updated: 7/24

Curriculum Vitae: Chad McKell

ABOUT

Position	Ph.D. Candidate, UC San Diego
Affiliation	Center for Visual Computing
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Research — My research covers mathematical modeling and numerical simulation of physical systems, with an emphasis on differential geometry and wave dynamics. Current projects include geometric boundary modeling for wave field simulation; non-spherical harmonics for acoustic wave simulation, capture, and rendering; and variational principles for elastic wave simulation in physical and biological structures. Past projects include underwater acoustic sensing and optical standing-wave trapping.

EDUCATION

9/19–	**University of California San Diego**, Ph.D. in Computer Music Dissertation: *Geometric Boundary Modeling for Wave Field Simulation.* Advisors: Albert Chern and Miller Puckette.
9/16–10/17	**University of Edinburgh**, M.S. in Acoustics and Music Technology
8/09–12/15	**Wake Forest University**, M.S. in Physics
6/02–8/09	**Brigham Young University**, B.S. in Biophysics

EMPLOYMENT

3/24–	**University of California San Diego**, Teaching Assistant in Computer Science
6/23–2/24	**Meta, Reality Labs Research**, Research Scientist Intern/Student Researcher
8/21–3/22	**Meta, Reality Labs Research**, Research Intern/Student Researcher
9/19–6/23	**University of California San Diego**, Teaching Assistant/Researcher in Music
7/18–7/19	**Applied Research in Acoustics**, R&D Scientist
5/18–5/18	**Moog Music**, Freelance Audio Software Developer
4/17–9/17	**Lofelt (acquired by Meta in 2022)**, Freelance Acoustics Researcher
10/14–8/16	**J.P. Morgan/Neovest**, Consulting Software Development Engineer in Test
8/12–12/12	**University of North Carolina School of the Arts**, Adjunct Instructor of Physics
9/09–9/11	**Wake Forest University**, Teaching Assistant in Physics
9/08–6/09	**Brigham Young University**, Tutorial Lab Assistant in Physics
8/07–3/09	**Brigham Young University**, Research Assistant in Philosophy

RESEARCH ACTIVITIES

9/19– **University of California San Diego**, Ph.D. Student (Computational Physics)
La Jolla, California. Research topics: *computational physics, numerical simulation, differential geometry.* Dissertation summary: developed mathematical and computational methods for handling geometric boundaries in wave field simulations. Committee members: Albert Chern (co-chair), Miller Puckette (co-chair), Melvin Leok, Shahrokh Yadegari, Stefan Bilbao (Univ. of Edinburgh), and Sebastian Prepeliță (Meta).

RESEARCH ACTIVITIES CONT.

6/23–2/24	**Meta, Reality Labs Research**, Research Scientist Intern/Researcher (Acoustics) Redmond, Washington / remote. Research topics: *computational acoustics, numerical simulation, parallel computing.* Research summary: Built custom numerical simulation software using finite-difference methods in C++/CUDA for applications in virtual and augmented reality. Supervisor: Sebastian Prepeliță. Team Lead: Ravish Mehra.
8/21–3/22	**Meta, Reality Labs Research**, Research Intern/Researcher (Acoustics) La Jolla, California. Research description: see above.
7/18–7/19	**Applied Research in Acoustics**, R&D Scientist (Acoustics) Culpeper, Virginia. Research topics: *underwater acoustic sensing, acoustic beamforming.* Research summary: developed physics-based signal processing algorithms for object detection and classification in naval sonar systems. Team Lead: Jonathan Botts.
1/17–8/17	**University of Edinburgh**, Master's Student (Acoustics) Edinburgh, Scotland. Research topics: *computational acoustics, elastodynamics, numerical simulation.* Research summary: developed numerical simulations of structural acoustic vibrations for commercial haptic devices. My thesis was partially funded by Lofelt, a Berlin-based haptic feedback company acquired by Meta in 2022. Advisor: Stefan Bilbao.
1/10–9/13	**Wake Forest University**, Master's Student (Optics) Winston-Salem, North Carolina. Research topics: *optical trapping, laser beam characterization, fluid dynamics.* Research summary: modeled, simulated, and fabricated standing-wave Bessel beam optical traps. Advisor: Keith Bonin.
8/07–8/09	**Brigham Young University**, Undergraduate Student (Biophysics) Provo, Utah. Research topics: *structural biology, scanning probe microscopy.* Research summary: investigated the effect of anesthetics on lipid bilayer structures using atomic force microscopy. Advisor: David Busath.

TEACHING EXPERIENCE

As Instructor

UNCSA

SCI 1100	General Physics. Fall 2012 (1 term).

As TA

UCSD

CSE 270	Discrete Differential Geometry. Fall 2024 (1 term) – *upcoming.*
CSE 291	Physics Simulation. Spring 2024 (1 term).
MUS 5	Sound in Time. Spring 2020 (1 term).
MUS 6	Electronic Music. Fall 2020 (1 term).
MUS 15	Popular Music: David Bowie. Winter 2021 (1 term).
MUS 15	Popular Music: Video Game Music. Winter 2020 (1 term).
MUS 171	Computer Music I. Winter 2022 (1 term).
MUS 172	Computer Music II. 2021–2022 (2 terms).

WFU

PHY 113	General Physics I (Mechanics). 2009–2011 (4 terms).
PHY 114	General Physics II (E&M). Fall 2010 (1 term).

TEACHING EXPERIENCE CONT.

As Tutor

BYU

PHSCS 105	General Physics 1 (Mechanics). 2008–2009 (2 terms).
PHSCS 106	General Physics 2 (E&M). Winter 2009 (1 term).
PHSCS 121	Principles of Physics 1 (Mechanics). 2008–2009 (2 terms).
PHSCS 123	Principles of Physics 2 (Waves/Thermo). W/Sp 2009 (2 terms).
PHSCS 220	Principles of Physics 3 (E&M). W/Sp 2009 (2 terms)

SELECTED PH.D. COURSEWORK

CSE 167	Computer Graphics I (Jürgen Schulze)
CSE 274	Discrete Differential Geometry (Albert Chern)
CSE 299	Differential Geometry Research (Albert Chern)
MUS 206	Deep Learning for Music Generation (Shlomo Dubnov)
MUS 206	Computational Acoustic Modeling (Tamara Smyth)
MUS 270A	Digital Audio Processing (Tamara Smyth)
MUS 270B	Analysis of Musical Sound (Miller Puckette)
MUS 270C	Compositional Algorithms (Miller Puckette)

PUBLICATIONS

Manuscripts in Progress

(1) **C. McKell**, M. Nabizadeh, S. Wang, and A. Chern, "Wave simulations in infinite spacetime".

Simulating wave propagation on an infinite domain has been a long-standing computational challenge. Conventional approaches to this problem only produce wave simulations on a small subset of the infinite domain. Using the fact that wave propagation on an infinite Minkowski spacetime is equivalent to wave propagation on a bounded Minkowski spacetime under a Kelvin-like transformation, we simulate wave propagation on the entire infinite domain using a finite discretization of the bounded domain with no additional loss of accuracy from the transformation.

(2) **C. McKell**, *Geometric Boundary Modeling for Wave Field Simulation*, Ph.D. Dissertation, University of California San Diego. Defense planned for Fall 2024. Advisors: Albert Chern and Miller Puckette.

This work presents novel geometric methods for handling open exterior boundaries in wave field simulations. First, I discuss extensions to the reflectionless discrete perfectly matched layer for the wave and Helmholtz equations. Then, I demonstrate that the conformal invariance of the wave equation under a Kelvin transform in Minkowski spacetime allows one to convert an infinite domain problem into a bounded domain problem that can be solved using standard numerical methods with no additional loss of accuracy introduced by the transform. I conclude by discussing parallel computing strategies for the geometric boundary models, applications in architectural acoustics and binaural audio, and future work in obstacle boundary flattening.

Journal Articles

(3) **C. McKell** and K. Bonin, "Optical corral using a standing-wave Bessel beam," *Journal of the Optical Society of America B*, Vol. 35, No. 8, 1910–1920, 2018.

PUBLICATIONS CONT.

Conference Proceedings

(4) **C. McKell**, "Sonification of optically-ordered Brownian motion," In Proceedings of the International Computer Music Conference (ICMC), Utrecht, Netherlands, September 2016.

Master's Theses

(5) **C. McKell**, *Real-Time Physical Modeling for Haptic Feedback Rendering*, Master's Thesis, University of Edinburgh, Acoustics and Audio Group, 2017. Advisor: Stefan Bilbao.

(6) **C. McKell**, *Confinement and Tracking of Brownian Particles in a Bessel Beam Standing Wave*, Master's Thesis, Wake Forest University, Department of Physics, 2015. Advisor: Keith Bonin.

Technical Reports

(7) **C. McKell**, H. Conley, and D. Busath, "AFM study of structural changes in supported planar DPPC bilayers containing general anesthetic isoflurane," Brigham Young University, Paper 827, 2010.