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Chad McKell

ABOUT

Position	Ph.D. Candidate, UC San Diego
Affiliations	Center for Visual Computing, Department of Music
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Research — My research covers mathematical modeling and numerical simulation of physical systems. I am especially interested in differential geometry and its applications in computational acoustics, computer graphics, and biophysics. Current projects include boundary modeling for wave simulations; sound source modeling for computer animation; and physical simulation of musical instruments and the human cochlea.

Teaching — Recent courses: computer graphics, physical simulation, discrete differential geometry

EDUCATION

9/19– **University of California San Diego**, Ph.D. in Computer Music
GPA: 4.0. Dissertation: *Geometric Boundary Modeling for Wave Simulations.*
Advisors: Albert Chern (CSE) and Miller Puckette (Music).

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

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

RESEARCH ACTIVITIES

9/19– **University of California San Diego**, Ph.D. Student (Acoustics/Computer Graphics)
La Jolla, California. Research topics: *computational acoustics, differential geometry, numerical simulation.* Dissertation summary: develop differential geometric methods for modeling boundaries in scalar wave 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.

8/21–3/22	**Meta, Reality Labs Research**, Research Intern/Student Researcher (Acoustics) La Jolla, California. Research topics: *binaural audio, numerical simulation, parallel programming, discrete complex analysis*. Research summary: conducted computational acoustics research for virtual and augmented reality devices. Supervisor: Sebastian Prepeliță. Team Lead: Ravish Mehra.
7/18–7/19	**Applied Research in Acoustics**, R&D Scientist (Acoustics) Culpeper, Virginia. Research topics: *underwater acoustics, matched filtering, sparse estimation, beamforming*. Research summary: developed physics-based signal processing algorithms for naval sonar systems. Team Lead: Jonathan Botts.
1/17–8/17	**University of Edinburgh**, Master's Student (Acoustics) Edinburgh, Scotland. Research topics: *speech acoustics, elastodynamics, numerical simulation*. Thesis summary: developed physics-based numerical simulations of structural vibrations for haptic feedback 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 characterization, fluid dynamics*. Thesis summary: implemented transverse nanoparticle tracking in surface-isolated laser 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: studied the effect of anesthetics on lipid bilayer structure using atomic force microscopy. Advisor: David Busath.

TEACHING EXPERIENCE

As Instructor

UNCSA

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

As TA

UCSD

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)

PH.D. COURSEWORK

CSE 167	Computer Graphics I (Jürgen Schulze)
CSE 169	Computer Animation—*audit* (Steve Rotenberg)
CSE 274	Discrete Differential Geometry (Albert Chern)
CSE 291	Physical Simulation—*audit* (Chern/Rotenberg)
CSE 299	Differential Geometry Research (Albert Chern)
MUS 206	Spatialization (Shahrokh Yadegari)
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)
MUS 270D	Advanced Projects in Computer Music (Puckette/Smyth)
MUS 298	Virtual Acoustics Research (Puckette/Smyth/Dubnov)
MUS 298	Differential Geometry Research (Miller Puckette)

PUBLICATIONS

Manuscripts in Progress

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

> *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 Simulations*, Ph.D. Dissertation, University of California San Diego, Department of Music. Defense planned for Spring 2024. (Advisors: Albert Chern, Miller Puckette).

> *I introduce a differential geometric framework for handling boundaries arising from infinite spacetime domains and curved obstacles. I show that the scalar wave equation is conformally invariant under Kelvin transformations in Minkowski spacetime while the difficulties associated with these boundaries are not. I use this fact to transform infinite domain problems into bounded domain problems and curved obstacle boundaries into flat boundaries. The transformed problems can then be solved using standard numerical methods. Compared to conventional approaches for solving these boundary problems, my framework achieves higher efficiency without losing any numerical accuracy.*

PUBLICATIONS CONT.

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.

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.