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Theory of Non-Markovian dynamics in resonance fluorescence spectra ABHISHEK KUMAR, SIGURDUR I. ERLINGSSON, School of Science and Engineering, Reykjavik University, Iceland, BILL COISH, Department of Physics, McGill University, Canada — Robust quantum coherence is an important prerequisite for any system that may be used to perform quantum information processing tasks. For systems that can be probed optically, the resonance fluorescence spectrum may provide indirect evidence of coherence times when supplemented with an appropriate model of the decay process. A common approach is to assume a Markovian system, resulting in exponential decay of correlation functions and Lorentzian features in the associated spectrum. For physical systems with strongly history-dependent (non-Markovian) dynamics, there is currently no satisfying systematic theoretical approach to establish the associated spectrum. We present a detailed theoretical method to obtain the resonance fluorescence spectrum for a general system undergoing non-Markovian dynamics. This procedure can be used to systematically account for features in resonance-fluorescence spectra due to genuine non-Markovian dynamics. Our approach is based on a Nakajima-Zwanzig generalised master equation for the dynamics of the reduced density matrix. We apply this theory to study the resonance fluorescence in the non-Markovian dynamics of a three level lambda system, relevant to recent experiments on heavy-hole spin dynamics in a quantum dot.

Abhishek Kumar
School of Science and Engineering, Reykjavik University, Iceland

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