

updated: 9/24

# Curriculum Vitae: Chad McKell

## ABOUT

Position	Research Scientist
Company	Meta, Reality Labs Research (via Sigma Connectivity)
Address	10301 Willows Road NE, Redmond, WA 98052
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Research	My research spans mathematical modeling and numerical simulation of physical systems with an emphasis on differential geometry and wave motion. I am especially interested in applications of physics simulation in music technology and auditory biophysics. Current projects include geometric boundary modeling for wave simulation; non-spherical harmonics for acoustic wave simulation, capture, and rendering; and variational principles for elastic wave simulation. Past projects include underwater acoustic sensing and optical standing-wave trapping.
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## EDUCATION

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

## EMPLOYMENT

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

## RESEARCH ACTIVITIES

9/24–	<b>Meta, Reality Labs Research (via Sigma Connectivity)</b> , Research Scientist Redmond, Washington. Research topics: <i>computational physics, numerical simulation, parallel computing</i> . Research summary: Run COMSOL multiphysics simulations and build custom high-performance acoustic simulation software in C++/CUDA for applications in virtual and augmented reality. Supervisor: Sebastian Prepelitã. Team Lead: Ravish Mehra.
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## RESEARCH ACTIVITIES CONT.

- 9/19–  
La Jolla, California. **University of California San Diego**, Ph.D. Student  
Research topics: *computational physics, numerical simulation, differential geometry*. Dissertation summary: developed mathematical and computational methods for handling geometric boundaries in wave simulations. Committee members: Albert Chern (co-chair), Miller Puckette (co-chair), Melvin Leok, Shahrokh Yadegari, Stefan Bilbao (Univ. of Edinburgh), and Sebastian Prepelitã (Meta).
- 6/23–2/24  
Redmond, Washington. **Meta, Reality Labs Research**, Research Scientist Intern  
Research topics: *computational acoustics, numerical simulation, parallel computing*. Research summary: Built custom acoustic simulation software using finite-difference methods in C++/CUDA for applications in virtual and augmented reality. Supervisor: Sebastian Prepelitã. Team Lead: Ravish Mehra.
- 8/21–3/22  
La Jolla, California. **Meta, Reality Labs Research**, Research Intern  
Research description: see above.
- 7/18–7/19  
Culpeper, Virginia. **Applied Research in Acoustics**, R&D Scientist  
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  
Edinburgh, Scotland. **University of Edinburgh**, Master’s Student  
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  
Winston-Salem, North Carolina. **Wake Forest University**, Master’s Student  
Research topics: *optical trapping, laser beam characterization, fluid dynamics*. Research summary: simulated and fabricated standing-wave optical traps for Brownian particle tracking. Advisor: Keith Bonin.
- 8/07–8/09  
Provo, Utah. **Brigham Young University**, Undergraduate Student  
Research topics: *structural biology, scanning probe microscopy*. Research summary: investigated the physical 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 291  
MUS 5  
MUS 6  
MUS 15  
MUS 15

Physics Simulation. Spring 2024 (1 term).  
Sound in Time. Spring 2020 (1 term).  
Electronic Music. Fall 2020 (1 term).  
Popular Music: David Bowie. Winter 2021 (1 term).  
Popular Music: Video Game Music. Winter 2020 (1 term).

## TEACHING EXPERIENCE CONT.

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).

### 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)

## 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 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 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.