

Eric M. Rains

Work Address

Department of Mathematics
California Institute of Technology
1200 E. California Blvd.
MC 253-37
Pasadena, CA 91125
Internet: rains@caltech.edu

Home Address

500 E. Del Mar Blvd. #14
Pasadena, CA 91101

Education

Case Western Reserve University
Graduated May 1991
Bachelor of Arts with concentration in Physics, summa cum laude
Bachelor of Science, summa cum laude
Master of Science in Mathematics

Cambridge University
Graduated June 1992
Certificate of Advanced Study in Mathematics

Harvard University
Graduated June 1995
Doctor of Philosophy in Mathematics
Thesis advisor: Persi Diaconis
Thesis title: *Topics in Probability on Compact Lie Groups*

Experience

July 2007–present: Professor of Mathematics, California Institute of Technology
July 2003–June 2007: Professor, Department of Mathematics,
University of California at Davis

Fall 2006: Visiting Professor,
Department of Mathematics and Statistics
University of Melbourne

April 2002–August 2003: Mathematician,
Center for Communications Research–Princeton

Fall 2002: Visiting Associate and Lecturer,
Mathematics Department and Institute for Quantum Information,
California Institute of Technology

April 2001–March 2002: Principal Member of Technical Staff,
AT&T Laboratories–Research

September 1996–March 2001: Senior Member of Technical Staff,
AT&T Laboratories–Research

June 1995–September 1996: Mathematician, CCR–Princeton

Awards, Honors, and Funding

Invited talk at ICM 2010, combinatorics section (forthcoming)
Plenary talk at the Western Sectional AMS meeting, Fall 2007

National Science Foundation Grant 0401387
“Multivariate special functions”
Three year grant starting July 2004, extended.
The best paper of the year award 2005 in difference equations, awarded by
the International Society of Difference Equations for [53, 54, 55]
National Science Foundation Fellowship (Fall 1992-Spring 1995)
Churchill Scholarship (for one year of study in Mathematics and Physics
at Cambridge University, England, Fall 1991-Spring 1992)
Inducted into Phi Beta Kappa (1991)
8th place in William Lowell Putnam Examination (1990)

Publications

- [1] R. W. Brown, E. M. Rains, and C. C. Taylor. Harmonic analysis of the relativistic string in spinorial coordinates. *Classical and Quantum Gravity*, 8(7):1245–1253, 1991.
- [2] J. A. Mann, E. M. Rains, and W. A. Woyczynski. Measuring the roughness of interfaces. *Chemometrics and Intelligent Laboratory Systems*, 12(2):169–180, 1991.
- [3] A. R. Calderbank, E. M. Rains, P. W. Shor, and N. J. A. Sloane. Quantum error correction and orthogonal geometry. *Phys. Rev. Lett.*, 78(3):405–408, 1997.
- [4] E. M. Rains. High powers of random elements of compact Lie groups. *Probab. Theory Related Fields*, 107:219–241, 1997.
- [5] E. M. Rains. Combinatorial properties of Brownian motion on the compact classical groups. *J. Theoret. Probab.*, 10(3):659–679, 1997.
- [6] E. M. Rains, R. H. Hardin, P. W. Shor, and N. J. A. Sloane. A nonadditive quantum code. *Phys. Rev. Lett.*, 79(5):953–954, 1997.
- [7] E. M. Rains. Shadow bounds for self-dual codes. *IEEE Trans. Inform. Theory*, 44(1):134–139, 1998.
- [8] E. M. Rains. Increasing subsequences and the classical groups. *Electron. J. Combin.*, 5(1):R12, 1998.
- [9] Y. Edel, E. M. Rains, and N. J. A. Sloane. On kissing numbers in dimensions 32 to 128. *Electron. J. Combin.*, 5(1):R22, 1998.
- [10] A. R. Calderbank, E. M. Rains, P. W. Shor, and N. J. A. Sloane. Quantum error correction via codes over $GF(4)$. *IEEE Trans. Inform. Theory*, 44(4):1369–1387, 1998.
- [11] E. M. Rains. Quantum weight enumerators. *IEEE Trans. Inform. Theory*, 44(4):1388–1394, 1998.

- [12] E. M. Rains. Normal limit theorems for symmetric random matrices. *Probab. Theory Related Fields*, 112(3):411–423, 1998.
- [13] E. M. Rains and N. J. A. Sloane. The shadow theory of modular and unimodular lattices. *J. Number Theory*, 73(2):359–389, 1998.
- [14] E. M. Rains and N. J. A. Sloane. Self-dual codes. In V. S. Pless and W. C. Huffman, editors, *Handbook of coding theory, Vol. I*, pages 177–294. North-Holland, Amsterdam, 1998.
- [15] E. M. Rains. Quantum codes of minimum distance two. *IEEE Trans. Inform. Theory*, 45(1):266–271, 1999.
- [16] E. M. Rains and N. J. A. Sloane. On Cayley’s enumeration of alkanes (or 4-valent trees). *J. Integer Seq.*, 2(1), 1999.
- [17] C. H. Bennett, D. P. DiVincenzo, C. A. Fuchs, T. Mor, E. Rains, P. W. Shor, and J. A. Smolin. Quantum nonlocality without entanglement. *Phys. Rev. A*, 59(2):1070–1091, 1999.
- [18] A. R. Calderbank, R. H. Hardin, E. M. Rains, P. W. Shor, and N. J. A. Sloane. A group-theoretic framework for the construction of packings in Grassmannian spaces. *J. Algebraic Combin.*, 9(2):129–140, 1999.
- [19] E. M. Rains. Optimal self-dual codes over \mathbb{Z}_4 . *Discrete Math.*, 203(1–3):215–228, 1999.
- [20] E. M. Rains. Rigorous treatment of distillable entanglement. *Phys. Rev. A*, 60(1):173–178, 1999.
- [21] E. M. Rains. Bound on distillable entanglement. *Phys. Rev. A*, 60(1):179–184, 1999.
- [22] E. M. Rains. Nonbinary quantum codes. *IEEE Trans. Inform. Theory*, 45(6):1827–1832, 1999.
- [23] E. M. Rains. Quantum shadow enumerators. *IEEE Trans. Inform. Theory*, 45(7):2361–2366, 1999.
- [24] E. M. Rains. Monotonicity of the quantum linear programming bound. *IEEE Trans. Inform. Theory*, 45(7):2489–2491, 1999.
- [25] J. H. Conway, E. M. Rains, and N. J. A. Sloane. On the existence of similar sublattices. *Canad. J. Math.*, 51(6):1300–1306, 1999.
- [26] E. M. Rains. Polynomial invariants of quantum codes. *IEEE Trans. Inform. Theory*, 46(1):54–59, 2000.
- [27] A. M. Odlyzko and E. M. Rains. On longest increasing subsequences in random permutations. In *Analysis, geometry, number theory: the mathematics of Leon Ehrenpreis (Philadelphia, PA, 1998)*, pages 439–451. Amer. Math. Soc., 2000.

- [28] A. Bonnecaze, E. Rains, and P. Solé. 3-colored 5-designs and \mathbb{Z}_4 -codes. *J. Statist. Plann. Inference*, 86(2):349–368, 2000.
- [29] E. Rains. Bounds for self-dual codes over \mathbb{Z}_4 . *Finite Fields Appl.*, 6(2):146–163, 2000.
- [30] J. Baik and E. M. Rains. Limiting distributions for a polynuclear growth model with external sources. *J. Stat. Phys.*, 100(3-4):523–541, 2000.
- [31] E. M. Rains. Class groups and modular lattices. *J. Number Theory*, 88(2):211–224, 2001.
- [32] J. Baik and E. M. Rains. Symmetrized random permutations. *MSRI Publications*, 40:1–19, 2001.
- [33] P. J. Forrester and E. M. Rains. Inter-relationships between orthogonal, unitary and symplectic matrix ensembles. *MSRI Publications*, 40:171–207, 2001.
- [34] G. Nebe, E. M. Rains, and N. J. A. Sloane. The invariants of the Clifford groups. *Des. Codes Cryptogr.*, 24(1):99–121, 2001.
- [35] J. Baik and E. M. Rains. Algebraic aspects of increasing subsequences. *Duke Math. J.*, 109(1):1–65, 2001.
- [36] J. Baik and E. M. Rains. The asymptotics of monotone subsequences of involutions. *Duke Math. J.*, 109(2):205–281, 2001.
- [37] E. M. Rains. A semidefinite program for distillable entanglement. *IEEE Trans. Inform. Theory*, 47(7):2921–2933, 2001.
- [38] J. Baik, P. Deift, and E. M. Rains. A Fredholm determinant identity and the convergence of moments for random Young tableaux. *Comm. Math. Phys.*, 223(3):627–672, 2001.
- [39] G. Nebe, E. M. Rains, and N. J. A. Sloane. A simple construction for the Barnes-Wall lattices. In R. E. Blahut and R. Koetter, editors, *Codes, Graphs, and Systems (Forney Festschrift)*, pages 333–342. Kluwer, 2002.
- [40] E. M. Rains, N. J. A. Sloane, and J. Stufken. The lattice of N -run orthogonal arrays. *J. Statist. Plann. Inference*, 102(2):477–500, 2002.
- [41] J. C. Lagarias, E. M. Rains, and N. J. A. Sloane. The EKG sequence. *Experiment. Math.*, 11(3):437–446, 2002.
- [42] J. C. Lagarias and E. Rains. On a two-variable zeta function for number fields. *Ann. Inst. Fourier (Grenoble)*, 53(1):1–68, 2003.
- [43] D. Applegate, E. M. Rains, and N. J. A. Sloane. On asymmetric coverings and covering numbers. *J. Combin. Des.*, 11(3):218–228, 2003.

- [44] E. M. Rains. Images of eigenvalue distributions under power maps. *Probab. Theory Related Fields*, 125(4):522–538, 2003.
- [45] E. M. Rains. New asymptotic bounds for self-dual codes and lattices. *IEEE Trans. Inform. Theory*, 49(5):1261–1274, 2003.
- [46] H.-G. Quebbemann and E. M. Rains. On the involutions fixing the class of a lattice. *J. Number Theory*, 101(1):185–194, 2003.
- [47] G. Nebe, E. M. Rains, and N. J. A. Sloane. Codes and invariant theory. *Math. Nachr.*, 274–275:104–116, 2004.
- [48] G. Nebe, H.-G. Quebbemann, E. M. Rains, and N. J. A. Sloane. Complete weight enumerators of generalized doubly-even self-dual codes. *Finite Fields Applic.*, 10:540–550, 2004.
- [49] P. J. Forrester and E. M. Rains. Correlations for superpositions and decimations of Laguerre and Jacobi orthogonal matrix ensembles with a parameter. *Probab. Theory Related Fields*, 130(4):518–576, 2004.
- [50] P. J. Forrester and E. M. Rains. Interpretations of some parameter dependent generalizations of classical matrix ensembles. *Probab. Theory Related Fields*, 131(1):1–61, 2005.
- [51] E. M. Rains. BC_n -symmetric polynomials. *Transform. Groups*, 10(1):63–132, 2005.
- [52] P. Etingof and E. Rains. New deformations of group algebras of Coxeter groups. *Int. Math. Res. Not.*, 2005(10):635–646.
- [53] J. C. Lagarias and E. Rains. Dynamics of a family of piecewise-linear area-preserving plane maps. I. Rational rotation numbers. *J. Difference Equ. Appl.*, 11(12):1089–1108, 2005.
- [54] J. C. Lagarias and E. Rains. Dynamics of a family of piecewise-linear area-preserving plane maps. II. Invariant circles. *J. Difference Equ. Appl.*, 11(13):1137–1163, 2005.
- [55] J. C. Lagarias and E. Rains. Dynamics of a family of piecewise-linear area-preserving plane maps. III. Cantor set spectra. *J. Difference Equ. Appl.*, 11(14):1205–1224, 2005.
- [56] A. Borodin and E. M. Rains. Eynard-Mehta theorem, Schur process, and their Pfaffian analogs. *J. Stat. Phys.*, 121(3-4):291–317, 2005.
- [57] G. Nebe, E. M. Rains, and N. J. A. Sloane. *Self-dual codes and invariant theory*, volume 17 of *Algorithms and Computation in Mathematics*. Springer-Verlag, Berlin, 2006.

- [58] P. J. Forrester and E. M. Rains. Jacobians and rank 1 perturbations relating to unitary Hessenberg matrices. *Int. Math. Res. Not.*, Art. ID 48306, 36 pp., 2006.
- [59] P. Etingof and E. Rains. Central extensions of preprojective algebras, the quantum Heisenberg algebra, and 2-dimensional complex reflection groups. *J. Algebra*, 299(2):570–588, 2006.
- [60] P. Forrester, T. Nagao, and E. M. Rains. Correlation functions for random involutions. *Int. Math. Res. Not.*, Art. ID 89796, 35 pp., 2006.
- [61] T. G. Draper, S. A. Kutin, E. M. Rains, and K. M. Svore. A logarithmic-depth quantum carry-lookahead adder. *Quantum Inf. Comput.*, 6(4-5):351–369, 2006.
- [62] N. Heninger, E. M. Rains, and N. J. A. Sloane. On the integrality of n -th roots of generating functions. *J. Combin. Theory Ser. A*, 113:1732–1745, 2006.
- [63] L. Bartholdi, B. Enriquez, P. Etingof, and E. Rains. Groups and Lie algebras corresponding to the Yang-Baxter equations. *J. Algebra*, 305:742–764, 2006.
- [64] E. M. Rains. BC_n -symmetric abelian functions. *Duke Math. J.*, 135(1):99–180, 2006.
- [65] E. M. Rains. A difference-integral representation of Koornwinder polynomials. In V. Kuznetsov and S. Sahi, editors, *Jack, Hall-Littlewood and Macdonald polynomials*, volume 417 of *Contemporary Mathematics*. AMS, 2006.
- [66] P. Etingof, F. Latour, and E. Rains. On central extensions of preprojective algebras. *J. Algebra*, 313(1):165–175, 2007.
- [67] P. Etingof, A. Oblomkov, and E. Rains. Generalized double affine Hecke algebras of rank 1 and quantized del Pezzo surfaces. *Adv. Math.*, 212(2):749–796, 2007.
- [68] F. van de Bult, E. M. Rains, and J. Stokman. Properties of generalized univariate hypergeometric functions. *Comm. Math. Phys.*, 275(1):37–95, 2007.
- [69] P. J. Forrester and E. M. Rains. Symmetrized models of last passage percolation and non-intersecting lattice paths. *J. Stat. Phys.*, 129(5-6):833–855, 2007.
- [70] E. M. Rains and M. Vazirani. Vanishing integrals of Macdonald and Koornwinder polynomials. *Transform. Groups*, 12(4):725–759, 2007.
- [71] P. Etingof and E. Rains. New deformations of group algebras of Coxeter groups. II. *Geom. Funct. Anal.*, 17(6):1851–1871, 2008.

- [72] A. Henderson and E. Rains. The cohomology of real De Concini-Procesi models of Coxeter type. *Int. Math. Res. Not.*, (7):Art. ID rnn001, 29, 2008.
- [73] A. Günther, G. Nebe, and E. M. Rains. Clifford-Weil groups of quotient representations. *Albanian J. Math.*, 2(3):159–169, 2008.
- [74] E. M. Rains. Limits of elliptic hypergeometric integrals. *Ramanujan J.*, 18(3):257–306, 2009.
- [75] E. M. Rains. The action of S_n on the cohomology of $\overline{M}_{0,n}(\mathbb{R})$. *Selecta Math. (N.S.)*, 15(1):171–188, 2009.
- [76] E. M. Rains and V. P. Spiridonov. Determinants of elliptic hypergeometric integrals. *Funct. Anal. Appl.*, to appear.
- [77] E. M. Rains. Transformations of elliptic hypergeometric integrals. *Ann. Math.*, to appear, 2010.
- [78] P. Etingof, A. Henriques, J. Kamnitzer, and E. Rains. The cohomology ring of the real locus of the moduli space of stable curves of genus 0 with marked points. *Ann. Math.*, to appear, 2010.