Ryan R. Cheng

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Academic Appointments

- **Assistant Professor of Chemistry** — August 1, 2022−Current
  University of Kentucky
- **Research Scientist 1** — Mar. 2022−July 31, 2022
  The Center for Theoretical Biological Physics, Rice University
- **Postdoctoral Research Associate** — Oct. 2012−Mar. 2022
  The Center for Theoretical Biological Physics, Rice University
  Research Advisor: José N. Onuchic

Education

- **University of Texas at Austin** — Aug. 2007−Dec. 2012
  Ph.D. in Theoretical Chemistry
  Research Advisor: Dmitrii E. Makarov
  Dissertation Title: Conformational dynamics of an unfolded biopolymer: Theory and Simulation
  link: http://repositories.lib.utexas.edu/handle/2152/ETD-UT-2012-12-6459
- **Carnegie Mellon University** — Sept. 2003−May 2007
  B.S. in Chemistry with *University Honors* and *Research Honors*
  Research Advisors: Linda A. Peteanu (2005-2007), David Yaron (2006), Kenneth D. Jordan (2006)

In Preparation

† shared authorship
$^{\phi}$ PI

32. M. Mello, V. G. Contessoto, J. N. Onuchic, **R. R. Cheng**$^{\phi}$,"On the spatial positioning and compartmental polarization of human interphase chromosomes".
31. A. Das, **R. R. Cheng**, D. A. Potoyan, M. Di Pierro, "3D genome architecture regulates the traffic of transcription factors throughout human chromosomes".
30. **R. R. Cheng**, E. Dodero-Rojas, M. Di Pierro, and J. N. Onuchic, "Evolutionary differences in the ACE2 reveals the molecular origins of COVID-19 susceptibility".

Peer Reviewed Publications

† shared authorship
$^{\phi}$ PI

University of Kentucky

29. M. Shibata, X. Lin, K. Yura, and J. N. Onuchic, **R. R. Cheng**$^{\phi}$, "Amino acid co-evolution reveals novel monomer conformations in DNA-binding response regulators", *Biophysical Journal*, In Press DOI (2024).

Rice University

28. B. S. Ruben, S. Brahmachari, V. G. Contessoto, **R. R. Cheng**, A. B. Oliveira Junior, M. Di Pierro, and J. N. Onuchic "Structural Reorganization and Relaxation Dynamics of Axially Stressed Chromosomes", *Biophysical Journal*, 122 (9), 1633-1645 DOI (2023).

27. V. Contessoto†, **R. R. Cheng**†, J. N. Onuchic, "Uncovering the Statistical Physics of 3D Chromosomal Organization Using Data-Driven Modeling", *Current Opinions in Structural Biology*, DOI (2022).

26. K. Mehrabiani, **R. R. Cheng**, and J. N. Onuchic, "Expanding Direct Coupling Analysis to identify heterodimeric interfaces from limited protein sequence data", *Journal of Physical Chemistry B*, 125, 41, 11408–11417 DOI (2021).

25. V. G. Contessoto, **R. R. Cheng**, A. H. Taheri, E. Dodero-Rojas, M. F. Mello, E. Lieberman Aiden, P. G. Wolynes, M. Di Pierro, and J. N. Onuchic, "The Nucleome Data Bank: Web-based Resources to Simulate and Analyze the Three-Dimensional Genome", *Nucleic Acids Research* 49 (D1) DOI (2021).

24. **R. R. Cheng**, V. Contesotto, E. Lieberman Aiden, P. G. Wolynes, M. Di Pierro, and J. N. Onuchic, "Exploring Chromosomal Structural Heterogeneity Across Multiple Cell Lines", *eLife*, DOI (2020).

    Featured by Rice University in a Press Release (link).

23. A. Mandic, R. L. Hayes, H. Lammert, **R. R. Cheng**, J. N. Onuchic, "Structure-based model of RNA captures thermodynamics of folding of the BWYV Pseudoknot", *Journal of Physical Chemistry B*, 123 (7), 1505-1511 (2019). DOI

22. D. Kreppel, **R. R. Cheng**, M. Di Pierro, and J. N. Onuchic, "Deciphering the Structure of the Condensin Protein Complex". *Proc. Natl. Acad. Sci. USA*, 115 (47), 11911-11916 (2018). DOI

21. **R. R. Cheng**†, E. Haglund†, N. Tiee†, F. Morcos, H. Levine, J. A. Adams, P. Jennings, and J. N. Onuchic, "Designing Bacterial Signaling Interactions with Coevolutionary Landscapes". *PLOS One*, 13(8): e0201734 (2018). DOI

20. L. Vian et al, "The Energetics and Physiological Impact of Cohesin Extrusion", *Cell*, 173 (5) 1165-1178.e20 (2018). DOI

19. M. Di Pierro†, **R. R. Cheng**†, E. Lieberman Aiden, P. G. Wolynes, and J. N. Onuchic, "De novo prediction of human chromosome structures: Epigenetic marking patterns encode genome architecture", *Proc. Natl. Acad. Sci. USA*, 114 (46) 12126-12131 (2017). DOI

    Featured by Rice University in a Press Release, Recommended on F1000 Prime.

18. F. Bai, F. Morcos, **R. R. Cheng**, H. Jiang, and J. N. Onuchic, "Elucidating the druggable interface of protein-protein interactions using fragment-docking and coevolutionary analysis", *Proc. Natl. Acad. Sci. USA*, E8051-E8058 (2016). DOI

17. **R. R. Cheng**, O. Nordesjö, R. L. Hayes, H. Levine, S. C. Flores, J. N. Onuchic, and F. Morcos, "Connecting the sequence-space of bacterial signaling proteins to phenotypes using coevolutionary landscapes", *Mol. Biol. Evol.*, 33 (12): 3054-3064 (2016). DOI

    Selected as the cover of the December 2016 issue.

16. J. Boyd, **R. R. Cheng**, M. Paddock, C. Sancar, F. Morcos and S. Golden, "A Combined Computational and Genetic Approach Uncovers Network Interactions of the Cyanobacterial Circadian Clock", *J. Bacteriol.*, 198 (18), 2439-2447 (2016). DOI

15. **R. R. Cheng**†, M. Raghunathan†, J. K. Noel, and J. N. Onuchic, "Constructing sequence-dependent protein models using coevolutionary information", *Protein Science*. Available online for a special Issue in honor of Ron Levy (2015). DOI

14. F. Morcos, N. P. Schafer, **R. R. Cheng**, J. N. Onuchic, and P. G. Wolynes, "Coevolutionary Information, Folding Landscapes and the Thermodynamics of Natural Selection", *Proc. Natl. Acad. Sci. USA*, (2014). DOI
    Featured by Rice University in a Press Release (link).

13. **R. R. Cheng**, F. Morcos, H. Levine, and J. N. Onuchic, "Towards rationally redesigning bacterial two-component signaling systems using coevolutionary information", *Proc. Natl. Acad. Sci. USA*, (2014). DOI

    Featured by Rice University in a Press Release (link).

    Featured by the NSF in article discussing potential future application of our work to reduce biofouling (News article link).

University of Texas at Austin

12. **R. R. Cheng**†, A. T. Hawk†, and D. E. Makarov, "Exploring internal friction in the conformational dynamics of unfolded proteins using simple models", *J. Chem. Phys.*, 138, 074112 (2013). DOI

11. A. Soranno, B. Buchli, D. Nettels, S. Muller-Spath, **R. R. Cheng**, S. H. Pfeil, A. Hoffmann, E. A. Lipman, D. E. Makarov, B. Schuler, "Quantifying internal friction in unfolded and intrinsically disordered proteins with single molecule spectroscopy", *Proc. Natl. Acad. Sci. USA*., 109 (44), 17800-17806 (2012). DOI

10. J. A. Madsen, **R. R. Cheng**, T. S. Kaoud, K. N. Dalby, D. E. Makarov, J. S. Brodbelt, "Charge-site Dependent Dissociation of Hydrogen-Rich Radical Peptide Cations upon Vacuum UV Photoexcitation", *Chem. Eur. J.*, 18 (17), 5374-5383 (2012). DOI

9. C. W. Cone, **R. R. Cheng**, D. E. Makarov, D. A. Vanden Bout, "Molecular Weight Effect on the formation of Beta Phase poly(9,9-dioctylfluorene) in a poor solvent", *J. Phys. Chem. B*, 115 (43), 12380-12385 (2011). DOI

8. **R. R. Cheng** and D. E. Makarov, "Failure of one-dimensional Smoluchowski diffusion models to describe the duration of conformational rearrangements in floppy, diffusive molecular systems: A case study of polymer cyclization", *J. Chem. Phys.*, 134, 085104 (2011). DOI

    Selected to The Journal of Chemical Physics Editors' Choice for 2011

7. **R. R. Cheng**, T. Uzawa, K. W. Plaxco, and D. E. Makarov, "Universality in the timescales of internal loop formation in unfolded proteins and single-stranded oligonucleotides", *Biophys. J.*, 99 (12), 3959-3968 (2010). DOI

6. T. Uzawa, **R. R. Cheng**, R. J. White, D. E. Makarov, and K. W. Plaxco, "A mechanistic study of electron transfer from the distal termini of electrode-bound, single-stranded DNAs", *J. Am. Chem. Soc.*, 132 (45), 16120-16126 (2010). DOI

5. **R. R. Cheng** and D. E. Makarov, "End-to-surface reaction dynamics of a single surface attached DNA or polypeptide", *J. Phys. Chem. B*, 114 (9), 3321-3329 (2010). DOI

4. **R. R. Cheng**, T. Uzawa, K. W. Plaxco, and D. E. Makarov, "The rate of intramolecular loop formation in DNA and polypeptides: The absence of the diffusion-controlled limit and fractional power law viscosity dependence", *J. Phys. Chem. B*, 113 (42), 14026-14034 (2009). DOI

3. T. Uzawa, **R. R. Cheng**, K. J. Cash, D. E. Makarov, and K. W. Plaxco, "The Length and Viscosity Dependence of End-to-End Collision Rates in Single-Stranded DNA", *Biophys. J.*, 97 (1), 205-210 (2009). DOI

Carnegie Mellon University

2. G. A. Sherwood, **R. Cheng**, K. Chacon-Madrid, T. M. Smith, and L. A. Peteanu, "Chain length and substituent effects on the formation of excimer-like states in nanoaggregates of CN-PPV model oligomers", *J. Phys. Chem. C*, 114 (28), 12078-12089 (2010). DOI

1. G. A. Sherwood, **R. Cheng**, T. M. Smith, J. H. Werner, A. P. Shreve, L. A. Peteanu, and J. Wildeman, "Aggregation Effects on the Emission Spectra and Dynamics of Model Oligomers of MEH-PPV", *J. Phys. Chem. C*, 113 (43), 18851-18862 (2009). DOI

Book Chapters

1. M. D. Pierro, **R. R. Cheng**, B. Zhang, J. N. Onuchic, and P. G. Wolynes, "Learning Genomic Energy Landscapes from Experiments", *Modeling the 3D Conformation of Genomes*, Editor G. Tiana and Editor L. Giorgetti (2019).

Honors and Awards

- Full Member of Sigma Xi, The Scientific Research Honor Society 2021
- Excellence in Graduate Polymer Research Award, American Chemical Society 2012
- Graduate Student Professional Development Award, University of Texas at Austin 2012
- Welch Summer Fellowship Award, University of Texas at Austin 2011
- Pre-emptive Recruitment Fellowship, University of Texas at Austin 2007
- Mellon College of Science Research Honors, Carnegie Mellon University 2007
- Graduated with *University Honors*, Carnegie Mellon University 2007
- Bausch and Lomb Honorary Science Award 2002

Teaching Experience

- **Instructor for CHE440G: Introductory Physical Chemistry, UKY** Fall 2023
  Course introduces modern physical chemistry to undergraduate chemistry majors. Topics include thermodynamics, kinetics, and quantum mechanics.

- **Instructor for CHE548: Principles of Physical Chemistry II, UKY** Spring 2023
  Teaching 11 chemistry graduate students; Course covered classical thermodynamics and equilibrium statistical mechanics

- **Instructor for CHE-446G-001/201: Physical Chemistry for Engineers, UKY** Fall 2022
  Teaching 60 students; Course covered thermodynamics and an introduction in quantum mechanics

- **TOMODACHI STEM at Rice University** 2018−Present
  Mentor to Mayu Shibata (Ph.D. student in Biology at Ochanomizu University, Japan)
  Research: "A survey of bacterial response regulator effector domains using coevolutionary information"

- **Undergraduate Research Mentor, Rice University** 2017
  Mentor to Jeremy Kao (BS in Physics 2017) for Undergraduate Thesis
  Thesis: "Combining evolutionary direct coupling analysis with structure-based models to study the physical mechanism of the HAMP domain in signal transduction"

- **Graduate Research Mentor, Rice University** 2015
  Mentored research culminating in a publication (Mohit Raghunathan, MA Physics 2015)

- **Undergraduate Research Mentor, CTBP/Rice/University of Houston** 2014
  Mentor to Rodney Helm (Undergraduate in Physics at University of Houston)
  Research: "Exploring coevolution in real and designed protein sequences using Direct Coupling Analysis"

- **Intro. to Quantum Mechanics, University of Texas at Austin** 2011
  Provided supplemental instruction through office hours, graded homework and exams
- **Physical Chemistry Laboratory, University of Texas at Austin** 2007−2008
  Supervised lab experiments, graded lab reports and homework assignments

Invited Talks

11. "Structural heterogeneity and compartmental polarization of human chromosomes", Northeastern University Physics Colloquium, Boston, MA, October 26, 2023.
10. "On the spatial positioning and compartmental polarization of human chromosomes", Genome Architecture and Function, Workshop Talk, Sofia, Bulgaria, June 6, 2023.
9. "A Physicochemical Basis for Chromosome Organization and Structural Heterogeneity Across Human Cell Types", Genome Architecture and Function, Summer School Lecture, Sofia, Bulgaria, June 3, 2023.
8. "A Physicochemical Basis for Chromosome Organization and Structural Heterogeneity Across Human Cell Types", Biophysical Society Thematic Meeting: Biophysics at the Dawn of Exascale Computers, Hamburg, Germany, May 20, 2022.
7. "Uncovering physicochemical principles by learning from biological sequences", University of Kentucky, Department of Chemistry, January 27, 2022.
6. "Exploring Chromosomal Structural Heterogeneity Across Multiple Cell Lines", University of Hawaii at Mānoa, Department of Chemistry Symposium, October 19, 2020.
5. "Exploring Chromosomal Structural Heterogeneity Across Multiple Cell Lines", NSF Funded MIT Virtual Workshop: Genome Architecture and Dynamics, May 30, 2020 .
4. "Learning Biology from Information Encoded in Sequences", The Institute for Computational Engineering and Sciences (ICES), University of Texas at Austin, April 9, 2018.
3. "Inferring essential features of large biological datasets", 1st International Conference on Computational Genomics and Proteomics, Guanacaste, Costa Rica, October 2016.
2. "Constructing predictive models of proteins using coevolutionary information", ACS March Meeting: Modeling Complex Biomolecules: From Structure to Dynamics & Function, Denver, CO, March 2015.
1. "Spatio-temporal correlations in unfolded biopolymers: Theory and simulations", ACS March Meeting: Excellence in Graduate Polymer Research Symposium, San Diego, CA, March 2012.

Journal Reviewer

Proceedings of the National Academy of Sciences of the USA (PNAS)
Journal of the American Chemical Society (JACS)
PLOS Computational Biology
Bioinformatics
The Journal of Physical Chemistry B
IEEE/ACM Transactions on Computational Biology and Bioinformatics
Molecular Biology and Evolution
ACS Omega
Biophysical Journal
Biopolymers

Additional Reviewer Activities

3. National Academies' Molecular Dynamics proposal review committee. *Proposal Evaluation for Allocation of Supercomputing Time for the Study of Molecular Dynamics, Fourteenth Round.* August 1, 2023−Sept 2, 2023.
2. National Academies' Molecular Dynamics proposal review committee. *Proposal Evaluation for Allocation of Supercomputing Time for the Study of Molecular Dynamics, Thirteenth Round.* August 2022.
1. Judge for the Science Engineering Fair of Houston (Middle School/High School), 2017

UKY Committee Activities

3. Graduate Recruitment Committee, Department of Chemistry @ UKY, Spring 2023−Present.
2. Diversity, Equity, and Inclusivity Committee, Department of Chemistry @ UKY, Fall 2022−Present.
1. Associate Member of Graduate Faculty, Department of Chemistry @ UKY, Fall 2022−Present.