Invited speaker

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Optically Driven Strongly Correlated Quantum Systems

Abstract

Recent experiments [1] indicate that selective optical driving of phonons may generate or enhance ordered phases in strongly correlated quantum materials. In this talk I will discuss toy-model quantum optically inspired schemes that may help explain and engineer such phenomena.

I will first describe a parametric cooling scheme, akin to laser cooling, for stacks of Josephson junctions which may model bilayer cuprates [2]. The scheme exploits a c-axis vibrational mode as a transducer making the Josephson plasma frequencies time-dependent. I will show how modulation at the difference frequency between the intra- and interbilayer plasmon substantially suppresses interbilayer phase fluctuations, responsible for switching c-axis transport from a superconducting to resistive state. Our calculations indicate that this may provide a viable mechanism for stabilizing non-equilibrium superconductivity. This may be possible even above the critical temperature, provided a finite pair density survives between the bilayers out of equilibrium.

I will then consider a driven one-dimensional fermionic Hubbard model in the strongly correlated limit [3]. I will show how driving may lead to enhanced fermion pairing thus taking the system from a metallic to a superconducting phase at zero temperature. I will also present results at finite temperature and discuss the prospect of observing driven superconductivity out-of-equilibrium in this system.

References

[1] M. Mitrano, A. Cantaluppi, D. Nicoletti, S. Kaiser, A. Perucchi, S. Lupi, P. Di Pietro, D. Pontiroli, M. Riccò, S. R. Clark, D. Jaksch & A. Cavalleri, doi:10.1038／nature16522, Nature (2016).

[2] S.J. Denny, S.R. Clark, Y. Laplace, A. Cavalleri and D. Jaksch, Phys. Rev. Lett. 114, 137001 (2015).

[3] J. Coulthard et al., in preparation (2016).

About the Author

Professor Dieter Jaksch is the Head of Atomic and Laser Physics at the University of Oxford. He obtained his PhD from the University of Innsbruck (Austria) in 1999 and moved as a University Lecturer and Fellow & Tutor in Keble College to the University of Oxford in 2003. He became a Reader in 2008 and Professor of Physics in 2010. Dieter Jaksch currently holds visiting Professor positions at the Centre for Quantum Technologies in Singapore and the Graduate School of Excellence Materials Science in Mainz. His research background is in strongly correlated ultracold quantum gases starting with a proposal for achieving a superfluid to Mott insulator transition with ultracold gases in 1998. This was followed by theoretical work that helped laying the foundations for the research fields of coherent quantum dynamics in strongly correlated ensembles of ultracold atoms and realizations of quantum information processors with neutral atoms. He has recently extended his research interests to include the study of coherent dynamics in optically driven condensed matter on ultrafast time scales and is a Principal Investigator on the ERC Synergy Grant Frontiers in Quantum Materials' Control.