropic regularization and quantum optimal transport.

Professional Career & Personal Information

Since 2011	**Professorships:** Professor (W3) at Univ. Leipzig (since 2012; declined W3 offer from Univ. Jena) • Professor (W2) at LMU Munich (2011–2012; declined W2 offer from Univ. Paderborn)
2003–2011	**PostDoc & Habilitation:** University Assistant (C1) and Habilitation (2010) at TU Berlin • PostDoc at Courant Institute, New York (2005) and TU Berlin (2003–2004)
1992–2002	**Education & PhD:** In-house Consultant, IKB Deutsche Kreditbank AG (2002) • PhD (2002) and Scientific Assistant at Univ. Bonn (Advisor: Prof. K.-T. Sturm) • Studies of Mathematics, Physics & Computer Science in Marburg, Bonn, and St. Petersburg (Diploma 1997)
Personal	Born February 28, 1972 • Nationality: German • Married, five children

Five Selected Publications

1. **M.-K. von Renesse and K.-T. Sturm.** *Transport inequalities, gradient estimates, entropy, and Ricci curvature.* Communications on Pure and Applied Mathematics (CPAM), 2005.
   Main result: Characterizes lower Ricci curvature bounds via entropy convexity on Wasserstein space, providing a foundation for the later Lott–Sturm–Villani theory.
2. **M.-K. von Renesse and K.-T. Sturm.** *Entropic measure and Wasserstein diffusion.* Annals of Probability, 2009.
   Main result: Introduces stochastic diffusion processes on Wasserstein space of probability measures.
3. **M.-K. von Renesse.** *An optimal transport view of Schrödinger's equation.* Canadian Mathematical Bulletin, 2012.
   Main result: Derives Schrödinger's equation as Newtonian dynamics on Wasserstein space.
4. **V. Konarovskyi, T. Lehmann, and M.-K. von Renesse.** *Dean–Kawasaki dynamics: ill-posedness vs. triviality.* Electronic Communications in Probability, 2019.
   Main result: Establishes a fundamental dichotomy for Dean–Kawasaki SPDEs.
5. **M. Hehl, M.-K. von Renesse, and M. Weber.** *Neural Feature Geometry Evolves as Discrete Ricci Flow.* ICML 2026 (Spotlight Paper).
   Main result: Shows that feature evolution in neural networks can be modeled as a discrete Ricci flow on data graphs.

Scholarships & Awards

- German National Merit Foundation (Studienstiftung), 1994–1997
- German Academic Exchange Service (DAAD), 1996–1997
- Hausdorff Award of Bonn Faculty of Mathematics, 2004
- Humboldt Foundation Feodor-Lynen Fellowship, 2005–2006

Third Party Funding (Selection since 2017)

- Principal Investigator: School of Embedded Composite AI (SECAI), Dresden/Leipzig (2022–2027), total volume: €13.2M (BMBF)
- Principal Investigator: DFG Priority Programme 2026 "Geometry at Infinity"
- Host/Mentor: Humboldt Fellowship (Dr. Vitalii Konarovskyi, approx. €210,000)
- Host/Mentor: DAAD PRIME Fellowship (Dr. Mark Kirstein, approx. €110,000)
- Academic Fellow: IMPRS Graduate School at MPI-MIS Leipzig

Academic Mentorship

Supervised PhD Students

- Dr. Sebastian Andres (2009, TU Berlin) – now Professor (W3), TU Braunschweig
- Dr. Stefan Bachmann (2019, Univ. Leipzig)
- Dr. Tobias Weihrauch (2020, Univ. Leipzig)
- Dr. Tobias Lehmann (2022, Univ. Leipzig)
- Dr. Fenna Müller (2025, Univ. Leipzig)
- Dr. Marie Bormann (2025, Univ. Leipzig)
- Dr. Qi Yan (2025, Chinese Academy of Sciences, joint supervision)
- Current PhD students: Alexander Weiss, Kevine Toukam, Marvin Randig, Moritz Hehl

Postdoctoral Mentorship

- Prof. Dr. Martina Hofmanová – now Professor (W3), Univ. Bielefeld
- Prof. Dr. Vitalii Konarovskyi – now Professor (W2), Univ. Hamburg
- Dr. Florent Barret – now Maître de Conférences, Univ. Paris Nanterre
- Dr. Giovanni Conforti – now Associate Professor, Univ. Padova
- Dr. Abdelhadi Es-Sarhir – now Professor, Ibn Zohr Univ. Agadir
- Dr. Jonas Tölle – now Senior Lecturer, Aalto Univ. Helsinki
- Other mentored postdocs: Dr. Robert Baumgarth, Dr. Mark Kirstein, Dr. Victor Marx

Service to the Community

- Regular reviewer for major international journals including *Annals of Probability*, *Archive for Rational Mechanics and Analysis*, *Communications in Mathematical Physics*, *Electronic Journal of Probability*, *Inventiones Mathematicae*, *Journal of Functional Analysis*, *Probability Theory and Related Fields*, *SIAM Journal on Mathematical Analysis*, and *Stochastic Processes and their Applications*.
- Reviewer for funding agencies including DFG, EPSRC, FWF, NWO, Humboldt Foundation, and NSERC.
- External referee for PhD theses in Germany, France, UK, and Romania.
- External committee member and reviewer for professorial appointments in Germany and Austria.

- Vice Dean (2014–2017) and Dean (2017–2019) of the Faculty of Mathematics and Computer Science, Leipzig University.
- Co-speaker jointly with Sylvia Schöneburg-Lehnert of the Saxonian University Initiative for School Mathematics ("Sächsischer Arbeitskreis Schulmathematik"), since 2023.
- Organizer and co-organizer of numerous international conferences and workshops in stochastic analysis, optimal transport, fluctuating hydrodynamics, geometric analysis, and data science.

Selected Invited Talks (since 2021)

- MFO Conferences and Workshops, Oberwolfach (2021, 2023, 2025)
- Imperial College London (2022, 2025)
- Chinese Academy of Sciences, Beijing (2023)
- IHP Paris (2023)
- EPFL Lausanne (2025)
- La Sapienza Rome (2025)
- TU Munich, TU Braunschweig, Univ. Hamburg, Dortmund, Chemnitz, Hagen
- International conferences in Lisbon, Lake Como, Bucharest, Sendai, and Münster

Teaching (Selection since 2012)

Lectures

- Financial Mathematics I (Discrete-Time Option Pricing)
- Geometric Stochastic Processes
- Linear Algebra for Physicists
- Malliavin Calculus and Stochastic Analysis on Manifolds
- Mathematics I & II for Economics
- Mathematical Foundations of Machine Learning
- Mathematical Statistics
- Mathematical Statistical Mechanics
- Optimal Transport
- Rough Paths
- Stochastic Differential Equations and Financial Mathematics
- Probability Theory I & II
- Stochastic Analysis
- Stochastic Partial Differential Equations
- Stochastic Processes I & II

Seminars

- Determinantal Point Processes
- Markov Chains and Applications
- Machine Learning
- Neural Networks
- Optimal Transport
- Quantum Field Theory and Regularity Structures
- Spectral Graph Theory
- Support Vector Machines
- Random Graphs

Undergraduate Supervision

- Supervision of more than 30 diploma and undergraduate theses in mathematics, particularly in stochastic analysis, mathematical finance, optimization, statistics, and machine learning.

Complete List of Publications (Thematically Structured)

(A) Geometric Analysis, Ricci Curvature & Optimal Transport

[1] M.-K. von Renesse and K.-T. Sturm. *Transport inequalities, gradient estimates, entropy, and Ricci curvature.* Communications on Pure and Applied Mathematics, 58(7):923–940, 2005.

[2] M.-K. von Renesse and K.-T. Sturm. *Entropic measure and Wasserstein diffusion.* Annals of Probability, 37(3):1114–1191, 2009.

[3] M.-K. von Renesse. *An optimal transport view of Schrödinger's equation.* Canadian Mathematical Bulletin, 55(4):858–869, 2012.

[4] B. Güneysu and M.-K. von Renesse. *Molecules as metric measure spaces with Kato-bounded Ricci curvature.* C. R. Math. Acad. Sci. Paris, 358(5):595–602, 2020.

(B) Stochastic Analysis, Interacting Particle Systems & Dean–Kawasaki Theory

5. V. Konarovskyi, T. Lehmann, and M.-K. von Renesse. *Dean–Kawasaki dynamics: ill-posedness vs. triviality.* Electronic Communications in Probability, 24, 2019.

6. V. Konarovskyi, T. Lehmann, and M.-K. von Renesse. *On Dean–Kawasaki dynamics with smooth drift potential.* Journal of Statistical Physics, 178(3):666–681, 2020.

7. F. Müller, M.-K. von Renesse, and J. Zimmer. *Well-posedness for Dean–Kawasaki models of Vlasov–Fokker–Planck type.* Proceedings of the Royal Society A, 2025.

8. A. Dorogovtsev, V. Konarovskyi, and M.-K. von Renesse. *A central limit theorem for modified massive Arratia flow.* arXiv preprint, arXiv:2408.05030, 2024.

9. M.-K. von Renesse and A. Weiss. *Strong Feller Regularisation of 1-d Nonlinear Transport by Reflected Ornstein–Uhlenbeck Noise.* Preprint, arXiv:2508.01355, 2025.

(C) Wasserstein Dynamics, Diffusions & Infinite-Dimensional Systems

10. V. Konarovskyi and M.-K. von Renesse. *Modified massive Arratia flow and Wasserstein diffusion.* Communications on Pure and Applied Mathematics, 72(4):764–800, 2019.

11. V. Konarovskyi and M.-K. von Renesse. *Reversible coalescing–fragmenting Wasserstein dynamics on the real line.* Journal of Functional Analysis, 286(8), 2024.

12. V. Konarovskyi, V. Marx, and M.-K. von Renesse. *Spectral gap estimates for Brownian motion on domains with sticky-reflecting boundary diffusion.* To appear in *Journal of Geometric Analysis*, arXiv:2106.00080, 2021.

13. M. Bormann, M.-K. von Renesse, and F.-Y. Wang. *Functional inequalities for Brownian motion on manifolds with sticky-reflecting boundary diffusion.* Probability Theory and Related Fields, 2024.

14. S. Andres and M.-K. von Renesse. *Particle approximation of the Wasserstein diffusion.* Journal of Functional Analysis, 258(11), 2010.

15. M.-K. von Renesse and J. M. Tölle. *On an EVI curve characterization of Hilbert spaces.* Journal of Mathematical Analysis and Applications, 385(1), 2012.

(D) Variational Methods, Gradient Flows & PDE Structures

16. M. Bormann, L. Monsaingeon, D. R. M. Renger, and M.-K. von Renesse. *A gradient flow that is none: heat flow with Wentzell boundary condition.* Accepted for publication in *Indagationes Mathematicae*, arXiv:2506.22093, 2025.

17. G. Conforti and M.-K. von Renesse. *Couplings, gradient estimates and logarithmic Sobolev inequality for Langevin bridges.* Probability Theory and Related Fields, 172:493–524, 2018.

18. F. Barret and M.-K. von Renesse. *Averaging principle for diffusion processes via Dirichlet forms.* Potential Analysis, 41(4):1033–1063, 2014.

19. S. Andres and M.-K. von Renesse. *Uniqueness and regularity for a system of interacting Bessel processes via the Muckenhoupt condition.* Transactions of the American Mathematical Society, 364(3):1413–1426, 2012.

20. A. Es-Sarhir, M.-K. von Renesse, and W. Stannat. *Estimates for the ergodic measure and polynomial stability of plane stochastic curve shortening flow.* NoDEA Nonlinear Differential Equations and Applications, 19(6):663–675, 2012.

21. M.-K. von Renesse and M. Scheutzow. *Existence and uniqueness of solutions of stochastic functional differential equations.* Random Operators and Stochastic Equations, 18(3):267–284, 2010.

22. A. Es-Sarhir, M.-K. von Renesse, and M. Scheutzow. *Harnack inequality for functional SDEs with bounded memory.* Electronic Communications in Probability, 14:560–565, 2009.

(E) Optimal Transport, Geometry & Computational Methods

23. B. Sturmfels, S. Telen, F.-X. Vialard, and M.-K. von Renesse. *Toric geometry of entropic regularization.* Journal of Symbolic Computation, 120, 2024.

24. T. Lehmann, M.-K. von Renesse, A. Sambale, and A. Uschmajew. *A note on overrelaxation in the Sinkhorn algorithm.* Optimization Letters, 16(8):2209–2220, 2022.

25. M. Randig and M.-K. von Renesse. *Dual block gradient ascent for entropically regularised quantum optimal transport.* arXiv preprint, arXiv:2503.17590, 2025.

(F) Mathematics & Artificial Intelligence / Geometric Deep Learning

26. M. Hehl, M.-K. von Renesse, and M. Weber. *Neural Feature Geometry Evolves as Discrete Ricci Flow.* Accepted at ICML 2026 (Spotlight Paper), arXiv:2509.22362.

(G) Additional Contributions in Stochastic Geometry and Mathematical Physics

27. P. Fuchs, A. Jüngel, and M.-K. von Renesse. *On the Lagrangian structure of quantum fluid models.* Discrete and Continuous Dynamical Systems, 34(4):1375–1396, 2014.

28. A. Es-Sarhir and M.-K. von Renesse. *Ergodicity of stochastic curve shortening flow in the plane.* SIAM Journal on Mathematical Analysis, 44(1):224–244, 2012.

29. M. Hofmanová, M. Röger, and M.-K. von Renesse. *Weak solutions for a stochastic mean curvature flow of two-dimensional graphs.* Probability Theory and Related Fields, 168:373–408, 2017.

30. N. Dirr, F. Dragoni, and M.-K. von Renesse. *Evolution by mean curvature flow in sub-Riemannian geometries: a stochastic approach.* Communications on Pure and Applied Analysis, 9(2):307–326, 2010.

31. M.-K. von Renesse. *On local Poincaré via transportation.* Mathematische Zeitschrift, 259(1):21–31, 2008.

32. M.-K. von Renesse, M. Yor, and L. Zambotti. *Quasi-invariance properties of a class of subordinators.* Stochastic Processes and their Applications, 118(11):2038–2057, 2008.

33. M.-K. von Renesse. *Intrinsic coupling on Riemannian manifolds and polyhedra.* Electronic Journal of Probability, 9(14):411–435, 2004.

34. M.-K. von Renesse. *Heat kernel comparison on Alexandrov spaces with curvature bounded below.* Potential Analysis, 21(2):151–176, 2004.

35. M.-K. von Renesse. *A counterexample to Hencky plasticity in the case of a thin plate under vertical load.* Journal of Mathematical Sciences (New York), 97(4):4306–4310, 1999.

Monographs

36. M.-K. von Renesse. *Comparison properties of diffusion semigroups on spaces with lower curvature bounds.* Bonner Mathematische Schriften, Vol. 355, 2003.

37. J.-D. Deuschel et al. (eds.). *Probability in Complex Physical Systems: In Honour of Erwin Bolthausen and Jürgen Gärtner.* Springer Proceedings in Mathematics, 2012.