Cavity Quantum Electrodynamics in Condensed Matter

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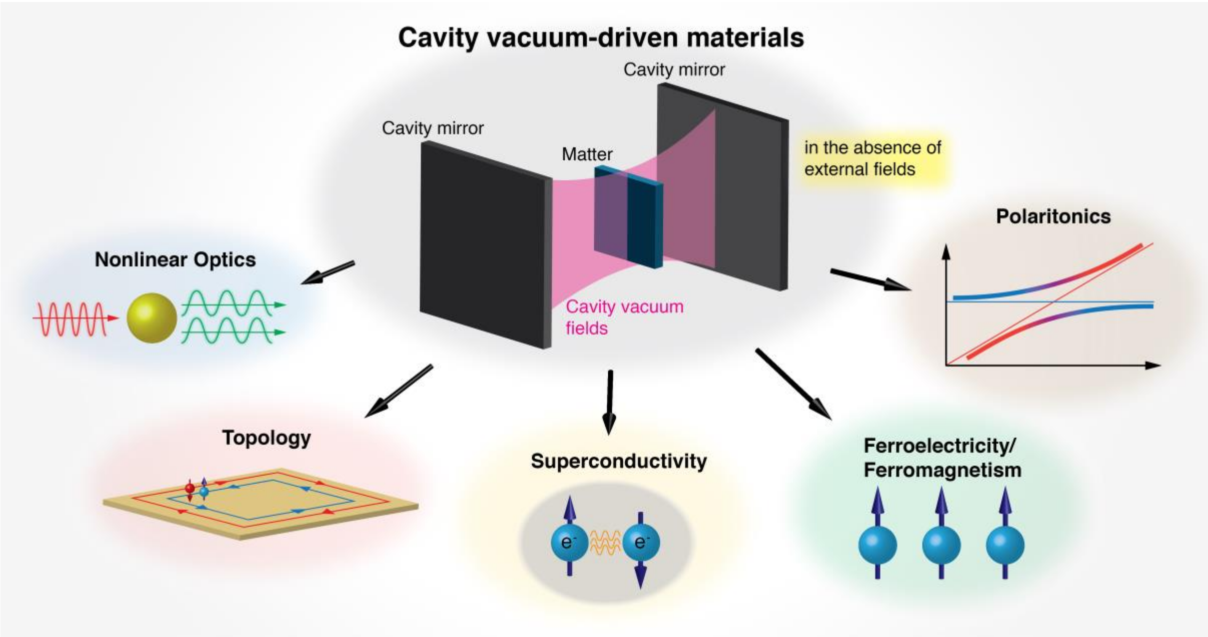
Recent experiments on materials systems in cavities have demonstrated that light and condensed matter can mix together, or hybridize, to an extreme degree, and previously uncharted regimes of light–matter interactions are currently being explored. The so-called ultrastrong coupling (USC) regime arises when the interaction energy becomes a significant fraction of the bare frequencies of light and matter [1]. Most intriguingly, when a material is ultrastrongly coupled with cavity-enhanced vacuum electromagnetic fields (or zero-point fields), its ground-state properties can be considerably modified. This nonperturbative virtual driving without any external field can lead to novel equilibrium phases with exotic properties. This talk will describe our recent studies of USC phenomena in various condensed matter systems in search of such vacuum-induced phases of matter, including Landau polaritons [2,3], exciton polaritons [4], spin–magnon [5,6], and magnon–magnon [7] systems. We take advantage of the quantum optics concept of Dicke cooperativity [8] — i.e., many-body enhancement of light–matter and matter–matter interaction — to explore new states and phenomena in condensed matter systems in the USC regime. These results provide quantum optical strategies for creating, controlling, and utilizing novel phases of matter enabled by the quantum vacuum.



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