1147-20-896 **Jennifer R Fowler***, jennifer.fowler@lamar.edu. *The KAK Decomposition in Quantum Computation.*

In quantum computation, new states evolve from initial states under a series of unitary transformations. The set of all unitary transformations form a Lie group called the unitary group $U(2^n)$. Without loss of generality, we only consider those unitary transformations in $SU(2^n)$ the Lie group of unitary matrices with determinant one. Decomposing arbitrary unitary transformations into the product of simple quantum gates is crucial to understanding the design of a quantum computer. One method of such decomposition utilizes consecutive Cartan decompositions into the ± 1-eigenspaces $\mathfrak{k}$ and $\mathfrak{p}$ of an involutive automorphism θ of the Lie algebra $\mathfrak{su}_(2^n)$. The Cartan decomposition induces a decomposition on the group level $SU(2^n) = KAK$, where $H = exp(\mathfrak{a})$ for a maximal toral subalgebra $\mathfrak{a}$ of $\mathfrak{p}$. In this work, we use root space decomposition as a means to establish a basis for the sets $\mathfrak{k}$ and $\mathfrak{p}$ in the KAK decomposition. Once a basis is established, we can obtain a decomposition of any $U \in SU(2^n)$ into one qubit and controlled-not gates by exponentiating. (Received January 29, 2019)