

Nicholas Kurti science prize lecture

Friday 23 June at 14:00

Martin Wood lecture theatre

***Quantum Error Correction with Bosonic Qubits***

Dr Alexander Grimm

Experimental quantum physics has reached a degree of maturity that allows us to control individual quantum objects with high precision. We routinely encode bits of quantum information (qubits) into quantum two-level systems in a variety of implementations and explore their utility for emerging technologies such as quantum computers or quantum simulators. However, an important challenge in this exploration is that quantum two-level systems tend to be intrinsically fragile and suffer from errors that prevent further progress towards these quantum information processing applications. The field of quantum error correction (QEC) addresses this challenge by encoding effective qubits into more complex quantum systems. Unfortunately, the hardware overhead associated with standard approaches to QEC, based on coupling large numbers of two-level systems, is substantial.

In contrast, a so-called “bosonic” qubit, that is intrinsically protected against certain quantum errors, can be encoded into superpositions of a large number of microwave photons in a single nonlinear superconducting resonator. This type of qubit has the potential to significantly reduce the hardware complexity of QEC. In my talk, I will review some key concepts of quantum information processing and situate bosonic qubits within the larger field of QEC. Then, I will describe an example of this type of qubit, the “Schrödinger-cat” qubit, and discuss recent experimental demonstrations [1,2]. I will in particular focus on different ways in which the nonlinearity of Josephson junctions can be leveraged to create and stabilize the basis states of bosonic qubits.

References

[1] Mirrahimi, M. et al. New J. Phys. 16, 045014 (2014).

[2] Grimm, A. , Frattini N.E., et al. Nature 584, 205–209 (2020).

Tea, coffee and pastries will be served before the lecture from 13:30 at the Martin Wood foyer

*Host: Prof Robert Taylor*