# Curriculum Vitae: Chad McKell

## ABOUT

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| 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 acoustic systems. Current projects include boundary modeling for acoustic wave simulation, modal sound synthesis, and fluid-solid interaction simulation. I am especially interested in applications of acoustic simulation in audio technology and hearing science.

## EDUCATION

9/19–      **University of California San Diego**, Ph.D. in Music (Computational Acoustics)
GPA: 4.0. Dissertation: *Kelvin Transformations for Acoustic Wave Simulation.*
Advisors: Albert Chern and Miller Puckette.

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| 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

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|---|---|
| 9/19– | **University of California San Diego**, Teaching Assistant/Researcher in Music |
| 6/23– | **Meta, Reality Labs Research**, Research Scientist Intern in Acoustics |
| 8/21–3/22 | **Meta, Reality Labs Research**, Research Intern/Student Researcher in Acoustics |
| 7/18–7/19 | **Applied Research in Acoustics**, R&D Scientist in Acoustics |
| 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 (Acoustics)
La Jolla, California. Research topics: *computational acoustics, differential geometry.*
Dissertation summary: develop geometric boundary models for acoustic wave simulation.
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–          **Meta, Reality Labs Research**, Research Scientist Intern (Acoustics)
Redmond, Washington. Research topics: *binaural audio, numerical simulation, parallel programming, discrete complex analysis.* Research summary: develop computational acoustics simulations for virtual and augmented reality devices. 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 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 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: 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**
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
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| 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

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|---|---|
| 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 Simulation*, 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.