Tata Institute of Fundamental Research
Survey No. 36/P, Gopanpally Village, Serilingampally, Ranga Reddy Dist., Hyderabad – 500 046

Webinar

Controlling Cavity-Mediated Superconductivity and Criticality by Engineering Quantum States of Light

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Recent success in coupling electrons in two-dimensional materials to the quantum electromagnetic field of optical cavities has opened up many exciting but yet unexplored avenues of quantum electrodynamics, among which one promising idea is to use the photons in the cavity to mediate pairing between electrons, inducing superconducting states with novel properties. An exciting prospect, that makes photons the more interesting mediator with respect to the phonons of the standard BCS paradigm, is to exploit state-of-the-art engineering of the quantum states of light to control superconductivity. A naturally emerging question, which remains still open, is whether one can enhance superconductivity by feeding the cavity with certain quantum states of the photons. This new playground for quantum many-body physics is at the same time exciting and theoretically challenging to describe, requiring us to develop new approaches merging quantum optics, condensed matter, and quantum-field-theory. We recently developed a non-equilibrium field-theory approach that allows to tackle this question. I will describe our current understanding of the problem focusing on how critical properties of the superconducting transitions can be manipulated by initialising the photons in non-thermal initial density matrices.

References:

[1] H. Gao, F. Schlawin, M. Buzzi, A. Cavalleri, and D. Jaksch, Phys. Rev. Lett. 125, 053602 (2020)
[2] Ahana Chakraborty and Francesco Piazza [Phys. Rev. Lett. 127, 177002 (2021)]
[3] Ahana Chakraborty and Francesco Piazza [To appear in arXiv]

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