BSc Defense by Johannes Wahl

Place: 915

Title: The Micromaser in Quantum Complexity Theory

Based on the state preparation problem for the micromaser, we investigate the characteristics of the computations the micromaser can perform. For this purpose, we utilize concepts from automata theory. We translate the physical state preparation problem into a language problem and study which automaton model can accept these newly defined languages. The classification process is split into three scenarios regarding which atomic states are allowed to be sent through the cavity. In the first case, only atoms in the ground or excited state are allowed. The second case extends the first one, by allowing every superposition of ground and excited state to be sent through. We prove that the languages in these two cases can both be accepted by a classical automaton of polynomial size. In the third and general case, entanglement between atoms is allowed, and every atom string can be sent through the cavity. For this case, the language is recognized by a quantum circuit and, consequently also by a quantum Turing machine. Additionally, for each of these settings, we investigated whether measuring the atoms after their interaction with the cavity field changes the required automaton. For all three cases, we prove that adding the possibility to measure the states of the atoms after the interaction does not change the classification result.