Eesh Gupta

My goal as a physicist is to study how quantum computers can advance our understanding of the electronic structure and other many-body physics problems. To this end, I am interested in the interplay of quantum simulation and quantum information, which I hope to study as part of the QURIP program

My journey into quantum computing began with code contributions to the Qiskit Terra library, for which I later earned the Qiskit Advocate badge from IBM. Intent on studying more about the field, during my freshman year, I began research with Professor Stephen Schnetzer, a particle physicist turned quantum computing enthusiast. He first introduced me to the quantum simulation of small molecules but mentioned the lack of quantum computing faculty at Rutgers. Undeterred, I learned about developments in quantum chemistry, for example, the coupled-cluster method, and quantum algorithms such as the Variational Quantum Eigensolver (VQE). Through Professor Schnetzer's guidance, this early work culminated in an oral presentation to Professor Richard Remsing's chemical physics group. Their constructive criticism was crucial in refining my understanding of the Unitary Coupled-Cluster Singles and Doubles ansatz in VQE and shaping my future work on quantum noise.

Empowered by that experience, I received the Aresty Summer Science Research Fellowship, a program for rising sophomores seeking research experience. I continued research with Professor Schnetzer, where I assessed the Zero Noise Extrapolation (ZNE) in mitigating different forms of quantum errors in computing the hydrogen molecule's ground state energy. In particular, we independently devised the noise amplification technique, Fixed Identity Insertion Method, to produce noisy energies. Despite having little background in statistics, I quickly learned Monte Carlo error propagation, χ^2 testing, and Fischer statistic testing to compare polynomial fits and Richardson extrapolation. Moreover, I learned scientific computing and statistical modeling in Python. Most importantly, I learned from my Aresty poster presentation that developing, discussing, and presenting ideas are central to my undergraduate education. Alongside these research experiences, intermediate courses in classical mechanics, quantum physics, and electromagnetism solidified my interest in pursuing graduate studies in quantum computing and many-body physics.

At Princeton and IBM, I aspire to continue these adventures into quantum simulation and error mitigation. For example, my current project on designing a pulse simulator supporting noisy evolution requires a study of circuit quantum electrodynamics (cQED), a source of exciting research in the Houck Lab. In particular, I am fascinated by Professor Andrew Houck's work in cQED hyperbolic materials and their potential for simulation of interacting particles in curved space. The prospect of using photons traveling in different lattice arrangements of conducting planar waveguide resonators to study black hole physics and machine learning is exciting! Additionally, I am interested in extending the lab's work on optimization methods to VQE computations. Furthermore, I am taking a quantum computing course by Professor Schnetzer in Spring 2021 which would be useful for the IBMQ training. In fact, I am learning cQED through Dr. Zlatko Minev's lectures to Qiskit Global Summer School and Professor Houck's lectures to Princeton Summer School for Condensed Matter Physics (posted online). For these reasons, I believe QURIP is an ideal fit for my research interests and my previous experiences will enable me to be a successful student in your program.