# Investigating the Use of Parallel Computing With Quantum Computers

Miller, Jesse (School: College Park High School)

Quantum computers are integral to progress in computational capability but are limited by decoherence. This research investigated characteristics of qubit decoherence in systems of parallel quantum computers and evaluated the extent to which parallel processing affects the efficiency and stability of the quantum system. Three different tests were run to characterize decoherence as a function of the number of computers run in parallel. The first experiment measured the dependence of the decay rate of a quantum system based on $T_1$ decoherence and the number of computers run in parallel. Testing showed that $T_1$ decoherence was only marginally affected by the use of multi-computer processing. The second test, a $T_2$ Hahn test, showed the effect of increasing the number of computers run in parallel on the overall decay of a qubit from an excited state. This test was conducted with up to eight computers run in parallel. As the number of computers run in parallel increased, the decay rate of the qubit decreased, with the maximum difference achieved when four computers were used. The benefit margin was much less for more than four computers run. The third test performed was a $T_2$ Ramsey test which investigated the resulting oscillations of the qubit after it failed to land in a perfect excited state. The use of parallel computing significantly decreased the $T_2$ Ramsey decoherence, with the greatest reduction achieved when three computers were run in parallel. Statistical tests indicated that the use of parallel computing led to a significant reduction in the decay rate for $T_2$ Hahn and $T_2$ Ramsey for all parallel circuits tested. The reduction of $T_1$ decoherence was less effective, requiring at least 4 computers run in parallel to be significant.

**Awards Won:**

The University of Texas at Dallas: Scholarship awards of $5,000 per year, renewable for up to four years