Asymptotic behavior of eigenvalues of the Quantum Rabi Model

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The QRM (Quantum Rabi Model) describes a two level quantum system interacting with a single mode radiation. It plays a fundamental role in quantum optics, quantum information and condensed matter physics. A lot of research works has focused on the approximation of its eigenvalues. In particular, the RWA (Rotating Wave Approximation) was proposed in [1] and the GRWA (Generalized Rotating Wave Approximation) was proposed in [2].

In this talk we investigate the validity of the RWA by means of the quasi-degenerate perturbation theory and we give a mathematical justification of the GRWA on the basis of the eigenvalue estimates from [3]. We also consider the asymptotic behavior of large eigenvalues for the QRM with a bias, which is a basic model of the experimental circuit quantum dynamics. The talk is based on joint work with A. Boutet de Monvel and M. Charif.

[1] E. T. Jaynes, F. W. Cummings, Comparison of quantum and semiclassical radiation theories with application to the beam maser, *Proc. IEEE* 51 (1963), 89–109

[2] E. K. Irish, Generalized Rotating-Wave Approximation for Arbitrary Large Coupling, *Phys. Rev. Lett.* 99, 173601 (2007)

[3] A. Boutet de Monvel, L. Zielinski, Oscillatory Behavior of Large Eigenvalues in Quantum Rabi Models, *International Mathematics Research Notices* 2021(7), 5155–5213.