

## Curriculum Vitae

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### EDUCATION & ACADEMIC EXPERIENCES 教育工作背景

Assistant Professor (Tenure-track), BICMR, Peking University, 2017.8–

William W. Elliott Assistant Research Professor, Duke University, 2014.8 –2017. 7

*Mentor: Professor Jianfeng Lu*

Ph.D. in Mathematics, University of Wisconsin-Madison, 2014.

*Thesis Advisor: Professor Shi Jin*

*Thesis Title: Computational Methods for Semi-classical Schrödinger Equations with Vector Potentials and Ehrenfest Dynamics*

M.A., University of Wisconsin-Madison, 2011.

B.S., Jilin University, 2009.

### HONOR & AWARDS 荣誉与奖励

Excellent Teaching Award, 2022, Peking University (2022年度杨芙清-王阳元院士奖教金优秀奖)

The Thousand Talents Plan (Young Professionals, 14th)

Math Department TA Teaching Awards 2011, UW-Madison.

Honored Instructors by University Housing, UW-Madison. (Four times)

## RECENT FUNDING 科研项目

- National Natural Science Foundation of China 国家自然科学基金
  - Youth Program (P.I.) "Mathematical analysis and computational methods for non-adiabatic problems in quantum chemistry",  
青年项目（主持）《量子化学中非绝热问题的数学分析和计算方法》；
  - General Program (P.I.) "Computational methods in high dimensional quantum systems",  
面上项目（主持）《高维量子系统的新型计算方法》；
  - Key Programme (Key member) "Computational methods and theory for uncertainty quantification in multiscale dynamical systems equations",  
重点项目（参与）《多尺度动理学方程不确定量化问题的计算方法及理论》。
- Ministry of Science and Technology of the People's Republic of China 科技部
  - National Key R & D Program (P.I.) "Model analysis and numerical methods for tumor growth models"  
国家重点研发计划青年科学家项目（主持）《肿瘤生长模型中的模型分析和数值方法》；
  - National Key R & D Program (Key member) "Uncertainty quantification and multiscale aerodynamic simulation of aircraft icing"  
国家重点研发计划（参与）《大型客机结冰的不确定性量化与多尺度空气动力模拟》。
- Other Programs 其他项目
  - Youth 1000 Talents Program (2018), 中组部第十四批“千人计划”青年人才项目（2018）；
  - Beijing Association for Science and Technology (2020-2022) Young Talent Support Project,  
北京市科协（2020-2022 年）青年人才托举工程项目。

## RESEARCH INTEREST 研究兴趣

My primary research interests are in the **applied analysis** of PDE and stochastic models, and **numerical approximation** of scientific problems arising from quantum mechanics, theoretical chemistry, solid state physics, biology, etc. Many of these problems exhibit a **multi-scale nature**. I also take interest in selected topics in data science, such as **algorithm analysis**.

I have studied models such as semiclassical Schrödinger equations, path-integral molecular dynamics, chemotaxis, tumor growth, and neural networks. My methodology combines analytical and stochastic techniques to gain insight. I also investigate valid and efficient computational tools for these models.

## SEMINARS, PROGRAM AND CONFERENCES ORGANIZED: 组织学术活动

Workshop on "Recent advances in kinetic theory and related models", Peking University, Dec. 4 - Dec. 8, 2023.

Mini-symposium: Recent development in Quantum Simulation and Stochastic Methods, ICIAM 2023 Tokyo.

Young Mathematician Workshop on Computational and Applied Mathematics, Peking University, Nov. 21, 2022.

New Trends in Mathematical Biology, Duke Kunshan University, Oct. 29 - Oct. 30, 2022.

Colloquiums at Beijing International Center for Mathematical Research, since September 2021.

Workshop on dissipated systems, Duke Kunshan University, Oct. 22 - Oct. 24, 2021.

Recent Progress in Applied and Computational PDEs, Peking University, Dec. 17 - Dec. 20, 2020.

Launching program of the Zu Chongzhi Center for Mathematics and Computational Sciences, Duke Kunshan University, Oct. 29 - Nov. 2, 2019.

Mathematical Analysis and Computation for Quantum Systems, Peking University, Jan 4 - Jan 6, 2019.

AIMS Conference on Dynamical Systems, Differential Equations and Applications, Taipei, SS154, Jul 5 - Jul 9, 2018.

Mini-workshop on Nonadiabatic Chemistry, Peking University, May 19 - May 20, 2018.

Young Researchers Workshop: New Trends in Computational and Applied Mathematics, Peking University, Dec 18 - Dec 20, 2017.

2017 Data+ research program (by Duke I.I.D.): Comparing the Exploration of Academic Majors at Duke. (Project Manager)

Young Researchers Workshop: Stochastic and deterministic methods in kinetic theory, Duke University, Nov 28 - Dec 2, 2016.

Analysis and Applied Math seminar, Duke University.

Graduate students participation seminars in applied math, UW-Madison.

## PUBLICATIONS AND PREPRINTS: 发表论文与预印本

### Accepted and published works

1. Y. Luo, Y. Tang, C. Shen, Z. Zhou and B. Dong, *Prompt Engineering Through the Lens of Optimal Control*, accepted by JML, arXiv:2310.14201.
2. Y. Xie and Z. Zhou\*, *Frozen Gaussian Sampling: A Mesh-free Monte Carlo Method For Approximating Semiclassical Schrödinger Equations*, accepted by CMS, arXiv:2112.05405.
3. P. Zhang, Y. Wang and Z. Zhou, *A spectral method for a Fokker-Planck equation in neuroscience with applications in neural networks with learning rules*, accepted by CACP, arXiv:2305.00275.
4. Z. Du, Y. Xie and Z. Zhou, *A synchronization-capturing multi-scale solver to the noisy integrate-and-fire neuron networks*, accepted by SIAM MMS, arXiv:2305.05915.
5. J. Carrillo, X. Dou and Z. Zhou\*, *A simplified voltage-conductance kinetic model for interacting neurons and its asymptotic limit*, accepted by SIAM Mathematical Analysis, arXiv:2203.02746.
6. X. Ye and Z. Zhou\*, *Error Analysis of Time-Discrete Random Batch Method for Interacting Particle Systems and Associated Mean-Field Limits*, IMA Journal of Numerical Analysis, drad043, arXiv:2206.02166.
7. Y. Feng, M. Tang, X. Xu and Z. Zhou, *Tumor boundary instability induced by nutrient consumption and supply*, Zeitschrift für angewandte Mathematik und Physik volume 74, Article number: 107 (2023), arXiv:2210.01359.
8. S. Jin, L. Li, X. Ye and Z. Zhou\*, *Ergodicity and long-time behavior of the Random Batch Method for interacting particle systems*, Mathematical Models and Methods in Applied Sciences, Vol. 33, No. 01, pp. 67-102 (2023), arXiv:2202.04952.
9. Z. Huang, L. Xu and Z. Zhou\*, *Efficient Frozen Gaussian Sampling Algorithms for Nonadiabatic Quantum Dynamics at Metal Surfaces*, Journal of Computational Physics, Volume 474, 1 February 2023, 111771, arXiv:2206.02173.
10. X. Dou, B. Perthame, D. Salort and Z. Zhou\*, *Bounds and long term convergence for the voltage-conductance kinetic system arising in neuroscience*, Discrete and Continuous Dynamical Systems. doi: 10.3934/dcds.2022136, arXiv:2202.12539.
11. X. Dou, J.-G. Liu and Z. Zhou\*, *A tumor growth model with autophagy: The reaction-(cross-)diffusion system and its free boundary limit*, Discrete and Continuous Dynamical Systems - Series B, Volume 28, Issue 3 (2023): 1964-1992, arXiv:2007.13543.
12. Q. He, J. Hu and Z. Zhou\*, *A structure preserving numerical scheme for Fokker-Planck equations of structured neural networks with learning rules*, SIAM Journal on Scientific Computing, Volume 44, Issue 4 (2022), arXiv:2109.04667.
13. L. Li, J.-G. Liu, Z. Liu, Y. Yang and Z. Zhou, *On Energy Stable Runge-Kutta Methods for the Water Wave Equation and Its Simplified Non-Local Hyperbolic Model*, Commun. Comput. Phys., 32 (2022), pp. 222-258, arXiv:1712.04881.

14. B. Miao, G. Russo and Z. Zhou\*, *A novel spectral method for the semi-classical Schrödinger equation based on the Gaussian wave-packet transform*, IMA Journal of Numerical Analysis, 2022, drac013, arXiv:2102.10297.
15. S. Wu, Z. Zhou\*, Z.Huang and B. Bai, *Approximation of the Shannon Capacity via Matrix Cone Programming*, J. Oper. Res. Soc. China (2022).
16. X. Ye and Z. Zhou\*, *Efficient Sampling of Thermal Averages of Interacting Quantum Particle Systems with Random Batches*, Journal of Chemical Physics, 05/2021, Volume 154, Issue 20, arXiv:2102.04688.
17. Z. Sun, K. Li, Z. Xu, H. Deng, Z. Zhou, and Y. Dang, *Dimeric Cycloparaphenylenes with Rigid Aromatic Linker*, Angewandte Chemie, 03/2021, Volume 133, Issue 14.
18. J.-G. Liu, Z. Wang, Y. Xie, Y. Zhang and Z. Zhou\*, *Investigating the integrate and fire model as the limit of a random discharge model: a stochastic analysis perspective*, Mathematical Neuroscience and Applications, 2021, Volume 1, arXiv:2009.04679.
19. Y. Zhang, Y. Zhao and Z. Zhou\*, *A unified structure preserving scheme for a multi-species model with a gradient flow structure and nonlocal interactions via singular kernels*, SIAM J. Sci. Comput., 05/2021, Volume 43, Issue 3, B539–B569, arXiv:2006.16526.
20. X. Lei and Z. Zhou\*, *Multi-level Monte Carlo path integral molecular dynamics for thermal average calculation in the nonadiabatic regime*, Numerical Mathematics: Theory, Methods & Applications. May2021, Vol. 14 Issue 2, p321-354. 34p, arXiv:2006.09138.
21. J.-G. Liu, Z. Wang, Y. Zhang and Z. Zhou\*, *Rigorous justification of the Fokker-Planck equations of neural networks based on an iteration perspective*, SIAM Journal on Mathematical Analysis, 2022, 54 (1),1270-1312, arXiv:2005.08285.
22. J.-G. Liu, J. Wang, Y. Zhao and Z. Zhou, *Field model for complex ionic fluids: analytical properties and numerical investigation*, Communications in computational physics (1815-2406), 06/2021, 30 (3), p. 874., arXiv:1912.09208.
23. J. Hu, J.-G. Liu, Y. Xie and Z. Zhou\*, *A structure preserving numerical scheme for Fokker-Planck equations of neuron networks: numerical analysis and exploration*, Journal of Computational Physics, Volume 433, 15 May 2021, 110195, arXiv:1911.07619.
24. J.-G. Liu, M. Tang, L. Wang and Z. Zhou\*, *Towards understanding the boundary propagation speeds in tumor growth models*, SIAM J. Appl. Math., 2021, Volume 81, Issue 3, 1052–1076, arXiv:1910.11502.
25. Z. Chen and Z. Zhou\*, *The Bayesian Inversion Problem for Thermal Average Sampling of Quantum Systems*, Journal of Computational Physics (2020): 109448, arXiv:1910.02116.
26. C. Xie, C.J. Garcia-Cervera, C. Wang, Z. Zhou, and J. Chen, *Second-order semi-implicit projection methods for micromagnetics simulations*, Journal of Computational Physics (2020), 404, p.109104. arXiv:1907.02358.
27. S. Jin, L. Liu, G. Russo, and Z. Zhou, *Gaussian wave packet transform based numerical scheme for the semi-classical Schrödinger equation with random inputs*. Journal of Computational Physics (2020), 401, p.109015. arXiv:1903.08740.

28. J. Lu, Y. Lu and Z. Zhou\*, *Continuum limit and preconditioned Langevin sampling of the path integral molecular dynamics*, Journal of Computational Physics 423 (2020): 109788, arXiv: 1811.10995.
29. K. Lafata, J. Hong, R. Geng, B. Ackerson; J.-G., Liu; Z. Zhou, J. Torok, C. Kelsey, F.-F. Yin, *Association of pre-treatment radiomic features with lung cancer recurrence following stereotactic body radiation therapy*, Physics in Medicine & Biology (2019), 64(2): 025007.
30. K. Lafata, Z. Zhou, J.-G. Liu, J. Hong, C. Kelsey and F.-F. Yin, *An Exploratory Radiomics Approach to Quantifying Pulmonary Function in CT Images*, Scientific Reports (2019), 9(1): 1-9.
31. Q. Zhan, M. Zhuang, Z. Zhou, J.-G. Liu and Q. Liu, *Complete-Q model for poro-viscoelastic media: large-scale simulation with an adaptive DG algorithm*, IEEE Transactions on Geoscience and Remote Sensing, 2019.
32. Z. Zhou\* and G. Russo, *The Gaussian wave packets transform for the semi-classical Schrödinger equation with vector potentials*, Communications in Computational Physics, 26 (2019): 469-505, arXiv:1802.03705.
33. K. Lafata, Z. Zhou, J.-G. Liu and F. Yin, *Data Clustering based on Langevin Annealing with a Self-Consistent Potential*, Quarterly of Applied Mathematics (2018).
34. J. Lu and Z. Zhou, *Accelerated sampling by infinite swapping of path integral molecular dynamics with surface hopping*, Journal of Chemical Physics, 148.6 (2018): 064110, arXiv:1709.06424.
35. J.-G. Liu, M. Tang, L. Wang and Z. Zhou\*, *An accurate front capturing scheme for tumor growth models with a free boundary limit*, Journal of Computational Physics, 364 (2018): 73-94, arXiv:1708.08395.
36. J. Lu and Z. Zhou, *Path integral molecular dynamics with surface hopping for thermal equilibrium sampling of nonadiabatic systems*, Journal of Chemical Physics, 146.15 (2017): 154110, arXiv:1701.06494.
37. J.-G. Liu, M. Tang, L. Wang and Z. Zhou\*, *Analysis and computation of some tumor growth models with nutrient: from the cell density models to the free boundary dynamics*, Discrete and Continuous Dynamical Systems, 24.7 (2019): 3011-3035, arXiv:1802.00655.
38. J.-G. Liu, Z. Ma and Z. Zhou\*, *Explicit and implicit TVD schemes for conservation laws with Caputo derivatives*, Journal of Scientific Computing, 72.1 (2017): 291-313, arXiv:1610.03025.
39. J. Lu and Z. Zhou, *Improved sampling and validation of frozen Gaussian approximation with surface hopping algorithm for nonadiabatic dynamics*, Journal of Chemical Physics, 145.12 (2016), 124109, arXiv:1606.05365.
40. J.-G. Liu, L. Wang and Z. Zhou\*, *Positivity-preserving and asymptotic preserving method for 2D Keller-Segel equations*, Mathematics of Computation, 87 (2018), 1165-1189, arXiv:1610.03016.
41. J. Lu and Z. Zhou, *Frozen Gaussian approximation with surface hopping for mixed quantum-classical dynamics: A mathematical justification of surface hopping algorithms*, Mathematics of Computation(2018), 87.313, 2189-2232, arXiv:1602.06459.
42. Z. Ma, Y. Zhang and Z. Zhou, *An improved semi-Lagrangian time splitting spectral method for the semi-classical Schrödinger equation with vector potentials using NUFFT*, Applied Numerical Mathematics, 111 (2017), 144-159.

43. J. Chen, J.G. Liu and Z. Zhou, *On a Schrödinger-Landau-Lifshitz system: Variational structure and numerical methods*, Multiscale Modeling and Simulation, 14-4 (2016), 1463-1487.
44. J. Lu, Z. Zhang and Z. Zhou\*, *Bloch dynamics with second order Berry phase correction*, Asymptotic Analysis. Mar2021, p1-30. 30p., arXiv:1512.07357.
45. S. Jin, C. Sparber and Z. Zhou, *On the classical limit of a time-dependent self-consistent field system: analysis and computation*, Kinetic and related models, 10-1 (2017), 263-298, arXiv:1406.3810.
46. Z. Zhou\*, *Numerical approximation of the Schrödinger equation with the electromagnetic field by the Hagedorn wave packets*, Journal of Computational Physics, 272 (2014), 386-407.
47. S. Jin, and Z. Zhou, *A semi-Lagrangian time splitting method for the Schrödinger equation with vector potentials*, Communications in Information and Systems, 13 (2013), no. 3, 247-289.

### Preprints

1. J. Lu, C. Yang and Z. Zhou, *Asymptotic analysis for Bloch electrons with Weyl nodes*, arXiv:2311.02334.
2. Y. Luo, C. Shen and Z. Zhou, *Fictitious Play via Finite Differences for Mean Field Games with Optimal Stopping*, arXiv:2310.05741.
3. Z. Huang, L. Xu and Z. Zhou, *Stochastic Schrödinger equation approach to real-time dynamics of Anderson-Holstein impurities: an open quantum system perspective*, arXiv:2309.08890.
4. X. Ye and Z. Zhou, *Quantitative Convergence Analysis of Path Integral Representations for Quantum Thermal Average*, arXiv:2309.05188.
5. X. Dou, C. Shen and Z. Zhou, *Tumor growth with a necrotic core as an obstacle problem in pressure*, arXiv:2309.00065.
6. X. Ye and Z. Zhou, *Exact Calculation of Quantum Thermal Average from Continuous Loop Path Integral Molecular Dynamics*, arXiv:2307.06510.
7. Y. Feng, L. Liu and Z. Zhou, *A unified Bayesian inversion approach for a class of tumor growth models with different pressure laws*, arXiv:2306.02060.
8. X. Dou, F. Kong, W. Xu and Z. Zhou, *A voltage-conductance kinetic system from neuroscience: probabilistic reformulation and exponential ergodicity*, arXiv:2305.03992.
9. X. Dou, B. Perthame, C. Qi, D. Salort, Z. Zhou, *An infinite-times renewal equation*, arXiv:2304.01605.
10. Z. Xue, Y. Zhang, Z. Zhou, M. Tang, *Transition behavior of the waiting time distribution in a jumping model with the internal state*, arXiv:2303.06910.
11. D. Wu and Z. Zhou, *A convergent numerical algorithm for the stochastic growth-fragmentation problem*, arXiv:2212.09091.
12. L. Chai, Y. Feng and Z. Zhou, *Frozen Gaussian Sampling for Scalar Wave Equations*, arXiv:2211.04829.

13. X. Dou and Z. Zhou\*, *Dilating blow-up time: A generalized solution of the NNLF neuron model and its global well-posedness*, arXiv:2206.06972.
14. X. Dou and Z. Zhou\*, *Exponential convergence to equilibrium for a two-speed model with variant drift fields via the resolvent estimate*, arXiv:2201.12494.
15. L. Klinger, L. Zhang and Z. Zhou, *A Mean Field Game Analysis of Consensus Protocol Design*, arXiv:2108.09999.
16. Z. Zhang, Q. Zhan and Z. Zhou\*, *Fast Algorithms and Error Analysis of Caputo Derivatives with Small Fractional Orders*, arXiv:2108.02999.