

# Zachary M. Raines

CONDENSED MATTER THEORY RESEARCHER

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## Education

### University of Maryland, College Park

PH.D. IN PHYSICS

*College Park, Maryland*

*Aug. 2011 - Aug. 2019*

### Boston University

B.A. IN PHYSICS

*Boston, Massachusetts*

*Aug. 2007- May 2011*

## Research Interests

**Superconductivity** Unconventional superconductivity and collective modes of superconductors

**Non-equilibrium systems** Novel methods of utilizing and enhancing superconductivity out of equilibrium

**Light-matter hybridization** Cavity polaritons and collective mode hybridization

**Quantum spin systems** Fermionization of spin problems

**Weyl and Dirac systems** Phenomena in linearly dispersing electronic media

## Research Experience

### University of Maryland, College Park, Condensed Matter Theory Center (CMTC) and Joint Quantum Institute (JQI)

*College Park, Maryland*

GRADUATE RESEARCH ASSISTANT

*2012 - 2019*

- Theoretical investigation of the interplay between ordered states in high temperature superconductors as well the effects of coupling photonic cavities to superconductor under Prof. Victor Galitski.

### University of Maryland, College Park, Institute for Physical Science and Technology (IPST)

*College Park, Maryland*

GRADUATE RESEARCH ASSISTANT

*2012*

- Theoretical investigation of the Local Molecular Field theory of water under Prof. John Weeks.

### Boston University

*Boston, Massachusetts*

INDEPENDENT WORK FOR DISTINCTION

*2011*

- Detailed simulation work to determine the properties of the light collection subsystem for the NEDM experiment. Work includes determination of total transmission, form of the experimental signal, and simulation of noise in the experiment.

### Boston University Physics Department, Medium Energy Group

*Boston, Massachusetts*

RESEARCH ASSISTANT

*2009-2011*

- Data acquisition and simulation in development of the light collection subsystem for the Neutron Electric Dipole Moment experiment at the Spallation Neutron Source at Oak Ridge National Laboratory under Prof. B. Lee Roberts and Prof. James Miller.

### University of Pennsylvania HEP Instrumentation Group

*Philadelphia, Pennsylvania*

RESEARCH ASSISTANT

*2008*

- Research and prototyping work under Richard van Berg in the development of more sensitive positron emission tomography(PET) technology.

### Lankenau Institute for Medical Research (LIMR)

*Wynnewood, Pennsylvania*

RESEARCH ASSISTANT

*2006*

- Administrative and research work under Dr. Michael Ezekowitz in connection with clinical trials of a new anticoagulant.

## Honors & Awards

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2011	<b>University Fellowship</b> , University of Maryland	College Park, Maryland
2011	<b>Physics Alumni Award</b> , Boston University	Boston, Massachusetts
2011	<b>Summa cum Laude</b> , Boston University	Boston, Massachusetts
2010	<b>Inductee</b> , Phi Beta Kappa Society, Epsilon of Massachusetts	Boston, Massachusetts
2010	<b>Member</b> , Boston University Metcalf Award selection committee	Boston, Massachusetts
2010	<b>Harold Case Scholarship for Academic Excellence</b> , Boston University College of Arts and Sciences	Boston, Massachusetts

## Papers & Publications

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### Cavity Higgs-Polaritons

ZACHARY M. RAINES, ANDREW A. ALLOCCA, MOHAMMAD HAFEZI, AND VICTOR M. GALITSKI 2019  
• [arXiv:1905.03377](#)

### Manifestations of spin-orbit coupling in a cuprate superconductor

ANDREW A. ALLOCCA, ZACHARY M. RAINES, AND VICTOR M. GALITSKI 2018  
• [arXiv:1812.07949](#)

### Phase pinning and interlayer effects on competing orders in cuprates

ZACHARY M. RAINES 2018  
• [arXiv:1809.06879](#)

### Cavity superconductor-polaritons

ANDREW A. ALLOCCA, ZACHARY M. RAINES, JONATHAN B. CURTIS, AND VICTOR M. GALITSKI 2018  
• Editor's Suggestion *in* Physical Review B **99** (2): 020504(R)

### Cavity Quantum Eliashberg Enhancement of Superconductivity

JONATHAN B. CURTIS, ZACHARY M. RAINES, ANDREW A. ALLOCCA, MOHAMMAD HAFEZI, AND VICTOR M. GALITSKI 2019  
• Physical Review Letters **122** (16): 167002

### Enriched axial anomaly in Weyl materials

ZACHARY M. RAINES AND VICTOR M. GALITSKI 2017  
• Physical Review B **96** (16): 161115(R)

### Hybridization of Higgs Modes in a Bond-Density-Wave State in Cuprates

ZACHARY M. RAINES, VALENTIN G. STANEV, AND VICTOR M. GALITSKI 2015  
• Physical Review B **92** (18): 184511

### Enhancement of Superconductivity via Periodic Modulation in a Three-Dimensional Model of Cuprates

ZACHARY M. RAINES, VALENTIN G. STANEV, AND VICTOR M. GALITSKI 2015  
• Physical Review B **91** (18): 184506

## Presented Works

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### American Physical Society (APS), March Meeting

Los Angeles, California

ROLE OF INTERLAYER COUPLING ON THE COMPETITION BETWEEN BOND-DENSITY-WAVE ORDER AND SUPERCONDUCTIVITY 2018

### Ultrafast Dynamics and Metastability

Georgetown, Washington, DC

ENHANCEMENT OF SUPERCONDUCTIVITY VIA PERIODIC MODULATION IN A THREE-DIMENSIONAL MODEL OF CUPRATES 2017

**American Physical Society (APS), March Meeting**

ELECTROMAGNETIC RESPONSE OF A WEYL SEMIMETAL WITH COEXISTING DENSITY WAVES

*New Orleans, Louisiana*

2017

**American Physical Society (APS), March Meeting**

HYBRIDIZATION OF HIGGS MODES IN A BOND-DENSITY-WAVE STATE IN CUPRATES

*Baltimore, Maryland*

2016

**University of Maryland, Condensed Matter Theory Center Fall Symposium**

ENHANCEMENT OF SUPERCONDUCTIVITY VIA PERIODIC MODULATION IN A THREE-DIMENSIONAL MODEL OF CUPRATES

*College Park, Maryland*

2015

**American Physical Society (APS), March Meeting**

ENHANCEMENT OF SUPERCONDUCTIVITY IN A THREE-DIMENSIONAL HOTSPOT MODEL OF COMPETING ORDERS IN THE CUPRATES

*San Antonio, Texas*

2015

**American Physical Society (APS), March Meeting**

THE CASIMIR EFFECT ACROSS A SUPERCONDUCTING TRANSITION

*Denver, Colorado*

2014

**Candidacy Talk**

INDUCED SUPERCONDUCTIVITY IN A MAGNETIC HALF SPACE-QUASI TWO DIMENSIONAL METAL HETEROSTRUCTURE

*College Park, Maryland*

2013