Cal Poly Physics Department

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**SymPy: Open-Source Symbolic Quantum Information Software**

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The simulation of quantum computers on classical computers is an important part of quantum information science. There is a need to create software tools that i) help newcomers to learn the field, ii) enable practitioners to design and simulate quantum circuits, iii) assist in the development of new algorithms and iv) provide an open-source foundation for further research in the field. Towards these ends we have created a package, in the open-source symbolic computation library SymPy, that simulates the quantum circuit model of quantum computation using standard Dirac notation.

This package builds on the extant powerful symbolic capabilities of SymPy to perform its simulations in a fully symbolic manner. As part of this work, we have extended SymPy to handle the Dirac notation in its most general and abstract form. This includes operators, states, inner/outer products, tensor products, commutators/anticommutators,

Building on this general foundation, we use object oriented design to abstract circuits as ordered collections of quantum gate and qubit objects. Gate objects can either be applied symbolically to the qubit objects or be represented as matrices in different bases. The package is also capable of performing standard quantum algorithms such as the quantum Fourier transform, Shors factoring algorithm and Grover's search algorithm. A variety of measurements types are also possible on qubits. In this talk we will describe the software through examples and outline how we are using the software in our research.