Siao-Fong Li

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Education

Ph.D. in Physics, **University of Massachusetts, Amherst.** Sep 2017 - Dec 2023

- Additionally, I was granted "Certificate in Statistical and Computational Data Science".

M.S. in Physics, **National Taiwan University.** Sep 2012 - May 2014

B.S. in Physics, **National Tsing Hua University.** Sep 2008 - May 2012

Honors and Awards

2014: "Dean's Award of College of Science." *in National Taiwan University.*

2014: "Best Paper Awards of Center of Theoretical Science." *in National Taiwan University.*

2009: "Academic Achievement Award." *in National Tsing Hua University.*

2008: "College of Science Young Elite Scholarship" *in National Tsing Hua University.*

Publications

Google Scholar: Siao Fong Li - Google Scholar

Li, Siao-Fong, and Murugappan Muthukumar. "Theory of Microphase Separation in Concentrated Solutions of Sequence-Specific Charged Heteropolymers." *Macromolecules* 55, no. 13 (2022): 5535-5549.

Singha, Tapas, **Siao-Fong Li**, and Murugappan Muthukumar. "Coupled dynamics of charged macromolecules and counterions mediated by binding enzymes." *bioRxiv* (2021): 2021-06.

Chen, Kuo, **Siao-Fong Li**, and M. Muthukumar. "Boundaries of the topologically frustrated dynamical state in polymer dynamics." *ACS Macro Letters* 11, no. 5 (2022): 699-705.

Jin, Zehao, Joshua Yao-Yu Lin, and **Siao-Fong Li**. "Learning Principle of Least Action with Reinforcement Learning." *arXiv preprint arXiv:2011.11891* (2020).

He, Xiao-Gang, **Siao-Fong Li**, Bo Ren, and Xing-Bo Yuan. "Tests for CPT Sum Rule and U-spin Violation in Time-Dependent CP Violation of $B_s^0 \to K^+K^-$ and $B^0 \to \pi^+\pi^-$. " Phys. Rev. D 96,053004. (alphabetic order)

He, Xiao-Gang, Chao-Jung Lee, **Siao-Fong Li**, and Jusak Tandean. " Fermion EDMs with Minimal Flavor Violation. " Journal of High Energy Physics 2014, no. 8 (2014): 1-31. (alphabetic order)

He, Xiao-Gang, Chao-Jung Lee, **Siao-Fong Li**, and Jusak Tandean. "Large electron electric dipole moment in minimal flavor violation framework with Majorana neutrinos." Physical Review D 89, no. 9 (2014): 091901. (alphabetic order)

He, Xiao-Gang, **Siao-Fong Li**, and Hsiu-Hsien Lin. "CP violation in $B_s^0 \to K^-\pi^-$, $B^0 \to K^+\pi^-$ decays and tests for SU(3) flavor symmetry predictions." Journal of High Energy Physics 2013, no. 8 (2013): 1-16. (alphabetic order)

He, Xiao-Gang, **Siao-Fong Li**, and Hsiu-Hsien Lin. "Further Studies of Higgs Properties at An ILC γγ Collider ." Modern Physics Letters A 28, no. 18 (2013): 1350085. (alphabetic order)

Submitted publications

Li, Siao-Fong, and Murugappan Muthukumar. "Theory of Thermoreversible Gelation and Anomalous Concentration Flucutations in Polyzwitterion Solutions."

Manuscripts in preparation

Das, Shibananda, **Siao-Fong Li**, and Murugappan Muthukumar. "Thermally Induced Globule-Coil Transition of Patterned Polyzwitterions."

Samule, Hoover, **Siao-Fong Li**, and Murugappan Muthukumar. "XGBoost-based Machine Learning Prediction to the Stability of Micro-structures Based on Sequence-specified Heteropolymer Data.".

Presentations

"Theory of Microphase Separation in Concentrated Solutions of Sequence Specific Charged Heteropolymers." in APS March Meeting, Chicago, Illinois. (2022)

"Theory of Microphase Separation and Micellization in Solutions of Intrinsically Disordered Proteins." in APS March Meeting, in virtual. (2021)

"CP Violation in $B_s^0 \to K^-\pi^+$, $B^0 \to K^+\pi^-$ Decays and Tests for SU(3) Flavor Symmetry Predictions." in High1-2014 KIAS-NCTS Joint workshop on Particle Physics, String Theory and Cosmology, Gangwon, Korea. (2014)

"CP Violation in $B_s^0 \to K^-\pi^+$, $B^0 \to K^+\pi^-$ Decays and Tests for SU(3) Flavor Symmetry Predictions." in Regular Seminars at High Energy Theory Group, Institute of Physics, Academia Sinica, Taipei, Taiwan. (2013, invited talk).

Posters

"Thermoreversible Gelation in Polyzwitterion Systems." in CUMIRP Polymer Event, Amherst, Massachusetts. (2022)

"Probing Turbulence Power Spectrum in Molecular Clouds." in Astronomical Society of Taiwan Annual Meeting, Taiwan. (2012)

Research Experiences

Formations of thermoreversible phases in polyzwitterion solutions

- Facilitated the understanding of charged biopolymer associations by demonstrating thermoreversible associations and the gel phase in a homo-polyzwitterion model. Besides, exhibited the anomalous concentration fluctuations near critical points.
- Incorporated the electrostatic interactions into percolation theoretical frameworks and derived the mean-field free energy and the correlation function using field theory formalism, leading to the predictions of phase transitions and critical behaviors.

Analytical frameworks for protein aggregations in biological condensates

- Created opportunities to efficiently realize protein aggregation in biological condensates by inventing general machinery to predict the formation of microphases beyond previous limitations on sequences of amino acids.
- Derived comprehensive expressions for the free energy of sequence-specified polyelectrolyte models and utilized minimization of free energy to predict the formations of microphases in concentrated environments.

Models for enzyme-enhanced diffusions of biopolymers

- Explored the influence of enzyme binding on the dynamics of charged biopolymers by employing active noise to describe the enzyme binding-unbinding process in collaboration with Dr. Singha.
- Established a correspondence between enzyme-biopolymer systems and charged macromolecule-polyelectrolyte models, exhibiting that the binding-unbinding dynamics lead to the generation of time-correlated noise, thereby increasing the stiffness, relaxation rate, and diffusion of polyelectrolytes.

Simulations of conformations of polyzwitterions and polyelectrolyte complexations

- Developed algorithm to analyze the conformational entropy in globule-to-coil transitions using MD simulations and showed the critical temperature of diblock polyzwitterion is 2 times higher than the alternative one in collaboration with Dr. Das.
- Advised a reasonable design of efficient drug deliveries by performing simulations between linear polyelectrolyte and host polyelectrolyte of variant architectures under the long-range Debye-Hückel potential.
- Presented complexations of comb-like host polyelectrolyte are more stable than host polyelectrolytes of other architectures.

Applications of machine learning to physics-related data

- Achieved a 98% sensitivity in predicting microphases of sequence-specified polymers from a trained machine learning model.
- Collected theoretical data of microphase of 6000 sequence-specified heteropolymers at 25 physical conditions and designed a probability method to describe sequences for the training on XGBoost algorithm with Mr. Hoover.
- Discussed the application of least action principle on a physics-informed machine learning model

References

Prof. **Murugappan Muthukumar**, University of Massachusetts, Amherst. (muthu2346@gmail.com)

Prof. **David Hoagland**, University of Massachusetts, Amherst. (hoagland@mail.pse.umass.edu)

Assoc. Prof. **Romain Vasseur**, University of Massachusetts, Amherst. (rvasseur@umass.edu)