PhD Application Presentation Script

Slide 1: Title Slide

“Good [morning/afternoon], my name is Zhongqi Xiu, and I am here to present my application for the PhD program in [Program Name]/introduce myself . My research interests lie in quantum optics, particularly cavity quantum electrodynamics (QED) and single-photon emitters in two-dimensional materials. Today, I will walk you through my academic background, research experience, and future research plans, which I believe align closely with the objectives of your department.”

Slide 2: Outline

“Here is the outline of my presentation. First, I will introduce myself briefly. Then, I will delve into my research experience and results, highlighting key projects I have worked on. Finally, I will conclude with my doctoral research plan and the directions I would like to pursue during my PhD.”

Slide 3: Personal Introduction

Let me begin with a brief introduction about myself. I will completed my undergraduate studies in Optics and Optical Engineering next year, with a GPA of 87 out of 100. My academic journey has been strengthened by rigorous coursework in Quantum Mechanics, Advanced Photonics, and Engineering Optics, in which I consistently performed well. These courses have equipped me with a strong foundation in both theoretical and experimental aspects of quantum optics.
My primary research interests include cavity QED, quantum memory based on cold atoms, and the optical characteristics of two-dimensional materials, especially transition metal dichalcogenides.

Slide 4: Resume and Honors

“Throughout my academic journey, I have received several honors and awards, including the Outstanding Student Scholarship and the Endeavor Scholarship, which placed me in the top 5% of my cohort. I also had the opportunity to participate in the Chung-Yao Chao Talent Program, a highly selective scholarship program.

I have co-authored a paper titled *Approaching the Intrinsic Purity of Single-Photon Emitters in Atomically Thin Semiconductors*, however the paper now is still undereview, we submit it to ACS Nano. Additionally, I have gained valuable teaching experience as a Teaching Assistant for the Optics B course in Fall 2023, under the supervision of Professor Zheng Xi. This role involved supporting a class of 58 junior students, contributing to their understanding of optics concepts.

Finally, my Skills in programming languages include Python, C/C++, and HTML/CSS. I am proficient in various frameworks and software tools such as Anaconda, MATLAB, Solidworks, LabVIEW, Keil, and COMSOL, which are critical for conducting simulations, data analysis, and experimental setups in my research work.

Overall, these experiences have equipped me with a strong foundation in both theoretical knowledge and practical applications, preparing me to contribute meaningfully to the research group and academic community

Slide 5-6: Research Experience

In terms of research, I have had the privilege of working in two major areas. First, I was involved in single-atom trapping using movable optical lattices, where I successfully demonstrated high-precision atomic position control through fluorescence detection. Additionally, I explored combining cavity cooling with feedback cooling to push temperature limits, verifying this through theoretical calculations. More recently, I have been working on single-photon emitters in atomically thin semiconductors, specifically WSe2. In this project, I conducted polarization-resolved photoluminescence measurements and time-correlated single-photon counting to improve the understanding of defect-bound excitonic emissions. This research is critical to improving the purity and reliability of single-photon sources, which are key to the development of quantum light technologies.

Slide 7: Project 1: Single Atom Trapping

Introduction to group and the aim
First, I led ... you can see the graph of the system and the optical paths served for the system.
Then, as a fiber cavity group, we use the fiber to create cavity in vacuum environment, so it's important for the fiber to remove the original cladding and have polymide coating on the fiber. What I do is build up a system to treat the fiber automatically and test the parameters like temperature of PI, baking time, coating velocity... Finally the system I bulit became a patent of my mentor.
What's more, about the electrical setup, I designed and tested....
After setting up those optical and electrical paths, then we tried to load the atoms to our cavity.

Slide 8-9: Project 2: Single-Photon Emission in 2D Materials

In 2024 summer, I came to Rice University to further explore the quantum optics and optical imaging in surface area. This project is proposed to... and here is our group
We have already finished this work, however we are still writing paper and the calculation results from the co-workers are under progress so now the paper is not submitted.
So let me introduce you about the work: at first... In this work...
Then there is a picture of our sample and the sample is ... the c to e plots are the Photonluminensence spectrum of the SPE spot and we seperate it out using the fitting method. f to h is g2 and then we will improve that.
First we use dif polarization lights to excite and

collect the signal with fliters.
We found that...
Then we also used monolayer and bilayer WSe2 then we got better counts in g2, that mean the better spots in bilayer
What I do in this work is from sample preparation, spectrum and g2 measurement, peak analyze to the figure drawing and paper writing, we supposed to submit it to acs nano or nature communication as we got very good purity and very low g2
In the process, the most difficult part is the sample preparation and data analyze, as the sample is small and I only study to operate about 1 months. As for the data analyze, the spectrum is broad as there are multiple emission, what I should do is seperate the SPE peak from others and get its parameters like position/linewidth/peak intensity...
But finally we did everything well and you can also find the slides which shows my process from new to the area to the success SPE finder.

Slide 10: Other projects

Also, dispite the three projects supervised by mentors, I did some projects by myself and those also helped me a lot about learning knowledge.
First in my freshman year, I took a course in which the professor gave each of us a paper to refer and improve the work. I chose the paper related to ai 4 sci

and the paper built a neural network to find the physical concepts and gain the parameters in the formula. I used matlab to do that and found some datasets in our library for the planke black body formula.You can see the work on my homepage in detail.
Second is the simulation of light field. When I first met with COMSOL, I took Optics that semester and I joined the fiber cavity group. So I try to write some review of FP cavity and do some simulation to explore the charateristics of the cavity.
Third is about the course Compute Physics, after learning the Ising model and machine learning, I try to follow a science paper in which it discovered the exotic particles from the huge dataset in the collapsing machine. So I want to use the dataset buliding up deep learning model and see what else can be found.
About the RoboGame,...
In 2024, I also do some simulation of vectorial polarized beam: linear, circular, with phase and so on.

Slide 11: Future Research Plan

In the context of this lab, my primary research objective is to apply my background in quantum optics to advance two-photon fluorescence microscopy, particularly for in vivo neurovascular studies. One specific direction is to develop ultrafast fluorescence imaging techniques, which could capture data more rapidly and with higher precision than current methods. The goal is to extend the imaging capacity beyond conventional limits, allowing us to better track dynamic processes, such as blood flow, with unprecedented speed and resolution.

Additionally, I am excited to explore the integration of AI-driven data analysis techniques to improve label-free imaging and fluorescence microscopy. By developing or enhancing computational algorithms, such as matrix factorization for fluorescence data, my aim is to improve the detection and interpretation of neural activity and vascular structures, allowing for more accurate and efficient data processing. This work would contribute to the lab's focus on multimodal imaging while pushing the boundaries of what current imaging technologies can achieve in both clinical and basic neuroscience contexts.

Slide 12: Conclusion

“In conclusion, my research background in cavity QED, single-photon emitters, and quantum optics has prepared me to contribute meaningfully to your program. I believe that my skills, combined with the resources and mentorship available in your department, will allow me to tackle cutting-edge challenges in quantum information science. I am eager to contribute to ongoing research while exploring new directions in this rapidly evolving field.

Thank you for your time. I would be happy to answer any questions you may have.”

Slide 13: Questions

About the Research Plan: "Thank you for the opportunity to present today. I’m particularly interested in understanding more about the lab’s direction as it’s relatively new. Regarding my proposed research plan, how do you envision the lab’s early work being structured? For instance, what steps should we prioritize in terms of starting experiments, and what is the current status or outlook on securing funding to support these projects?"

Mentor Style: "I’d also like to get a sense of your mentorship style. What is your typical approach to working with PhD students? Specifically, how do you manage work-life balance within the lab, such as expected working hours, and how frequently do you hold meetings to track progress?"

Expectations for PhD Students: "In addition, I'd love to hear more about your expectations for PhD students. How do you typically support your students in reaching key milestones throughout the program, and what do you prioritize in helping them successfully complete their degrees on time?"

About the Program Application: "Lastly, as I continue with the formal application process, could you provide any insights into which specific PhD program I should be applying through? Also, should I mention your name or the lab's in my application to ensure it aligns with the right research group?"