Yi Zhu (朱毅)

Curriculum Vitae

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Education

2003–2008	**Ph.D. in Mathematics**, *Tsinghua University*
1999–2003	**B.S. in Mathematics**, *Tsinghua University*

Academic Experience

Regular Position

2021-present	**Research Fellow (adjunct)**, *Yanqi Lake Beijing Institute of Mathemaitcal Sciences and Applications*
2020–present	**Associate Professor**, *Yau Mathematical Sciences Center, Tsinghua University*
2011–2019	**Associate Professor**, *Zhou Pei-Yuan Center for Applied Mathematics, Tsinghua University*
2008–2011	**Instructor & Postdoctoral Researcher**, *Department of Applied Mathematics, University of Colorado-Boulder*

Visiting Position

11/2016–12/2016	**Visiting Research Scientist**, *Department of Applied Physices and Applied Mathematics, Columbia University*
08/2015–12/2015	**Visiting Research Scientist**, *Department of Applied Physices and Applied Mathematics, Columbia University*
05/2012–08/2012	**Visiting Associate Professor**, *Department of Applied Mathematics, University of Colorado-Boulder*

Research Interests

I am broadly interested in applied mathematics, including
- Applied Analysis–mathematical modeling and analysis for topological materials, nonlinear optics, non-equilibrium thermodynamics, fluids etc.
- Scientific Computing–numerical methods for material sciences, wave motion, machine learning etc.

Research Grants

PI	National Key R&D Program of China, No.2021YFA0719200, CNY 1,560,000, 2021-2026
PI	National Natural Science Foundation of China, No.11871299, CNY 520,000, 2019-2022
PI	National Natural Science Foundation of China, No.11204155, CNY 240,000, 2012-2015
PI	Tsinghua University Initiative Scientific Research Program, No.20121087902, CNY 600,000, 2012-2015
Co-PI	Tsinghua University Initiative Scientific Research Program, No.20131089184, CNY 860,000 2014-2016,
Participator	National Natural Science Foundation of China, No.11471185, CNY 700,000, 2015-2018

Awards and Honors

2021	**National Youth Top Talent Program (国家青年拔尖计划)**, *China*
2015	**Highlights of 2015**, *Paper Chris W. Curtis and Yi Zhu, Stud. Appl. Math. 135 (2015): 139-170 is chosen by the journal Stud. Appl. Math. for its "Highlights of 2015" for the "novelty, quality and importance"*
2008	**Best Student Paper**, *the International Conference: Nonlinear Waves-Theory and Applications*, Beijing, China

Preprints & Publications

Published

- *Integrable nonlocal derivative nonlinear Schrödinger equations* (with M. Ablowitz, X. Luo and Z. Musslimani), **Inverse Problems** 38 (2022), 065003
- *Three-fold Weyl points in the Schrödinger operator with periodic potentials* (with H. Guo and M. Zhang), **SIAM Math. Anal.** 54 (2022), 3654-3695
- *Revealing hidden dynamics from time-series data by ODENet* (with P. Hu, W. Yang, L. Hong), **J. Comp. Phys.**, 465(2022), 111203
- *Unfitted Nitsche's method for computing wave modes in topological materials* (with H. Guo and X. Yang), **J. Sci. Comput.** 88 (2021), 24
- *Unfitted Nitsche's method for computing band structures in phononic crystals with impurities* (with H. Guo and X. Yang), **Comput. Methods Appl. Mech. Engrg.** 380 (2021), 113743
- *Wave packets in the fractional nonlinear Schrödinger equation with a honeycomb potential* (with P. Xie), **(SIAM) Multiscale. Model. Simul.** 19 (2021), 951-979
- *When machine learning meets multiscale modeling in chemical reactions* (with W. Yang, L. Peng and L. Hong), **J. Chem. Phys.** 153 (2020), 094117, **Featured & Cover Article**

- *Linear and nonlinear wave dynamics in modulated honeycomb media* (with P. Hu and L. Hong), **Stud. Appl. Math.** 144 (2020), 18-45

- *Wave-packet dynamics in slowly modulated photonic graphene* (with P. Xie), **J. Differential Equations** 267 (2019), 5775-5808

- *Elliptic operators with honeycomb symmetry: Dirac points, edge states and applications to photonic graphene* (with J. P. Lee-Thorp and M. I. Weinstein), **Arch. Rational Mech. Anal.** 232 (2019), 1-63

- *Bloch theory-based gradient recovery method for computation of edge mode in photonic graphene* (with H. Guo and X. Yang), **J. Comp. Phys.** 379 (2019), 403-420

- *Generalized Onsager's reciprocal relations for the master and Fokker-Planck equations* (with L. Peng and L. Hong), **Phys. Rev. E** 97 (2018), 062123

- *The Markov process admits a consistent steady-state thermodynamic formalism* (with L. Peng and L. Hong), **J. Math. Phys.** 59 (2018), 013302

- *Local bifurcation of electrohydrodynamic waves on a conducting fluid* (with Z. Lin and Z. Wang), **Phys. Fluids** 29 (2017), 032107

- *Transport properties in the photonic super-honeycomb lattice–a hybrid fermionic and bosonic system* (with H. Zhong, Y. Zhang, et al), **Ann. Phys.** 529 (2017), 1600258

- *Novel dissipative properties of the master equation* (with L. Hong, J. Chen and W.-A. Yong), **J. Math. Phys.** 57 (2016), 103303

- *PT symmetry in a fractional Schrödinger equation* (with Y. Zhang, H. Zhong, M. R. Belic et al), **Laser Photon. Rev.** 10(2016), 526-531

- *A novel construction of thermodynamically compatible models and its correspondence with Boltzmann-equation-based moment-closure hierarchies* (with L. Hong, Z. Yang and W.-A. Yong), **J. Non-Equil Thermodynamics** 40 (2015), 247-256

- *Conservation-dissipation formalism for non-equilibrium thermodynamics* (with L. Hong, Z. Yang and W.-A. Yong), **J. Non-Equil Thermodynamics** 40 (2015), 67-74

- *Dynamics in PT-symmetric honeycomb lattices with nonlinearity* (with C. W. Curtis), **Stud. Appl. Math.** 135 (2015), 139-170

- *Unveiling pseudospin and angular momentum in photonic graphene* (with D. Song, V. Paltoglou et al), **Nat. Commun.** 6 (2015), 6272

- *Direct observation of pseudospin-mediated vortex generation in photonic graphene* (D. Song, L. Tang, S. Liu, et al), In **CLEO:EELS Fundamental Science**, 2014

- *Nonlinear wave packets in deformed honeycomb lattices* (with M. J. Ablowitz), **SIAM J. Appl. Math.** 73 (2013), 1959-1979

- *Nonlinear Dynamics of Bloch Wave Packets in Honeycomb Lattices* (with M. J. Ablowitz), in book "Spontaneous Symmetry Breaking, Self-Trapping, and Josephson Oscillations" **Progress in Optical Science and Photonics** 1 (2013), 1-26

- *Localized nonlinear edge states in honeycomb lattices* (with M. J. Ablowitz and C. W. Curtis), **Phys. Rev. A** 88 (2013), 13850.

- *Unified orbital description of the envelope dynamics in two-dimensional simple periodic lattices* (with M. J. Ablowitz), **Stud. Appl. Math.** 131 (2013),41-71
- *Nonlinear dynamics of wave packets in parity-time-symmetric optical lattices near the phase transition point* (with S.D. Nixon and J. Yang), **Opt. Lett.** 37 (2012), 4874-4876
- *On Tight binding approximations in optical lattice* (with M. J. Ablowitz and C. W. Curtis), **Stud. Appl. Math.** 129 (2012),362-388
- *Nonlinear waves in shallow honeycomb lattices* (with M. J. Ablowitz), **SIAM J. Appl. Math.** 72 (2012) 240-260
- *Scalable Misbehavior Detection in Online Video Chat Services* (with X. Xing, Y. Liang, et al), **Proceedings of the 18th ACM SIGKDD international conference on Knowledge discovery and data mining** 2012, 552-560
- *Nonlinear diffraction in photonic graphene* (with M. J. Ablowitz), **Opt. Lett.** 36 (2011), 762-3764
- *Nonlinear wave dynamics: from lasers to fluids* (with M. J. Ablowitz, T. S. Haut, T. P. Horikis and S. D. Nixon), **Discrete Contin. Dyn. Syst. S** 4 (2011), 923 - 955
- *Evolution of Bloch-mode envelopes in two-dimensional generalized honeycomb lattices* (with M. J. Ablowitz),**Phys. Rev. A** 82 (2010), 013840
- *Conical diffraction in honeycomb lattices* (with M.J. Ablowitz and S. D. Nixon), **Phys. Rev. A** 79 (2009), 053830
- *Asymptotic analysis of pulse dynamics in mode-locked lasers* (with M. J. Ablowitz, T. P. Horikis and S. D. Nixon), **Stud. Appl. Math.** 122 (2009), 411-425
- *Separatrix map analysis for fractal scatterings in weak solitary wave interactions* (with J. Yang and R. Haberman), **Stud. Appl. Math.** 122 (2009), 449-483
- *A universal separatrix map for weak interactions of solitary waves in generalized nonlinear Schrödinger equations* (with J. Yang and R. Haberman), **Physica D** 237 (2008), 2411-2422
- *Universal map for fractal structures in weak interactions of solitary waves* (with J. Yang and R. Haberman), **Phys. Rev. Lett.** 100(2008), 143901
- *Universal fractal structures in the weak interaction of solitary waves in generalized nonlinear Schrödinger equations* (with J. Yang), **Phys. Rev. E** 75 (2007), 036605

Preprints
- *Weak Collocation Regression method: fast reveal hidden stochastic dynamics from high-dimensional aggregate data* (with L. Lu, Z. Zeng, Y. Jian and P. Hu), arXiv 2209.02628
- *Double Conical degeneracy on the band structure of periodic Schrödinger operators* (with Y. Cao), arXiv:2212.05210
- *Traveling edge states in massive Dirac equations along slowly varying edges* (with P. Hu and P. Xie), arXiv:2202.13653
- *Identification of hydrodynamic instability by convolutional neural networks* (with W. Yang, L. Peng and L. Hong), arXiv:2006.01446

- *Generalized hydrodynamics and the classical hydrodynamic limit* (with Z. Yang and W.-A.Yong), arXiv: 1809.01611
- *A rigorous derivation of multicomponent diffusion laws* (with Z. Yang and W.-A. Yong), arXiv:1502.03516

Invited talks (selected)

Conference/Workshop Talks

- *Topologically Protected Edge States in Photonic Materials,* THU-CSRC Joint Workshop, Beijing, November 6, 2020
- *Topologically Protected Wave Motion Along Curved Edges,* Metamaterials Congress, New York, 28 Sep–3 Oct 2020 (Online Talk)
- *Analysis and Computations of Topologically Protected Wave Propagation,* BIMSA Summer Workshop on Computational and Applied Mathematics II, Beijing, Aug. 21-22 2020
- *Analysis of Topologically Protected Wave Propagation,* SIAM Conference on Analysis of Partial Differential Equations, La Quinta, Dec 11-Dec 14, 2019
- *Topologically protected wave propagation,* International workshop on frontiers in mathematics and its application, Duke Kunshan University, Oct.31-Nov. 03, 2019
- *Analysis on topologically protected wave propagation,* PDE Modeling and Analysis in Bioscience and Complex Media, TSIMF, Sanya, Jul. 29-Aug.02, 2019
- *Waves in topological photonic materials,* The Eleventh IMACS International Conference on Nonlinear Evolution Equations and Wave Phenomena: Computation and Theory, Athens, GA, Apr. 17-19, 2019 (**Mini-symposium organizer**)
- *Linear and Nonlinear Waves in topological photonic materials,* Nonlinear waves, theory, computation and real-world application, TSIMF, Sanya, Jan. 7-11, 2019
- *Topological edge states in honeycomb photonic materials,* Mathematical Analysis and Computation for Quantum Systems, Beijing, Jan. 4-6, 2019
- *Analysis and computation of topological materials,* AIMS Conference on Dynamical Systems, Differential Equations and Applications, Taipei, Jul. 5-9, 2018
- *Analysis on Topological Materials,* PDE Models and Nonlinear, Waves in Fluids and Plasmas, Sanya, Dec. 25-29, 2017
- *Conservation-dissipation formalism of Non-equilibrium thermodynamics,* Workshop on Moment Methods in Kinetic Theory III, Beijing, Sep. 24-27, 2017
- *Electromagnetic waves in honeycomb structures,* Workshop on physical and mathematical aspects of topological insulators, Banff, Sep. 10-15, 2017
- *Dirac points and edge states in photonic graphene,* Forum on Frontiers in Applied and Computational Mathematics, Beijing, Aug. 3, 2017
- *Analysis and computation of photonic graphene*, Workshop on Computational Problems in Materials Science Beijing, Oct. 22-23, 2016
- *Photonic graphene and photonic topological insulators*, The fourth international conference: Nonlinear waves — Theory and Applications, Beijing, Jun. 25-28, 2016

- *Generalized hydrodynamics and its classical limit*, International Conference on Nonlinear Systems of Fluid Dynamic Equations and Applications, TSIMF, Sanya, Dec. 19-22, 2015
- *Nonlinear dynamics in deformed and PT symmetric honeycomb lattices*, The Ninth IMACS International Conference on Nonlinear Evolution Equations and Wave Phenomena: Computation and Theory, Athens, GA, Apr. 1-4, 2015 (**Mini-symposium organizer**)
- *Nonlinear wave packets in deformed honeycomb lattices*, The Third International Conference: Nonlinear Waves–Theory and Applications, Beijing, China, Jun. 11-15, 2013
- *Nonlinear diffraction and inter band transitions in photonic graphene*, SIAM Conference on Nonlinear Waves and Coherent Structures, Seattle, Washington, Jun. 13, 2012
- *Nonlinear waves in shallow honeycomb lattices*, Frontiers in Applied and Computational Mathematics, Newark, New Jersey, May 18, 2012
- *Unified description of envelope dynamics in 2-D nonlinear periodic lattices,* SIAM Conference on Nonlinear Waves and Coherent Structures, Philadelphia, Pennsylvania, Aug. 16-19, 2010
- *Conical diffraction in honeycomb lattices,* The Second International Conference: Nonlinear Waves–Theory and Applications, Beijing, China, Jun. 26-29, 2010
- *A universal map for fractal structures in weak solitary wave interactions,* The First International Conference: Nonlinear Waves–Theory and Applications, Beijing, China, Jun. 09-12, 2008
- *Weak interactions of solitary waves in generalized nonlinear Schrödinger equations,* SIAM Conference on Nonlinear Waves and Coherent Structures, Seattle, Washington, Sep. 9-12, 2006

Colloquium/Seminar Talks

- *Conically degenerate spectral points of the periodic Schrödinger operator,* The University of Hong Kong, Nov. 2, 2022
- *Topologically Protected Wave Motion–Analysis and Computations,* Xiangtan University, Apr. 20, 2022
- *Three-fold Weyl points for the periodic Schrödinger operators,* Beijing Computational Science Research Center, Apr. 12, 2022
- *Mathematical Aspects of Topologically Protected Wave Motion,* Renmin University of China, Dec. 29, 2021
- *Wave Motion in Topological Materials,* Beijing Normal University, Dec. 27, 2021
- *Recent Advances on Applied Analysis in Topological Materials,* Peking University (Online), Nov. 10, 2021
- *Numerical Methods for Computing Wave Modes in Topological Materials,* Tsinghua University , Oct. 16, 2021
- *Three-fold Weyl points for the periodic Schrödinger operators,* University of Colorado-Boulder (Online), Oct. 05, 2021
- *Three-fold Weyl points for the periodic Schrödinger operators,* Columbia University (Online), Mar. 10, 2021

- *Analysis of topologically protected wave motion,* University of Science and Technology of China (Online), Dec. 25, 2020
- *Topologically Protected Wave Motion,* Institute of Systems Science, Chinese Academy of Sciences, Oct. 14, 2020
- *Introduction to topological quantum mechanics and photonics,* Mathematical quantum mechanics seminar, Peking University, Mar. 6, 2019
- *Analysis and computation of topological materials,* Mathematical research seminar, Duke Kunshan University, Sep. 25, 2018
- *Topological edge states in photonic graphene,* Inverse problem seminar, Institute for Advanced Study, Hong Kong University of Science and Technology, Mar. 21, 2018
- *Analysis and computation of topological materials,* Yau mathematical sciences center, Tsinghua University, Dec. 2, 2017
- *Analysis and computation of topological edge states,* Department of computational mathematics, Peking University, Nov. 21, 2017
- *Electromagnetic waves in honeycomb structures,* Yau mathematical sciences center, Tsinghua University, Oct. 31, 2016
- *Conservation-dissipation formalism of non-equilibrium thermodynamics,* Applied mathematics colloquium, Columbia University, Nov. 17, 2015
- *Nonlinear wave in honeycomb lattice,* Department of applied mathematics, University of Colorado-Boulder, Aug. 23, 2012
- *Unified description of envelope dynamics in 2-D nonlinear periodic lattices,* Mathematics Colloquium, University of Colorado-Colorado Springs, Sep. 7, 2010
- *Conical diffraction in honeycomb lattices,* Theoretical Physics Seminar, Colorado School of Mines, Mar. 1, 2010
- *Universal Map for Fractal Scattering in Weak Solitary Wave Interactions,* Dynamical System Seminar, University of Colorado-Boulder, Feb. 26, 2009
- *Weak interactions of solitary waves in generalized nonlinear Schrödinger equations I*, Nonlinear Wave Seminar, University of Colorado-Boulder, Sep. 16, 2008
- *Weak interactions of solitary waves in generalized nonlinear Schrödinger equations II*, Nonlinear Wave Seminar, University of Colorado-Boulder, Oct. 7, 2008
- *Universal fractal structures in the weak interaction of solitary waves in generalized nonlinear Schrödinger equations*, Mathematics Seminar, University of Vermont, Dec. 4, 2006

Teaching Experience

2011-Present   **Tsinghua University**, *Instructor*, Asymptotic Methods, Introduction to Partial Differential Equations, Ordinary Differential Equations

2008-2011   **University of Colorado-Boulder**, *Instructor*, Differential Equations with Linear Algebra, Matrix Methods

Services

Editorial Board

2020-present **Studies in Applied Mathematics**, *Associate Editor*

Conference/workshop organizer

- **Local Organizeation Committee Member**, The 9th International Congress of Chinese Mathematicians, Nanjing, China, Jul. 31-Aug. 5, 2022
- **Mini-symposium organizer**, The Eleventh IMACS International Conference on Nonlinear Evolution Equations and Wave Phenomena: Computation and Theory, Athens, GA, Apr. 17-19, 2019
- **Local Orgalization Committee Chair**, The Fourth International Conference: Nonlinear Waves-Theory and Applications, Beijing, Jun. 25-28, 2016
- **Mini-symposium Organizer**, The Ninth IMACS International Conference on Nonlinear Evolution Equations and Wave Phenomena: Computation and Theory, Athens, GA, Apr. 1-4, 2015
- **Local Organizeation Committee Member**, The Third International Conference: Nonlinear Waves-Theory and Applications, Beijing, Jun. 11-15, 2013

Reviewer of the journals

- Commun. Math. Phys.
- Phys. Rev. Lett.
- J. Math. Phys.
- Journal de l'École polytechnique
- Physica D
- Opt. Express
- Annalen der Physik
- Commun. Nonlin. Sci. Numer. Simul.
- J. Turblence
- Math. Reivew
- SIAM J. Math. Anal.
- J. Fluid Mech.
- Appl. Math. Comput.
- J. Phys. A
- Opt. Lett.
- J. Opt. Soc. Am. B
- Adv. Appl. Math. Mech.
- Int. J. Nonlin. Sci. Num.
- Theor. Appl. Mech. Lett.
- $\cdots$

University Services

2020- **Member of Postdoc committee**, *Yau Mathematical Sciences Center*

2020- **Member of Graduate Student committee**, *Yau Mathematical Sciences Center*

2021- **Member of Teaching and Academic Degree Committee**, *Qiuzhen College*

2021- **Member of Curriculum Selection Steering Committee**, *Qiuzhen College*

2021- **Associate Director**, *Yanqi Lake Beijing Institute of Mathematical Sciences and Applications*

Postdocs

2021- **Li Wang**, *Ph.D. from University of Chinese Academy of Sciences*, Working on Nonlinear Wave Motions

2021- **Shuo Yang**, *Ph.D. from University of Maryland*, Working on Numerical Methods for Materials

Ph.D. Students

Former

2017-2022 **Wuyue Yang**, *Position: Assistant Research Fellow at Beijing Institute of Mathematical Science and Applications*, Honored Graduate in Bejing 2022
Dissertation: Theory and Applications of Machine Learning Based on Differential Equations

2017-2022 **Haimo Guo**, *Position: National Civil Servant at Hangzhou*
Dissertation: Three-fold Weyl Points for the Schrödinger Operator with Periodic Potentials

2015-2020 **Pipi Hu**, *Position : Senior Researcher at Microsoft Research Asia*
Dissertation: Analysis and computation of wave propagation in photonic topological material

2015-2020 **Peng Xie**, *Position: Postdoc at The Hong Kong University of Science and Technology*
Dissertation: Mathematical Analysis of Wave Packet Dynamics in Honeycomb Latticed Materials

2011-2016 **Zaibao Yang co-advised with Wen-An Yong**, *Position: Data Analyst at Postal Savings Bank of China*, Best Ph.D. Dissertation at Tsinghua University 2016
Dissertation: Mathematical modeling and analysis of multicomponent fluid mixtures

Current

2020- **Yin Cao**, *Working on Mathematics in Topological Matters*

2020- **Borui Miao**, *Working on Metamaterials in Subwavelenght Regimes*

2020- **Yan Jiang**, *Working on Machine-Learning-Based Mathematical Modeling*

2020- **Liwei Lu**, *Working on Machine Learing and Stochastic Differential Equations*

2022- **Liya Guo**

2022- **Zifan Ye**

2022- **Zhijun Zeng**

Undergraduate Students

- Wenbing Tong (2017)
- Hao Sun (2018) Best Undergraduate Thesis at Tsinghua University
- Lei Bao (2021)
- Kaifang Kan (2022)
- Shaozhang Xu (2022)
- Zhijun Zeng(2022)