Department of Physics
Condensed Matter Physics
Clarendon Laboratory, Parks Road, Oxford OX1 3PU

UNIVERSITY OF OXFORD

CONDENSED MATTER SEMINAR

Thursday 7 June at 2.15pm

"Quantum technology with artificial quantum spin circuits "

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Quantum technology receives considerable attention from the academic and commercial sector, as well as from the media. Realizing this second quantum revolution appears feasible, with superconducting quantum circuits being a leading candidate to implement quantum coherent devices ranging from quantum simulators, quantum sensing to quantum information processing. We report on such a superconducting anharmonic multi-level circuits coupled to a harmonic readout resonator.

The concentric qubit is a promising candidate to establish a site-selective passive direct z-coupling between neighbouring qubits, being a pending quest in the field of quantum processing. The planar qubit design is based on a concentric outer electrode, yielding qubit lifetimes and coherence times about 15 µs [1]. Due to the large loop size, the qubit architecture features a strongly increased magnetic dipole moment. It facilitates the emulation of the one-dimensional Fermi-Hubbard model by a double chain of concentric qubits [2].

The quantum Rabi model, describing the fundamental mechanism of light-matter interaction, is simulated by a driven qubit coupled to a quantized harmonic mode. In the ultra-strong coupling (USC) regime, where the effective coupling strength g is comparable to the energy ω of the bosonic mode, remarkable features in the system dynamics are revealed [3].

For sensing applications, analyzing weak microwave signals in the GHz regime is a challenging task if the signal level is very low and the photon energy widely undefined. A multi-level quantum system (qudit) allows deducing the unknown photon frequency and amplitude from the higher level AC Stark shifts [4].

[1] J. Braumueller, M. Sandberg, M. R. Vissers, A. Schneider, S. Schloer, L. Gruenhaupt, H. Rotzinger, M. Marthaler, A. Lukashenko, A. Dieter, A. V. Ustinov, M. Weides, and D. P. Pappas, Appl. Phys. Lett. 108, 032601 (2016)
[2] J.-M. Reiner, M. Marthaler, J. Braumüller, M. Weides, and G. Schön, Phys. Rev. A 94, 032338 (2016)
[3] J. Braumueller, M. Marthaler, A. Schneider, A. Stehli, H. Rotzinger, M. Weides, and A. V. Ustinov, Nature Communications 8, 779 (2017)
[4] Andre Schneider, Jochen Braumüller, Lingzhen Guo, Patrizia Stehle, Hannes Rotzinger, Michael Marthaler, Alexey V. Ustinov and Martin Weides, arXiv:1801.05144

Host: Dr Peter Leek

Audrey Wood Seminar Room, Clarendon Laboratory