Polaron Picture for the Quantum Rabi and related Models

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Abstract：

　　The quantum Rabi model (QRM)[1], as a most basic archetype to describe light-matter interaction, has recently attracted a renewed interest [2-7] due to mathematically remarkable achievement to prove its integrability and experimental breakthroughs in upgrading atom-cavity coupling order where a full QRM is needed as well as requests on understanding its physics. However, the challenge to formulate exact wavefunction in a general case still hinders physical exploration of the QRM despite that its energy spectra are exactly available[2,4].

　　In the this talk, we present a polaron picture to explore the physics involved in the QRM. We present a novel competition diagram of the polaron and anitpolaron in the QRM by using a variational wavefunction which facilitates to extract physics in entire parameter regimes with high accuracy[8]. A hidden scaling relation is found for bipolaron states in strong coupling regime and an overweighted antipolaron is revealed for quadpolaron states identified in intermediate and weak coupling regimes. An experimentally- measurable parameter is proposed to distinguish the quantum states of bipolaron, quadpolaron and their changeover. In addition, we will also mention briefly the overweighted anti-polaron in the biased case [9] and the scaling behavior of the QRM[10,11]. Some improvements are also shown by frequency-renormalized multipolaron expansion[12]. We present an application of the polaron picture to the two-photon Rabi model, in which a two-photon process is involved. It is found that the polaron picture also works well [13] and the physics involved is shown. Some perspective is also given.

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