

CURRICULUM VITAE

YI ZHU

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Education

- 07/2008 Ph.D. in Applied Mathematics
Tsinghua University, Beijing, China
Dissertation Advisors: Jianke Yang, Din-Yu Hsieh
- 07/2003 B.S. in Mathematics
Tsinghua University, Beijing, China

Academic Experience

- **Regular Positions**

- 01/2020- present Associate Professor, Yau Mathematical Sciences Center, Tsinghua University
- 09/2011-12/2019 Associate Professor, Zhou Pei-Yuan Center for Applied Mathematics, Tsinghua University
- 08/2008-07/2011 Postdoctoral Researcher/Instructor, Department of Applied Mathematics, University of Colorado-Boulder

- **Visiting Positions**

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

Research Interests

Applied analysis and numerical computations of scientific problems arising from optics, material science and complex systems. My recent research topics include mathematical theory and numerical methods of topological materials, nonlinear waves in fluids and optics, non-equilibrium thermodynamic modeling.

Publications and Preprints

Preprints

- (5) *Three-fold Weyl points in the Schrödinger operator with periodic potentials* (with H. Guo and M. Zhang), arXiv:2102.08728
- (4) *Identification of hydrodynamic instability by convolutional neural networks* (with W. Yang, L. Peng and L. Hong), arXiv:2006.01446
- (3) *Revealing hidden dynamics from time-series data by ODENet* (with P. Hu, W. Yang, L. Hong), arXiv:2005.04849
- (2) *A rigorous derivation of multicomponent diffusion laws* (with Z. Yang and W.-A. Yong), arXiv:1502.03516
- (1) *Generalized hydrodynamics and the classical hydrodynamic limit* (with Z. Yang and W.-A. Yong), arXiv: 1809.01611

Published

- (1) *Unfitted Nitsche's method for computing wave modes in topological materials* (with H. Guo and X. Yang), **J. Sci. Comput.** 88 (2021)24
- (2) *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
- (3) *Wave packets in the fractional nonlinear Schrödinger equation with a honeycomb potential* (with P. Xie), **(SIAM) Multiscale. Model. Simul.** 19 (2021), 951-979
- (4) *When machine learning meets multiscale modeling in chemical reactions* (with W. Yang, L. Peng and L. Hong), **J. Chem. Phys.** 153 (2020), 094117 **Cover Article.**
- (5) *Linear and nonlinear wave dynamics in modulated honeycomb media* (with P. Hu and L. Hong), **Stud. Appl. Math.** 144 (2020), 18-45
- (6) *Wave-packet dynamics in slowly modulated photonic graphene* (with P. Xie), **J. Differential Equations** 267 (2019), 5775-5808
- (7) *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
- (8) *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
- (9) *Generalized Onsager's reciprocal relations for the master and Fokker-Planck equations* (with L. Peng and L. Hong), **Phys. Rev. E** 97 (2018), 062123
- (10) *The Markov process admits a consistent steady-state thermodynamic formalism* (with L. Peng and L. Hong), **J. Math. Phys.** 59 (2018), 013302
- (11) *Local bifurcation of electrohydrodynamic waves on a conducting fluid* (with Z. Lin and Z. Wang), **Phys. Fluids** 29 (2017), 032107
- (12) *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
- (13) *Novel dissipative properties of the master equation* (with L. Hong, J. Chen and W.-A. Yong), **J. Math. Phys.** 57 (2016), 103303
- (14) *PT symmetry in a fractional Schrödinger equation* (with Y. Zhang, H. Zhong, M. R. Belic et al), **Laser Photon. Rev.** 10(2016), 526-531

- (15) *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
- (16) *Conservation-dissipation formalism for non-equilibrium thermodynamics* (with L. Hong, Z. Yang and W.-A. Yong), **J. Non-Equil Thermodynamics** 40 (2015), 67-74
- (17) *Dynamics in PT-symmetric honeycomb lattices with nonlinearity* (with C. W. Curtis), **Stud. Appl. Math.** 135 (2015), 139-170 **The paper was selected as the Highlight of the year 2015 of the journal**
- (18) *Unveiling pseudospin and angular momentum in photonic graphene* (with D. Song, V. Paltoglou et al), **Nat. Commun.** 6 (2015), 6272
- (19) *Direct observation of pseudospin-mediated vortex generation in photonic graphene* (D. Song, L. Tang, S. Liu, et al), In **CLEO:EELS Fundamental Science**, 2014
- (20) *Nonlinear wave packets in deformed honeycomb lattices* (with M. J. Ablowitz), **SIAM J. Appl. Math.** 73 (2013), 1959-1979
- (21) *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
- (22) *Localized nonlinear edge states in honeycomb lattices* (with M. J. Ablowitz and C. W. Curtis), **Phys. Rev. A** 88 (2013), 13850.
- (23) *Unified orbital description of the envelope dynamics in two-dimensional simple periodic lattices* (with M. J. Ablowitz), **Stud. Appl. Math.** 131 (2013), 41-71
- (24) *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
- (25) *On Tight binding approximations in optical lattice* (with M. J. Ablowitz and C. W. Curtis), **Stud. Appl. Math.** 129 (2012), 362-388
- (26) *Nonlinear waves in shallow honeycomb lattices* (with M. J. Ablowitz), **SIAM J. Appl. Math.** 72 (2012) 240-260
- (27) *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
- (28) *Nonlinear diffraction in photonic graphene* (with M. J. Ablowitz), **Opt. Lett.** 36 (2011), 762-764
- (29) *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
- (30) *Evolution of Bloch-mode envelopes in two-dimensional generalized honeycomb lattices* (with M. J. Ablowitz), **Phys. Rev. A** 82 (2010), 013840
- (31) *Conical diffraction in honeycomb lattices* (with M.J. Ablowitz and S. D. Nixon), **Phys. Rev. A** 79 (2009), 053830 **One figure in the paper appears in the Kaleidoscope May 2009 of the journal**
- (32) *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
- (33) *Separatrix map analysis for fractal scatterings in weak solitary wave interactions* (with J. Yang and R. Haberman), **Stud. Appl. Math.** 122 (2009), 449-483
- (34) *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
- (35) *Universal map for fractal structures in weak interactions of solitary waves* (with J. Yang and R. Haberman), **Phys. Rev. Lett.** 100(2008), 143901

- (36) *Universal fractal structures in the weak interaction of solitary waves in generalized nonlinear Schrödinger equations* (with J. Yang), **Phys. Rev. E** 75 (2007), 036605

Research Grants

- PI NSFC Project 11871299 “Computation and analysis of edge states in topological optical materials”, 2019-2022.
- PI NSFC Project 11204155 “Nonlinear waves in 2-D honeycomb lattices”, 2013-2015
- PI THUISRP 20121087902 “Mathematical modeling, analysis and numerical methods on complex fluids” 2012-2015
- Co-PI THUISRP 20131089184 “Study on the fundamental theories of granular system and applications ” 2014-2016
- Participator NSFC Project 11471185 “Numerical analysis of lattice Boltzmann method for multi-component fluids” 2015-2018
- Participator THUISRP 20151080424 “Mathematical theories of non-equilibrium thermodynamics and applications” 2015-2018

Awards

- The publication Chris W. Curtis and Yi Zhu, *Dynamics in PT -symmetric honeycomb lattices with nonlinearity*, **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*”.
- Best Student Paper Award in the International Conference: Nonlinear Waves-Theory and Applications, Beijing, China, Jun. 09-12 2008

Invited conference/workshop lectures

- *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 (**Conference organizer and coordinator**)
- *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

Invited colloquia and seminar talks

- *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

- Tsinghua University
 - 2021 Spring: Introduction to Partial Differential Equations.
 - 2020 Fall: Introduction to Partial Differential Equations.
 - 2018 Spring: Asymptotic analysis.
 - 2017 Spring: Asymptotic analysis.
 - 2016 Spring: Asymptotic analysis.
 - 2015 Spring: Asymptotic analysis.
 - 2014 Spring: Asymptotic analysis.
 - 2013 Spring: Asymptotic analysis.
- University of Colorado-Boulder
 - 2011 Spring: Differential Equations with Linear Algebra.
 - 2010 Fall: Matrix Methods.
 - 2010 Spring: Differential Equations with Linear Algebra.
 - 2009 Fall: Differential Equations with Linear Algebra.
 - 2009 Spring: Differential Equations with Linear Algebra.
 - 2008 Fall: Differential Equations with Linear Algebra.

Students

Current

- Yan Jiang (PhD student, 2020-present)
- Borui Miao (PhD student, 2020-present)

- Yin Cao (PhD student, 2020-present)
- Liwei Lu (PhD student, 2020-present)
- Wuyue Yang (PhD student, 2017-present) Current project: *Machine-learning-based mathematical modeling*
- Haimo Guo (PhD student, 2017-present, co-advised with Prof. Meirong Zhang)
Current project: *Analysis of Weyl points*

Former

- Pipi Hu (PhD student, 2015-2020)
Dissertation: *Wave dynamics in photonic topological materials*
- Peng Xie (PhD student, 2015-2020)
Dissertation: *Analysis of wave packets in honeycomb materials*
- Hao Sun (Undergraduate, Feb. 2018-Jul. 2018)
Thesis: *Application of nonlinear analysis to mechanics*
Honor: **Best undergraduate thesis at Tsinghua University in 2018**
- Wenbin Tong (Undergraduate, Feb. 2017- Jul. 2017)
Thesis: *Electromagnetic waves in honeycomb structures*
- Zaibao Yang (PhD student, 2011-2016, co-advised with Prof. Wen-An Yong)
Dissertation: *Mathematical modeling and analysis of multicomponent fluid mixtures*
Honor: **Best PhD dissertation at Tsinghua University in 2016**

Academic Services

Editorial Board

- Studies in Applied Mathematics (2020-)

Conference/workshop organized

- Mini-symposium organizer, *Waves in topological materials*. The Eleventh IMACS International Conference on Nonlinear Evolution Equations and Wave Phenomena: Computation and Theory, Athens, GA, Apr. 17-19, 2019, co-organized with Hailong Guo and Xu Yang.
- Conference coordinator, The Fourth International Conference: Nonlinear Waves-Theory and Applications, Beijing, Jun. 25-28, 2016
- Mini-symposium organizer, *Graphene lattices: phenomena and analysis*. The Ninth IMACS International Conference on Nonlinear Evolution Equations and Wave Phenomena: Computation and Theory, Athens, GA, Apr. 1-4, 2015, co-organized with Chris W. Curtis and Yiping Ma.
- Conference organizer, The Third International Conference: Nonlinear Waves-Theory and Applications, Beijing, Jun. 11-15, 2013, co-organized with Xingbiao Hu and Qinpeng Liu

Reviewer of the (selected) journals

Commun. Math. Phys., Commun. Nonlinear Sci., J. Fluid Mech., Appl. Math. Comput., Opt. Lett., Opt. Express, J. Opt. Soc. Am. B, Adv. Appl. Math. Mech., Mech. Eng.