

Ultrafast spectroscopy and control of correlated quantum materials

By

Bryan T. Fichera

B.S., University of Pennsylvania (2017)

Submitted to the Department of Physics
in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

at the

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

May 2024

©Bryan Thomas Fichera, 2024. All rights reserved.

The author hereby grants to MIT a nonexclusive, worldwide, irrevocable, royalty-free license to exercise any and all rights under copyright, including to reproduce, preserve, distribute and publicly display copies of the thesis, or release the thesis under an open-access license.

Authored by: Bryan T. Fichera
Department of Physics
May?, 2024

Certified by: Nuh Gedik
Donner Professor of Physics, Thesis supervisor

Accepted by: ?
? Professor of ?
? Chair of ?

Abstract

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetur adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetur adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

Contents

Contents	3
List of Figures	3
List of Tables	4
1 Ultrafast spectroscopy	5
2 Ultrafast control	7
3 Second harmonic generation: theory	9
4 Second harmonic generation: practical	11
5 Second harmonic generation as a probe of broken mirror symmetry in 1T-TaS₂	13
6 Light-induced reorientation transition in the antiferromagnetic semiconductor CaMn₂Bi₂	15
7 Amplitude-mode electromagnon in the XXZ chain CuBr₂	17
8 Concluding remarks	19
Bibliography	21

List of Figure

List of Table

CHAPTER 1

Ultrafast spectroscopy

CHAPTER 2

Ultrafast control

CHAPTER 3

Second harmonic generation: theory

CHAPTER 4

Second harmonic generation: practical

CHAPTER 5

Second harmonic generation as a probe of broken mirror symmetry in 1*T*-TaS₂

CHAPTER 6

Light-induced reorientation transition in the antiferromagnetic semiconductor CaMn_2Bi_2

CHAPTER 7

Amplitude-mode electromagnon in the XXZ chain CuBr_2

CHAPTER 8

Concluding remarks

Bibliography

bibliography.bib