Zhi Liang

Department of Mechanical and Aerospace Engineering
Missouri University of Science and Technology

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RESEARCH INTERESTS:

- Micro/nanoscale thermodynamics and heat transfer
- Dynamics of nanodroplet, nanobubbles, and nanoparticles
- Structure-property relationship for materials and interfaces
- Computational modeling

EDUCATION:

Ph. D. in Mechanical Engineering July 2010

Missouri University of Science & Technology, MO, U.S.

(Formerly known as University of Missouri-Rolla)

Dissertation: Molecular Simulations of the infrared absorption cross section and thermophysical properties of a polyatomic fluid

M.S. in Materials Science and Engineering March 2004

Shanghai Jiaotong University, Shanghai, China

Thesis: The simulation of temperature distribution in vacuum electron beam brazing of a pin-to-plate joint

B.S. in Materials Science and Engineering June 2001

Shanghai Jiaotong University, Shanghai, China

EXPERIENCE RECORD:

- **Associate Professor** (August 2022 – Present) in Department of Mechanical and Aerospace Engineering, Missouri University of Science and Technology.
- **Associate Professor** (August 2021 – August 2022) in Department of Mechanical Engineering, California State University, Fresno.
- **Assistant Professor** (August 2016 – August 2021) in Department of Mechanical Engineering, California State University, Fresno.
- **Post-Doctoral Research Associate** (May 2012 – July 2016) in Rensselaer Nanotechnology Center, Rensselaer Polytechnic Institute.
- **Post-Doctoral Fellow** (July 2010 – May 2012) in Department of Mechanical and Aerospace Engineering, Missouri University of Science and Technology.
- **Graduate Research and Teaching Assistant** (July 2004 – July 2010) in Department of Mechanical and Aerospace Engineering, Missouri University of Science and Technology.
- **Welding Engineer** (April 2004 – May 2004) in Shanghai Volkswagen.

AWARDS:

- College of Engineering Outstanding Research Award (California State University, Fresno, 2021)
- Provost's Award for Promising New Faculty (California State University, Fresno, 2020).
- Hewlett-Packard Best Paper Award (Heat Transfer Division, ASME IMECE 2008).
- Best Paper Award (2nd place, Intelligent Systems Center, MST, 2008).
- Best Poster Award (1st place, Intelligent Systems Center, University of Missouri Rolla, 2007).
- Best Paper Award (2nd place, Intelligent Systems Center, University of Missouri Rolla, 2007).

AWARDED RESEARCH PROPOSALS:

- **Sole PI:** Zhi Liang, "Understanding the merging dynamics of surface nanobubbles and the resulting capillary force between particles from molecular simulations", NSF/CBET-Particulate and Multiphase Processes, $276,237, 2019-2023, award number: 1911434.
- **Sole PI:** Zhi Liang, "RUI: Thermal Transport across Liquid-gas Interfaces", NSF/CBET-Thermal Transport Processes, $276,237, 2019-2023, award number: 1911433.
- **Sole PI:** Zhi Liang, "Phase change and dynamics of nanobubbles and nanodroplets", the eXtreme Science and Engineering Discovery Environment (XSEDE), which is supported by NSF grant number ACI-1548562, 420,000 Service Units (Value of $108,400), 2020-2022, award number: CTS130030.
- **Co-PI**: Zhi Liang, "A novel micro-nano bubbling aeration method to enhance aerobic process efficiency in winery wastewater treatment", CSU Water resources and & policy initiatives, $12,000, 2021-2022.

AWARDED EDUCATION PROPOSAL:

- **Sole PI:** Zhi Liang, "An education allocation request for a graduate course Micro/nanoscale heat and mass transfer", the eXtreme Science and Engineering Discovery Environment (XSEDE), which is supported by NSF grant number ACI-1548562, 1,600 Service Units (Value of $425.36), 2021-2022, award number: MCH200024.

RESEARCH EXPERIENCE:

- **Associate Professor** (2022 – present) in Department of Mechanical and Aerospace Engineering, Missouri University of Science and Technology.
  - Dynamics and phase change of nanodroplets (supported by **NSF**)
  - Dynamics of nanobubbles (supported by **NSF**)
- **Associate/Assistant Professor** (2016 – 2022) in Department of Mechanical Engineering, California State University, Fresno.
  - Thermal transport across liquid-gas interfaces (supported by **NSF** and **Edison International**)
  - Dynamics of nanobubbles (supported by **NSF**)
  - Power generation by a nanofluidic device. (supported by **Edison International**)
- **Post Doctoral Research Associate** (2012 – 2016) in Rensselaer Polytechnic Institute.
  - Design of solid-gas interfaces for enhanced thermal transfer. (supported by **AFOSR**)
  - The exchange of heat between a nanoparticle and the surrounding liquid. (supported by **NSF**)
  - Thermal transport in GaN-based microelectronic devices. (supported by **ARL**)

- Attenuation of narrow-band shear waves at THz in vitreous silica. (supported by **NASA**)

- **Post Doctoral Fellow** (2010 – 2012) in MAE department, MST.
  - Molecular dynamics simulation of thermal transport across solid-liquid and solid-solid interfaces. (support by National Institute for Computational Sciences)

- **Graduate Research Assistant** (2004 - 2010) in Department of Mechanical and Aerospace Engineering, Missouri University of Science and Technology.
  - Experimental investigation and ab initio molecular dynamics simulation of optical and thermophysical properties of fluid systems. (supported by **ONR** through **MURI** program)

MENTORING EXPERIENCE:

(in Department of Mechanical Engineering, California State University, Fresno)

- Master student: Jesus Gutierrez Plascencia
  - Master thesis: "Evaporation of nanodroplets in a non-condensable gas: a molecular dynamics study". (supported by **NSF**)
- Master student: Eric Bird
  - Master thesis: "Merging Dynamics of Nanobubbles". (supported by **NSF**)
- Undergraduate students: James Gonzalez, Eric Bird and Jesus Gutierrez Plascencia
  - Research project: "Molecular simulation of thin film evaporation/condensation in nanoscale heat pipes". (supported by **NSF** and Edison International)

TEACHING EXPERIENCE:

- Assistant Professor in Department of Mechanical Engineering, California State University, Fresno.

	Semester	Teaching evaluation score
ME 145 Heat and Mass Transfer	Fall 2016	4.5/5.0
	Spring 2017	4.2/5.0
	Fall 2017	4.3/5.0
	Fall 2018	4.4/5.0
	Spring 2019	4.5/5.0 (two sections)
	Fall 2019	4.5/5.0
	Spring 2020	4.8/5.0
	Fall 2020	4.4/5.0
	Spring 2021	4.4/5.0
	Fall 2022	4.9/5.0 (two sections)
	Spring 2022	4.5/5.0
ME 136 Thermodynamics	Fall 2016	4.5/5.0
	Spring 2017	4.7/5.0
	Fall 2017	4.4/5.0
	Spring 2018	4.7/5.0
ME 118 Fluid Mechanics Laboratory	Fall 2016	4.5/5.0
	Spring 2017	3.7/5.0
	Fall 2017	4.4/5.0
	Spring 2018	4.2/5.0
	Fall 2018	4.6/5.0
	Spring 2019	4.8/5.0

	Fall 2019	4.8/5.0
	Fall 2020	4.7/5.0
o ME 225 Heat Transfer (a graduate course)	Spring 2020	4.1/5.0
	Spring 2022	4.7/5.0
o ME 291T Micro and Nanoscale Heat and Mass Transfer (a graduate course)	Spring 2019	4.6/5.0
	Spring 2021	4.9/5.0

- Adjunct lecturer in School of Engineering, Rensselaer Polytechnic Institute.
    - ENGR 1100 Introduction to Engineering Analysis (Statics) Fall 2015 and Spring 2016
- Instructor in Department of Mechanical and Aerospace Engineering, Missouri University of Science and Technology
    - ME 231 Thermofluid Mechanics I Fall 2008, Spring 2009 and Fall 2009

PROFESSIONAL ACTIVITIES:

- **Reviewer for**

  Nano Letters, Nanoscale, Nanotechnology, Applied Physics Letters, Journal of Applied Physics, Journal of Heat Transfer, Journal Chemical Physics, International Journal of Heat and Mass Transfer, International Journal of Thermophysics, Physical Chemistry Chemical Physics, Journal of Physics D: Applied Physics, Journal of Physics: Condensed Matter, Chemical Physics Letters, Journal of Molecular Liquids, International Journal of Thermal Sciences, Aerospace Science and Engineering, Semiconductor Science and Technology, Langmuir, ASME IMECE.
- **Member of advisory panel** for Journal of Physics D: Applied Physics.
- **NSF panelist.**

PUBLICATIONS:

Journal Papers (* indicates corresponding author)

1. Jesus Gutierrez Plascencia, Eric Bird, and **Zhi Liang***, "*Thermal and mass transfer resistance at a liquid-gas interface of an evaporating droplet: A molecular dynamics study*", ***International Journal of Heat and Mass Transfer*** 192, 122867 (2022).

2. Eric Bird, and **Zhi Liang***, "Nanobubble capillary force between parallel plates", ***Physics of Fluids*** 34, 013301 (2022).

3. Eric Bird, Jesus Gutierrez Plascencia, Pawel Keblinski, and **Zhi Liang***, "Molecular simulation of steady-state evaporation and condensation of water in air", ***International Journal of Heat and Mass Transfer*** 184, 122285 (2022).

4. Eric Bird, Eric Smith, and **Zhi Liang***, "Coalescence characteristics of bulk nanobubbles in water: A molecular dynamics study coupled with theoretical analysis", ***Physical Review Fluids*** 6, 093604 (2021).

5. Eric Bird, Jun Zhou, and **Zhi Liang***, "Coalescence speed of two equal-sized nanobubbles", ***Physics of Fluids*** 32, 123304 (2020) **Featured article**.

6. Eric Bird, and **Zhi Liang***, "Maximum evaporation flux of molecular fluids from a planar liquid surface", ***Physical Review E*** 102, 043102 (2020).

7. Eric Bird, Jesus Gutierrez Plascencia, and **Zhi Liang***, "Thermal transport across the interface between liquid n-dodecane and its own vapor: A molecular dynamics study", ***Journal of Chemical Physics***, 152, 184701 (2020).

8. Eric Bird and **Zhi Liang***, "Transport phenomena in the Knudsen layer near an evaporating surface", ***Physical Review E*** 100, 043108 (2019).

9. James Gonzalez, Josue Ortega, **Zhi Liang***, "Prediction of thermal conductance at liquid-gas interfaces using molecular dynamics simulations", ***International Journal of Heat and Mass Transfer*** 126, 1183 (2018).

10. **Zhi Liang*** and Ming Hu, "Tutorial: Determination of thermal boundary resistance by molecular dynamics simulations", ***Journal of Applied Physics*** 123, 191101 (2018).

11. **Zhi Liang***, Anirban Chandra, Eric Bird, and Pawel Keblinski, "A molecular dynamics study of transient evaporation and condensation", ***International Journal of Heat and Mass Transfer*** 149, 119152 (2020).

12. **Zhi Liang*** and Pawel Keblinski, "Molecular simulation of steady-state evaporation and condensation in the presence of a non-condensable gas", ***Journal of Chemical Physics***, 148, 064708 (2018).

13. **Zhi Liang***, Thierry Biben and Pawel Keblinski, "Molecular simulation of steady-state evaporation and condensation: validity of the Schrage relationships" ***International Journal of Heat and Mass Transfer*** 114, 105 (2017).

14. **Zhi Liang***, Thomas E. Wilson and Pawel Keblinski, "Phonon interference in crystalline and amorphous confined nanoscopic films" ***Journal of Applied Physics*** 121, 075303 (2017).

15. **Zhi Liang*** and Pawel Keblinski, "Sound attenuation in amorphous silica at frequencies near the Boson peak" ***Physical Review B*** 93, 054205 (2016).

16. Raunak Bardia, **Zhi Liang**, Pawel Keblinski, and Mario F. Trujillo, "Continuum and molecular dynamics simulation of nano-droplets collision" ***Physical Review E*** 93, 053104 (2016).

17. **Zhi Liang*** and Pawel Keblinski, "Coalescence-induced jumping of nanoscale droplets on super-hydrophobic surfaces" ***Applied Physics Letters*** 107, 143105 (2015).

18. **Zhi Liang**, Ankit Jain, Alan McGaughey, and Pawel Keblinski, "Molecular simulations and lattice dynamics determination of Stillinger-Weber GaN thermal conductivity" ***Journal of Applied Physics*** 118, 125104 (2015).

19. **Zhi Liang*** and Pawel Keblinski, "Slip length crossover on a graphene surface" ***Journal of Chemical Physics*** 142, 134701 (2015).

20. **Zhi Liang***, Kiran Sasikumar and Pawel Keblinski, "Thermal transport across substrate-thin film interface: effect of film thickness and surface roughness" ***Physical Review Letters*** 113, 065901 (2014).

21. **Zhi Liang*** and Pawel Keblinski, "Finite size effects on molecular dynamics interfacial thermal-resistance predictions" ***Physical Review B*** 90, 075411 (2014).

22. **Zhi Liang*** and Pawel Keblinski, "Parametric studies of the thermal and momentum accommodation of monoatomic and diatomic gases on solid surfaces" ***International Journal of Heat and Mass Transfer*** 78, 161 (2014).

23. **Zhi Liang***, William Evans and Pawel Keblinski, "Thermal resistance at an interface between a crystal and its melt" ***Journal of Chemical Physics*** 141, 014706 (2014).

24. **Zhi Liang**, Kiran Sasikumar and Pawel Keblinski, "Liquid phase stability under an extreme temperature gradient" ***Physical Review Letters*** 111, 225701 (2013).

25. **Zhi Liang***, William Evans, Tapan Desai and Pawel Keblinski, "Improvement of heat transfer efficiency at solid-gas interfaces by self-assembled monolayers" ***Applied Physics Letters*** 102, 061907 (2013).

26. **Zhi Liang***, William Evans, and Pawel Keblinski, "Equilibrium and nonequilibrium molecular dynamics simulations of thermal conductance at solid-gas interfaces" ***Physical Review E*** 87, 022119 (2013).

27. **Zhi Liang** and Hai-Lung Tsai, "A method to generate pressure gradients for molecular simulation of pressure-driven flows in nanochannels" ***Microfluidics and Nanofluidics*** 13, 289 (2012).

28. **Zhi Liang** and Hai-Lung Tsai, "Reduction of Solid-Solid Thermal Boundary Resistance by Inserting an Interlayer**,"** ***International Journal of Heat and Mass Transfer*** 55, 2999 (2012).

29. **Zhi Liang** and Hai-Lung Tsai, "Effect of Thin Film Confined between Two Dissimilar Solids on Interfacial Thermal Resistance," ***Journal of Physics: Condensed Matter*** 23, 495303 (2011).

30. **Zhi Liang** and Hai-Lung Tsai, "Thermal Conductivity of Interfacial Layers in Nanofluids," ***Physical Review E*** 83, 041602 (2011).

31. **Zhi Liang** and Hai-Lung Tsai, "Effect of Molecular Film Thickness on Thermal Conduction across Solid–Film Interfaces," ***Physical Review E*** 83, 061603 (2011).

32. **Zhi Liang** and Hai-Lung Tsai, "Prediction of the Transport Properties of a Polyatomic Gas," ***Fluid Phase Equilibria*** 293, 196 (2010).

33. **Zhi Liang** and Hai-Lung Tsai, "Calculation of Thermophysical Properties of CO_2 Gas Using an Ab Initio Potential Model," ***Molecular Physics*** 108, 1285 (2010).

34. **Zhi Liang** and Hai-Lung Tsai, "The Vibrational Contribution to the Thermal Conductivity of a Polyatomic Fluid," ***Molecular Physics*** 108, 1707 (2010).

35. **Zhi Liang** and Hai-Lung Tsai, "Molecular Dynamics Simulations of Self-diffusion Coefficient and Thermal Conductivity of Methane at Low and Moderate Densities," ***Fluid Phase Equilibria*** 297, 40 (2010).

36. **Zhi Liang** and Hai-Lung Tsai, "Determination of Vibrational Energy Levels and Transition Dipole Moments of CO_2 Molecules by Density Functional Theory," ***Journal of Molecular Spectroscopy*** 252**,** 108 (2008).

Other journal papers as a contributing author

37. Anirban Chandra, **Zhi Liang**, Assad Oberai, Onkar Sahni, and Pawel Keblinski, "On the applicability of continuum scale models for ultrafast nanoscale liquid-vapor phase change" ***International Journal of Multiphase Flow*** 135, 103508 (2021).

38. Jihui Nie, Anirban Chandra, **Zhi Liang**, and Pawel Keblinski, "Mass accommodation at a high-velocity water liquid-vapor interface" ***Journal of Chemical Physics*** 150, 154705 (2019).

39. Jihui Nie, Raghavan Ranganathan, **Zhi Liang**, and Pawel Keblinski, "Structural vs. compositional disorder in thermal conductivity reduction of SiGe alloys" ***Journal of Applied Physics*** 122, 045104 (2017).

40. Kiran Sasikumar, **Zhi Liang**, David G. Cahill and Pawel Keblinski, "Curvature induced phase stability of an intensely heated Lennard-Jones liquid – a molecular dynamics approach" ***Journal of Chemical Physics*** 140, 234506 (2014).

41. Cheng-Hsiang Lin, **Zhi Liang**, Jun Zhou and Hai-Lung Tsai, "Radical species generation and their lifetime extension by a femtosecond and nanosecond dual-laser system," ***Applied Physics A*** 116, 119 (2014).

42. Cheng-Hsiang Lin, **Zhi Liang**, Jun Zhou and Hai-Lung Tsai, "Femtosecond and nanosecond dual–laser optical emission spectroscopy of gas mixtures," ***Applied Spectroscopy*** 68, 222 (2014).

43. Yukun Han, **Zhi Liang**, Huilai Sun, Hai Xiao and Hai-Lung Tsai, "Nanostructured Substrate with Nanoparticles Fabricated by Femtosecond Laser for Surface Enhanced Raman Scattering," ***Applied Physics A*** 102, 415 (2011).

Conference papers/presentations

1. Eric Bird and **Zhi Liang**, "Nanobubble capillary force between parallel plates", American Physical Society March Meeting, March 2022, Virtual Conference.

2. Jesus Gutierrez Plascencia and **Zhi Liang**, "Temperature jump across the liquid-gas interface of an evaporating nanodroplet: a molecular dynamics study", ASME IMECE, November 2021, Virtual Conference.

3. Eric Bird and **Zhi Liang**, "Coalescence characteristics of bulk nanobubbles in water: A molecular dynamics study coupled with theoretical analysis", ASME IMECE, November 2021, Virtual Conference.

4. **Zhi Liang**, "Maximum evaporation flux of molecular fluids from a planar liquid surface", Materials Research Society Spring Meeting & Exhibit, April 2021, Virtual Conference.

5. Eric Bird and **Zhi Liang**, "Coalescence speed of two equal-sized nanobubbles", American Physical Society March Meeting, March 2021, Virtual Conference.

6. Eric Bird, Jesus Gutierrez Plascencia, and **Zhi Liang**, "Thermal transport across the interface between liquid n-dodecane and its own vapor: A molecular dynamics study", ASME IMECE, November 2020, Virtual Conference.

7. Eric Bird and **Zhi Liang**, "Prediction of thermal conductance at liquid-gas interfaces using molecular dynamics simulations", The 2nd Pacific Rim Thermal Engineering Conference, Dec. 2019, Maui, HI.

8. Eric Bird and **Zhi Liang**, "Prediction of thermal conductance at liquid-gas interfaces using molecular dynamics simulations", ASME IMECE, November 2019, Salt Lake City, UT.

9. James Gonzalez and **Zhi Liang**, "Prediction of thermal conductance at liquid-gas interfaces using molecular dynamics simulations", Materials Research Society Spring Meeting & Exhibit, April 2019, Phoenix, AZ.

10. **Zhi Liang** and Pawel Keblinski, "Molecular simulation of steady-state evaporation and condensation in the presence of a non-condensable gas" 2018 ASME International Mechanical Engineering Congress and Exposition (IMECE), November 2018, Pittsburgh, PA.

11. **Zhi Liang** and Pawel Keblinski, "Molecular simulation of steady-state evaporation and condensation: validity of the Schrage relationships", 2017 ASME International Mechanical Engineering Congress and Exposition (IMECE), November 2017, Tampa, FL.

12. **Zhi Liang** and Pawel Keblinski, "Sound attenuation in amorphous silica at frequencies near the Boson peak", Materials Research Society Spring Meeting & Exhibit, April 2017, Phoenix, AZ.

13. **Zhi Liang** and Pawel Keblinski, "Coalescence-induced jumping of nanoscale droplets on super-hydrophobic surfaces", American Physical Society March Meeting, March 2016, Baltimore.

14. **Zhi Liang**, Kiran Sasikumar, and Pawel Keblinski, "Thickness Dependence of Kapitza Resistance at a Substrate-Thin Film Interface: Effect of Phonon Scattering at the Thin Film Surface", Materials Research Society Spring Meeting & Exhibit, April 2015, San Francisco.

15. **Zhi Liang**, and Pawel Keblinski, "Molecular dynamics simulations of coalescence of liquid droplets on hydrophobic surfaces", Materials Research Society Spring Meeting & Exhibit, April 2015, San Francisco.

16. **Zhi Liang**, William Evans and Pawel Keblinski, "Improvement of Heat Transfer Efficiency at Solid-gas Interfaces by Self-assembled Monolayers", Materials Research Society Spring Meeting & Exhibit, April 2013, San Francisco.

17. **Zhi Liang** and Hai-Lung Tsai, "Effect of Interlayer between Semiconductors on Interfacial Thermal Transport." ASME 2012 3rd Micro/Nanoscale Heat and Mass Transfer International Conference, March 2012: MNHMT2012-75273, Atlanta.

18. **Zhi Liang** and Hai-Lung Tsai, "Ab Initio Calculations of Infrared Absorption Cross Sections of CO_2 Gas." 2008 ASME International Mechanical Engineering Congress and Exposition, November 2008: IMECE2008-67776, Boston.

19. **Zhi Liang** and Hai-Lung Tsai, "Ab Initio Calculations of Vibrational Energy Levels and Transition Dipole Moments of CO_2 molecules." 2008 ASME International Mechanical Engineering Congress and Exposition, November 2008: IMECE2008-677765, Boston. (**HP best paper award**)

20. **Zhi Liang** and Hai-Lung Tsai, "A Study of Laser-Gas Interactions by Ab Initio Method," Intelligent Systems Center Research Symposium, Rolla, Missouri University of Science and Technology, April 2008.

21. **Zhi Liang** and Hai-Lung Tsai, Poster titled "Thin Film Coating at Room Temperature and in Open Atmosphere by Using Multiple Lasers" at the third annual Intelligent Systems Center poster presentation, November 2007, University of Missouri Rolla.

22. **Zhi Liang** and Hai-Lung Tsai "Thin Film Coating at Room Temperature and in Open Atmosphere by Using Multiple Lasers," at the Intelligent Systems Center Research Symposium, April 2007, University of Missouri Rolla.