Quantum computations of inflationary, higher dimensional, and dark energy cosmology

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The early universe, expansion rate of the universe, and dark energy were explored using both classical methods and quantum computing algorithms. The main program used for classical calculations was Mathematica, while the quantum computing program was IBM's open-source software, Qiskit. We mainly focused on the effects of dark energy on the universe and the overall expansion rate - beginning with the Friedmann equation, followed by the Starobinsky potential, and building up to the dark energy potential along with its respective Hamiltonian. The dark energy model and Hamiltonian were derived and studied using classical computers, and then referenced for the quantum computer calculations. We determined the classical computer was more accurate, whereas the quantum computer suffered when using higher matrice size and greater number of qubits (quantum bits). Lastly, we briefly touched on a similar dark energy theory known as quintessence - which differs from its companion in that it is time-varying whereas dark energy is typically a constant. We were able to successfully calculate a promising approximation for the value of dark energy (four dimensional lambda) and showed, by comparison, the quantum computer was less precise. The entirety of the research project was conducted remotely, under the supervision of Brookhaven National Laboratory's Computer Science Initiative. As a result of this internship, I have become familiar with a myriad of quantum cosmology theories including the most fascinating one explaining the need for higher dimensions in order to account for the tiny size of the dark energy we observe today. I am also able to add quantum computing to my repertoire of coding experience.