Huay Din
(+1) 703-344-1847
huaydin0@gmail.com

To whom this may concern, November 30, 2022

Greetings,

My name is Huay Din and I aspire to pursue a life in research in medical physics. As a modern student in the sciences, I have come to terms that precise descriptions of reality often lack closed form analytic solutions, and often these events are probabilistic in nature. But not all hope is lost! In this world of massively available data, I find great interest in using mathematical models, machine learning, and other statistical tools to obtain insights into systems of interest. In my time as an undergraduate, I've worked on a wide range of mathematical modeling projects, starting from modeling a first-principles music system, to a generalized magnetic resonance imaging fingerprinting model, to examining the dual-energy CT-Xray, and to working as a research assistant in the Griswold Lab at University Hospitals. From these experiences, I have only become increasingly fascinated by the potential for rich mathematical and physical investigations for medical imaging systems, and in the Biomedical PhD program at Stanford, I wish to continue pushing the boundaries of models versus reality.

So what's behind my fascination with mathematical models, and what's with my focus on using these models for medical imaging? From my own experience, who would have thought that because music and physics share the same symmetry that their structure could be understood through statistical mechanics? Or that you could obtain images through magnets? through shooting gamma rays? To me, mathematical modeling is the perfect mix of imagination and science. To me, medical physics and imaging is a research area that's abundant in questions, rich in potential for innovation, and is substantially impactful. A larger goal I would like to dedicate myself to is working towards accessible healthcare through the use of medical imaging.

I have had considerable research experience with mathematical modeling, data analysis, and machine learning methods – most particularly with neural networks. To outline my work so far, I've worked with Jesse Berezovsky in the physics department at Case Western Reserve University (CWRU) to build a system of music from first principles – the laws of thermodynamics. More specifically, we studied emergent critical behavior in a musical phase transition via statistical mechanical methods (Kibble Zurek Mechanisms, XY Model, Metropolis Monte Carlo-Langevian equations) to simulate a system of music. To me, the project was a powerful demonstration of the universality of mathematical models, although music and condensed matter systems are so obviously different on the macroscopic level, through sharing the same symmetry group class, we were able to invoke the same physics! Additionally, the interdisciplinary nature of the work was also significant in my development of becoming an effective scientific communicator, with outcomes of this particular project involving a paper still currently under review in PLOS One, building software and hardware for our physics based compositions, and holding a concert in collaboration with the Cleveland Institute of Music. For my work here, I was also granted the James C. Wyant Award from the CWRU physics department for research accomplishments outside the senior project.

After my work with Jesse Berezovsky, I conducted research with Julia Dobrosotskaya in the math department at CWRU to investigate the inverse problem of recovering partial fourier data for the specific purpose of Magnetic Resonance Fingerprinting (MRF) via the framework of neural networks. This is where I became introduced to medical physics, and I haven't looked back. MRF itself is a wonderful

example of how a simple but astute observation (exchanging spatial undersampling with time undersampling) can profoundly change our understanding of MRI and information retention. Along with the technical skills I acquired (Fourier transforms, linear algebra/real analysis, sampling theorems, designing neural networks), this work also demonstrated to me the need for sound mathematical formulism and reasoning to 1) avoid biased models, and 2) grant greater insights into a more general problem (here it would be pushing the boundaries of deep learning (DL) for lossy fourier data recovery and lossy medical fourier data recovery). We plan on publishing a paper in the coming months. Since my work with Professor Dobrosotskaya, I have continued to work in the optimization of medical imaging techniques in CT-Xray with Adam Wang at Stanford and a more targeted clinical DL use with Yong Chen at CWRU/University Hospitals.

So why Stanford? And why the Biomedical PhD program at RSL? Through the American Association of Physicists in Medicine Summer Research Fellowship, I was able to work with Adam Wang at Stanford last summer. At RSL, I participated in their REU program, where I had the wonderful opportunity to learn about their research groups and meet the people in the department. If accepted into the Biomedical PhD program, I would love to continue working on model-based image reconstruction methods with a focus on Fourier based metrics for CT X-ray with Adam Wang. Another group I would be interested in working with is Jeremy Dahl's group on ultrasound and particularly low-cost 3D ultrasound. I would also be excited to continue working with Michael Moseley on diffusion MRF or pushing the limits of low-dose PET/MRF. In addition to the research at RSL, my own interdisciplinary work and experience in the Griswold Lab where we have our own mix of academics, clinicians, and Siemens industry people, I am familiar with working with a diverse group of professionals. Projects with collaboration are always immensely rewarding and I intend on continuing to engage those works. Another draw to Stanford is that through RSL's close proximity to their research hospital and the close connections that faculty have to industry, those collaborations are possible.

Outside of research, I am also actively involved in providing a platform for others to communicate. I am currently co-president of Math Club, where the club role is to facilitate and inspire student math presentations. In the last two years, I have directed our club's purpose to become a more general undergraduate representative group for the Math Department. Some highlights of my actions and initiatives are organizing a new math undergraduate colloquium series and providing a better undergraduate working space. Furthermore, this semester I founded an Association of Women in Mathematics chapter at CWRU. The aim of this club is to build a math circle of female mathematicians, where we hold discussions about our experiences in the field as mathematicians. What's more, I've been business manager for CWRU's Literary Magazine since my freshman year, where our aim is to collect creative works by the student body in all the colleges to then showcase in semesterly magazines. All these activities I've listed above have been towards building and strengthening the community around me. At Stanford, I would love to not only continue contributing to the scientific discussion and group, but to also begin building my own platform towards a broader audience.

Through my motivations and experiences, I believe I am well prepared to not only flourish in the Biomedical PhD program at Stanford, but to also contribute to the research community there.

Thank you for your time and consideration. Sincerely,

Huay Din