SYRACUSE UNIVERSITY

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Dear Colleagues,

I am writing to you to nominate Bharath Sambasivam for the quantum computing bootcamp. I am extremely lucky to be Bharath's research advisor. I have witnessed first-hand and benefitted from his incredible dedication to research. He has split his research efforts in two main areas: applications of quantum computing to particle theory, and recently on the cosmology of conformal extensions of the standard model.

In his first paper, "*Quantum Algorithms for Open Lattice Field Theory*," Bharath helped us understand many crucial concepts surrounding certain types of quantum systems coupled to an external environment that are relevant for condensed matter physics, for systems at high density (such as neutron stars that are being experimentally probed by LIGO data), and for theories with "topological terms." All of these theories are difficult to study on standard classical machinery, due to a technical difficulty referred to as "the sign problem." This work is thus a good case study for models that will be amenable to simulation once quantum hardware is sufficiently well-developed.

Bharath's contributions helped to resolve many open questions:

- Is there a physical (not just mathematical) meaning to a generalized non-Hermitian effective hamiltonian? The answer is yes - for an arbitrary theory, we can "make sense" of the theory.
- A related question was then: Can one simulate on standardized quantum hardware such a theory? The answer is again: yes. Bharath was instrumental in constructing many possible mappings of different physical systems of interest to "quantum channels" which can be implemented on standardized quantum hardware.
- Are there *efficient* algorithms to implement these channels, and is there near term (noisy) hardware promise for their study? The answer here was more mixed. The problem itself is fantastic for near term study, with an expected resilience to noise in particular interesting corners of the parameter space. Simulating a system of a given size could be done efficiently. The downside

is an exponential cost required to simulate for long times. We did identify possible ways out of this that Bharath is now studying. These have to do with generalizing and modifying algorithms that were published by other authors as we were in the progress of our own work.

While not directly relevant for the boot camp, I can note that additionally, Bharath is exploring a class of models that may be relevant for new models of particle physics and cosmology that may have implications not just for collider physics, but potentially for gravitational waves created during the big bang. We are studying the dynamics of a particular type of phase transition that could generate a gravitational wave signal detectable by future proposed experiments. We have been studying the dynamical cosmology of the stabilized holographic dilaton with the aim of investigating alternatives to the equilibrium thermal phase transition. We have carefully worked out the cosmology with various mistunes of brane tensions in the unstabilized case, which turns out to closely parallel the stabilized phenomenology with the addition of "slow-roll" parameters analogous to those in inflationary cosmology. This work will be published in the coming weeks on the arxiv. This dual nature of his research brings diversity of background to those attending the bootcamp.

In short, Bharath Sambasivam is a truly excellent researcher. He is certainly on par or better than the strongest students I have worked with. He is careful, methodical, and is also a skilled communicator of his work. He has given many internal talks and journal clubs. With his attendance at the quantum computing boot camp, he will continue to develop the skills he needs for his career.

Sincerely,

Jay Hubisz

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