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## Time Optimal Quantum Computers

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The science of time optimisation has a long and illustrious history dating to the original investigations of Fermat in discovering the ray principle of optics and the brachistochrone; others such as Pontryagin followed with many applications in control theory, physics and engineering science. In this talk we will discuss how to apply the methods of time optimisation and variational calculus to derive unitary operators that are useful for quantum computation, in particular simple logic gates that can be used to process quantum information and perform basic computational tasks in a timely fashion.

We show how these can be used to form a universal set of gates and the connection between these ideas and other concepts such as the Bloch equation and Floquet theorem. Using some simple physical implementations, we show how some types of these time optimal quantum computations can be carried out in low dimensional spin systems.

These methods form much in common with the ideas of analog computation, involving a periodic signal to process the information instead of a digital/binary formalism, and we discuss how the implementation of these processes will require significant alteration in our understanding of quantum computing in order to approach the quantum speed limit.

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