

# Cristopher Moore

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## 1 Education

Born March 12, 1968 in New Brunswick, New Jersey.

Northwestern University, B.A. in Physics, Mathematics, and the Integrated Science Program, with departmental honors in all three departments, 1986.

Cornell University, Ph.D. in Physics, 1991. Philip Holmes, advisor. Thesis: “Undecidability and Unpredictability in Dynamical Systems.”

## 2 Employment

Professor, Santa Fe Institute	2012–present
Professor, Computer Science Department with a joint appointment in the Department of Physics and Astronomy, University of New Mexico, Albuquerque	2008–2012
Associate Professor, University of New Mexico	2005–2008
Assistant Professor, University of New Mexico	2000–2005
Research Professor, Santa Fe Institute	1998–1999
City Councilor, District 2, Santa Fe	1994–2002
Postdoctoral Fellow, Santa Fe Institute	1992–1998
Lecturer, Cornell University	Spring 1991
Graduate Intern, Niels Bohr Institute/NORDITA, Copenhagen	Summers 1988 and 1989
Teaching Assistant, Cornell University Physics Department	Fall 1986–Spring 1990
Computer programmer, Bio-Imaging Research, Lincolnshire, Illinois	Summers 1984–1986

## 3 Other Appointments

Visiting Researcher, Microsoft Research New England	Fall 2019
Visiting Professor, École Normale Supérieure	October–November 2016
Visiting Professor, Northeastern University	October–November 2015
Visiting Professor, University of Michigan, Ann Arbor	September–October 2005
Visiting Professor, École Normale Supérieure de Lyon	June 2004
Visiting Professor, Institut Universitaire de France	June 2003
Visiting Professor, Université Paris 7 (Denis Diderot)	June 2001 and 2002

External Faculty, Santa Fe Institute  
Visiting Professor, École Polytechnique

2000–present  
September 1999

## 4 Honors and awards

Rocky Mountain Emmy Award for *The Majesty of Music and Mathematics*, 2019  
Fellow, American Association for the Advancement of Science, elected 2017  
Fellow, American Mathematical Society, class of 2016  
Fellow, American Physical Society, elected 2014  
University of New Mexico School of Engineering Outstanding Senior Faculty Award for Excellence in Research, 2007  
University of New Mexico School of Engineering Outstanding Junior Faculty Award for Excellence in Teaching, 2002  
University of New Mexico School of Engineering Outstanding Junior Faculty Award for Excellence in Research, 2002  
National Science Foundation Graduate Fellowship, 1986-1989  
Clark Award for Best Teaching Assistant, 1987  
Marcy Award for Undergraduate Independent Study, 1986  
Richter Fellowship for Undergraduate Independent Study, 1985  
Phi Beta Kappa, 1985

## 5 Public lectures and educational outreach

Presidential Dream Course, University of Oklahoma: Data, Algorithms, Justice, and Fairness. April 2022.  
Reese Prosser Memorial Lecture, Dartmouth College, October 2021.  
Ulam Memorial Lecture #1, Easy, Hard, and Impossible: The Limits of Computation. Santa Fe, September 2018.  
Ulam Memorial Lecture #2, Data, Algorithms, Fairness and Justice. Santa Fe, September 2018.  
The Majesty of Music and Mathematics, a collaboration with the Santa Fe Symphony (Guillermo Figueroa, conductor). On stage at the Lensic Theater in Santa Fe, November 2013 (conducted by David Felberg) and a New Mexico PBS special, aired in 2018. Short version at the Julia Robinson Mathematics Festival in Santa Fe, 2018.  
Sending Secrets: Security and Privacy in a Quantum World. Santa Fe Institute Community Lecture, April 2011; John von Neumann Public Lecture Series in Complexity and Computation, Wisconsin Institute for Discovery, January 2015; Complex Data Systems Distinguished Lecture, University of South Florida, October 2016.

## 6 Recent invited talks, lecture series, and colloquia

Physics and Astronomy Colloquium, University of New Mexico, September 2022  
NetSci School, tutorial lecture on statistical inference, July 2022  
Complex Systems Seminar, Northwestern University, May 2022  
Computer Science Colloquium, University of New Mexico, May 2022

Stockholm University Physics Colloquium, April 2022  
 Mesa Community College Math Club, November 2021  
 Mathematics Colloquium, Dartmouth College, October 2021  
 Conference on Future Synergies for Stochastic and Learning Algorithms, Central International de Rencontres Mathématiques, Marseille, September 2021  
 National Meeting of the Portuguese Mathematical Society, July 2021  
 Staff Briefing on Disparate Impact and Fair Housing, House Financial Services Committee of the US Congress, April 2021  
 MIT-Harvard Communications Information Networks Circuits and Signals (CINCS) / Hamilton Institute Seminar, February 2021  
 New Mexico Black Lawyers Association Continuing Legal Education, November 2020  
 Los Angeles Combinatorics and Complexity Seminar, November 2020  
 Simons Institute Seminar, Program on Probability, Geometry, and Computation in High Dimensions, November 2020  
 Northwestern Institute on Complex Systems Seminar, Northwestern University, October 2020  
 Probability Seminar, University of Waterloo, October 2020  
 Tufts Workshop on Graphs and Networks, July 2020  
 Cardano Virtual Summit, July 2020  
 Computer Science Seminar, West University of Timișoara, Romania, May 2020  
 Complex Networks and Systems Colloquium, Indiana University, February 2020  
 Complex Systems Seminar, University of Vermont, December 2019  
 Network Science Seminar, Northeastern, November 2019  
 Physics Colloquium, Boston University, November 2019  
 Computer Science Colloquium, Dartmouth, October 2019  
 Stochastics and Statistics Seminar, MIT, October 2019  
 57th Annual Allerton Conference on Communication, Control, and Computing. University of Illinois, Urbana-Champaign, September, 2019  
 Tutorial on Noisy Tensors for Machine Learning, at Tensors: Algebra, Computation, Applications. University of Colorado, Boulder, June 2019  
 Distinguished Lecture, Computer Science and Engineering, University of Michigan, April 2019  
 Plenary, Condensed Matter Section of Deutsche Physikalische Gesellschaft, Regensburg, April 2019  
 Electrical and Systems Engineering Colloquium, University of Pennsylvania, December 2018  
 Tutorial, Workshop on Physics, Inference and Learning. Institute of Theoretical Physics, Chinese Academy of Sciences, October 2018  
 Math and Data Seminar, NYU, September 2018  
 Keynote speaker, Conference on Data Science for Business and Economics, Purdue, May 2018  
 Physics Colloquium, Otto-von-Guericke University, Magdeburg, May 2018  
 Centre for Mathematics of Precision Healthcare Lecture, Imperial College, London, April 2018  
 University of Michigan–Santa Fe Institute Symposium on Complexity in Ecological, Evolutionary, and Social Dynamics. Ann Arbor, April 2018  
 Invited talk, Dynamics Days, January 2018  
 INFORMS Session on Random Graphs and Learning in Applied Probability, Houston, October 2017  
 Invited plenary talk, DNA23, Austin, September 2017

Lectures on Random Constraint Satisfaction Problems. Hausdorff Center for Mathematics, Bonn, July 2017

Lectures on Computational Complexity and Belief Propagation. Boulder Condensed Matter Summer School, July 2017

American Institute of Mathematics Workshop on Connecting Communities via the Block Model, May 2017

Joint Probability and Computer Science Theory Seminar, Cornell, April 2017

## 7 Publications

### 7.1 Books, book chapters, and less-technical writing

S. Blumsack, P. Hines, C. Moore, J.E. Trancik, I. Azevedo, K. Araújo, R. Bent, P. Brown, M. Cather, M.R. Edwards, G. Kavlak, D. Klein, H. Passell, D. Patino-Echeverri, L.C. Stokes, M.S. Ziegler, “The Energy Transition in New Mexico: Insights from a Santa Fe Institute Workshop.” Santa Fe Institute, 2020.

C. Moore, “Why COVID-19 Flare-Ups Will Keep Happening: Like earthquakes and forest fires, outbreaks have a ‘heavy tail’ of large events.” *Nautilus* May 13, 2020.

C. Moore and J. Kaag, “The Uncertainty Principle: in an age of deep disagreements, mathematics shows us how to pursue truth together.” *The American Scholar* March 2, 2020.

A. Decelle, J. Hüttl, A. Saade, and C. Moore, “Computational Complexity, Phase Transitions, and Message-Passing for Community Detection.” In *Statistical Physics, Optimization, Inference, and Message-Passing Algorithms*. F. Krzakala, F. Ricci-Tersenghi, L. Zdeborová, R. Zecchina, E. W. Tramel, L. F. Cugliandolo, Eds., Oxford University Press, 2016.

C. Moore, “A Complex Legacy.” *Nature Physics* 7 (2011) 828–830.

C. Moore and S. Mertens, *The Nature of Computation*. Oxford University Press, 2011.

A. Percus, G. Istrate, and C. Moore, Eds., *Computational Complexity and Statistical Physics*. Oxford University Press, 2005.

D. Griffeath and C. Moore, Eds., *New Constructions in Cellular Automata*. Oxford University Press, 2003.

C. Moore, “Limiting the Computational Power of Recurrent Neural Networks: VC Dimension and Noise.” J. Kolen and S. Kremer, Eds., *A Field Guide to Dynamical Recurrent Networks*. IEEE Press, 2001.

### 7.2 Articles in journals, peer-refereed conference proceedings, and preprints

Dmitriy Kunisky and Cristopher Moore, “The spectrum of the Grigoriev-Laurent pseudomoments.” Preprint, arxiv:2203.05693.

Andrea J. Allen, Cristopher Moore, and Laurent Hébert-Dufresne, “A network compression approach for quantifying the importance of temporal contact chronology.” Preprint, arxiv:2205.11566.

Alexander M. Mercier, Samuel V. Scarpino, and Cristopher Moore, “Effective Resistance for Pandemics: Mobility Network Sparsification for High-Fidelity Epidemic Simulation.” *PLoS Computational Biology*, to appear.

A. Allard, C. Moore, S. V. Scarpino, B. M. Althouse, and L. Hébert-Dufresne, “The role of directionality, heterogeneity and correlations in epidemic risk and spread.” *SIAM Review*, to appear.

- Sandro Coretti, Aggelos Kiayias, Alexander Russell, and Cristopher Moore, “The Generals’ Scuttlebutt: Byzantine-Resilient Gossip Protocols.” *Proc. ACM Conference on Computer and Communications Security (CCS’ 22)*, to appear.
- George T. Cantwell and Cristopher Moore, “Belief propagation for permutations, rankings, and partial orders.” *Physical Review E* 105, L052303 (2022).
- Varsha Dani, Josep Díaz, Thomas P. Hayes, and Cristopher Moore, “Improved Reconstruction of Random Geometric Graphs.” *Proc. Intl. Colloquium on Automata, Languages and Programming (ICALP ’22)*, 48:1–48:17.
- A. Kiayias, C. Moore, S. Quader, and A. Russell, “Efficient Random Beacons with Adaptive Security for Ungrindable Blockchains.” *IACR Cryptology Preprint Archive*, [eprint.iacr.org/2021/1698.pdf](https://eprint.iacr.org/2021/1698.pdf).
- Afonso S. Bandeira, Jess Banks, Dmitriy Kunisky, Cristopher Moore, and Alexander S. Wein, “Spectral Planting and the Hardness of Refuting Cuts, Colorability, and Communities in Random Graphs.” *Proc. 34th Ann. Conf. on Learning Theory (COLT ’21)* 410–473.
- M. Moharrami, C. Moore, and J. Xu, “The Planted Matching Problem: Phase Transitions and Exact Results.” *Annals of Applied Probability* 31(6): 2663–2720 (2021).
- E. Blum, A. Kiayias, C. Moore, S. Quader, and A. Russell, “The Combinatorics of the Longest-Chain Rule: Linear Consistency for Proof-of-Stake Blockchains.” *Proc. Symposium on Discrete Algorithms (SODA ’20)* 1135–1154.
- S. Mertens and C. Moore, “Percolation is Odd.” *Physical Review Letters* 123 (2019) 230605.
- A. Wein, A. El Alaoui, and C. Moore, “The Kikuchi Hierarchy and Tensor PCA.” *Proc. Foundations of Computer Science (FOCS ’19)* 1446–1468.
- J. Banks, C. Moore, and R. Kleinberg, “The Lovász Theta Function for Random Regular Graphs and Community Detection in the Hard Regime.” *SIAM J. Computing* 48(3) 1098–1119 (2019). Conference version in *Proc. 21st Intl. Workshop on Randomization and Computation (RANDOM ’17)* 1–28.
- S. Mertens and C. Moore, “Series Expansion of Critical Densities for Percolation on  $\mathbb{Z}^d$ .” *J. Physics A: Mathematical and Theoretical*, 51 (47) 475001 (2018).
- S. Mertens and C. Moore, “Percolation Thresholds and Fisher Exponents in Hypercubic Lattices.” *Physical Review E* 98, 022120 (2018).
- C. De Bacco, D. B. Larremore, and C. Moore, “A physical model for efficient ranking in networks.” *Science Advances* 4 (7) 2018.
- J. Banks, C. Moore, R. Vershynin, N. Verzelen, and J. Xu, “Information-theoretic bounds and phase transitions in clustering, sparse PCA, and submatrix localization.” *IEEE Transactions on Information Theory* 64(7):4872–4894 (2018). Conference version in *Proc. IEEE International Symposium on Information Theory (ISIT 2017)*.
- E. Allender, J. A. Grochow, D. van Melkebeek, C. Moore, and A. Morgan, “Minimum Circuit Size, Graph Isomorphism, and Related Problems.” *SIAM J. Computing* 47(4) 1339–1372 (2018). Conference version in *Proc. Innovations in Theoretical Computer Science (ITCS ’18)*, 1–20.
- A. Russell, C. Moore, A. Kiayias, and S. Quader, “Forkable strings are rare.” *IACR Cryptology Preprint Archive*, [eprint.iacr.org/2017/241](https://eprint.iacr.org/2017/241) (2017).
- S. Mertens and C. Moore, “Percolation Thresholds in Hyperbolic Lattices.” *Physical Review E* 96, 042116 (2017).
- X. Zhang, C. Moore, and M.E.J. Newman, “Random graph models for dynamic networks.” *European Physical Journal B*, 90:200 (2017).
- C. Moore, “The Computer Science and Physics of Community Detection: Landscapes, Phase Tran-

- sitions, and Hardness.” *Bulletin of the EATCS* 121, 25–61 (2017).
- C. De Bacco, E. A. Power, D. B. Larremore, and C. Moore, “Community detection, link prediction, and layer interdependence in multilayer networks.” *Physical Review E* 95, 042317 (2017).
- J. A. Grochow and C. Moore, “Matrix multiplication algorithms from group orbits.” Preprint, [arxiv.org/1612.01527](https://arxiv.org/abs/1612.01527).
- A. Godoy-Lorite, R. Guimera, C. Moore, and M. Sales-Pardo, “Accurate and scalable social recommendation using mixed-membership stochastic block models.” *Proc. National Academy of Sciences* 113 (50) 14207–14212 (2016).
- T. Lesieur, C. De Bacco, J. Banks, F. Krzakala, C. Moore, and L. Zdeborová, “Phase transitions and optimal algorithms in high-dimensional Gaussian mixture clustering.” *Proc. 54th Allerton Conference on Communication, Control, and Computing* (2016).
- A. Z. Jacobs, J. A. Dunne, C. Moore, and A. Clauset, “Untangling the roles of parasites in food webs with generative network models.” Preprint, [arxiv:1505.04741](https://arxiv.org/abs/1505.04741)
- T. P. Hayes and C. Moore, “Lower bounds on the critical density in the hard disk model via optimized metrics.” Preprint, [arxiv:1407.1930](https://arxiv.org/abs/1407.1930)
- J. Banks, C. Moore, J. Neeman and P. Netrapalli, “Information-theoretic thresholds for community detection in sparse networks.” *Proc. 29th Ann. Conf. on Learning Theory (COLT 2016)* 383–416.
- A. Ghasemian, P. Zhang, A. Clauset, C. Moore, and L. Peel, “Detectability thresholds and optimal algorithms for community structure in dynamic networks.” *Physical Review X* 6, 031005 (2016).
- C. Moore, “The phase transition in random regular exact cover.” *Annales l’Institut Henri Poincaré D, Combinatorics, Physics and their Interactions*, 3 (3) 349–362 (2016).
- V. Dani, T. P. Hayes, C. Moore, and A. Russell, “Codes, lower bounds, and phase transitions in the symmetric rendezvous problem.” *Random Structures and Algorithms* 49(4) 742–765 (2016).
- H. Youn, L. Sutton, E. Smith, C. Moore, J. F. Wilkins, I. Maddieson, W. Croft, and T. Bhat-tacharya, “On the universal structure of human lexical semantics.” *Proc. National Academy of Sciences*, 113(7) 1766–1771 (2016).
- P. Zhang, C. Moore, and M. E. J. Newman, “Community detection in networks with unequal groups.” *Physical Review E* 93, 012303 (2016).
- S. Lovett, C. Moore, and A. Russell, “Group representations that resist random sampling.” *Random Structures and Algorithms* 47(3) 605–614 (2015).
- M. Shrestha, S. Scarpino, and C. Moore, “Message-passing approach for recurrent-state epidemic models on networks.” *Physical Review E* 92 022821 (2015).
- C. Moore and A. Russell, “Optimal  $\epsilon$ -biased sets with just a little randomness.” *SIAM J. Discrete Math.* 29(3) 1303–1311 (2015).
- C. Moore and A. Russell, “Approximate representations, approximate homomorphisms, and low-dimensional embeddings of groups.” *SIAM J. Discrete Math.* 29 (1) 182–197 (2015).
- H. Dinh, C. Moore, and A. Russell, “Limitations of single coset states and quantum algorithms for code equivalence.” *Quantum Information and Computation* 15 260–294 (2015).
- C. Moore and A. Russell, “Heat and Noise on Cubes and Spheres: The Sensitivity of Randomly Rotated Polynomial Threshold Functions.” Preprint, [arXiv:1408.5425](https://arxiv.org/abs/1408.5425).
- P. Zhang and C. Moore, “Scalable detection of statistically significant communities and hierarchies: message-passing for modularity.” *Proc. National Academy of Sciences* 111 (51) 18144–18149 (2014).
- P. Zhang, C. Moore, and L. Zdeborová, “Phase transitions in semisupervised clustering of sparse networks.” *Physical Review E* 90 052802 (2014).
- M. Shrestha and C. Moore, “A message-passing approach for threshold models of behavior in

- networks.” *Physical Review E* 89 022805 (2014).
- F. Caccioli, M. Shrestha, C. Moore, and J. D. Farmer, “Stability analysis of financial contagion due to overlapping portfolios.” *J. Banking and Finance* 46 233–245 (2014).
- G. Ver Steeg, C. Moore, A. Galstyan, and A. E. Allahverdyan, “Phase transitions in community detection: a solvable toy model.” *Europhysics Letters* 106 48004 (2014).
- C. Moore and L.J. Schulman, “Tree codes and a conjecture on exponential sums.” *Proc. 5th Innovations in Theoretical Computer Science (ITCS ’14)* 145–154.
- R. Impagliazzo, C. Moore, and A. Russell, “An entropic proof of Chang’s inequality.” *SIAM J. Discrete Math.*, 28(1) 173–176 (2014).
- X. Yan, J. Jensen, F. Krzakala, C. Moore, C. Shalizi, L. Zdeborová, P. Zhang, and Y. Zhu, “Model Selection for Degree-corrected Block Models.” *J. Stat. Mech.* 5 P05007 (2014). Conference version in *Workshop on Social Network and Social Media Analysis*, NIPS ’12.
- Y. Zhu, X. Yan, and C. Moore, “Oriented and Degree-generated Block Models: Generating and Inferring Communities with Inhomogeneous Degree Distributions.” *J. Complex Networks* 2(1) 1–18 (2014). Conference version in *Workshop on Social Network and Social Media Analysis*, NIPS ’12.
- F. Krzakala, C. Moore, E. Mossel, J. Neeman, A. Sly, L. Zdeborová, and P. Zhang, “Spectral redemption in clustering sparse networks.” *Proc. National Academy of Sciences* 110 (52) 20935–20940 (2013).
- V. Dani, J. Diaz, T. P. Hayes, and C. Moore, “The power of choice for random satisfiability.” *Proc. 17th Intl. Workshop on Randomization and Computation (RANDOM ’13)* 484–496.
- S. Chen, C. Moore, and A. Russell, “Small-Bias Sets for Nonabelian Groups: Derandomizing the Alon-Roichman Theorem.” *Proc. 17th Intl. Workshop on Randomization and Computation (RANDOM ’13)* 436–451.
- Y. Zhu, X. Yan, L. Getoor, and C. Moore, “Scalable text and link analysis with mixed-topic link models.” *Proc. 19th Int. Conf. on Knowledge Discovery and Data Mining (KDD ’13)* 473–481.
- S. Mertens and C. Moore, “The complexity of the fermionant, and immanants of constant width.” *Theory of Computing* 9 (6) 273–282 (2013).
- C. D. Brummitt, P. D. H. Hines, I. Dobson, C. Moore, R. M. D’Souza, “Transdisciplinary electric power grid science.” *Proc. National Academy of Sciences* 110 (30) 12159 (2013).
- S. Mertens and C. Moore, “Continuum percolation thresholds in two dimensions.” *Physical Review E* 86 (2012) 061109.
- C. Moore and A. Russell, “Approximating the permanent via nonabelian determinants.” *SIAM J. Computing* 41 (2012) 332–355.
- V. Dani, C. Moore, and A. Olson, “Tight bounds on the threshold for permuted  $k$ -colorability.” *Proc. 16th Intl. Workshop on Randomization and Computation (RANDOM ’12)* 505–516.
- H. Bauke, C. Moore, J.-B. Rouquier, and D. Sherrington, “Topological phase transition in a network model with preferential attachment and node removal.” *Euro. Phys. J. B* 83 (2011) 519–524.
- A. Decelle, F. Krzakala, C. Moore, and L. Zdeborová, “Asymptotic analysis of the stochastic block model for modular networks and its algorithmic applications.” *Physical Review E* 84 (2011) 066106.
- A. Decelle, F. Krzakala, C. Moore, and L. Zdeborová, “Phase transition in the detection of modules in sparse networks.” *Physical Review Letters* 107 (2011) 065701.
- J. Machta, S. DeDeo, S. Mertens, and C. Moore, “Parallel complexity of random Boolean circuits.” *J. Stat. Mech.* P04015 (2011).
- C. Moore and A. Russell, “A graph integral formulation of the circuit partition polynomial.” *Combinatorics, Probability, and Computing* 20 (2011) 911–920.

- H. Dinh, C. Moore, and A. Russell, “McEliece and Niederreiter Cryptosystems That Resist Quantum Fourier Sampling Attacks.” *Proc. 31st Annual Cryptology Conference (CRYPTO ’11)* 761–779.
- V. Dani and C. Moore, “Independent sets in random graphs from the weighted second moment method.” *Proc. 15th Intl. Workshop on Randomization and Computation (RANDOM ’11)* 472–482.
- C. Moore, X. Yan, Y. Zhu, J.-B. Rouquier, and T. Lane, “Active learning for node classification in assortative and disassortative networks.” *Proc. 17th Int. Conf. on Knowledge Discovery and Data Mining (KDD ’11)* 841–849.
- S. Kasiviswanathan, C. Moore, and L. Theran, “The rigidity transition in random graphs.” *Proc. 22nd Symp. on Discrete Algorithms (SODA ’11)* 1237–1252.
- S. Hallgren, C. Moore, M. Rötteler, A. Russell, and P. Sen, “Limitations of quantum coset states for Graph Isomorphism.” *J. ACM* 57 (6) (2010). Conference version in *Proc. 38th Symp. on Theory of Computing (STOC ’06)*, 604–617.
- C. Moore, A. Russell, and P. Śniady, “On the impossibility of a quantum sieve algorithm for Graph Isomorphism.” *SIAM J. Computing* 39(6) (2010) 2377–2396. Conference version in *Proc. 39th Symp. on Theory of Computing (STOC ’07)*, 536–545.
- A. Denney, C. Moore, and A. Russell, “Finding conjugate stabilizer subgroups in  $\text{PSL}(2, q)$  and related groups.” *Quantum Information and Computation* 10(3–4) (2010) 282–291.
- Y. Park, C. Moore, and J.S. Bader, “Dynamic networks from hierarchical Bayesian graph clustering.” *PLoS One* 5(1) (2010).
- D. Kempe, M. Salek, and C. Moore, “Frugal and truthful auctions for vertex covers, flows, and cuts.” *Proc. 51st. Foundations of Computer Science (FOCS ’10)* 745–754.
- S. Bravyi, C. Moore, and A. Russell, “Bounds on the quantum satisfiability threshold.” *Proc. 1st Symp. on Innovations in Computer Science (ICS ’10)* 482–489.
- G. Alagic, C. Moore, and A. Russell, “Quantum algorithms for Simon’s problem over general groups.” *ACM Transactions on Algorithms* 6 (2009) 331–345. Conference version in *Proc. 18th Symp. on Discrete Algorithms (SODA ’07)*, 1217–1224.
- D. Achlioptas, A. Clauset, D. Kempe, and C. Moore, “On the bias of traceroute sampling: or, power-law degree distributions in regular graphs.” *J. ACM* 56(4) (2009) 1–28. Conference version in *Proc. 37th Symp. on Theory of Computing (STOC ’05)*, 694–703.
- V. Kalapala and C. Moore, “The phase transition in Exact Cover.” *Chicago Journal of Theoretical Computer Science*, article 5 (2008).
- A. Clauset, C. Moore, and M. E. J. Newman, “Hierarchical structure and the prediction of missing links in networks.” *Nature* 453 (2008) 98–101.
- C. Moore, A. Russell, and L.J. Schulman, “The symmetric group defies strong Fourier sampling.” *SIAM J. Computing* 37 (2008) 1842–1864. Invited paper in special issue for FOCS 2005. Conference version in *Proc. 46th Foundations of Computer Science (FOCS ’05)*, 479–490.
- C. Moore, A. Russell, and U. Vazirani, “A classical one-way function to confound quantum adversaries.” Preprint, arXiv:0701115.
- R.M. D’Souza, P.L. Krapivsky, and C. Moore, “The power of choice in growing trees.” *European J. Phys. B* 59 535–543 (2007).
- C. Moore and A. Russell, “For distinguishing conjugate hidden subgroups, the Pretty Good Measurement is as good as it gets.” *Quantum Information and Computation* 7 (2007) 752–765.
- C. Moore, D. Rockmore, A. Russell, and L.J. Schulman, “The value of strong Fourier sampling: quantum algorithms for affine groups and hidden shifts.” *SIAM J. Computing* 37 (2007) 938–958. Conference version in *Proc. 15th Symp. on Discrete Algorithms (SODA ’04)*, 1113–1122.



- C. Moore, G. Istrate, D. Demopoulos, and M.Y. Vardi, “A continuous-discontinuous second-order transition in the satisfiability of random Horn-SAT formulas.” *Random Structures and Algorithms* 31 (2007) 173–185.
- H. Jia, C. Moore, and D. Strain, “Generating hard satisfiable formulas by hiding solutions deceptively.” *J. Artificial Intelligence Research* 28 (2007) 107–118. Conference version in *Proc. 20th Natl. Conf. on Artificial Intelligence (AAAI ’05)*, 384–389.
- T. Berger-Wolfe, C. Moore, and J. Saia, “A computational approach to animal breeding.” *Journal of Theoretical Biology* 244 (2007) 433–439.
- C. Moore, D. Rockmore, and A. Russell, “Generic quantum Fourier transforms.” *ACM Transactions on Algorithms* 2 (2006) 707–723. Invited paper in special issue for SODA 2004. Conference version in *Proc. 15th Symp. on Discrete Algorithms (SODA ’04)*, 778–787.
- D. Achlioptas and C. Moore, “Two moments suffice to cross a sharp threshold.” *SIAM J. Computing* 36 (2006) 740–762.
- C. Moore and M. Nauenberg, “New periodic orbits for the  $n$ -body problem.” *Journal of Computational and Nonlinear Dynamics* 1 (2006) 271–367. Special issue for Philip Holmes’ 60th birthday.
- A. Coja-Oghlan, C. Moore, and V. Sanwalani, “Counting connected graphs and hypergraphs via the probabilistic method.” *Random Structures and Algorithms* 28 (2006) 289–322. Conference version in *Proc. 8th Intl. Workshop on Randomization and Computation (RANDOM ’04)*, 322–333.
- C. Moore, G. Ghoshal, and M. E. J. Newman, “Exact solutions for models of evolving networks with addition and deletion of nodes.” *Physical Review E* 74 (2006) 036121.
- C. R. Shalizi, R. Haslinger, J.-B. Rouquier, K. L. Klinkner, and C. Moore, “Automatic filters for the detection of coherent structure in spatiotemporal systems.” *Physical Review E* 73 (2006) 036104.
- A. Coja-Oghlan, C. Moore, and V. Sanwalani, “MAX  $k$ -CUT and approximating the chromatic number of random graphs.” *Random Structures and Algorithms* 28 (2006) 289–322. Conference version in *Proc. Intl. Colloquium on Automata, Languages and Programming (ICALP ’03)* 200–211.
- V. Kalapala, V. Sanwalani, A. Clauset, and C. Moore, “Scale invariance in road networks.” *Physical Review E* 73 (2006) 026130.
- R. D’Souza, D. Galvin, C. Moore, and D. Randall, “Global connectivity from local geometric constraints for sensor networks with various wireless footprints.” *Proc. 6th Intl. Conf. on Information Processing in Sensor Networks (IPSN ’06)*, 19–26.
- A. Clauset, C. Moore, and M. E. J. Newman, “Structural inference of hierarchies in networks.” *Proc. Workshop on Statistical Network Analysis, Intl. Conf. on Machine Learning (ICML ’06)*. E. M. Airoldi et al., Eds., *Lecture Notes in Computer Science* 4503, 1–13.
- D. Achlioptas, M. Molloy, C. Moore, and F. Van Bussel, “Rapid mixing for lattice colorings with fewer colors.” *J. Stat. Mech.* (2005) P10012. Conference version in *Proc. Latin American Theoretical Informatics Symposium (LATIN ’04)* 80–89.
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- D. Achlioptas and C. Moore, “On the two-colorability of random hypergraphs.” *Proc. 6th Intl. Workshop on Randomization and Approximation Techniques in Computer Science* (RANDOM ’02) 78–90.
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*Neural Information Processing Systems* (NIPS '02)

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C. Moore, P. Tesson, and D. Thérien, "Satisfiability of systems of equations over finite monoids." *Proc. 26th Intl. Symp. on Mathematical Foundations of Computer Science* (MFCS '01) 537–547.

J. Linde, C. Moore, and M.G. Nordahl, "An  $n$ -dimensional generalization of the rhombus tiling." *Proc. 1st Intl. Conf. on Discrete Models: Combinatorics, Computation, and Geometry* (DM-CCG'01) 23–42.

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C. Moore and M. E. J. Newman, "Height representation, critical exponents, and ergodicity in the four-state triangular Potts antiferromagnet." *Journal of Statistical Physics* 99 (2000) 629–660.

C. Moore and J.P. Crutchfield, "Quantum automata and quantum grammars." *Theoretical Computer Science* 237 (2000) 275–306.

C. Moore, D. Thérien, F. Lemieux, J. Berman, and A. Drisko, "Circuits and expressions with non-associative gates." *Journal of Computer and System Sciences* 60 (2000) 368–394. Conference version in *Proc. 12th Ann. IEEE Conf. on Computational Complexity* (1997) 193–203.

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C. Moore and M.E.J. Newman, "Epidemics and percolation in small-world networks." *Physical Review E* 61 (2000) 5678–5682.

M.E.J. Newman, C. Moore, and D.J. Watts, "Mean-field solution of the small-world network model." *Physical Review Letters* 84 (2000) 3201–3204.

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M. Campagnolo and C. Moore, "Upper and lower bounds on continuous-time computation." *Proc. 2nd Intl. Conf. on Unconventional Models of Computation* (UMC '00) 135–153.

M. Lachmann, C. Moore, and I. Rapaport, "Who wins Domineering on rectangular boards?" In R.J. Nowakowski, Ed., *More Games of No Chance* (MSRI Workshop on Combinatorial Games, 2000) 307–315.

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D.M. Barrington, P. McKenzie, C. Moore, P. Tesson, and D. Thérien, "Equation satisfiability and

- program satisfiability for finite monoids.” *Proc. 25th Intl. Symp. on Mathematical Foundations of Computer Science* (MFCS ’00) 172–181.
- M. Campagnolo and C. Moore, “An analog characterization of the subrecursive functions.” *Proc. 4th Real Numbers and Computers* (RNC ’00) 91–110.
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- C. Moore and M. Nilsson, “The computational complexity of sandpiles.” *Journal of Statistical Physics* 96 (1999) 205–224.
- P. Koiran and C. Moore, “Closed-form analytic maps in one and two dimensions can simulate universal Turing Machines.” *Theoretical Computer Science* 210(1) (1999) 217–223, Special Issue on Real Numbers.
- C. Moore, “Predicting non-linear cellular automata quickly by decomposing them into linear ones.” *Physica D* 111 (1998) 27–41.
- K. Lindgren, C. Moore, and M.G. Nordahl, “Complexity of two-dimensional patterns.” *Journal of Statistical Physics* 91 (1998) 909–951.
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- C. Moore, “Finite-dimensional analog computers: flows, maps, and recurrent neural networks.” *Proc. 1st Intl. Conf. on Unconventional Models of Computation* (UMC ’98).
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- C. Moore, “Quasi-linear cellular automata.” *Physica D* 103 (1997) 100–132.
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- C. Moore, “Recursion theory on the reals and continuous-time computation.” *Theoretical Computer Science* 162 (1996) 23–44.
- C. Moore and A. Drisko, “Algebraic properties of the block transformation on cellular automata.” *Complex Systems* 10(3) (1996) 185–194.
- C. Moore, “Braids in classical dynamics.” *Physical Review Letters* 70 (1993) 3675–3679.
- C. Moore, “Generalized one-sided shifts and maps of the interval.” *Nonlinearity* 4 (1991) 727–745.
- C. Moore, “Generalized shifts: undecidability and unpredictability in dynamical systems.” *Nonlinearity* 4 (1991) 199–230.
- C. Moore, “Undecidability and unpredictability in dynamical systems.” *Physical Review Letters* 64 (1990) 2354–2357.
- C. Moore, “Comment on ‘Space-time as a causal set’.” *Physical Review Letters* 60 (1988) 655.

## 8 Recent professional, editorial, and organizing activities

Advisor, Microgrid Systems Laboratory, 2021–

Co-organizer, Simons Institute Workshop on Computational Phase Transitions, September 2020

Steering Committee, Workshop on Randomization and Computation (RANDOM) 2018–

Program Committee, Symposium on Theory of Computing (STOC) 2017

Chair, Lars Onsager Prize Committee, American Physical Society, 2016

Advisory Board, Indiana University Interdisciplinary Training Program in Complex Networks and Systems, 2016–

Program Committee, International Colloquium on Automata, Languages and Programming (ICALP) 2016, Track C

Program Committee, Foundations of Computer Science (FOCS) 2015

Program Committee, Workshop on Mining Networks and Graphs (SDM) 2015

Member, Lars Onsager Prize Committee, American Physical Society, 2015

Program Committee (Chair), Workshop on Randomization and Computation (RANDOM) 2014

Organizing Committee, SIAM Workshop on Network Science, 2014

Technical Advisory Group, HRL 2014

Jury, Turing Centenary Research Fellowship and Scholar Competition, 2012

External Review Panel, CIFAR Quantum Information Processing Program, 2012

Associate Editor, *Journal of Complex Networks*, 2012–2018

Associate Editor, *SIAM Journal on Discrete Mathematics*, 2010–2018

Editorial Board, *Journal of Statistical Mechanics: Theory and Experiment*, 2004–2007

## 9 Teaching

### 9.1 Courses taught at UNM

Introduction to the Theory of Computation (grad)	Spring '04, '07–'12
Data Structures and Algorithms	Spring and Fall '02, Fall '03, '04, '06
Physics and Computation	Spring '00, Spring '01, Spring and Fall '02, Spring '04, Fall '10
Introduction to Quantum Computation	Fall '04, Spring '08, Fall '11
Combinatorics, Probability, and Computation	Fall '06
Introduction to the Theory of Computation (undergrad)	Spring '03
Theoretical Foundations of Computer Science	Fall '03
Intermediate Object-Oriented Programming	Fall '00, Fall '01

### 9.2 Courses taught elsewhere

Summer 2005–2018: Santa Fe Institute Complex Systems Summer School, Santa Fe.

January 2003: Complex Systems Summer School. Valparaiso, Chile.

Summer 2001, 2002: Santa Fe Institute Complex Systems Summer School, Budapest.

Spring 2001: Short Course on Computational Complexity for the NSF Physics Graduate Student Fellowship program at the Santa Fe Institute.

Spring 1991: Cornell University, “Components, Systems, and Society: Science and Engineering in

a Social Context” (with Zellman Warhaft, Mechanical and Aerospace Engineering).

### 9.3 Students supervised

Munik Shrestha, Ph.D., Physics, 2015, “Statistics of Epidemics in Networks by Passing Messages.” Currently a postdoc at the University of Vermont.

Yaojia Zhu, Ph.D. Computer Science, 2013, “Community Detection in Complex Networks.” Now a data scientist at Microsoft.

Xiaoran Yan, Ph.D. Computer Science, 2013, “Model Selection for Stochastic Block Models.” Currently a postdoc at ISI at the University of Southern California.

Aaron Denney, Ph.D. Physics, 2012, “Quantum Algorithms, Symmetry, and Fourier Analysis.”

Tiffany Pierce, M.S. Computer Science, 2008, “Inference of Large-Scale Structure in Networks.”

Haixia Jia, Ph.D. with distinction, Computer Science, 2007, “Hard Problems with Hidden Solutions.”

Aaron Clauset, Ph.D. with distinction, Computer Science, 2006, “Structural Inference and the Statistics of Networks.” After a postdoc at the Santa Fe Institute, Aaron is now an Assistant Professor in Computer Science at the University Colorado-Boulder.

Vishal Sanwalani, Ph.D. with distinction, Computer Science, 2005, “Applications of the Probabilistic Method to Random Graphs.” Postdocs at the University of Waterloo and at Microsoft Research.

Vamsi Kalapala, M.S. 2005, “Results on Phase Transitions and Scale Invariance.”

Douglas Strain, M.S. 2005.

Qian Liang, M.S. 2003, “The Evolution of Mulan, Some Studies in Game-Tree Pruning and Evaluation Functions in the Game of Amazons.” Now at Microsoft.

Manuel Campagnolo. Ph.D. 2002 from the Lisbon University of Technology (co-advised with José Felix Costa). “Computational Complexity of Real-valued Recursive Functions and Analog Circuits.” Now Professor of Mathematics at the Lisbon University of Technology.

### 9.4 Reviewing

(Computer Science, Mathematics, and Statistics) *Journal of the ACM*, *SIAM Journal of Computing*, *SIAM Journal of Discrete Mathematics*, *SIAM Journal on Mathematics of Data Science*, *Theory of Computing*, *Journal of Computer and System Sciences*, *Information and Computation*, *Theoretical Computer Science*, *Information Processing Letters*, *Random Structures and Algorithms*, *Quantum Information and Computation*, *Theory of Computing Systems*, *Discrete and Computational Geometry*, *IEEE Trans. on Information Theory*, *IEEE Trans. on Computers*, *IEEE Trans. on Networks*, *ACM Trans. on Modeling and Computer Simulation*, *Computer Networks*, *Foundations of Computer Science (FOCS)*, *Symposium on Theory of Computing (STOC)*, *Symposium on Discrete Algorithms (SODA)*, *Randomization and Approximation Techniques in Computer Science (RANDOM)*, *Intl. Colloquium on Automata, Languages, and Programming (ICALP)*, *Symposium on Theoretical Aspects of Computer Science (STACS)*, *Mathematical Foundations of Computer Science (MFCS)*, *Computing and Combinatorics Conference (COCOON)*, *Intl. Symposium on Symbolic and Algebraic Computation (ISSAC)*, *Annals of Statistics*, *Annals of Applied Statistics*, *Annals of Applied Probability*, *International Mathematics Research Notices*

(Physics) *Physical Review Letters*, *Nature Physics*, *Physical Review A*, *Physical Review E*, *Physics Letters A*, *Physica A*, *Physica D*, *Europhysics Letters*, *Communications in Mathematical Physics*,

*Intl. J. Modern Physics C, Computers in Physics*

(Other) *Nature, Science, Proceedings of the National Academy of Sciences, Proceedings of the Royal Society, Nature Physics, PLoS One, Journal of Theoretical Biology, Applied Artificial Intelligence, IEEE Trans. Evolutionary Computation, Fluctuation and Noise Letters, Advances in Complex Systems, Chaos, Journal of Complexity, Mathematics Magazine, History and Philosophy of Logic, Portugaliae Mathematica*

## 10 Recent Funding (Principal Investigator)

NSF IIS BIGDATA with Jiaming Xu, “Mining for Patterns in Graphs and High-Dimensional Data: Achieving the Limits.” \$737,645, 2018–2021.

NSF REU Site, “Computational and Mathematical Modeling of Complex Systems.” \$346,958, 2014–2017 and \$323,821, 2018–2021.

DARPA GRAPHS with Aaron Clauset and Mark Newman, “Statistical Inference for Detecting Structures and Anomalies in Networks.” \$2.9M, 2012–2016.

NSF CCF with Tom Hayes, “The Physics of Markov Chains: Closing the Gap Between Theory and Practice.” \$200,000, 2012–2015.

NSF CCF with Alex Russell, “Representation-theoretic Techniques for Pseudorandomness and Lower Bounds.” \$240,979, 2012–2015.

McDonnell Foundation with Aaron Clauset and Mark Newman, “Statistical Inference and Machine Learning for Complex Networks.” \$417,576, 2008–2011.