

# Yi-Hsuan Lin, PhD

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## EDUCATION

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### Ph.D., Physics

2015

The Ohio State University, Ohio, USA

Thesis: *The interplay between single-stranded binding proteins on RNA secondary structure*

Supervisor: Ralf Bundschuh

### B.Sc., Physics

2009

University of Illinois at Urbana-Champaign, Illinois, USA

High Distinction in Physics

(National Taiwan University, Taiwan, 2005–2007, transferred)

## RESEARCH SUMMARY

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Theoretical and computational physics, chemistry, and biology. Focusing on polymer physics theories, protein molecular mechanisms, biopolymer phase separation, and RNA-protein interaction. **11** invited talks, **15** papers, **804** citations, h-index = **11** (Jul 2021)

## ACADEMIC POSITIONS

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### Joint Postdoctoral Fellow

Jul 2015 – Jul 2021

Department of Biochemistry, University of Toronto

Molecular Medicine Program, Hospital for Sick Children

- Developing statistical physics theories for the “sequence specificity” in biological liquid-liquid phase separation
- Collaborating with experimentalists and computational biologists to test the above-mentioned physics theory
- Develop Monte Carlo simulation programs from scratch for modelling protein assemblies
- Published **13** peer-reviewed papers in theoretical/computational physics, chemistry, and biology
- Supervised and mentored over **3** junior scientists (students and trainees)

Project: *Theories for sequence-dependent phase behaviours of biomolecular condensates*

Supervisors: Hue Sun Chan & Julie D. Forman-Kay

### Graduate Research Associate

Aug 2012 – May 2015

Department of Physics, The Ohio State University

- Developed statistical physics theory for RNA secondary structure and RNA-protein binding systems
- Developed Monte Carlo simulation programs for investigating RNA membrane translocation
- Developed solvable Markov system describing DNA-repair process
- Established theoretical framework for online RNA-protein binding predictor RBPBind
- Published **2** first-author papers in theoretical physics and bioinformatics

Project: *Biophysics of interactions between proteins and nucleic acids*

Supervisor: Ralf Bundschuh

### Graduate Research Associate

Aug 2011 – May 2012

Department of Physics, The Ohio State University

- Applied the Nozières-Schmitt-Rink method to calculate the phase transition temperature in BEC-BCS crossover

Project: *BEC-BCS crossover in cold-atomic systems*

Supervisor: Tin-Lun Ho

## PUBLICATIONS

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15. Wessén J, Pal T, Das S, **Lin Y-H**, and Chan HS (2021) A simple explicit-solvent model of polyampholyte phase behaviors and its ramifications for dielectric effects in biomolecular condensates. *J Phys Chem B* **125** 4337–4358 (selected supplementary cover)
14. Das S, **Lin Y-H**, Vernon RM, Forman-Kay JD, and Chan HS (2020) Comparative roles of charge,  $\pi$ , and hydrophobic interactions in sequence-dependent phase separation of intrinsically disordered proteins. *Proc Natl Acad Sci USA* **117** 28795–28805
13. Amin AN\*, **Lin Y-H\***, Das S, and Chan HS (2020) Analytical theory for sequence-specific binary fuzzy complexes of charged intrinsically disordered proteins. *J Phys Chem B* **124** 6709–6720 (\*equal contribution; selected supplementary cover)
12. **Lin Y-H**, Brady JP, Chan HS, and Ghosh K (2020) A unified analytical theory of heteropolymers for sequence-specific phase behaviors of polyelectrolytes and polyampholytes. *J Chem Phys* **152** 045102
11. Cinar H, Oliva R, **Lin Y-H**, Chen X, Zhang M, Chan HS, and Winter RHA (2020) Pressure sensitivity of SynGAP/PSD-95 condensates as a model for postsynaptic densities and its biophysical and neurological ramifications. *Chem Eur J* **26** 11024–11031 (cover feature)
10. Das S, Amin AN, **Lin Y-H**, and Chan HS (2018) Coarse-grained residue-based models of disordered protein condensates: utility and limitations of simple charge pattern parameters. *Phys Chem Chem Phys* **20** 28558–28574
9. **Lin Y-H**, Forman-Kay JD, and Chan HS (2018) Theories for sequence-dependent phase behaviors of biomolecular condensates. *Biochemistry* **57** 2499–2508
8. Das S, Eisen A, **Lin Y-H**, and Chan HS (2018) A lattice model of charge-pattern-dependent polyampholyte phase separation. *J Phys Chem B* **122** 5418–5431
7. **Lin Y-H**, Brady JP, Forman-Kay JD, and Chan HS (2017) Charge pattern matching as a “fuzzy” mode of molecular recognition for the functional phase separations of intrinsically disordered proteins. *New J Phys* **19** 115003
6. Brady JP, Farber PJ, Sekhar A, **Lin Y-H**, Huang R, Bah A, Nott TJ, Chan HS, Baldwin AJ, Forman-Kay JD, and Kay LE (2017) Structural and hydrodynamic properties of an intrinsically disordered region of a germ-cell specific protein upon phase separation. *Proc Natl Acad Sci USA* **114** E8194–E8203
5. **Lin Y-H** and Chan HS (2017) Phase separation and single-chain compactness of charged disordered proteins are strongly correlated. *Biophys J* **112** 2043–2046
4. **Lin Y-H**, Song J, Forman-Kay JD, and Chan HS (2017) Random-phase-approximation theory for sequence-dependent, biologically functional liquid-liquid phase separation of intrinsically disordered proteins. *J Mol Liq* **228** 176–193
3. **Lin Y-H**, Forman-Kay JD, and Chan HS (2016) Sequence-specific polyampholyte phase separation in membraneless organelles. *Phys Rev Lett* **117** 178101
2. **Lin Y-H** and Bundschuh R (2015) RNA structure generates natural cooperativity between single-stranded RNA binding proteins targeting 5' and 3'UTRs. *Nucleic Acids Res* **43** 1160–1169
1. **Lin Y-H** and Bundschuh R (2013) Interplay between single-stranded binding proteins on RNA secondary structure. *Phys Rev E* **88** 052707

## Working Papers

- **Lin Y-H**, Wu H, Zhang M, and Chan HS (2021) Phase separation of the SynGap/PSD-95 condensate model of postsynaptic densities involves multivalent interactions auxiliary to dilute-phase stoichiometric binding (in preparation)
- **Lin Y-H**, Wessén J, Pal T, Das S, and Chan HS (2021) Numerical techniques for applications of analytical theories to sequence-dependent phase separations of intrinsically disordered proteins (submitted)
- Gaither J, **Lin Y-H**, and Bundschuh R (2016) RBPBind: Quantitative prediction of Protein-RNA Interactions. Preprint: arXiv:1611.01245

## HONORS AND AWARDS

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<b>Postdoctoral Award</b> , Intrinsically Disordered Protein Subgroup, Biophysical Society (USA)	2019
<b>Connell Award for Postdoctoral Fellow</b> , Department of Biochemistry, University of Toronto	2018
<b>Dean's List</b> , College of Liberal Arts and Sciences, University of Illinois at Urbana-Champaign	2007
<b>Presidential Award</b> , Department of Physics, National Taiwan University	2007
<b>Gold Medal</b> , The 36 <sup>th</sup> International Physics Olympiad	2005

### Scholarships and Travel Awards

<b>Travel Award</b> , Biophysical Society 63 <sup>rd</sup> Annual Meeting (USA)	2019
<b>Scholarship for Study Abroad</b> , Graduate Study, Taiwan Ministry of Education	2009–2013
<b>Scholarship for Study Abroad</b> , Undergraduate Study, Taiwan Ministry of Education	2007–2009

## PROFESSIONAL SERVICE

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- Poster judge for divisional student poster competition of the Division of Physics in Medicine and Biology at the Canadian Association of Physicists Congress 2021
- Co-chair of "Using Polymer Sequence to Control Material Properties" session at the American Physical Society March Meeting 2019 (with Dr. Lisa Hall at The Ohio State University)

## INDUSTRIAL EXPERIENCE

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**Molecular Modelling Lead** Jan 2021 – present

HTuO Biosciences, Vancouver, BC, Canada

- Establishing the physics principles of a new molecular dynamics force field for pharmaceutical applications
- Developing a molecular dynamics simulation software with the above-mentioned new force field embedded
- Incorporating machine learning to parametrize force fields and optimize their simulation performance
- Implementing mathematical physics to validate stability of various simulation methods

**Data Scientist** Jun 2020 – Oct 2020

Sustainability.Exchange, Toronto, ON, Canada

- Applied supervised machine learning algorithms and Bayesian statistics to build models for time series forecasting of environmental, social and corporate governance (ESG) financial data.

**Science Advisor** Nov 2019 – Dec 2019

StemCellerant, Remotely

- Providing consultation on biotech application and business development of new stem cell differentiation technology and systems biology.

## MENTORING EXPERIENCE

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### Department of Biochemistry, University of Toronto

Designed research projects, provided instructions on math, physics, and computational methods, and manuscript writing

- Alan Amin, Research Undergraduate Student Sep 2017 – Jun 2019  
Project: *Cluster-expansion theory for sequence-specific IDP-IDP interactions*
- Adam Eisen, Research Undergraduate Student Jun 2016 – Aug 2016  
Project: *Monte Carlo simulation of lattice models for polyampholytes*

### Molecular Medicine, The Hospital for Sick Children

Provided instructions on thesis writing and defense preparation

- Shuo-Chin Yen, Masters Student Jul 2018 – Sep 2018  
Thesis: *Characterization of the dependence of Src:ND2 binding on phosphorylation and intramolecular Src interactions*

## TEACHING EXPERIENCE

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### Lecturer, Center for Study Overseer Inc.

2020

Taught undergraduate level online courses in biology and physics, designing homework and exams and grading standards, and providing recitation sessions upon request

Introduction to Physics (~10 students)

Summer 2020

Introduction to Biology (~10 students)

Summer 2020

### Teaching Associate, Department of Physics, The Ohio State University

2009 – 2011

Taught regular homework review sessions and recitations before exams, provided office hours for students' needs of extra learning helps, and graded homework

Physics 836, Electromagnetic Field Theory III (Graduate Level, ~70 students )

Spring 2011

Physics 835, Electromagnetic Field Theory II (Graduate Level, ~70 students)

Winter 2011

Physics 834, Electromagnetic Field Theory I (Graduate Level, ~70 students)

Autumn 2010

Physics 730, Methods of Theoretical Physics (~20 students)

Spring 2010

Physics 664, Theoretical Mechanics (~40 students)

Spring 2010

Physics 622, Statistical Physics II (~40 students)

Winter 2010

Physics 656, Fields and Waves II (~40 students)

Winter 2010

Physics 621, Statistical Physics I (~40 students)

Autumn 2009

## PRESENTATIONS

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### Invited Seminars and Colloquia

11. *Introduction to machine learning and its application in biophysics and computational biology*, Division of Physics in Medicine and Biology (DPMB) 101 Lecture, Canadian Association of Physicists Congress, Online, **Jun 7, 2021**
10. *Polymer field theory for sequence-specific intracellular phase separation of biological heteropolymers*, Department of Physics, University of Manitoba, Winnipeg, MB, Canada, **Nov 25, 2020**
9. *Polymer theory for the sequence-specific phase separation behaviors of charged intrinsically disordered proteins*, Intrinsically Disordered Protein Subgroup Postdoctoral Award Talk, Biophysical Society 63<sup>rd</sup> Annual Meeting, Baltimore, MD, USA, **Mar 2, 2019**
8. *Theories and simulations for sequence-specific behaviors of intrinsically disordered proteins in liquid-liquid phase separation*, Institute of Chemistry, Chinese Academy of Sciences, Beijing, China PRC, **Oct 16, 2018**
7. *Theories and simulations for sequence-specific behaviors of intrinsically disordered proteins in liquid-liquid phase separation*, Center for Quantitative Biology, Peking University, Beijing, China PRC, **Oct 15, 2018**
6. *Theories and simulations for liquid-liquid phase separation in biology*, Institute of Biophysics, Central China Normal University, Wuhan, China PRC, **Oct 12, 2018**
5. *Sequence-specific theory for intrinsically disordered proteins in liquid-liquid phase separation (Connell Award for Postdoctoral Fellow)*, Department of Biochemistry Retreat of University of Toronto, Geneva Park, Orillia, ON, Canada, **Oct 2, 2018**
4. *Sequence-specific behaviors of charged intrinsically disordered proteins in liquid-liquid phase separation*, Protein Folding Consortium, University of California, Berkeley, CA, USA, **Jun 3, 2017**
3. *The interplay between single-stranded binding proteins on RNA secondary structures*, Molecular Structure and Function, The Hospital for Sick Children, Toronto, ON, Canada, **Mar 12, 2015**
2. *The interplay between single-stranded binding proteins on RNA secondary structures*, Center for Theoretical Biophysics, Rice University, Houston, TX, USA, **Oct 27, 2014**
1. *The interplay between single-stranded binding proteins on RNA secondary structures*, National Center for Theoretical Sciences, National Cheng Kung University, Tainan, Taiwan ROC, **Jun 9, 2014**

## Contributed Talks

7. *Random phase approximation and renormalized Gaussian chain for charged hetero-biopolymers and their sequence-specific phase behavior*, Canadian Association of Physicists Congress, Burnaby, BC, Canada, **Jun 4, 2019**
6. *Cluster-expansion theory for sequence-specific “fuzzy” interaction between pairs of intrinsically disordered proteins*, American Physical Society March Meeting, Boston, MA, USA, **Mar 8, 2019**
5. *Sequence-specific random-phase-approximation theory for polyampholytic intrinsically disordered proteins in liquid-liquid phase separation*, Canadian Association of Physicists Congress, Halifax, NS, Canada, **Jun 14, 2018**
4. *Sequence-specific polymer theory for charged intrinsically disordered proteins in liquid-liquid phase separation*, Chemical Biophysics Symposium at University of Toronto, Toronto, ON, Canada, **May 4, 2018**
3. *Random-phase-approximation theory for sequence-dependent behaviors of intrinsically disordered proteins in liquid-liquid phase separation*, American Physical Society March Meeting, New Orleans, LA, USA, **Mar 15, 2017**
2. *Loop cost in RNA secondary structures and the long-range cooperativity between RNA-binding proteins*, American Physical Society March Meeting, Denver, CO, USA, **Mar 5, 2014**
1. *The interplay between single-stranded binding proteins on RNA secondary structures*, American Physical Society March Meeting, Baltimore, MD, USA, **Mar 22, 2013**

## Poster Presentations

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| 10. Biophysical Society of Canada 5 <sup>th</sup> Annual Meeting, Mississauga, ON, Canada | May 28–31, 2019 |
| 9. Biophysical Society 63 <sup>rd</sup> Annual Meeting, Baltimore, MD, USA                | Mar 2–6, 2019   |
| 8. Gordon Research Conference – Polymer Physics, South Hadley, MA, USA                    | Jul 21–27, 2018 |
| 7. Protein Folding Consortium, Ann Arbor, MI, USA   | Jun 8–10, 2018  |
| 6. Gordon Research Conference – Protein, Holderness, NH, USA                              | Jun 18–23, 2017 |
| 5. Biophysical Society of Canada 3 <sup>rd</sup> Annual Meeting, Montréal, QC, Canada     | May 24–26, 2017 |
| 4. Protein Folding Consortium, St. Louis, MO, USA   | Jun 9–12, 2016  |
| 3. Rustbelt RNA Meeting, Pittsburgh, PA, USA  | Oct 17–18, 2014 |
| 2. Soft Matter Science Summer School, Mittelwihr, France                                  | Jul 6–11, 2014  |
| 1. Rustbelt RNA Meeting, Cleveland, OH, USA   | Oct 18–19, 2013 |

## SKILLS

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- **Math/Stat:** Numerical Analysis, Bayesian Statistics, Multivariate Linear/Nonlinear Optimization, Linear Algebra, Multivariable Calculus, Stochastic Calculus, Partial Differential Equation, Complex Analysis
- **Modelings:** Theoretical Physics, Molecular Biophysics, Bioinformatics, Monte Carlo Simulation, Molecular Dynamics Simulation, Data-Driven Statistical Modeling, Machine Learning, Deep Learning, Data Visualization, Principal Component Analysis, Time Series Forecasting
- **Programming:** Python, Matlab/Octave, C/C++, Mathematica, Julia, SQL
- **Tools:** Numpy, Scipy, Pandas, Matplotlib, Scikit-Learn, PyMC, SQLite, MPI, PyCharm, Git

## CERTIFICATES

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Financial Engineering and Risk Management I & II (Coursera.org/Columbia Univ)  
Introduction to Deep Learning with Honors (Coursera.org/HSE Univ)  
Bayesian Methods for Machine Learning with Honors (Coursera.org/HSE Univ)  
Practical Reinforcement Learning with Honors (Coursera.org/HSE Univ)