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Re: Mengyao Huang

Dear Quantum Computing Boot Camp Organizers:

It is a pleasure to recommend my former graduate student, Dr. Mengyao Huang, for admission to your Quantum Computing Boot Camp. Mengyao worked with me for three years for her PhD and graduated in December 2021 with an excellent record of academic and research accomplishments. Following graduation, she began a postdoc working with my group on two projects that are based in part on her PhD research. The first is to calculate two-body correlations with structure of light nuclei. The second is to solve an important problem in quantum field theory with quantum computers for the first time: calculate the critical coupling for the phase transition in 1+1 dimensional scalar field theory. Mengyal has accepted a verbal offer of a postdoc at LLNL and will begin that position when the formal offer is completed following a security screening process.

Since Mengyao is self-taught on quantum computing methods, this Quantum Computing Boot Camp will afford her the opportunity to become more broadly trained in QIS which is expected to be central to her new research position at LLNL. As I will further elaborate, I firmly believe Mengyao is an excellent candidate for the Quantum Computing Boot Camp, will work hard to have a valuable training experience and will bring greater credit to the field as a result of that experience.

Mengyao has a keen interest in understanding physics across diverse scales and to develop her skills working with forefront theoretical tools. To deepen her knowledge, she initiated a project in collaboration with our visiting Fulbright Scholar, Tobias Frederico, aimed at identifying cluster structure in light nuclei using many-body solutions from the *ab initio* no-core shell model. While this problem is a challenging low-energy nuclear theory problem, the techniques she developed can have much broader applications. In this project, Mengyao calculates moments of the 2-nucleon correlation functions in ^{4}He and ^{6}He from their ground state wave functions. She has developed a sequence of progressively more sophisticated (reduced number of assumptions) classical models using these moments for these 4-body and 6-body systems to detect whether the ^{4}He is a cluster within ^{6}He while leaving the two excess neutrons in a “halo” configuration. Indeed, she finds these models successfully describe her suite of calculated *ab initio* moments and support the interpretation of the quantum states as providing

evidence for emergent clustering in light nuclei. Mengyao has reported her results in her PhD thesis and has also polished a draft of two papers in which she is the lead author. She has provided these drafts to the co-authors and once she has their feedback, we expect she will finalize these papers and submit them for publication to Phys. Rev. C.

Mengyao played a major role in a recent Phys. Rev. D paper that solves an important non-perturbative problem in quantum field theory using classical computing techniques on supercomputers. This paper (J.P. Vary, **Mengyao Huang**, et al., Phys. Rev. D 105, 016020 (2022), arXiv: 2109.13372) applies discretized light cone quantization (DLCQ) to solve for the critical coupling of scalar φ^4 field theory in 1+1 dimensions. In this light-front Hamiltonian framework, she solves for the invariant mass spectra and light-front wave functions as a sparse matrix eigenvalue problem in momentum space and as a function of total light-front momentum K. At each finite value of K, she determines the coupling that produces a vanishing mass gap. Using a sequence of such vanishing mass gap couplings, Mengyao then extrapolates to the continuum limit (K to infinity) to determine the critical coupling. She also establishes the key signal of symmetry breaking by showing that the continuum limit is the same for the lowest eigenstates of both the even boson and odd boson sectors.

Mengyao took the lead among the three graduate students in this major project, derived the equations and wrote an efficient parallel code to solve this numerically challenging sparse matrix eigenvalue problem in double precision. She also led the students in the analysis that was essential to taking the continuum limit and assessing the uncertainties. Mengyao also played a lead role reading and interpreting the relevant literature. The outcome of this research is that we obtain a critical coupling that compares well with one recently published paper while disagreeing with another where both references use techniques independent of ours and independent of each other.

In order to investigate the use of quantum computers for Hamiltonian eigenvalue problems, she adopted the goal of solving for the critical coupling of the same field theory problem she had solved for her PhD thesis using classical supercomputers. Thus, the solution is now known but it will be very challenging to obtain that solution using present-day noisy quantum computers. Once it is solved with quantum computers, this will open a pathway to solving realistic Hamiltonian eigenvalue problems with future quantum computers. She has made rapid progress and has presented her initial results in a poster session at the April APS meeting in Minneapolis last week.

Mengyao is a talented physicist who learns quickly (as evident from her two diverse research projects for her PhD and her drive to learn and apply quantum computing since graduation), works very hard and accurately solves challenging problems using both formal analysis and precision numerical methods on advanced computers. Mengyao has a very broad skill

set including proficiency in mathematics and fluency in English. In addition, she has demonstrated independent creative thinking and she delivers excellent lectures. As a further measure of her talents and team spirit, she has assisted other students in our group on both theoretical and computational issues. For all these reasons, I would rate Mengyao as one of the top 5 graduate students out of 25 that I have mentored in my career. Note that several of my former students, with whom she compares favorably at comparable stages in their careers, now have tenured or tenure-track faculty positions in the US or abroad.

In summary, it is a pleasure to recommend Mengyao Huang for admission to the Quantum Computing Boot Camp. I am confident that, with her talents and skills, she will be successful in her career and will make major contributions to the field.

With kind regards,